DR-LOG

Dynamics and Sustainability in International Logistics and Supply Chain Management

Proceedings of the 6th German-Russian Logistics and SCM Workshop DR-LOG 2011 in Bremen

Dmitry Ivanov
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DEUTSCH-RUSSISCHE WISSENSCHAFTSGEMEINSCHAFT LOGISTIK DR-LOG

Wie die 1.-5. Deutsch-Russische Logistik-Workshops DR-LOG in 2006 (St. Petersburg), 2007 (Chemnitz), 2008 (Moskau), 2009 (Cottbus) und 2010 (St. Petersburg) zeigten, ist der wissenschaftliche Kenntnisstand auf dem Gebiet der Logistik in deutscher und russischer Forschungslandschaft durch ein hohes Niveau und zahlreiche Überschneidungspunkte gekennzeichnet. Heutzutage ist DR-LOG eine der bedeutendsten deutsch-russischen Veranstaltungen und die Nummer 1 auf dem Gebiet der Logistik. Besonders hervorzuheben ist hier die Bildung der deutsch-russischen Wissenschaftsgemeinschaft Logistik DR-LOG.

Im DR-LOG Rahmen hat sich die wissenschaftliche Zusammenarbeit in der Logistik und Supply Chain Management entwickelt. Die gastwissenschaftlichen Aufenthalte von Hochschullehrern, Doktoranden, und Studenten aufgrund der Förderung seitens des Deutschen Akademischen Austauschdienstes (DAAD) und die bilateralen Vereinbarungen zwischen den Hochschulen wurden verstärkt. Darüber hinaus fand eine Reihe von themenspezifischen, praxisorientierten Seminaren statt. Gemeinsame Arbeiten von bilateralen Forschungsgruppen wurden in führenden internationalen Zeitschriften veröffentlicht. Insgesamt lassen sich eine weitgehende Entwicklung der deutsch-russischen wissenschaftlichen Zusammenarbeit in der Logistik und im Supply Chain Management, eine Zunahme der Teilnehmer dieser Zusammenarbeit, der Wechselbeziehungen zwischen den Teilnehmern und der Dynamik dieser Wechselbeziehungen feststellen. An den bisherigen DR-LOG Workshops nahmen mehr als 200 Wissenschaftler von mehr al 150 Universitäten, Fachhochschulen, Instituten der Fraunhofer Gesellschaft und Russischer Akademie für Wissenschaft sowie die Industrievertreter teil.

Am VI. DR-LOG an der Universität Bremen nehmen viele führende Wissenschaftler und Industrievertreter beider Länder teil. Neben dem spannenden Vortragsprogramm liegt ein besonderer Focus auf den gemeinsamen Projekten in den Bereichen der Aus- und Weiterbildung, der Forschungsaktivitäten sowie der Logistikpraxis.

Themen DR-LOG‘2011:

- ✓ Wissenschaftliche Probleme in der Logistik und SCM
- ✓ Informationstechnologien in der Logistik und SCM
- ✓ Bilaterale Aus- und Weiterbildung in der Logistik und SCM
- ✓ Bilaterale anwendungsnahen Projekte mit der Industrie
- ✓ Forschungsmobilität

Wir danken der Deutschen Forschungsgemeinschaft (DFG) für die finanzielle Unterstützung der Veranstaltung. Ein hohes Niveau des Workshops und das große Interesse seitens zahlreicher prominenter Fachleute nährt die Hoffnung, dass diese Serie von DR-LOG auch in der Zukunft erfolgreich fortgesetzt werden kann.

H. Kopfer, H.-D. Haasis, J. Schönberger, D. Ivanov

РОССИЙСКО-ГЕРМАНСКОЕ НАУЧНОЕ ЛОГИСТИЧЕСКОЕ СООБЩЕСТВО DR-LOG

Логистика как междисциплинарная отрасль экономики, науки и образования является одним из ключевых направлений развития Российско-Германского сотрудничества. Вполне закономерно, что именно логистика тем направлением, по которому уже пятый год подряд (2006 г. – Санкт-Петербург, 2007 – Хемниц, 2008 – Москва, 2009 – Коттбус, 2010 – Санкт-Петербург) при участии крупнейших ведущих научно-исследовательских и образовательных учреждений и профессиональных объединений обеих стран проходит конференция, объединяющая ведущих ученых и практиков логистики и управления цепями поставок из России и Германии. На сегодняшний день DR-LOG является одной из наиболее представительных конференций в российско-немецком сотрудничестве и ведущей конференцией в российско-немецкой логистике. Уникальным является созданное Российско-Немецкое Научное Логистическое Сообщество.

Можно констатировать несколько важных аспектов развития российско-немецкого научного сотрудничества в DR-LOG. Продолжена систематическая работа по научным стажировкам ученых, аспирантов и студентов по линии Немецкой службы академических обменов (DAAD), а также двухсторонним соглашениям между ВУЗами. Проведен ряд практических семинаров по логистике и управлению цепями поставок в Санкт-Петерубрге, Москве и Хемнице. Совместные работы немецко-российских рабочих групп опубликованы в ряде ведущих мировых журналов. В предыдущих конференциях DR-LOG приняли участие более 200 ученых России и Германии из более чем 150 университетов и научно-исследовательских институтов общества Фраунгофера и Российской Академии Наук, а также представители практики логистики и SCM.

Шестая конференция DR-LOG’11 организована в университете г. Бремен с финансовой поддержкой Немецкого Исследовательского Сообщества (DFG) Наряду с насыщенной и интересной программой докладов особое внимание будет уделено обсуждению совместных проектов, в частности:

- Вопросы подготовки профессионалов в логистике,
- Проведение совместных научно-исследовательских проектов,
- Информационные технологии в логистике и SCM,
- Реализация совместных логистических проектов на практике,
- Академическая международная мобильность.

Ежегодная Германо-Российская конференция о логистике является специально организованным форумом, предназначенным для создания единой площадки общения немецких и российских специалистов в области логистики. Высокий уровень конференции и большой интерес к нему позволяют надеяться, что данный ряд конференций будет успешно продолжен и в будущем.

Х. Копфер, Х.-Д. Хаасис, Й. Шорнбергер, Д.А. Иванов

CONTROL THEORETIC PERSPECTIVE FOR NETWORKED LOGISTICS AND SCM PROBLEMS WITH MULTI-DIMENSIONAL DYNAMIC CHARACTERISTICS

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Abstract: The purpose of this paper is (1) to describe the important issues and perspectives that delineate dynamics in complex networked problems with multi-dimensional characteristics in logistics and supply chain management (SCM), (2) comment on methodical issues, and (3) describe one specific context of control theoretic approach to tackling dynamics in logistics and SCM. Based on the analysis of different streams in classical and modern control theory, recent literature on dynamics in logistics and SCM, recent literature on applications of control theory to logistics and SCM, and our own elaborations, we analyse state-of-the-art, derive some classifications, perform a critical analysis, and discuss future research avenues.

1. INTRODUCTION

As logistics and supply chains (SC) deal *a priori* with physical movement of produced materials and products (transportation, warehousing, trans-shipment and order-picking processes, i.e., logistics) and integration and coordination of these processes with each other and with the transformation production processes (i.e., supply chain management – SCM), dynamics exists both in logistics systems and in SCs inevitably.

Understanding the importance and the impact of dynamics on performance and resilience of logistics and SC systems is becoming a more and more important topic in literature and in practice [6, 7, 17, 29, 30, 48]. As modern logistics and SC systems are highly networked, integrated, and coordinated, the conventionally isolated problems of operations and logistics management evolve into networked problems, which are characterized by multi-dimensional characteristics (e.g., multi-stage, multi-period, multi-commodity, etc.) [4, 39, 44]. The existence of a great diversity of different dynamic characteristics in those problems, e.g., demand fluctuations, inventory dynamics, dynamic lot-sizes, dynamic schedules, changes in suppliers' structures, information dynamics subject to partial or full information unavailability, natural and human-driven catastrophes and attacks on logistics and SC systems can significantly impact logistics and SC performance [7, 17, 48].

The distribution of these dynamic characteristics upon different structures (organizational, functional, product-based, informational, financial, etc.) along with the coordinated and distributed decision-making (so called active decision-makers, unlike in automatic systems) subject to the above-mentioned multi-dimensional space lead to the understanding of modern logistics and SC systems as *multi-structural active systems with structure dynamics* [21, 27]

The purpose of this paper is (1) to describe the important issues and perspectives that delineate dynamics in complex networked problems with multi-dimensional characteristics in logistics and supply chain management (SCM), (2) comment on methodical issues, and (3) describe one specific context of control theoretic approach to tackling dynamics in logistics and SCM.

Based on the analysis of different streams in classical and modern control theory, recent literature on dynamics in logistics and SCM, recent literature on applications of control theory to logistics and SCM, and our own elaborations, we analyse state-of-the-art, derive some classifications, perform a critical analysis, and discuss future research avenues.

2. STATE-OF-THE-ART

CT has been extensively applied for management and economics applications in both the dynamics dimensions [44, 46, 47]. In the logistics and SCM domain, application of CT has been increasingly developed since 1980s beginning with the works on inventory control [2, 36] and SC dynamics [50].

In reviewing literature on the applications of CT to logistics and SCM, the following problem domains can be indicated:

1) Dynamic production-inventory control policies,
2) Optimal planning of multi-stage, multi-period, non-stationary processes,
3) Analysis of disturbances and fluctuations (e.g., bullwhip-effect), and
4) Adaptation and real-time control.

Dynamic production-inventory control policies

In particular, integrated production-inventory problems with lot-size and capacity optimization, coordinated production-marketing strategies regarding simultaneous manufacturing and price decisions have been considered in this domain [2, 12, 46]. The authors of the studies [10] and [18] investigated recently the effects of inventory control policies on order and inventory variability with *linear classical CT*. However, the authors frequently point out certain limitations in linear CT analytics.

Optimal planning of multi-stage, multi-period, non-stationary processes

Optimal design, planning and scheduling is another application of CT in logistics and SCM domain [25, 26, 27, 44, 47]. Optimal control (OC) has been applied to optimal planning problems in logistics and SCM right from the start [19] and in the recent research [14, 20-28, 44].

Along with numerous advantages regarding the possibility to optimize multi-stage, multi-period, and multi-commodity systems with many control parameters, methods of OC have also some limitations. E.g., in optimal program control, one of the main problems by applying OC to network planning and dynamic resource distribution was caused by step functions and the arising sectionally continuous functions. The fact that the derived function from the step function is infinity has negatively influenced the further development of optimal control techniques for scheduling. Besides, such problems as numerical instability, non-existence of gradients, non-convexity of state space, difficulties in handling discrete event systems should be named.

Analysis of disturbances and fluctuations

Another fundamental domain of CT is related to analysis of disturbances, fluctuations, robustness and stability of SCs. There is considerable variation in the definitions of terms related to logistics and SC uncertainty, robustness, and performance [7, 30]. Basically, there are three main properties of an SC which can be analyzed regarding uncertainty. These are: (1) the ability to cope with volatility and continue plan execution after being perturbed, (2) the ability to remain stable and achieve the planned performance in the presence of disturbances, and (3) the ability to maintain, execute and recover (adapt) the planned execution along with the achievement of the planned (or adapted, but yet still acceptable) performance. In the systems and control theories, these properties are analyzed as *stability* (property 1), *robustness* (property 2), and *disaster-tolerance* (property 3).

The understanding of stability depends much on the system considered as well as on methods and goals of systems analysis. The studies [8] and [49] applied classical control theory and Lyapunov's stability metrics to the SCM domain. In some studies, *bullwhip-effect* has been addressed from control theoretic perspective. A system control framework was recently introduced to study the bullwhip effect in the frequency domain [9, 38]. Various strategies to avoid or mitigate the bullwhip have been discussed in [11] and [37].

However, although stability analysis is an useful tool for SC dynamics domain, it is subject to many restrictions if applied in the classical form of Lyapunov's stability or bounded-in-bounded-out stability. First, the classical models imply natural movement of objects. Second, they typically consider very small deviations of control and output variables and are difficult to apply to complex systems. Third, they imply the adaptation as a process which is driven by natural laws. Finally, stability analysis can help in estimating SC volatility in any concrete state. But it is not enough to stabilize the system – the system should also bring profits; hence, the inclusion of performance considerations (i.e., the robustness analysis) is required as the next step. Besides, stability in the classical control approaches is inevitably concerned with funding equilibrium states. However, the conditions of equilibriums and the corresponding mathematical models have been elaborated for mechanical and automatic systems.

Another problem with the application of stability analysis is that stability reflects the current *state* of the system, but do not take into account system *structure*. The structural properties are typically investigated in the robustness analysis [33]. The study [42] presented an optimal control approach to estimate the operational robustness of networked batch processes. In addition, numerous studies on robust and stochastic optimization of SCs (e.g., [41, 43]) should be named. An overview of recent developments in SC robustness analysis can be found in the study [30]).

An interesting research direction is the consideration of *complexity* in light of the robustness, adaptability (flexibility) and economic performance. Indeed, the increased complexity typically results either from the attempts to increase the economic performance or the robustness/flexibility. However, if the complexity becomes too high, the system can become very sensitive to even small perturbations and decrease in robustness and performance [1, 7].

With the robustness and stability analysis, CT opens constructive ways for integration of *non-stationary operability performance objectives* in SC synthesis (planning) decisions. However, logistics and SC systems can be robust and stable only on the basis of decisions which are taken by people (unlike a pendulum which returns to the stable state due to the natural laws without adaptation). In logistics and SC systems, even the *adaptation* (and more precisely, human-driven adaptation) is the precondition of stability and robustness [23, 25]. Besides, logistics and SC systems do not necessarily need 100% robustness and stability because of individual risk perceptions of decision-makers which are consciously taking risk for greater profits.

Adaptation and real-time control

The very extensive area of CT applications to logistics and SCM domain is related to the adaptation and real-time control [3, 39, 40, 44]. Actually, it is for many logistics and SC scholars and professionals the area, to which they refer first while talking about the CT. A popular technique of SC adaptation is the *model predictive control* (MPC). In MPC, a system model and current and historical measurements of the process are used to predict the system behaviour at future time instants. A control-relevant objective function is then optimized to calculate a control sequence that must satisfy the system constraints. The MPC approach is not simply to run the planning frequently, but rather to develop decision policies. Applications of MPC to multi-echelon production–inventory problems and SCs have been examined previously in the literature. The study [39] modeled multi-plant, multi-product polymer process through difference equations and schedule optimisation in MPC framework. The key result of this study is that a central coordinator rather than independent decision-making improved profit by 15%. The study [3] developed a decentralized MPC implementation for a six-node, two-product, and three-echelon demand network problem. In the study [40], a scenario-based multi-stage stochastic model has been employed. However, the stabilizing controllers remain a critical bottleneck in MPC [33].

A critical issue in applying MPC to logistics and SCM is the centralized controller and its functions. In technical systems, the controller is a technical device (e.g., a sensor) that adapts the system behavior based on error identification within milliseconds. The controller in the SC is a manager, or more precisely, a number of managers with possible interest conflicts. Even if a deviation in the SC execution has been identified (e.g., track delay identification with the help of RFID), the MPC controller will not be able to change anything in this situation. The role of this model will be to identify the deviations, to notify the SC managers, to estimate the impact of this disturbance on SC performance, and to develop any recommendations on the adaptation. That is why additional research is needed for analyzing the applicability of MPC to human-driven SC adaptation.

3. CRITICAL ANALYSIS

Based on the state-of-the-art analysis, we derive in this Section the basic problem domains for application of different control theoretic approaches to logistic and SCM and analyse their advantages and possible limitations (see Table 1).
In analyzing the Table 1, the following research issues can be indicated:

- *Issue 1 – Complexity and content of the planning models.* SCs are becoming more and more complex. It is becoming more and more difficult to represent the ever more complex SCM problems within only one model taking into account dynamic logistics and SC processes.
- *Issue 2 - Executeability, robustness, stability and adaptation.* Robust and stable processes in a complex environment ensure performance. The achievement of the planned performance can be inhibited by perturbation impacts. This forces the research on replanning to make SCs reliable and flexible enough to be able to adapt in the case of perturbations and to remain stable and robust by recovering disruptions once disturbed.

With regard to the above/mentioned research gaps, attracting CT methods is becoming timely and crucial. *Logistics and SC systems resemble control systems as a multi-stage dynamic flow of materials with information feedbacks*. CT contains a rigor quantitative basis for planning multi-stage dynamic systems. These tools can be applied to a wide range of systems, from discrete linear to stochastic non-linear systems with both stable and dynamically changing structures. OCT has been applied to optimal planning and scheduling of both continuous and discrete processes.

Table 1. Methodical contributions to the dynamics domain in logistics and SCM

Problem domain	Control theoretic approaches				
	Automatic regulation CT	**Optimal control theory**	**Model predictive control**	**Operations Research**	**Artificial Intelligence**
Design, Planning and Scheduling	Limited application	Optimal program and stochastic control	Limited application	Linear, dynamic, and integer programming	CAS /MAS evolutionary metaheuristics
Inventory control	Linear inventory control policies	Limited application	Limited application	Inventory management	MAS
Analysis of disturbances and fluctuations	Lyapunov's / BIBO stability; Bullwhip effect	Robustness analysis	Limited application	Stochastic and robust optimization	Limited application
Adaptation and real-time control	Limited application	Simulation-based adaptation	Adaptation-based real-time control	Limited application	CAS and MAS
Application issues					
Information	Centralized	Centralized	Centralized	Hybrid	Decentralized
Advantages	Dynamics in decisions, especially in the inventory domain, non-stationary performance indicators	Optimality, multi-stage, -period and -commodity, robustness, time-indepedent dimensions	Real-time control, monitoring, and adaptation	Optimality, clarity and accessibility	Coordination, active behaviour of decision-makers
Possible limitations	Problem dimensionality; delay time; numerical instability,	Algorithmic problems, nonexistence of gradients, form of state space, handling discrete event systems	Automatic centralized controllers, problem dimensionality	Poor flexibility: steady-state, full inform. sharing; problem dimensionality	The quality of solutions with regard to potential optimum usually remains unknown

4. FUTURE RESEARCH DIRECTIONS

Recent studies indicated some applications of CT to the logistics and SCM domain. Despite of some recent advancements and significant potential, the existing studies on CT approaches to SCM are rather episodic and do not reflect the CT potential. Although it is intuitive that CT is likely to be applicable to the logistics and SCM domain, there is little systematic analysis and documentation of the magnitude of these impacts in literature. There are several reasons for this.

Classical CT leads us to the fields of automatic control. In SCs, the controllers are human beings. SC tuning occurs not within milliseconds but with a time delay. Decision-makers consciously tend to take risks. In the light of multi-criteria problems, the decisions in logistics and SCs are typically taken based on individual psychological risk perceptions and preferences. Hence, interactive tools for multi-criteria decision-making are needed. Decision-making in SCs is of a discrete nature. In technical control systems, it is assumed that control is selected continuously. Besides, in OCT, differential equations are expressing the process dynamics of the systems' behavior in the input-output context. This non-linear mathematics is complicated and more suitable for automatic control.

In observing these shortcomings it can be concluded that CT can be applied to some problems in logistics and SC planning and control, however, not always. In many aspects, SCM domain-specific modifications of OCT are required. In addition, it becomes necessary to take into account discreteness of decision-making in SCs. In view of the above-mentioned advantages and possible limitations of CT, further research on systematic methodical justification of applicability of control theoretic approaches to logistics and SCM is timely and crucial.

Another observation from the results of Table 1 regarding the future research needs is that the different methods for tackling dynamics in logistics and SC systems have different application areas, advantages and disadvantages. These possible limitations reduce the application areas. However, the possible limitations of certain methods are frequently exactly compensated in the advantages of other methods. Hence, although those methods appear to differ in targets, presumptions, application areas, enabling technologies, and research methodologies, each compliments the others and endeavors to improve decision-making [22].

In the light of this, the *inter-disciplinary* contributions can also be stated as a future research avenue. Let us consider an example. In Table 2, three methods, namely mathematical programming, optimal program control and multi-agent systems for SC dynamics are considered.

Table 2. Analysis of methods for SC dynamics

Approach	Application areas	Advantages	Disadvantages
Mathematical programming	Models of SC design and planning with steady-state conditions and limited dimensionality	Optimal solutions; Clarity; Available software	Dimensionality and complexity of real problems; Dynamics and uncertainty of system and model evolution; Poor flexibility
Optimal program control	Dynamic models of SC design, planning, and scheduling; SC execution control and adaptation	Multi-stage, multi-period, multi-commodity SC dynamics; Time-independent problem dimensions; Non-stationary	Elaborated for automatic control systems; Centralized control; Non-linear mathematics is not always suitable for SCs; Difficulties in handling discrete event systems
Multi-agent systems (MAS)	Decentralized planning and coordination of SCs	Decentralized decision-making; Human-driven (not automatic decisions)	The quality of a found solution with regard to potential optimum usually remains unknown

The studies [13] and [20] investigated the possibilities of how multi-agent systems techniques for distributed decision-making in terms of agents can be combined with contemporary numerical optimization techniques for the purposes of SC optimization. To overcome the limitations of CT, OC is frequently combined with OR techniques. As OCT and OR are basically combinable, a possible approach to can be a “relief” of the dimensionality of OR models by distributing some of their elements to dynamic control models.

Let us provide two other *examples* [24, 26]. In integrated SC production and transportation scheduling models, different goals, variables and constraints can be expressed either in static or in dynamic form. In applying only one solution method, e.g., mathematical programming or OPC, significant difficulties in representing both static and dynamic aspects are frequently encountered. Therefore, it can be sensible to distribute static and dynamic elements between different models where the corresponding static or dynamic elements can be expressed in the best way.

Besides, during the planning horizon, different structural elements (decision-makers, processes, products, control variables, constraints, goals, perturbations, etc.) are involved in decision-making on SC planning, and not all of them *at the same time*. In moving on through the planning period, these elements appear and disappear from the decision-making. If so, there is no need to consider all the structural elements at the same time and to solve planning problems of enormous dimensionality in steady-state environments. By taking decisions within certain intervals (so called intervals of structural constancy [24], we can solve problems of significantly smaller dimensionality. As these intervals can differ in their duration and these durations are hardly predictable because of perturbations, the splitting of the planning period into those intervals should occur not at the planning stage like in mathematical programming (MP), but according to the natural logic of time and events, that is in SC dynamics.

The transitions between the multi-structural states (both planned and perturbation-driven, e.g., demand fluctuations) is modelled with the help of OCT [24, 27]. Within the intervals of structural constancy, the planning problems will be solved with the help of OR methods with attracting OCT for representation of time-dependent elements, e.g., transportation frequency. This basic SC dynamic representation can be applied to constructing models at the SC design, tactical planning, scheduling, and execution stages. The incorporation of the last stage will be favorable since the planning models will actually already be described in terms of execution and control.

Let us consider the second example [26]. Despite OC models make it possible to reflect the optimization of a performance indicator the value of which is accumulated over time, the consideration of sequencing and resource allocation in these models is significantly complicated by specific mathematical features. Hence, scheduling could not be performed. To overcome this shortcoming, we developed a SC dynamic scheduling model that is based on a combined application of OC and MP approaches. The model is based on a dynamic interpretation of SC execution as a dynamic complex of operations. We formulate the scheduling model as a linear non-stationary finite-dimensional controlled differential system with the convex area of admissible control and a reconfigurable structure. This is the essential structural property to allow the solution of the model and computing optimal control. In the proposed dynamic scheduling model, a multi-step procedure for SC planning and scheduling is implemented. At each instant of time while calculating solutions in the dynamic model with the help of the maximum principle, the LP problems to allocate jobs to resources and IP problems for (re)distributing material and time resources are solved with conventional capacitated LP/IP algorithms.

Both the examples have proved that in distributing static and dynamic elements of the considered problem between a static model (e.g., for planning within certain time intervals of structural constancy) and a dynamic control model (e.g., for representing SC structure dynamics and planning time-dependent processes within the intervals of structural constancy), it became possible to state a solvable integrated problem instead of partial problem (i.e., production scheduling, transportation scheduling, execution control) that have been previously treated inconsistently and in isolation.

Regarding analysis of logistics and SCs in terms of dynamics and uncertainty, further investigation in *robustness* and *stability* are needed. With the robustness and stability analysis, CT opens constructive ways for integration of *non-stationary operability performance objectives* in SC synthesis (planning) decisions. However, logistics and SC systems can be robust and stable only on the basis of management and control decisions which are taken by people (unlike a pendulum which returns to the stable state due to the natural laws without any adaptation). In logistics and SC systems, even the *adaptation* (and more precisely, human-driven adaptation) is the precondition of stability and robustness (Ivanov 2010). Besides, logistics and SC systems do not necessarily need 100% robustness and stability because of individual risk perceptions of decision-makers which are consciously taking risk as the main entrepreneurship incentive for greater profits. That is why the crucial future research direction should be the investigations in the property of logistics and SC systems to maintain, execute, and recover (adapt) their behavior, i.e. in *resilience* and *disaster-tolerance* of logistics and SC systems. These categories incorporate the analysis of states (stability) and structures (robustness). In the light of the adaptation, these properties can be incorporated as *structural states* (or multi-structural macrostates, see [27]), which will emerge through the adaptation-driven stability and robustness. In these setting, further investigations in some related CT categories like observeability and controllability are also needed.

The incorporation of intelligent IT (e.g., MAS or RFID) into CT, also known as intellectualization of control or *modern control theory*, can provide a variety of methods and tools for dynamics in the logistics and SC domain. This can become the area where the knowledge of SC managers and control specialists can be effectively integrated taking advantages of modern IT, e.g., for investigating SC dynamics in different *non-stationary* environments (not only in discrete or stochastic) or applying RFID to SC monitoring and adaptation [32].

Special focus should be directed to the subjective human decisions on adaptation and multi-criteria decision-making. Control schemes for the real-time adaptation of autonomy level are neede. The SC system and its operators should be modelled symmetrically as dynamic system components according to behavioural levels with different disturbance severity and reaction times. Comparing the human behaviour with the SC execution (model in MPC), a human reference model can be identified for interrelating basic classes of disturbances and corresponding adaptation actions. According to the SC structure, schemes should be developed for the adaptation of the autonomy level in real-time based on the individual characteristics. As a result, guidelines can be provided for the dependable design of interfaces between the human operators and the SC.

5. CONCLUSIONS

In this paper is we addressed describe the up-to-date issues and different methodical perspectives that delineate dynamics in complex networked problems with multi-dimensional characteristics in logistics and SCM. In particular, we focused on the control theoretic approach to tackling dynamics in logistics and SCM. Based on the analysis of different streams in classical and modern control theory, recent literature on dynamics in logistics and SCM, recent literature on applications of control theory to logistics and SCM, and our own elaborations, we analysed state-of-the-art, derived some classifications, performed a critical analysis, and discussed future research avenues.

We can conclude that logistics and SC planning and control depend a great deal on tackling uncertainty and dynamics of structures and processes in SCs that evolve over time. Modern control sciences provide a variety of methods and tools for the logistics and SCM domain. Control theoretic approaches to logistics and SC planning and control allows to take into account dynamics, real dimensions, non-linearity and non-stationary of SC processes. In addition, with the help of CT, *non-stationary performance indicators* such as robustness and stability can be investigated in their fullness and consistency with operations planning and execution control within a conceptually and mathematically integrated framework. However, in limiting the decision-making support on only methods of discrete optimization, the domain of SC dynamics still remains ill-investigated. The combined application of modern CT, OR, and MAS enriches the possibilities to develop solutions for many practical problems. Subsequently, modelling and optimization tools of decision-support systems can be enhanced.

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KORRIDORBILDUNG ALS GRUNDLAGE LEISTUNGSFÄHIGER TRANSPORTKETTEN IM LADUNGSVERKEHR

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Zusammenfassung: Bei einem Aufbau leistungsfähiger Transportstrukturen im Ladungsverkehr spielt die Festlegung und verkehrliche Ausgestaltung von grenzüberschreitenden Korridoren eine wesentliche Rolle. Die infrastrukturellen Grundlagen bilden hierbei Netzstrukturen mit den verfügbaren Trassen (sowie deren Kapazitäten) und (hierarchisch strukturierte) logistische Einrichtungen. Darüber hinaus müssen die Verkehrsträger als operatives Element in diesen Strukturen berücksichtigt werden sowie auch die Informations- und Kommunikationssysteme im Bereich der Planung sowie in der Betriebssteuerung. Ausgehend von den Pan-europäischen Korridoren und den TEN-T-Strukturen werden logistischen Lösungen für multimodale Transporte im Raum zwischen Nord- und Ostsee und deren Hinterlandvernetzung in Mittelost- und Osteuropa aufgezeigt und hinsichtlich des Leistungsangebotes analysiert. Ein wesentlicher Punkt ist hierbei neben den anfallenden Transportkosten und dem Zeitbedarf die Frage der Generierung von Verkehrsverlagerungseffekten zur Entlastung terrestrischer Verkehre und hierbei insbesondere des Straßengüterverkehrs. Als Beispiel wird der East West Transport Corridor(EWTC) betrachtet, der das Gebiet der Nordsee mit dem der Ostsee verbindet.

ФОРМИРОВАНИЕ КОРИДОРОВ КАК ОСНОВА ЭФФЕКТИВНЫХ ТРАНСПОРТНЫХ ЦЕПЕЙ И ДВИЖЕНИЯ ГРУЗОВ

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Abstract: In high performance transportation structures the design and determination of cross-border corridors are playing a key role. The infrastructural bases are forming the underlying network structures with their available paths (and capacities) together with the (hierarchically structured) logistics facilities. Furthermore the modes of transport as operational element in these structures, as well as information and communication systems for planning and operational control. Based on Pan-European corridors and TEN-T structures logistics solutions for multi-modal transports in the area of North Sea and Baltic Sea together with its hinterland networks in Central Eastern and Eastern Europe are pointed out and analyzed with regard to the range of services. An important aspect is, besides related transportation costs and required lead time, the generation of modal shifts to reduce terrestrial traffic, especially resulting from road freight transport. As a case the East West Transportation Corridor (EWTC) connecting the North Sea with the Baltic Sea Region will be considered in the paper.

1. VERKEHRSLOGISTISCHE MAKROSTRUKTUREN

Die zunehmende *Globalisierung* in *Industrie* und *Handel*, die immer mehr durch stark *dislozierte Beschaffungs-*, *Produktions-* und *Distributionsstrukturen* geprägt ist, stellt erhebliche Anforderungen an die *Leistungsfähigkeit* (*verkehrs-*)*logistischer Systeme*. Dies betrifft neben den verschiedenen *Verkehrsträgern* insbesondere auch die *makrologistischen Rahmenbedingungen*, die im Wesentlichen die *Verkehrs-* und *Kommunikationsinfrastruktur* betreffen. Nur wenn diese Strukturen in einem (quantitativ und qualitativ) ausreichenden Umfang verfügbar sind, lassen sich die notwendigen, international ausgerichteten *Supply Chains* (insbesondere in Verbindung mit *Ladungsverkehren*) aufbauen und effizient steuern.
Um diesen Anforderungen auch im *mittel-* und *südosteuropäischen* Raum gerecht werden zu können, wurden im Jahr 1994 *PanEuropäische Korridore* definiert (s. u.a. HB-Verkehrsconsult / VTT 2005: 6f), die die Anbindung einerseits (westwärts gerichtet) an das damalige Gebiet der *Europäischen Union* (EU) sowie andererseits auch (ostwärts gerichtet) an die *Russische Föderation* (RF) sicher stellen sollten. Hierbei wurden, ausgehend von Verkehrsströmen und prognostizierten Entwicklungen sowie unter Berücksichtigung politischer Zielvorgaben hinsichtlich der Realisierung eines (zukünftig) einheitlichen europäischen Wirtschaftsraumes entsprechende *Verkehrskorridore* erarbeitet, die zukünftig das Rückgrat leistungsfähiger Transportstrukturen bilden (sollen). Einbezogen sind dabei die (schon in Teilen realisierten) *Trans European Transport Network*(TEN-T)-Strukturen (s. u.a. Stratigea et al. 2008; Dionelis / Giaoutzi 2008). Als Verkehrsträger stehen hierbei als terrestrische Systeme der *Straßen-* und *Schienengüterverkehr* sowie der *Gütertransport* auf *Binnenwasserstraßen* im Vordergrund, im maritimen Bereich darüber hinaus das *Short Sea Shipping* (SSS) (s. u.a. Ng 2009), auch in Verbindung mit der *Fluss-Seeschifffahrt* (FSS).

Die *Bereitstellung* und *Unterhaltung* der hiermit verbundenen Infrastruktur wird, im Gegensatz zur weitgehend *deregulierten* (*operativen*) *Transportdurchführung*, nach wie vor als eine originäre *Aufgabenstellung* in staatlicher Verantwortung verstanden (s. u.a. Knorr 2005; Aberle 2009, S. 127ff), auch wenn diese Auffassung kritisch diskutiert wird, insbesondere in Verbindung mit der Frage *nicht-staatlicher Finanzierungsformen* (s. u.a. Eisenkopf 2005; Aberle 2009, S. 162ff). Außerdem ist eine übergeordnete (und langfristig ausgerichtete) Planung zwingend erforderlich, u.a. um eine länderübergreifende *Durchgängigkeit* der Korridor- bzw. Netzstrukturen (s. u.a. Gutiérrez et al. 2011) sowie eine *effiziente Verknüpfung* verschiedener Verkehrsträger gewährleisten zu können. Insoweit steht die Gestaltung *multimodaler Transportketten* im Vordergrund, mit dem Ziel, die verkehrsträgerspezifischen Vorteile unter *ökonomischen* sowie *ökologischen* Aspekten zu verknüpfen.

Im Vordergrund der folgenden Ausführungen stehen (multimodale) *Ladungverkehre*, da diese in der internationalen Logistik eine entscheidende Bedeutung (haben und auch hinsichtlich eines *intermodalen Verkehrsträgerwettbewerbs* die größten Potenziale aufweisen). Zunächst wird auf die wesentlichen Aspekte der strukturellen Gestaltung von Verkehrskorridoren sowie auf die damit verbundenen (verkehrs)logistischen Abläufe eingegangen. Darauf aufbauend werden Möglichkeiten der Transportdurchführung im Raum zwischen Nord- und Ostsee betrachtet und hinsichtlich ihrer (technischen und logistischen) Leistungsfähigkeit. Berücksichtigung finden hierbei u.a. Fragen zur Verkehrsverlagerung sowie zur Vermeidung verkehrsinduzierten Emissionen. Hieraus abgeleitet werden Aussagen für eine sinnvolle Gestaltung der erforderlichen Transporte im Bereich des East West Transport Corridors (EWTC) und dessen Einzugsbereich.

2. STRUKTURELLE GESTALTUNG VON VERKEHRSKORRIDOREN

Bei der Ausgestaltung von *Verkehrskorridoren* spielt zunächst die (verkehrsträgerbezogene) *Infrastruktur* eine entscheidende Rolle. Hierbei sind neben der *Führung* (bzw. *Verfügbarkeit*) und der (kapazitiven) *Auslegung* der *Trassen* sowie deren *intermodalen Vernetzung* auch die einbezogenen *logistischen Einrichtungen* von Bedeutung. Zu berücksichtigen sind außerdem die verschiedenen *Verkehrsträger*, die aufgrund ihrer *systemimmanenten Rahmenbedingungen* einen fallbezogen differenzierten *Nutzen* aufweisen. Mit Blick auf die Organisation der operativen Abläufe ist darüber hinaus der Bereich der (zum Teil verkehrsträgerspezifischen) *Informations-* und *Kommunikations*(IuK)-*Systeme* als weiterer Faktor einzubeziehen. Dies betrifft sowohl den Einsatz von *Planungs-* als auch von *Überwachungs-* und *Steuerungssystemen*. In den folgenden Ausführungen werden diese vier Bereiche skizziert und analysiert.

- *Netzstrukturen*:

Flächige oder *Hub-basierte* Netzstrukturen bilden die notwendige Basis für die Gestaltung leistungsfähiger Abläufe bei multimodalen Transporten, insbesondere in Verbindung mit trans- und interkontinentalen Nachfragestrukturen. Dies erfordert eine verkehrsträgerübergreifende (und grenzüberschreitende) Abstimmung der Infrastruktur, auch mit Blick auf einen effizienten Einsatz der verfügbaren Investitionsmittel. Für den Bereich der EU (unter Einbeziehung angrenzender Länder) ergeben sich aus den (auf der *politischen Ebene* festgelegten) Pan-Europäischen Korridoren in Verbindung mit den TEN-T-Vorhaben übergeordneten Strukturen, die für die Gestaltung von Transportprozessen auf der *makrologistischen* Ebene von wesentlicher Bedeutung sind.

Definiert sind derzeit zehn Korridore sowie 30 *prioritäre* TEN-T-Projekte. Unabhängig von dem aktuellen Planungs- und Realisierungsstatus bilden diese einen (europaweiten) Rahmen für eine zielgerichtete Entwicklung und Qualifizierung der (*verkehrslogistischen*) *Makrostrukturen*. Allerdings kann die potenzielle Leistungsfähigkeit flächendeckender Netzstrukturen nur bei einer durchgängigen Realisierung erreicht werden, die aber aufgrund finanzieller Restriktionen und des erforderlichen Zeitbedarfs für die Planung und Realisierung (noch) nicht gegeben ist.

- *Logistische Einrichtungen:*

Innerhalb von Verkehrsnetzen bilden die *Knoten* nicht nur die Ausgangs- und Zielpunkte von *Transportströmen*, sondern auch die Grundlage für eine *zielgerichtete Organisation* der Güterflüsse, wobei die Strukturierung *multimodaler Transportketten* im Rahmen von inter- und transkontinentalen Verkehren einen Schwerpunkt bildet. Die Knoten stellen *logistische Einrichtungen* mit (hierarchisch) differierender *Funktionalität* und *Dimensionierung* dar. Im Vordergrund stehen die Verknüpfung verschiedener Verkehrsträger sowie die Bereitstellung von Leistungen im Bereich Lagerhaltung und Distribution (s. u.a. Rimienė/ Grundey 2007; Jaržemskis 2007). In den Grundstrukturen kann (ausgehend von den *verkehrlichen* Funktionen) von den folgenden (*maritimen* und *terrestrischen*) Einrichtungen ausgegangen werden:

- ° *Seehafencontainerterminals* (SCT) mit internationaler Hub-Funktion.
- ° *Regionale* und *lokale* SCT im SSS mit weitgehend begrenztem Hinterland.
- ° *Binnenhäfen* mit regionaler und lokaler Funktion und mit gegebenenfalls einer Einbindung in die *Fluss-Seeschifffahrt* (FSS).
- ° *Hinterlandterminals* mit überregionaler Funktion (MegaHubs).
- ° *Regionale* und *lokale Terminals* im (*multimodalen) kombinierten Ladungsverkehr* (KLV).

Mit einer Einbeziehung der Lagerhaltung und Distribution sind (überwiegend im terrestrischen Bereich) die folgenden Grundformen zu nennen:

- ° *Güterverkehrszentren* (GVZ) mit überregionaler (bzw. internationaler) Bedeutung.
- ° *Regionale Güterverteilzentren* (GVtZ).
- ° *City-Terminals* in Verbindung mit einer lokal ausgerichteten Distribution.

Einen Überblick über die strukturellen Zusammenhänge der angesprochenen Formen logistischer Einrichtungen gibt Abbildung 1.

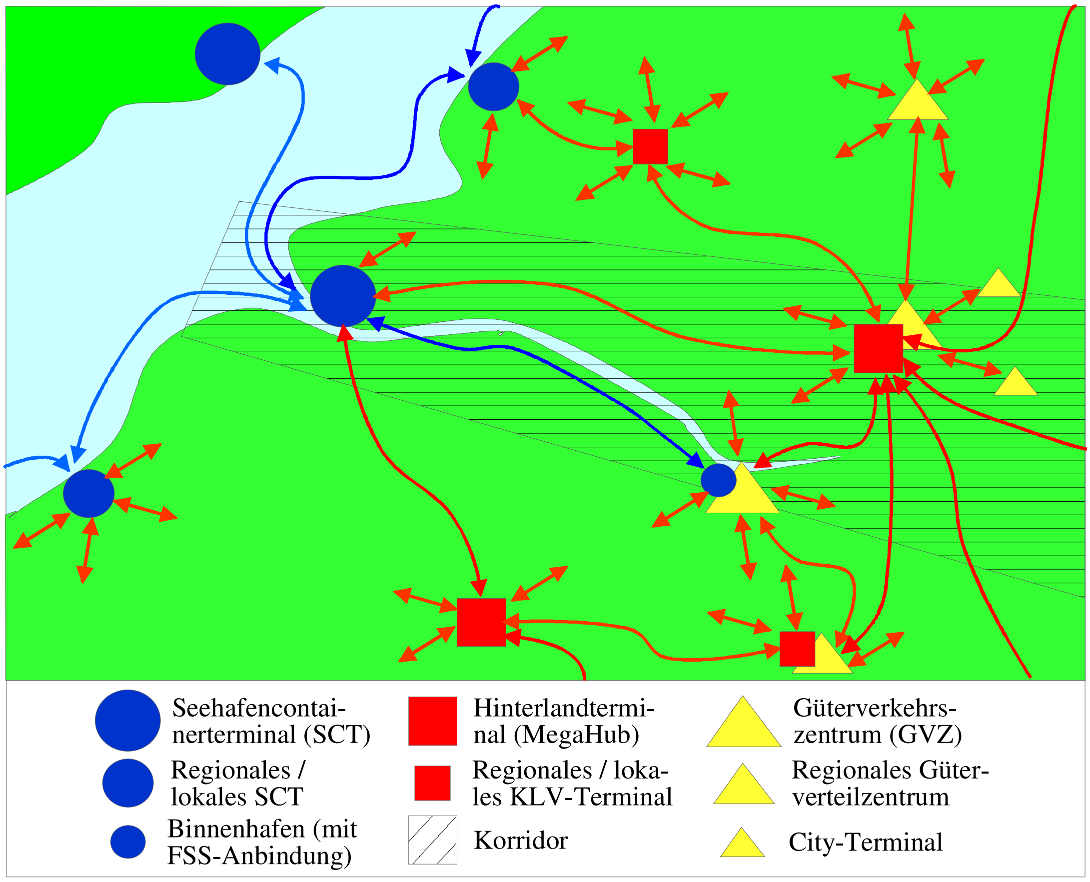

Abb. 1: Korridorbildung und Vernetzung logistischer Einrichtungen

In der Praxis sind die hier aufgeführten (Grund-)Formen in der Regel nicht anzutreffen. Vielmehr muss von Mischformen ausgegangen werden, insbesondere mit Blick auf die Generierung von Synergieeffekten, so u.a. durch die *räumliche Verknüpfung* von Hinterlandterminals und GVZ.

- *Verkehrsträger:*

Die verfügbaren Verkehrsträger mit den *Transportsystemen LKW*, *Bahn* und *Schiff* (im Binnenwasserstraßentransport sowie im SSS und in der FSS), sind durch *systemimmanente* (qualitative und quantitative) *Leistungsmerkmale* gekennzeichnet, den *Verkehrswertigkeiten*. Diese ermöglichen einen Vergleich hinsichtlich ihrer *technischen* und *funktionalen Einsatzmöglichkeiten* in der Transportdurchführung (s. u.a. Daduna 2009).

- ° *Schnelligkeit* der Verkehrsleistung.
- ° *Massenfähigkeit* des Transportsystems.
- ° Fähigkeit zur *Netzbildung*.

° *Berechenbarkeit* der Zeitpunkte und des Zeitbedarfs der Verkehrsleistung.

° *Häufigkeit* der in einem Zeitabschnitt zur Verfügung stehenden Verkehrsmöglichkeiten auf bestimmten Relationen.

° *Sicherheit* und *Störungsfreiheit*.

° *Bequemlichkeit* (hinsichtlich der Zugangsmöglichkeiten).

Bewertet man die Transportsysteme anhand ihrer Verkehrswertigkeiten, ergibt sich das in Tabelle 1 dargestellte Bild.

Verkehrswertigkeit	**Transportsysteme**				
	LKW	**Bahn**	**Binnen-schiff**	**Schiff (FSS)**	**Schiff (SSS)**
Schnelligkeit	++	+	-	-	-
Massenfähigkeit	--	++	++	++	++
Fähigkeit zu Netzbildung	++	-	-	-	--
Berechenbarkeit	+	+	o	o	o
Häufigkeit der Bedienung	++	o	o	o	o
Sicherheit	o	++	+	+	+
Bequemlichkeit	++	-	-	--	--
Bewertungen: ++ Sehr gut / + Gut / o Indifferent / - Mäßig / -- Schlecht					

Tab. 1: Systemvergleich auf Grundlage der Verkehrswertigkeiten

Zu berücksichtigen sind hierbei allerdings auch die organisatorischen Rahmenbedingungen, die erhebliche Auswirkungen auf die Effizienz der Leistungserstellungsprozesse haben können, wie es derzeit insbesondere im Schienengüterverkehr erkennbar ist. Unabhängig von derartigen Diskussionspunkten muss, mit Blick auf die Effizienz in der Transportdurchführung, der Fokus auf *multimodale Transportketten* liegen und nicht auf den Einsatz einzelner Verkehrsträger. Eine hohe *Leistungsqualität* im Transport wird nur durch die Verbindung der *positiven Leistungsmerkmale* der einzelnen Verkehrsträger erreicht, d.h., im Rahmen *vernetzter Strukturen*. Allerdings kann es hierbei keine verbindlichen Standardlösungen geben, da die *transporttechnischen* und *logistischen Anforderungen* der Verlader die Rahmenbedingungen setzten.

- *Informations- und Kommunikationssysteme:*
  Leistungsfähige IuK-Systeme sind eine unabdingbare Voraussetzung für eine effiziente *Planung*, *Steuerung* und *Überwachung* (transport-)logistischer Prozesse, wobei vier Bereiche differenziert zu betrachten sind.

- *Infrastrukturgebundene* IuK-Systeme im Rahmen der Leit- und Sicherungstechnik.
- IuK-Systeme innerhalb *logistischer Einrichtungen* als Basis einer Zusammenarbeit *aller* in diesem Bereich tätigen *Unternehmen* und (öffentlichen) *Institutionen.*
- *User-gruppenbezogene* IuK-Systeme zur DV-gestützten Vernetzung von (geschlossenen) Gruppen oder aber von einzelnen Branchen.
- *Innerbetriebliche* IuK-Systeme zur Planung, Steuerung und Überwachung von *betriebsinternen* Prozessenufe.

Um eine ausreichende Leistungsfähigkeit der auf den verschiedenen Ebenen genutzten DV-gestützten Systeme gewährleisten zu können, ist eine Verknüpfung dieser auf der Grundlage von eindeutig definierten *Schnittstellen* mit entsprechenden *Protokollen* zwingend erforderlich. Nur eine *zeitgenaue* und *medienbruchfreie* Gestaltung aller Informationsflüsse kann den aufgrund arbeitsteiliger Strukturen zunehmend steigenden Anforderungen an ein (*internes* und *externes*) *Informationsmanagement* in Industrie und Handel gerecht werden.

Die in diesem Abschnitt skizzierten Grundstrukturen für ein *effizientes Management* und eine *kundenorientierte Durchführung* (transport)logistischer Prozesse ist als eine langfristig ausgerichtete *Zielsetzung* zu verstehen. Erforderlich ist daher eine konsequente Weiterentwicklung der vorhandenen Infrastruktur sowie auch insbesondere der administrativen Rahmenbedingungen. Anhand von ausgewählten Beispielen werden im folgenden Abschnitt die Möglichkeiten multimodaler Transporte im Bereich der Nord- und Ostsee mit einer Einbeziehung des mittelost- und osteuropäischen Raumes dargestellt und verglichen.

3. MULTIMODALE TRANSPORTKETTEN AUF DER BASIS VON KORRIDOREN

In der europäischen Verkehrspolitik hat der Bildung von Transportkorridoren in Verbindung mit *multimodalen Transportketten* eine hohe Bedeutung, insbesondere mit Blick auf die TEN-T-Strukturen sowie die PanEuropäischen Korridore (s. oben). Dies betrifft insbesondere auch den *East West Transport Corridor* (EWTC), der sich über den Nord- und Ostseeraum mit dem angrenzenden Hinterland erstreckt, das im Wesentlichen den mittelost- und osteuropäischen sowie den skandinavischen Raum umfasst. Einbezogen sind allerdings auch über diesen Raum hinausgehende Schienenverkehrsprojekte, wie beispielsweise die Verbindung zwischen Ostsee und Schwarzen Meer (*Viking Project*) oder Richtung Moskau und weiter in den asiatischen Raum (*Mercury Project*). Kernelement sind die *Seever-*

kehre (s. u.a. Paulaukas / Bentzen 2008), u.a. mit Teilbereichen des TEN-T-Priority Projects N°. 21 (Motorways of the sea) sowie einigen der terrestrischen TEN-T-Projekte (u.a. 11, 12, 20, 23, 25, 27) und fünf der PanEuropäischen Korridore (I - III, VI, IX). Ausgegangen wird von einer Struktur mit zehn *Hafenregionen / -standorten* sowie acht *Hinterlandkorridoren* (s. Abb. 2). Ziel ist es hierbei, den KLV auf ausgewählte Relationen im Bereich des EWTC zu analysieren, wobei neben den *möglichen Transportwegen* auch die Kritierien *Länge*, *Dauer* und *Kosten* sowie auch die anfallenden *Emissionen* einfließen.

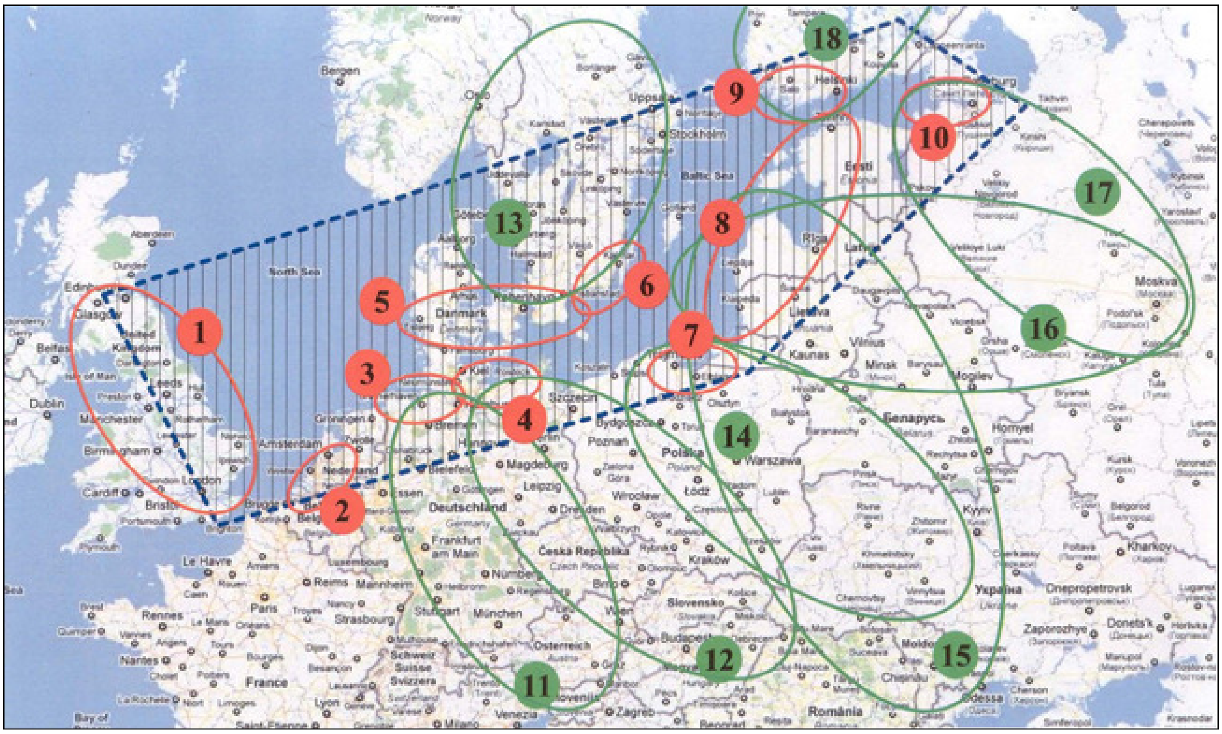

Abb. 2: Grundstruktur multimodaler Vernetzung Nord- / Ostseeraum

Für die Untersuchungen werden die zwei folgenden Relationen von Leeds (UK) nach Janova (LT) sowie von Neumarkt / Oberpfalz (D) nach Tampere (SF) zugrunde gelegt, wobei mit Hilfe der verfügbaren Verkehrsträger und logistischen Einrichtungen unterschiedliche multimodale Transportketten gebildet werden (s. Abb. 3 und 4 sowie Tab. 2-4). Ausgegangen wird hierbei der Transport eines 40´-Standardcontainer.

Für den Vergleich der verschiedenen Alternativen auf den betrachteten Relationen werden zunächst die *Entfernungen* ermittelt sowie (unter Berücksichtigung technischer und rechtlicher Restriktionen) die daraus resultierenden *Transportzeiten* und *Kosten*. Hinzu kommen die beim *Verkehrsträgerwechsel* anfallenden *Zeiten* und *Umschlagkosten*.

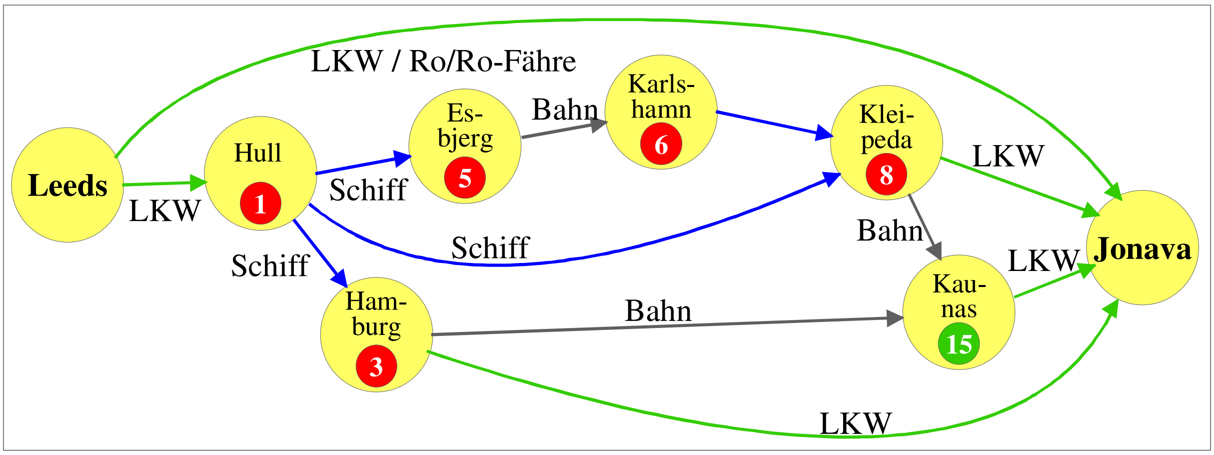

Abb. 3: Vernetzung Relation 1 (Leeds (GB) - Jonava (LT))

	Transportketten
(1.1)	Leeds - (LKW / RoRo-Fähre) - Jonava
(1.2)	Leeds - (LKW) - Hull - (Schiff) - Hamburg - (LKW) - Jonava
(1.3)	Leeds - (LKW) - Hull - (Schiff) - Hamburg - (Bahn) - Kaunas - (LKW) - Jonava
(1.4)	Leeds - (LKW) - Hull - (Schiff) - Kleipeda - (LKW) - Jonava
(1.5)	Leeds - (LKW) - Hull - (Schiff) - Kleipeda - (Bahn) - Kaunas - (LKW) - Jonava
(1.6)	Leeds - (LKW) - Hull - (Schiff) - Esbjerg - (Bahn) - Karlshamn - (Schiff) - Kleipeda - (LKW) - Jonava
(1.7)	Leeds - (LKW) - Hull - (Schiff) - Esbjerg - (Bahn) - Karlshamn - (Schiff) - Kleipeda - (Bahn) - Kaunas - (LKW) - Jonava

Tab. 2: Transportketten Relation 1 (Leeds (GB) - Jonava (LT))

Mit Blick auf die Diskussion über die (negativen) Umweltauswirkungen des (Güter-)Verkehrs wird außerdem für die verschiedenen Transportketten ein CO_2-*Emissionsfaktor* berechnet, wobei beim *Straßengüterverkehr* von 0,065 kg/tkm, im *Schienegüterverkehr* von 0,023 kg/tkm, im *Transport* auf *Binnenwasserstraßen* 0,015 kg/tkm sowie im SSS von 0,018 kg/tkm ausgegangen wird.

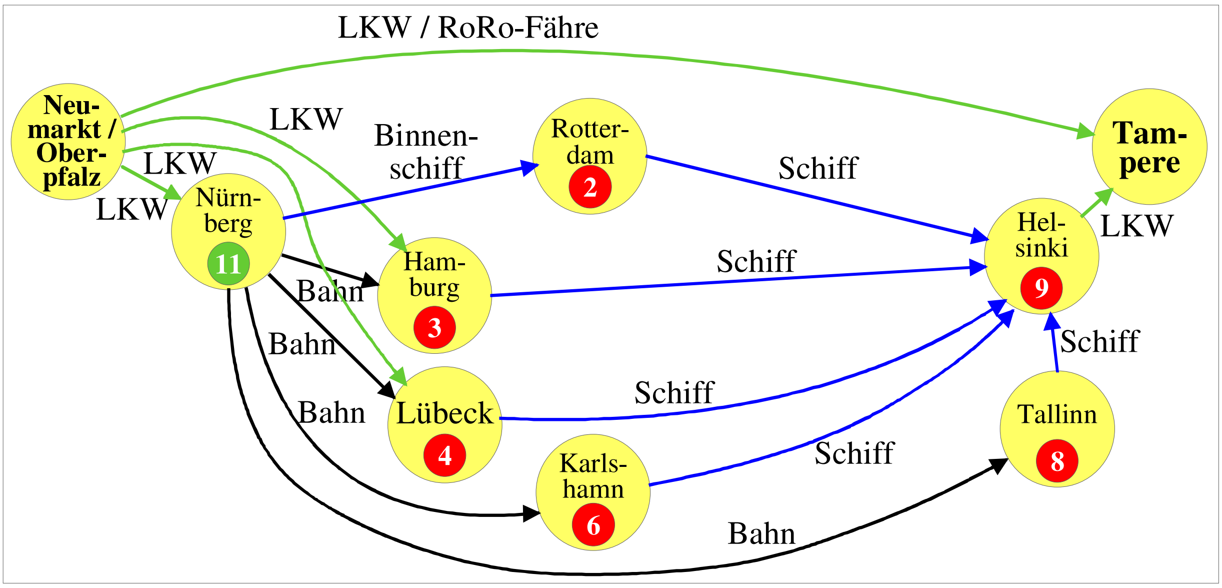

Abb. 4: Vernetzung Relation 2 (Neumarkt / Oberpfalz (D) - Tampere (SF))

Die Ergebnisse sind in den Tabellen 3.3 und 3.4 dargestellt.

	Transportketten
(2.1)	Neumarkt - (LKW / RoRo-Fähre) - Tampere
(2.2)	Neumarkt - (LKW) - Hamburg - (Schiff) - Helsinki - (LKW) - Tampere
(2.3)	Neumarkt - (LKW) - Lübeck - (Schiff) - Helsinki - (LKW) - Tampere
(2.4)	Neumarkt - (LKW) - Nürnberg - (Binnenschiff) - Rotterdam - (Schiff) - Helsinki - (LKW) - Tampere
(2.5)	Neumarkt - (LKW) - Nürnberg - (Bahn) - Hamburg - (Schiff) - Helsinki - (LKW) - Tampere
(2.6)	Neumarkt - (LKW) - Nürnberg - (Bahn) - Lübeck - (Schiff) - Helsinki - (LKW) - Tampere
(2.7)	Neumarkt - (LKW) - Nürnberg - (Bahn) - Karlshamn- (Schiff) - Helsinki - (LKW) - Tampere
(2.8)	Neumarkt - (LKW) - Nürnberg - (Bahn) - Tallinn - (Schiff) - Helsinki - (LKW) - Tampere

Tab. 3: Transportketten Relation 2 (Neumarkt / Oberpfalz (D) - Tampere (SF))

	Entfernungen (km)					Dauer (Stunden)	Kosten (€)	CO_2-Emissionen[1]
	LKW	Bahn	Binnenschiff	Seeschiff	Gesamt			
1.1	2.270			150	2.420	110	3.320	150,25
1.2	1.410			710	2.120	137	1.880	104,43
1.3	130	1.320		710	2.160	205	2.200	51,59
1.4	340			1.710	2.050	119	1.130	52,88
1.5	130	320		1.710	2.160	136	1.250	46,59
1.6	340	500		1.020	1.880	168	1.870	51,96
1.7	130	820		1.020	1.970	185	1.990	45,67
[1] kg per t/km								

Tab. 4: Ergebnisse Relation 1 (Leeds (GB) - Jonava (LT))

Bei den Berechnungen liegen Durchschnittswerten zugrunde, so auch bezüglich des Zeitaufwands und der Kosten beim Verkehrsträgerwechsel. Diese Werte können bei einer entsprechenden Synchronisation der Abläufe (so beispielsweise durch die Abstimmung der *Ankunfts-* und *Abfahrtzeiten* in den *Umschlagterminals* bei *fahrplanbasierten Angebotsstrukturen*) unterschritten werden. Allerdings kann bei ungünstigen Konstellationen auch ein Ansteigen der Transportdauer auftreten. Außerdem muss berücksichtigt werden, dass die tatsächlich anfallenden *Transport-* und *Umschlagkosten* vom Umfang der nachgefragten Leistungen abhängig sind und weitgehend auch als das Ergebnis (bilateraler) Verhandlungen zu betrachten sind.

	Entfernungen (km)					Dauer (Stunden)	Kosten (€)	CO_2-Emissionen[1]
	LKW	Bahn	Binnenschiff	Seeschiff	Gesamt			
2.1	1.880			90	1.970	110	2.600	123,82
2.2	810			1.395	2.205	113	1.820	77,76
2.3	900			1.150	2.050	106	1.840	79,20
2.4	220		960	2.145	3.325	252	1.700	67,31
2.5	220	600		1.395	2.215	138	1.465	53,21
2.6	220	650		1.150	2.020	131	1.445	49,95
2.7	220	1.250		830	2.300	141	2.365	57,99
2.8	220	2.050		90	2.360	202	2.535	63,07
[1] kg per t/km								

Tab. 5: Ergebnisse Relation 2 (Neumarkt / Oberpfalz (D) - Tampere (SF))

Die Ergebnisse zeigen, dass es in beiden Fällen keine eindeutig beste Lösung gibt, die hinsichtlich der wesentlichen Parameter *Transportdauer*, *Kosten* und erzeugten CO_2-*Belastung* die günstigsten Werte aufweist. Im Einzelnen zeigt sich das folgende Bild:

- *Kosten*: Die günstigsten Kostensituationen ergeben sich bei einem hohen Anteil des SSS, während der Transport auf der Straße (und auch auf der Schiene) tendenziell zu höheren Kosten führen.
- *Transportdauer*: Ein hoher Anteil an Transportleistungen mit LKW führt zur günstigsten Lösung, während der Schienengüterverkehr deutliche Nachteile aufweist.
- CO_2-*Emissionen*: Vorteilhaft ist ein hoher Anteil des SSS in der Transportdurchführung (abgesehen von der Variante 4.2), auch im Vergleich zum Schienengüterverkehr. Ein anteiliges Ansteigen des Straßengüterverkehrs führt dagegen zu eindeutig ungünstigeren Werten (wie in den Varianten 1.1, 1.2 und 2.1).

Insgesamt gesehen zeigen sich beim Schienengüterverkehr vergleichsweise wenig günstige Werte, obwohl aufgrund der Leistungsmerkmale eigentlich andere Ergebnisse erwartet werden sollten. Ursachen sind neben der unzureichenden (technischen) *Interoperabilität* im grenzüberschreitenden Verkehr, die (immer noch bestehenden) *Ineffizienzen* in den *organisatorischen Abläufen* sowie auch der *fehlende* bzw. noch *unzureichend entwickelte Wettbewerb* aufgrund einer nicht konsequent durchgesetzten *Deregulierung*.

4. FAZIT UND AUSBLICK

Für die Gestaltung multimodaler Transportketten im Ladungsverkehr gibt es *keine* (im mathematischen Sinne) optimale Lösung, da es sich in diesen Fällen um *multikriterielle Entscheidungsprobl*eme handelt, deren Ergebnis immer eine *Kompromisslösung* sein wird. Entscheidend sind zum einen die (*transport-*)*technischen* und *administrativen Rahmenbedingungen* sowie zum anderen die *zeitlichen* und *qualitätsbezogenen Anforderungen* auf Seiten der Verlader. Daneben spielen zunehmend *verkehrs*- und *umweltpolitische Aspekte* eine Rolle, die allerdings, soweit keine *rechtlichen Vorgaben* bestehen, unter Wettbewerbsgesichtspunkten (d.h. hinsichtlich der Kostensituation) eher eine nachrangige Bedeutung haben.
Um die politisch gewollte *Priorisierung* multimodaler Transporte umzusetzen bedarf es geeigneter Maßnahmen auf Seiten der verantwortlichen (politischen) Institutionen sowie auch der Anbieter logistischer Leistungen. Neben dem zielgerichteten (an den Korridorstrukturen ausgerichteten) Ausbau der *Verkehrswege* müssen auch die *Umschlageinrichtungen* (als intermodale Verknüpfungen) ausreichend Berücksichtigung finden. Qualifizierungs- und Ausbaumaßnahmen im Bereich der

Infrastruktur sind letztendlich der wesentliche Schritt für eine angebotsorientierte Gestaltung von Transportketten und damit für eine nachhaltige Entwicklung logistischer Strukturen.

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INCREASING EFFICIENCY OF FREIGHT CARRIERS THROUGH COLLABORATIVE TRANSPORT PLANNING: CHANCES AND CHALLENGES

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Abstract
Facing the pressure on the transportation market, freight carriers are suggested to exchange customer requests through collaborative transport planning for further increment of their profitability. This paper discusses the chances offered by this kind of horizontal collaboration and proposes challenges to meet its successful utilization.

Keyword: horizontal collaboration, request exchange, profit sharing

1. INTRODUCTION

Freight carriers are confronting increasing pressures to improve profitability, while it is difficult to further reduce operational costs. This problem is even more serious for those who already have almost exhausted their internal potentials by process optimization and by the application of new technologies including modern telecommunication equipments as well as powerful planning software. To further reduce cost and to increase operational efficiency, collaboration is proposed as a promising remedy for small and middle-sized companies. Collaboration partners can be suppliers, customers, or even competitors. Vertical collaboration, such as collaboration between shippers and carriers has been well studied in the last decades. An additional form of collaboration which happens between companies operating at the same level(s) in the market is given by horizontal collaboration. Although this kind of collaboration has attracted great attentions, it has not been thoroughly researched yet. In such a collaboration of freight carriers, which is referred to as a *groupage system* [6], transport planning is not executed by each participant separately but in a collaborative fashion, which is referred as collaborative transport planning (CTP). Such planning will generate extra benefits that cannot be achieved alone. In this paper, we will show how CTP could increase transport efficiency of less-than-truckload (LTL) carriers in detail. The emphasis of this paper is the discussion of the challenges on the research on CTP. We first analyze some basic issues of CTP and the difficulties as well as limitations of its application. Some general guidelines are then drawn for the design of a CTP model, while the challenges on the design of CTP models are discussed later.

This paper is organized as follows. A brief literature review of related works is presented in Section 2. In Section 3 the benefits of CTP are demonstrated. The challenges are then discussed in Section 4. Conclusions are drawn in Section 5.

2. LITERATURE REVIEW

Small and mid-size freight carriers are suggested to use CTP for efficiency increment because of its potential cost-savings that cannot be achieved individually. The achievable cost reduction is commonly estimated to be 5% to 15% [4][8][12]. In [4][8], a decrement of the number of utilized vehicles of 7.3 and 10 percent is also reported. Cruijssen et al. present the results of their large-scale survey on the potential benefits of and impediments for horizontal cooperation in logistics in general [3]. Based on a case study and simulations, Cruijssen and Salomon discuss factors affecting order sharing with its impact on clients, collaborating companies and the society [4]. Kopfer and Kopfer review some difficulties of applying CTP among profit centers of a large freight carrier company, especially the conflicts among parties in the distribution logistics including management, sales, drivers, schedulers and accounting personnel [5]. Bloos and Kopfer give some insights about the evaluation of the efficiency of transport collaboration mechanisms [2].

Another research direction is the design of CTP models. Schönberger develops a CTP model that also considers the usage of coalition external resources [11]. Krajewska and Kopfer propose a model concept including a profit sharing scheme based on game theory and combinatorial auctions. In the auction, each participant has to give bid prices not only for a bundle of requests but also for all single elements in this bundle [7]. Schwind et al. present an exchange mechanism for intra-enterprise order exchange among profit centers with the purpose of reducing total costs of the entire company [12]. They reduce the complexity of the problem enormously by employing a cluster building method while considering time windows and capacity constraints. Berger and Bierwirth develop a framework of request re-assignment where only a small part of requests to be exchanged is processed in each round. The marginal costs of this part are then determined by solving the traveling salesman problem with precedence constraints [1]. Krajewska et al. present another profit sharing scheme based on the Shapley value [8].

3. COST REDUCTION THROUGH COLLABORATIVE TRANSPORT PLANNING

Cost reduction through CTP means to take advantage of both economies of scale and economies of scope. Economies of scale may be achieved by integrating several LTL requests in one tour, while economies of scope are reached by the combination of various tours which might decrease empty miles.

Fig. 1 shows the situation, where transferring requests between two carriers may decrease the number of used vehicles. Without CTP, both carriers A and B would have to serve their requests with two vehicles. Suppose the total demands are less than one truckload, carrier B's two requests can be transferred to carrier A for a certain price less than carrier B's costs but higher than the additional costs for carrier A.

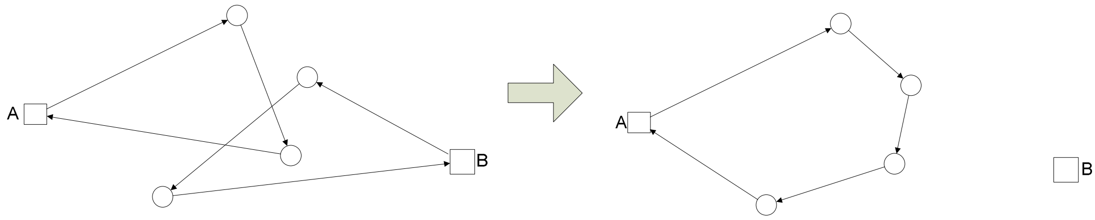

Figure 1. Reduction of used vehicles and empty miles

Fig. 2 illustrates another scenario, where the routes of both carriers A and B overlap. Through CTP they can exchange some requests and reduce the length of both routes. The total cost-savings achieved by performing CTP can then be shared between the two carriers.

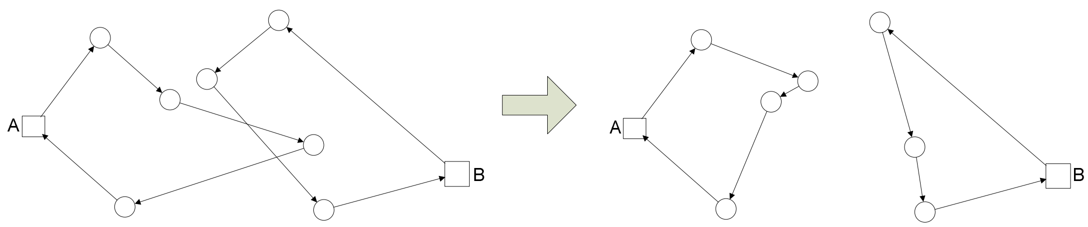

Figure 2. Reduction of extra traveled miles

A more complex possibility is to introduce transshipments. Fig. 3 gives an example of this idea. Carrier A would deliver cargos to D1 and D2 and then pick up goods at P1 and P2 before she goes back to her depot. One route of carrier B with enough capacity lies nearby. Carrier B could pick up the loads at both customers P1 and P2 in her route and pass them at the transshipment point TP.

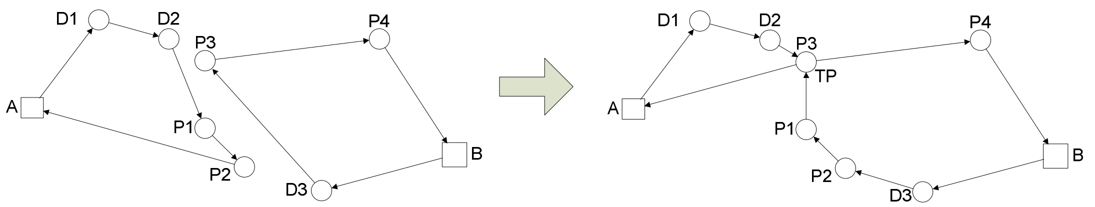

Figure 3. Reduction of extra traveled miles through introducing a transshipment point

4. CHALLENGES ON COLLABORATIVE TRANSPORT PLANNING

Although it is widely acknowledged that CTP could improve transport efficiency, there are still a lot of challenges on building up coalitions and on increasing their sustainability.

4.1 Determine the potential cost-savings

The first challenge is to determine the collaborative benefits for both the whole coalition and each participant. A common way to answer this question for the whole coalition is to calculate the cost difference between the total costs of all participants' plans without request exchange and the total costs of a centralized planning as in merge [4][8][11].

However, the real case could be much more complicated. The first difficulty is to gather all local information and transfer it to a central planer. This means that both requests and private company information including capacities and cost structures are to be exposed. The second difficulty is to develop algorithms that can solve the central planning problem effectively and efficiently. Since the vehicle routing and scheduling problems in the operational transport planning are all NP-hard problems, to get a global "optimal" plan for all participants' requests may be extremely difficult or even impossible.

Another disadvantage is that it disregards participants' autonomy. They may have different company strategies and in turn different objectives of business operations. These operational objectives are not always consistent with that of the whole coalition, which is the maximization of the collaborative benefits. A central planning omitting these individual settings could even be unacceptable for some participants and represents an unfeasible solution of the CTP. Autonomy also enables a better utilization of local knowledge which can be hardly considered centrally. Theoretically, both individual strategic preferences and local information can be formulated as lots of additional restrictions for the aggregated central planning problem. *The best achievable solutions* of the coalition may then have great deviations from the "optimal" solution obtained by models ignoring autonomy. To overcome this shortage, much more complicated algorithms are needed as central solver that can effectively process all local information and individual preferences. However, in a dynamic environment where additional restrictions reflecting environmental changes keep varying, the development of such a super algorithm will be extremely challenging.

The last factor is the transactional costs associated with CTP, which haven't been specifically studied yet. Activities including partner selection, bargaining and execution will cause many collaborative transaction costs. Thus, net benefits of the collaboration are actually less than the best achievable solutions offer.

Even if there is an appropriate expectation about the mutual benefits of the coalition, it is still not clear for individual participants, how much will they profit from the collaboration. This problem seems to be more important since the individual profit is the practical incentive for freight carriers to work together.

4.2 Egoistical rationality

The incentive of applying CTP is to increase participants' profits. However, regardless of the differences of individual planning, a collaborative planning or a central planning will only give participants a lower bound of their individual profits. Although a central planning considering all specifications of participants would achieve the maximal collaborative profits, some participants may still enlarge their profits by leaving from the central plan and shrinking partners' profits. Obviously this behavior is very "egoistical" and negative for the coalition. Nevertheless, if we assume that individual participants are rational and eager to maximize their own profits regardless of those of others, it seems to be more rational for them to deviate from central "optimum" to maximize own profits.

This dilemma will be even thornier for the following example. Suppose the situation where a participant offers a request for exchange with payment p, while another participant may execute this request with additional cost $c < p$. The latter partner may bid on this request for c, leaving the difference $\Delta = p - c$ as mutual benefits, or ask for p as transfer payment to keep all Δ without harming the exchange, with which both partners would be satisfied. It is admirable to reciprocate for the coalition by sharing Δ with partners but not rational for the own interest of a single partner.

The problem of how to offer individuals more incentives for not being selfish, or at least to reward someone's reciprocity is referred as the incentive compatibility problem [7][12]. A common way used in game theory to achieve this goal is to alternate the corresponding payoffs of egoistical behaviors to make them irrational. But we also have to recognize the limitation. If the compensation for being more cooperative, or more reciprocate are less than the benefits of behaving egoistically, such attempts will never succeed. In CTP context, this happens when the profit increment of mutual benefits is less than the benefits of behaving egotistically. Participants will otherwise get only a part of the additional mutual benefits as compensation for their scarification. This nature of CTP makes it impossible to use any profit sharing scheme to change participants' payoffs, or expectations of payoffs and force them to be more cooperative.

This dilemma causes also problems for the individual participants. Being too egotistic will make the coalition ineffective and will harm both the coalition and the individual partners themselves. It makes the decision quite irrational, since it is clearly dominated by the strategy to being totally reciprocate. It is then sophisticated to find out the best position.

4.3 Design of collaborative transport planning models

The next great challenge is the design of CTP models. A three-phase framework including preprocessing, profit optimization and profit sharing is proposed in [7]. We first discuss some general guidelines and then the three phases later.

4.3.1 General guidelines

The design of CTP models requires thinking holistically about all three phases. Participants may benefit from collaborating by 1) paying less for the execution of their transferred requests than their potential costs, 2) getting more paid for the fulfillment of partners' requests than their own costs, and 3) getting the shared mutual profits. All three possibilities need to be concretized in different phases considered simultaneously in the design.

The primary incentive to join in a groupage system is to gain more benefits. The goal of keeping the system profitable has two impacts. There must be enough cost-saving potentials and they have to be exhausted as much as possible. The first impact requires complementary request portfolios of participants, so that much synergy effects can be achieved. However, to identify how "complementary" two partners' portfolios are will not be easier than to specify the potential gains of collaboration. A heuristical resolution might be, to encourage partners to offer more requests for exchange. Exhausting the synergy effect means to find the best possible matching between the offered requests and capacities. For this purpose, coalition has to provide participants both sufficient information for their local decision-making processes and enough incentives for cooperative behaviors. Nevertheless, transactional costs of CTP have to be limited.

The second basic rule is "fairness". However, it seems impossible to give a definition of absolute fairness, with which no participant will disagree. Participant may have their own understandings of fairness, especially when it concerns with exposure of private information or transferring of decision competences, as well as with their shares of mutual benefits. The fairness principle can be relaxed that all the rules of a CTP must be enough fair perceived by individual participants to take part in it. Some general interpretations of fairness in CTP are:

- No one has to expose more private information than others.
- No one has to give up more competences than others.
- All contributions to the coalition, especially to a successful exchange leading to a win-win situation, should be awarded.
- The award for participants depends only on their contributions, but not on other characteristics.
- Same contribution has to be equally awarded.

Also, autonomy of partners must be acknowledged within the collaboration. It concerns primarily private information and decision competences. For different grades of autonomy with dissimilar willingness to expose private information and to abdicate decision competences, different models have to be developed.

The last point is simplicity of the processing. A collaborative model should be easy to understand by all participants for their execution. This will not only increase its acceptance but also help reducing transactional costs.

4.3.2 Preprocessing

The major task in this phase is to specify customer requests for exchange within the coalition and to identify the payments for transferring them to partners.

To specify which requests in the own portfolio should be offered for exchange is a pure local decision of autonomic collaboration partners and seems to be irrelative to the design of CTP models. However, in which form should a participant specify her requests must be given by the coalition and constitutes an important element of the design. Participants may offer requests both as single objects and as request bundles, which supposed to be completely transferred.

Generally, there are two principles for the evaluation of requests or request bundles. The first one is to use the customer payments as transfer price [11]. The challenge is how to encourage participants to report the real customer payments, which is strictly hidden as business secret. Another point that makes this method not realistic is the “egoistic rationality” (see Sec.4.2). For the request offering problem, it can be easily found for request bundles. Consider the situation where some requests can be well bundled together, and the resulting potential costs for this bundle are much less than the sum of customer payments. To offer less as transfer price seems more rational as to offer all customer payments, so long as it will not affect the exchange. This implies that to use customer payment as transfer price in the preprocessing phase doesn’t dominate the strategy of behaving somehow more egoistically.

Assume that individuals are aiming to maximize their own profits regardless of their partners’ and they believe in exchanges according to their knowledge. It will be more rational to build the transfer price based on the evaluation of requests’ potential costs using own disposable resources, keeping in mind that not all strategies are known in advance and their payoffs are hardly to be exactly identified. The advantage is that participants don’t have to worry about disclosing secret information. However, to determine the costs for a given request or request bundle may be quite complicated, since it relies on the composition of the whole request portfolio. It is especially intricate for the LTL business, when the request(s) would be executed with some others in a same route.

The payment p for transferring selected requests for exchange depends primarily on the possible execution cost of these requests using own disposable transport resources without collaboration c_0. The opportunity cost c_1 representing the evaluation of own capacities supposed to be engaged in fulfilling those requests also affects the payment amount. Furthermore, a participant may just behave selfishly and lower her offering payment by r. Suppose a certain collaborative result which could be achieved with both payments p_1 and p_2 with $r = p_1 - p_2 > 0$, this selfish behavior means keeping r for herself, which would otherwise be somehow shared with other partners as coalition profit. The last element to be considered is a preference value β for the requests offered. The payment can then be calculated as follows.

$$p = c_0 + c_1 - r + \beta$$

It is important to keep the evaluation of a given request or a request bundle simple and direct. For instance, it is much easier to evaluate the costs of a complete vehicle route with many LTL requests than each of them separately.

The opportunity cost factor may be not important if all capacities released by transferring own requests to partners will be reused for executing requests from other participants within the coalition. However, since capacities could be saved for new customer requests and would in turn bring more revenues (see Sec. 3), participants would pay more than their potential cost c_0 only.
It is clear that setting r too large will prohibit many exchanges from happing and reduce the possibility of transferring requests, which means a "lose-lose" situation. This gives a challenge on the design of CTP models to offer sufficient incentives to prevent individual participants from being too egoistic.
The preference value β measures how complementary these requests are with others in the own portfolio. The more complementary these requests are the more preferable are they to the participant. Other criteria apart from cost like quality, experiences, company strategy may also be taken into consideration. This measurement β may thus be negative if it is not important to transfer the according requests. It may also be greater than zero if the requests are so inconvenient for a participant so that she would rather pay some more to raise the possibility to transfer them to partners, than to fulfill these requests herself.

4.3.3 Exchange mechanism

It is aimed in the profit optimization phase to find out a mapping of requests offered for exchange and collaborating partners, so that the profit of the entire coalition is maximized [7]. An appropriate exchange mechanism has to be established to ensure an efficient exploration of cost-saving potentials.
A certain exchange mechanism will not work properly if it ignores the given autonomy grade of the collaborating partners. Consider an extreme situation where participants possess no autonomy, which makes the collaboration as a quasi fusion. All information would be processed centrally and the problem of profit optimization would be a routing problem for all vehicles of all participants. In another extreme situation, where all participants solve the request reallocating problem without mediators with accordingly competences, the CTP will work like an electronic transportation market [10]. For these two extreme situations, no mechanism with elaborated profit optimization function is needed. Between these two extreme values of grade of autonomy, participants may commit more or less decision competences to a mediator. Depending on the mediator's competences and available information from participants, the configurations of the exchange mechanisms will vary from each other.
Cost-saving potentials are embodied in the complementarities of single requests and are explored by combining them into bundles. The most intuitive examples of such bundles are vehicle routes. Thus a decisive factor for the success of a CTP model is to assist participants to excavate synergy effect by generating better bundles. However, this may lead to conflicts if some requests are included in more bundles. For the mediator, a simple splitting of certain bundles is definitely not a good solution, since the synergy effect would be destroyed. The situation

may be much worse for participants, whose bundles are only partially reassigned. In auctions, the problem of not obtaining a complete set of offered objects in a multi-object auction is called the exposure problem [9]. This trouble may be so severe that the new portfolio after exchange could be even less profitable for partners, when lots of centrally reallocated bundles are cut down for more mutual profits. This dilemma, to encourage the “troublesome” bundles and to offer enough incentives for inevitable splitting gives another great challenge.
The next great challenge is to ensure the functionality of the mechanism even if some participants play “non-cooperatively”, regardless if partners mean to. Participants may have different business focuses, or still need experiences with CTP. An exchange mechanism must still be working, even if such behaviors appear. The embodied profit optimization module should be able to find collaborative solutions, whereas the possible negative effects will be compensated. A better performance should be expected if the mechanism can eliminate the negative effect, so that no other partner will be “punished” by the “faults” of others. In order to fulfill these requirements, the mechanism should be able to limit such “non-cooperative” behaviors to minimum.
The last element to be concretized is the payment flow of exchanges. It is the basis for the calculation of both to be shared mutual profits of the whole coalition and the results for individual participants without shared profits.

4.3.4 Profit sharing scheme

A profit sharing scheme is the last component of a CTP model. The collaboration mutual profits achieved through exchanging requests in the profit optimization phase will be divided and given back to partners in a fair way.
The first difficulty is then to identify contributions to the coalition that should be awarded in the profit sharing phase. This identification has to be done both for the successful and profitable exchange for the short-run and for the sustainability and stability of the coalition for the long-run. After that, all identified elements must be given an appropriate weight, representing the evaluation of the importance of these identified contributions. Unfortunately, each participant will have their individual opinion on both the identification and weighting of awardable contributions. A pragmatic solution to resolve this conflict is to make an agreement that is fair enough to be accepted by all participants. Thus, the challenge on the design of CTP model is to find out a profit sharing scheme, which is fair enough to attract more possible participants to take part in while the profitability and sustainability of the coalition are strengthened.
The information required for a specific profit sharing scheme must be in accordance with those needed for the other parts of a CTP model. For instance, the idea proposed in [8] to use the Shapley value needs to know the collaborative benefits of all possible sub-coalitions. It is appropriate only if it is possible to employ a central planning or to repeat the same procedure of the first two stages of the models to get out the collaborative benefits for all sub-coalitions.

Profit sharing scheme may induce certain computational workloads as in [8] for both the mediator and the participants in the coalition. It is preferable to reduce these calculations to make the scheme easy for the implementation.

5. CONCLUSION

Request exchange among collaborating partners within CTP offers lots of potentials of cost-saving for freight carriers. Participants of such a groupage system can increase their efficiency while keeping their autonomy. In order to exhaust the potentials of the system, appropriate CTP models have to be developed. According to the willingness of participants to expose private information and to sacrifice decision competences, different compositions of CTP models are required. Based on the discussion about the chances and challenges related to CTP, we present both basic considerations for a better understanding of the complex problem and some challenging topics for future research. The first one is to estimate the collaborative benefits for the whole coalition and for each participant taking participants' autonomy into account. Nevertheless, a robust and efficient model is a crucial prerequisite for the success of CTP.

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МИНИМАЛЬНЫЙ ТРАНСПОРТНЫЙ СТАНДАРТ КАК ИНТЕГРАЛЬНЫЙ ПОКАЗАТЕЛЬ КАЧЕСТВА ТРАНСПОРТНЫХ УСЛУГ

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Аннотация: В статье рассмотрели методический подход формирования минимального транспортного стандарта как интегрального показателя качества транспортных услуг. Основной акцент сделан на составе единичных показателей качества, формирующих минимальный транспортный стандарт, в том числе на интегральной транспортной доступности.

MINIMUM VEHICLE STANDARDS AS AN INTEGRAL QUALITY OF TRANSPORT SERVICES

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Aim of this article is to develop a methodical approach to the minimal transport standard buildup and evaluation. Minimal transport standard is an integral indicator of the quality of transport services.
The research methodology is based on a systematic approach, complex analysis and synthesis method for ordering and groupings.
Structure of presentation corresponds to the logic of the study.
Main results. Considering the minimum vehicle standards (MTS) as an integrated indicator of the transport services quality, its characteristics were defined and they are reflected in the individual quality indicators. Due to the fact that transport is one of the critical infrastructure industries, providing the support for the country and its socio-economic development, we should first ensure that:

- meet the solvent demand for transport;
- services to enterprises and households are improved by expanding the range of services and improving their quality;
- restrictions imposed by the conditions of transportation on transport and economic links and the mobility of the population are weakened. The minimum transport standard (MTS) – is a set of interrelated indicators of consumption of transport services to

end consumers, which are important in everyday life. In contrast to the intermediate or pure sectoral indicators, key figures describing environments and those which are depend on the outcome of transport should be used in MTS. Key figures characterized by a set of indicators and their compliance with the standards by quantitative parameters. Range of indicators themselves and their values are determined depending on the strategic parameters of the local economic system, namely:

- GDP per capita (U.S. dollars);
- Life expectancy (years);
- level of budget costs for social needs (%);
- level of environmental safety (specific quantity of pollution, g / tkm);
- planning time-frame (long term).

MTS may include the following key indicators:

1) The share of transport pollution (%), including the "contribution" of vehicles in total vehicle pollution,%.
2) Reliability of road services (level of transport accessibility),%.

Basic measuring instrument - *integrated transport accessibility* (ITA) For freight traffic activities standard is 2.4 hours, for people traffic - 1,8 hours.

3) The level of transport discrimination of people on episodic Relations,%.
4) Lost Relative Fund of free time (for 1 person. Per week) an hour.
5) The level of road accidents caused by road units \ 100,000 trips.
6) Annual population mobility for social and cultural purposes, km / person. That is the minimum level of movements, ensured by the local transport system for every citizen.
7) Ratio of costs for infrastructure and rolling stock,%
8) The share of public transport in passenger transportation,%
9) Cargo intensity of the economy, tkm / 1 USD of GDP
10) The level of development of muscle types of transport (such as a bicycle) in urban and suburban,%
11) "Efficiency" integrated transport system.

Scientific novelty of the study is a methodological approach to the justification of individual quality indicators that form the MTS, their adaptation to local transport services and economic systems.

The practical significance of the issues addressed in this article is that the evaluation of the development of transport network in the region from the perspective of users of transport services appropriate to be carried out using MTS. In addition, the MTS can be used to justify the development of transport infrastructure at the level of local economic systems.

Услуги транспорта определяются как подвид деятельности транспорта, направленный на удовлетворение потребностей людей и характеризующийся наличием необходимого технологического, экономического, информационного, правового и ресурсного обеспечения. Под транспортной услугой подразумевается не только собственно перевозка грузов и пассажиров, а любая операция, не входящая в состав перевозочного процесса, но связанная с его подготовкой и осуществлением.

При изучении процесса формирования качества транспортных услуг, необходимо учитывать следующие особенности:

- выбор совокупности услуг требует рассмотрения всех возможных вариантов уровней транспортного обслуживания;
- потребностей у клиента может быть несколько, что влечет за собой соответствие свойств и характеристик услуг одновременно нескольким и зачастую противоречащим друг другу требованиям;
- при заключении договора запросы и потребности клиентов четко оговариваются и фиксируются;
- во многих случаях потребности клиента со временем меняются, что обуславливает необходимость периодического проведения маркетинговых исследований;
- потребности и запросы клиентов обычно выражаются в определенных свойствах с количественной их характеристикой и включают такие аспекты, как безопасность, функциональная пригодность, эксплуатационная готовность, надежность, экономические факторы, экологичность и т.д.

В связи с тем, что транспорт является одной из важнейших инфраструктурных отраслей, обеспечивающих жизнедеятельность страны и ее социально-экономическое развитие, следует прежде всего обеспечить:

- удовлетворение платежеспособного спроса на перевозки;
- улучшение обслуживания предприятий и населения путем расширения спектра предоставляемых услуг и повышения их качества;
- ослабление ограничений, накладываемых условиями перевозок на транспортно-экономические связи и подвижность населения.

Удовлетворение платежеспособного спроса на перевозки пассажиров и грузов является необходимым условием стабилизации и нормального функционирования экономики и социальной сферы. Задачи в этой области определяются прогнозируемыми на расчетные сроки величинами указанного спроса.

Цели относительно населения и потребителей транспортных услуг находят свое отражение в интегральном показателе качества транспортных услуг в Минимальном Транспортном Стандарте (МТС).

Минимальный транспортный стандарт (МТС) – это взаимосвязанный набор показателей потребления услуг транспорта конечным потребителем, которые являются важными в повседневной жизни.

В отличие от промежуточных и чисто отраслевых показателей таких как, отраслевая рентабельность, ввод дорог в эксплуатацию, коэффициент выпуска подвижного состава, характеризующих работу самого транспорта и обслуживающих его производств, в МТС должны использоваться показатели, характеризующие среду жизнедеятельности и зависящие от конечных результатов работы транспорта.

Для потребителя транспортных услуг (пассажиров, грузовладельцев) не столь важно, сколько участков сети реконструировано или отремонтировано, какова рентабельность дорожных ремонтно-строительных организаций, транспортных организаций и т.д., ему важны потребительские свойства конкретных маршрутов: скорость движения (затраты времени), безопасность, комфортность.

При этом условия характеризуются набором показателей, а их соответствие нормам - количественными параметрами. Круг самих показателей и их значения определяются в зависимости от стратегических параметров развития локальной экономической системы, а именно:

- ВВП на душу населения (долларов США);
- продолжительность жизни (лет);
- уровень расходов бюджета на социальные нужды (%);
- уровень экологической безопасности (удельная величина загрязнения, г/ткм);
- горизонт планирования, учитывая, что МТС должен отражать ценностные ориентации общества в долгосрочной перспективе.

Значения основных стратегических параметров определяется экспертно на основе анализа тенденций развития стран мирового сообщества, развития макроэкономической ситуации в стране Российской Федерации, существующего уровня и потенциала развития локальной экономической системы:

- ВВП задается на уровне 5000-10000 долларов США на душу населения (существующий уровень ВВП на душу населения составляет 904,2 долларов);
- продолжительность жизни задается 65 лет (сегодня 61,1 года);
- доля социальных расходов в бюджете должна быть на уровне не менее 20 %;
- уровень экологической безопасности задаем на уровне развивающихся стран со среднем уровнем развития (20 - 50 г/т.км.);
- горизонт планирования выбирается более 15 лет.

МТС может включать следующие основные показатели:

1) Доля транспорта в загрязнении окружающей среды (%), в том числе «вклад» автотранспорта в суммарном транспортном загрязнении, %.

Развитие транспортных систем породило проблему оценки влияния функционирования транспорта на экологию, которая может быть решена путем установления жестких норм, определяющих уровень экологической безопасности и стимулирования развития мускульных видов транспорта. Основные негативные последствия влияния транспорта на природную среду: атмосферное и шумовое загрязнения.

2) Надежность дорожного обеспечения (уровень транспортной доступности), %.

Базовый измеритель – *интегральная транспортная доступность* (ИТД) в отличие от принятой в градостроительной науке и описательной географии *парной транспортной доступности* показывает потенциальные возможности достижимости (по времени) из любой до любой другой точки рассматриваемой территории (сельсовет, сельский административных район, область, страна). ИТД является аналогом выгодности транспортно-географического положения каждой точки или локальной системы. ИТД измеряется в средних (средневзвешенных) чистых (нетто) затратах времени для достижения любой точки локальной системы по существующей или перспективной сети из заданной точки и отличается высокой чувствительностью даже к незначительным изменениям характеристик сети. ИТД может быть нормирована для грузоперевозок и пассажироперевозок, а последние – для получения регулярных и эпизодических услуг. Для грузоперевозок норматив 2,4 ч. (7 часов рабочий день минус время погрузочно-разгрузочных операций, деленные на 2 (2 конца) – исходя из суточных биологических циклов; для пассажироперевозок – 1,8 часа (в городах – 45 мин. для 90 % трудовых передвижений).

3) Уровень транспортной дискриминации населения по эпизодическим связям, %.

Уровень транспортной дискриминации населения показывает, какая доля населения локальной системы в % проживает вне нормативной зоны доступности.

4) Удельный потерянный фонд свободного времени (на 1 чел. в неделю),ч.

Суммарные непроизводительные потери времени на получение транспортных услуг социально-гарантированного минимума каждым жителем локальной системы в день (час). Количественное выражение данного стандарта позволяет оценить качество функционирования транспорта и его социальную (общественную) полезность.

5) Уровень ДТП по вине автодорог ед\100000 поездок.

Аварийность на транспорте – явление, сопровождающее развитие моторизации общества и приводящее к значительным потерям. Безопасность движения является критерием выбора транспортного средства.

6) Ежегодная подвижность населения с социально-культурными целями, км\чел., то есть минимальный уровень передвижений, который гарантирует каждому жителю локальная транспортная система.

Целевое выделение социально-культурных поездок связано с тем, что остальные поездки (на работу, учебу и т.д.) носят обязательный, вынужденный характер. Благодаря техническому прогрессу вынужденные поездки должны сокращаться, тогда как «свободные» - монотонно возрастать.

7) Соотношение затрат на инфраструктуру и подвижной состав, %
8) Доля общественного транспорта в пассажироперевозках, %
9) Грузоемкость экономики, ткм\1 USD ВВП

10) Уровень развития мускульных видов транспорта, (типа велосипеда) в городских и пригородных сообщениях, %

11) «Эффективность» Единой Транспортной системы.

Данный показатель рассчитывается как отношение результатов к затратам. В качестве результатов дается стоимостная оценка вклада транспорта в ВВП локальной системы (или валовую добавленную стоимость). Затратами являются вся сумма средств на финансирование локальной транспортной системы. Величина показателя больше 1 свидетельствует о целесообразности расширения финансирования транспортной локальной системы. Таким образом, оценивать результаты развития транспортной сети с позиции потребителей транспортных услуг целесообразно по МТС. Ежегодно органы управления транспортным комплексом и его отдельными отраслями должны показывать, в какой мере объем затраченных средств на ремонт, содержание, реконструкцию и строительство участков транспортных сетей способствовал улучшению вышеназванных показателей.

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KUNDENINTEGRATION IN HORIZONTALEN TRANSPORTKOOPERATIONEN

Herausforderung für Logistikdienstleister bei der Leistungsentwicklung und -vereinbarung in horizontalen Transportkooperationen

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Zusammenfassung: Der Beitrag befasst sich mit der Frage, wie der Leistungsanbahnungsprozess zwischen einem Transportdienstleister und mehren Verladern im Rahmen horizontaler Transportkooperationen gestaltet werden kann. Dabei wird insbesondere die Kundenintegration in der Phase der Leistungsdefinition und -vereinbarung als zentrale Herausforderung für Transportdienstleister fokussiert betrachtet. Während in der Literatur bei der Analyse der Herausforderungen horizontaler Transportkooperationen in der Regel die Perspektive der verladenden Unternehmen eingenommen wird, betrachtet dieser Beitrag die horizontale Transportkooperation zwischen Verladern unter Einbeziehung eines gemeinsamen Logistikdienstleisters aus der Dienstleisterperspektive. Ziel dieses Beitrags ist es aufzuzeigen, wie die Herausforderungen von LDL in der Zusammenarbeit mit horizontalen Verladerkooperationen mit Hilfe der aktuellen Dienstleistungsforschung konzeptionell erfasst werden können. Dazu bedient sich der Beitrag den konzeptionellen Grundlagen der Leistungslehre und des Dienstleistungsmarketing, um so die Interaktion des LDL mit den kooperierenden Kunden als Kundenintegrationsaufgabe zu formulieren. So lassen sich erste Hypothesen für die Gestaltung der Leistungsdefinition mit mehreren horizontal kooperierenden Verladern ableiten.

CUSTOMER INTEGRATION IN HORIZONTAL TRANSPORT ALLIANCES

Challenges for logistitcs service providers concerning solution development and solution negotiation processes in horizontal transport alliances

Purpose of the paper: Horizontal shipper alliances have attracted much interest in current logistics and transportation literature. Most contributions focus the shipper’s perspective on collaborative logistics solutions, although most alliances are characterized by a collaborative relationship of shippers with one logistics service provider (LSP), too. This paper takes the position of LSP who want to tender horizontal transport alliances. The objective is to develop a conceptual approach to formulate LSPs challenges in the service design and service negotiation phase as a customer integration problem and to develop a model for further research on customer integration in horizontal shipper alliances from an LSP’s perspective.

Design of the paper: In Section 2, we depict opportunities and challenges of LSPs to engage in horizontal shipper alliances. Section 3 describes how the depicted challenges of logistics service providers can be modelled as a customer integration problem. Then, two theses are formulated on how shippers can be enhanced to act as co-producers and co-designers in the service design and service negotiation process. Section 4 provides a summary of the outcomes and discusses possible further research steps.
Main results: In this paper, we addressed the opportunities and challenges of LSPs to engage in horizontal shipper alliances in the field of transportation. We argue that customer integration is the key challenge of logistics service providers who have to actively increase the awareness and willingness of industrial companies to act as co-designers and co-developers in collaborative transportation systems.
Academic contribution: The depicted approach to model the service design and service negotiation process in horizontal shipper alliances as a customer integration problem provides opportunities to apply existing outcomes of service research and service marketing in the field of logistics research. In particular, the approach can be used to conduct further conceptual and empirical research on tender management and solutions design in logistics and transportation alliances.
Managerial insights: The outcome of this paper contributes to understanding of customer integration processes in horizontal shipper alliances from an LSP perspective. The paper illustrates how service design and service negotiation processes can be planned and designed based on an understanding of customers knowledge and willingness to act as co-creators and co-developers of transportation solutions in horizontal shipper alliances.

1. EINFÜHRUNG UND ZIELSETZUNG

Horizontale Transportkooperationen zwischen Industrieunternehmen gewinnen zunehmend an Beachtung, da sie als neue Quelle von Synergieeffekten und als Ansatz für die Gestaltung ressourcenschonender Logistiksysteme erkannt werden [10]. Zwar sind in der Literatur zumeist Konsumgütertransporte als Anwendungsfall horizontaler Transportkooperationen untersucht worden, aber auch bei der Beschaffung und Distribution von Industriegütern lassen sich potenzielle Handlungsfelder für horizontale Transportkooperationen aufzeigen. Dabei ist insbesondere die Versorgung von Produktionsstandorten und die Beschaffung von Lieferanten bei hohen Transportdistanzen ein potenzielles Anwendungsfeld. Als Beispiel kann in der Automobilindustrie die Versorgung internationaler Produktionsstandorte durch europäische Lieferanten genannt werden. Dieser Argumentation folgend sind insbesondere Materialströme zur Versorgung der neu auf- und ausgebauten Produktionsstandorte in Osteuropa, Russland und Südeuropa potenziell interessante Anwendungsfälle für eine Bündelung von Materialströmen in horizontalen Transportkooperationen.

Neben den Möglichkeiten, die horizontale Transportkooperationen bieten, werden in der aktuellen Literatur auch zahlreiche Herausforderungen diskutiert. Zu nennen sind u.a. die Herausforderung der Partnerwahl, die Konkretisierung des Kooperationsgegenstandes (Sendungen der Unternehmen, die im Rahmen der Kooperation bearbeitet werden) sowie die Regeln für die Zusammenarbeit wie auch für die Ermittlung und Verteilung der Kooperationsgewinne [12]. Während bei der Analyse der genannten Herausforderungen in der Literatur zumeist die Perspektive der verladenden Unternehmen eingenommen wird, betrachtet dieser Beitrag die horizontale Transportkooperation zwischen diesen Unternehmen unter Einbeziehung eines gemeinsamen Logistikdienstleisters (LDL) aus der LDL-Perspektive. Ziel dieses Beitrags ist es aufzuzeigen, wie die Herausforderungen von LDL in der Zusammenarbeit mit horizontalen Verladerkooperationen mit Hilfe der aktuellen Dienstleistungsforschung konzeptionell erfasst werden können. Dazu bedient sich der Beitrag den konzeptionellen Grundlagen der Leistungslehre und des Dienstleistungsmarketing, um so die Interaktion des LDL mit den kooperierenden Kunden als Kundenintegrationsaufgabe zu formulieren. So lassen sich erste Hypothesen für die Gestaltung der Leistungsdefinition mit mehreren horizontal kooperierenden Verladern ableiten.

2. CHANCEN UND HERAUSFORDERUNGEN HORIZONTALER TRANSPORTKOOPERATIONEN FÜR LOGISTIKDIENSTLEISTER UND VERLADER

Chance und Herausforderungen durch horizontale Transportkooperationen für Verlader

In der Logistikforschung hat die Untersuchung von Kooperationen *entlang* der Wertschöpfungskette Tradition. Neben vertikalen Logistikkooperationen ziehen jedoch horizontale Logistikkooperationen zunehmend Aufmerksamkeit auf sich, insbesondere in der Transportlogistik [1][8]. Insbesondere horizontale Transportkooperationen zwischen Verladern gewinnen dabei in den letzten Jahren an Beachtung [13][1][18]. Eine umfassende Darstellung und Diskussion der Potenziale und Herausforderungen horizontaler Transportkooperationen aus Verladersicht wird von Cruijssen, Dullaert und Fleuren vorgestellt [11][12].

Als Hauptvorteil horizontaler Transportkooperationen wird die kosteneffiziente *Transportbündelung* und damit die Effizienzsteigerung sowohl auf der Inputseite durch Kostensenkungen, als auch auf der Output-Seite durch eine Steigerung des Lieferservice genannt [8][25]. Während bei der Bündelung von Sendungen durch LDL vorwiegend die Routen- und Tourenverdichtung im Vordergrund stehen, können Verlader in horizontalen Kooperationen zusätzlich eine Optimierung der Bündelung durch eine Sendungsverdichtung erreichen. Erfolg versprechend sind neben den bereits wissenschaftlich untersuchten Transporten in der Konsumgüterdistribution vor allem eine Zusammenarbeit von Unternehmen, welche die gleichen oder räumlich sehr nahe gelegene Sendungsziele haben. Regelmäßig wiederkehrende Anlieferungen, räumlich eng verdichtete Sendungsziele, lange Transportdistanzen und hohe Liefervolumen charakterisieren jedoch insbesondere internationale Beschaffungs- und Versorgungstransporte. Am Beispiel der Automobilindustrie ist daher die Materialversorgung internationaler Produktionsstandorte durch deutsche und europäische Lieferanten ein potenzielles Handlungsfeld. Hier könnte insbesondere die Versorgung neuer Produktionsstandorten in Osteuropa und Russland ein Anwendungsfall sein.

Möglichkeiten und Herausforderungen durch horizontale Transportkooperationen für Logistikdienstleister

Auch für LDL stellen horizontale Verladerkooperationen Möglichkeiten für die Erzielung von Effizienzgewinnen dar. Möglichkeiten ergeben sich insbesondere durch zusätzliche Bündelungseffekte in den von LDL betriebenen Transportnetzwerken [2]. Horizontale Kooperationen stellen somit ebenso für LDL einen Ansatzpunkt für die Effizienzsteigerung dar [10]. Neben Effizienzsteigerungen durch Bündelungseffekte sind weitere Vorteile für LDL zu vermuten. So kann durch die Bündelung der Sendungen mehrerer Verlader eine Auslastungsglättung erreicht werden, die sich vorteilhaft auf den Ressourceneinsatz und damit auf die Kostensituation von LDL auswirken kann. Darüber hinaus kann die Konzipierung kundenspezifischer Transportsysteme für horizontale Verladerkooperationen von LDL auch als Chance für Produktdifferenzierungsstrategien verstanden werden. Cruijssen sieht in horizontalen Logistikkooperationen daher die Möglichkeit für eine proaktive Marktbearbeitung durch LDL bei einer partiellen Beteiligung der Unternehmen an den Effizienzgewinnen der Kooperation [9][10].

Die Herausforderungen bei der Zusammenarbeit mit horizontal kooperierenden Verladern wurden aus Dienstleistersicht in der Literatur bislang nur ansatzweise untersucht [15]. Daher soll hier auf die in der allgemeinen Dienstleistungsliteratur vorhandenen Konzepte zurückgegriffen werden. Da die Zusammenarbeit von LDL mit horizontal kooperierenden Verladern zu einer Spezialisierung und Komplexitätssteigerung der Dienstleistungskonzepte führt, ist mit einer umfänglichen Abstimmung sowohl zwischen den Verladern als auch zwischen LDL und Verladern zu rechnen. Die Realisierung von Synergieeffekten kann dabei eine Abstimmung der verladenden Unternehmen von der Auswahl von Transporteuren, der Planung von Lieferzeitpunkten und -orten über die Abstimmung von Transportmodi, Transportmittel und Verpackungsmaterialien bis hin zu einer gemeinsamen Touren- und Routenplanung notwendig machen. Daher sind die beteiligten Unternehmen in einem deutlich stärkeren Ausmaß an der Mitgestaltung der Leistungen einzubinden, als dies in klassischen Tenderprozessen üblich ist.

Die Integration von Akteuren in die Leistungserstellung von Unternehmen ist in der betriebswirtschaftlichen Forschung mit unterschiedlichen Schwerpunkten untersucht worden. Da Logistikdienstleistungskonzepte im Rahmen horizontaler Logistikkooperationen den Charakter von kundenindividuellen Lösungen haben, wird in diesem Beitrag die Kundenintegration als konzeptioneller Rahmen zur Beschreibung der Herausforderungen von LDL in lateralen Logistikkooperationen gewählt [6][29]. Der *Kundenintegration* wird in den unterschiedlichen Denkschulen der Dienstleistungsforschung gleichermaßen eine zentrale Rolle eingeräumt [4][19] [16]. Kundenintegration im weiteren Verständnis bezeichnet die systematisch geplante Beteiligung des Kunden an unternehmerischen Prozessen des Dienstleisters. Der Kunde wird dabei nicht nur als Produktivressource im Leistungserstellungsprozess betrachtet, er wird vielmehr zum Co-Designer und Co-Creator bei der Gestaltung von Leistungen [3]. Neben der Leistungslehre betonen insbesondere jüngere angloamerikanische Ansätze der Dienstleistungsforschung die Bedeutung der Einbindung des Kunden [21][31][32][33] und [34]. In der Leistungslehre wird der Nachfrager zum Co-Produzenten und zum Co-Disponenten eines durch seine Beteiligung individualisierten Leistungsbündels. Im Gegensatz zu dem autonomen Aufbau des Leistungspotenzials eines Dienstleistungsunternehmens erfolgt der Leistungserstellungsprozess integrativ, d.h. unter der dispositiven und ausführenden Beteiligung des Kunden. Der Leistungserstellungsprozess wird daher auch als *Kundenintegrationsprozess* bezeichnet [5][17]. Im Gegensatz zu den internen Faktoren werden *externe Faktoren* dem Anbieter vom Nachfrager zur Verwendung in einem konkreten Leistungserstellungsprozess zur Verfügung gestellt, sie unterliegen dabei nicht der autonomen Disposition des Anbieters und sie werden entweder mit internen Faktoren kombiniert oder in den Leistungserstellungsprozess integriert [17].

3. GESTALTUNG DER KUNDENINTEGRATION ALS HERAUSFORDERUNG FÜR LOGISTIKDIENSTLEUSTER IN HORIZONTALEN TRANSPORTKOOPERATIONEN

Modellierung der Herausforderungen von Logistikdienstleistern in horizontalen Transportkooperationen als Kundenintegrationsproblem

Der Leistungserstellungsprozess individueller Logistikdienstleistungen umfasst auch alle der Leistungserbringung vorgelagerten Prozessschritte, an welchen Kunden beteiligt werden [24]. In diesem Beitrag werden insbesondere die Aktivitäten der Planung und Konzipierung neuer, kundenindividueller Dienstleistungen im Rahmen lateraler Logistikkooperationen fokussiert. Diese Fokussierung stützt sich auf die grundsätzlich in der Dienstleistungsforschung vertretene Position, dass die

Beteiligung des Kunden an der Leistungserstellung nicht nur die Leistungserbringung im Sinne der Faktor-Endkombination umfasst, sondern auch die Vorbereitung und Planung von Dienstleistungsprozessen zur Leistungserstellung zu zählen ist [17]. Nach Maleri sind in der Phase der Leistungsdefinition und -vereinbarung vorwiegend die dispositive Beteiligungen des Kunden zu berücksichtigen [21]. Nach Fließ kann die dispositive Ebene der Kundenintegration durch die Berücksichtigung von Verfügungsrechten, Nominalgütern und Informationen als externe Faktoren berücksichtigt werden [17]. Informationen können als Faktoren weiter untergegliedert werden nach der Art ihrer Verarbeitung. Dabei sind insbesondere Informationen interessant, die im Rahmen der Steuerung des Leistungserstellungsprozesses genutzt werden, ohne dass sie direkt in eine Faktorkombination eingehen (steuernde oder dispositive Prozessinformationen) [17]. Durch sie werden die Erwartungen der kooperierenden Nachfrager hinsichtlich Art, Umfang und Qualität der in der Kooperation erbrachten Leistung konkretisiert [17]. Dies umfasst Erwartungen der Nachfragers bezüglich des Kooperationsgegenstandes (u.a. hinsichtlich der zu bedienenende Relationen, der einzusetzende Transportmittel, Transportmodi und Technologien sowie hinsichtlich Volumen-, Häufigkeit und Frequenz der Transporte) und auch die Erwartungen der Nachfragers hinsichtlich der Gestaltung des Kundenintegrationsprozesses durch den Logistikdienstleister [17][28]. Dabei spielt insbesondere der Integrationsgrad eine wichtige Rolle: Der Frage, an welchen Prozessschritten bei der Dienstleistungsgestaltung die beteiligten Unternehmen in welchem Umfang eingebunden sein wollen [26][27]. Die klassischen vom Kunden erbrachten Prozesse bei der Vergabe von Logistikdienstleistungen sind dabei um Prozesse der Partnerwahl, der Analyse der Kooperationspotenziale, Prozesse der Regelentwicklung für die Kooperation und Prozesse zur Verhandlung der Leistungsverrechnung – d.h. zur Einigung über die Verteilung der erzielten Kooperationsgewinne – zu ergänzen. Diese Aufgaben können jedoch auch, hier wird die zentrale Rolle des LDL in horizontalen Logistikkooperationen deutlich, zu einem mehr oder weniger hohen Anteil autonom vom LDL geplant werden. Je nach dem Umfang und der Intensität der Beteiligung der Kunden an diesen Prozessschritten wird die Dienstleistung in einem stärkeren oder weniger starken Ausmaß individualisiert. Aus der Sicht des LDL stellt daher die Bestimmung der Kundenbeteiligung eine Herausforderung dar [17].

Modellierung der Herausforderungen von Logistikdienstleistern in horizontalen Transportkooperationen als Kundenintegrationsproblem

Bei der Integration von Kunden in die Wertschöpfungsprozesse von Logistikdienstleistern ist es zweckmäßig, die Phasen der Leistungsdefinition,- vereinbarung und -erstellung gedanklich zu trennen, da sich die Art und Umfang der eingesetzten externen Faktoren des Kunden im Leistungserstellungsprozess unterscheiden. Eine

Fokussierung der Phase der Leistungsdefinition und -vereinbarung lässt sich durch ein Aufgreifen der Prozessschritte erreichen, die in einem klassischen Tenderprozess in der Domäne des Kunden liegen [24]. Die sind die (1) Entwicklung und die Verifikation des Auslagerungsbedarfs, die (2) Formulierung der Leistungsanforderungen, ggf. (3) die Einbeziehung weiterer Anbieter, (4) die Beurteilung und Mitgestaltung der Leistungskonzeption sowie schließlich die (5) Beteiligung an den Vertragsverhandlungen bis zum Vertragsschluss. Die Aufgaben der Kooperationspartnerwahl, der Analyse der Kooperationspotenziale sowie der Verhandlung der allgemeinen Kooperationsbedingungen und der Verteilung von Kooperationsgewinnen können diesen Phasen zugeordnet werden. Es ergibt sich das nachfolgend dargestellte Modell eines integrativen Prozesses der Leistungsdefinition und -vereinbarung in horizontalen Transportkooperationen. Dabei ist davon auszugehen, dass die Reihenfolge der Bearbeitung der einzelnen Prozessschritte und die Form der Prozessbearbeitung (Subprozesse, Kommunikationswege und zum Einsatz kommende Routinen und Prozeduren) davon abhängig gewählt werden, wie stark die Kunden an den einzelnen Prozessschritten beteiligt sind. Die Steuerung der Kundenbeteiligung durch den LDL muss dabei berücksichtigen, in welchem Umfang die Kunden fähig und bereit sind, sich aktiv in die Gestaltung der Leistungsanbahnung einzubringen. Diese Eigenschaften werden in der Dienstleistungsforschung mit dem Konstrukt der *Prozessevidenz* beschrieben. Die *Prozessevidenz* setzt sich zusammen aus der Problemevidenz und der Integrationsevidenz [17].

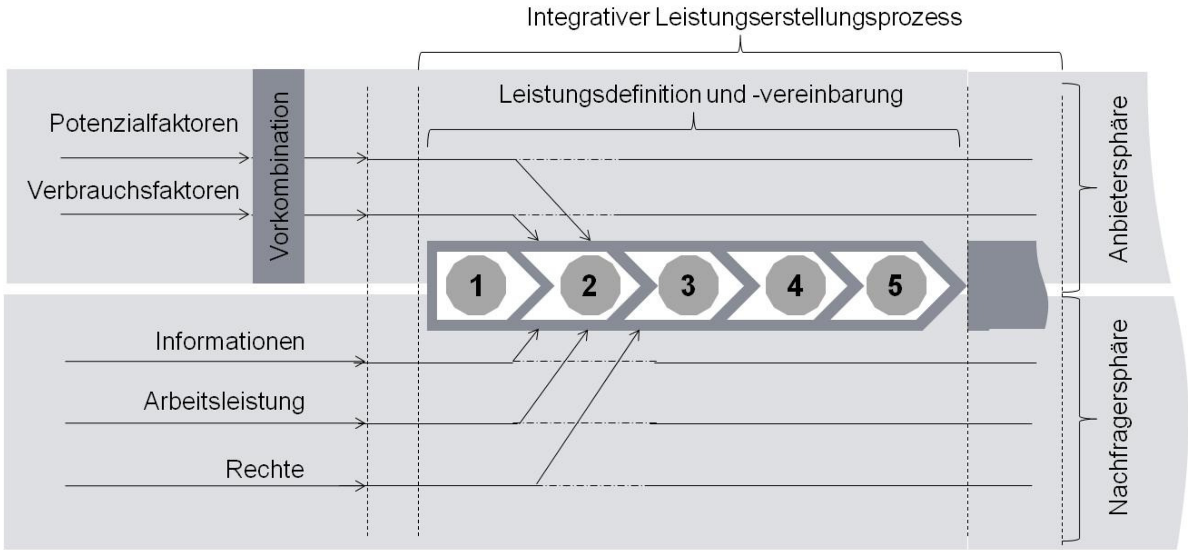

Abb. 1: Gestaltung der Phase der Leistungsdefinition und -vereinbarung in lateralen Logistikkooperationen. Eigene Darstellung.

Die *Problemevidenz* beschreibt in lateralen Logistikkooperationen die Kenntnis des Nachfragers über dessen Vorteile durch eine Beteiligung an der Transportkooperation. Problemevidenz kann mit Hilfe der Parameter Problembewusstsein und Problemtransparenz erfasst werden [17]. Eine mangelndes Problembewusstsein der Nachfrager liegt vor, wenn die Vorteile der horizontalen Kooperation (i.d.R. die Kosteneinsparungen) kundenseitig nicht erkannt werden und daher mangelndes Interesse an einer Kooperationsbeteiligung besteht. Mangelnde Problemtransparenz hingegen liegt vor, wenn die Kunden zwar den Nutzen der Transportkooperation erkennen können, jedoch nicht in der Lage sind, ihre Präferenzen hinsichtlich der Zusammenarbeit (Kooperationsgegenstand, Leistungs-anforderungen, Partnerwahl etc.) so zu formulieren, dass eine Konzeptentwicklung durch den Dienstleister ermöglicht wird. Problemtransparenz kann zwar durch Beratungstätigkeiten und unterstützende Analysen des LDL aufgebaut werden, allerdings ist eine Mindestniveau an Problembewusstsein aller beteiligten Akteure erforderlich, damit diese Hilfestellungen des LDL angenommen und horizontale Transportkooperationen erfolgreich geplant und umgesetzt werden können. Daraus kann folgende Forschungshypothese 1 zur Problemevidenz abgeleitet werden.

Hypothese 1 (Problemevidenz): LDL können in horizontalen Verladerkooperationen eine unzureichende Problemtransparenz der beteiligten Unternehmen durch unterstützende und beratende Maßnahmen in den ersten Phasen der Leistungsdefinition aufbauen, sofern ein ausreichendes Problembewusstsein der Verlader bereits vorhanden ist.

Das zweite Element der Prozessevidenz stellt die Integrationsevidenz dar, die das Wissen und die Bereitschaft der Nachfrager beschreibt, sich in der lateralen Logistikkooperation mit steuernden Prozessinformationen einzubringen. Integrationsevidenz ist ebenso wie die Problemevidenz operationalisierbar durch die Parameter Integrationsbewusstsein und Integrationstransparenz [17]. Das Integrationsbewusstsein beschreibt das Wissen der an der Kooperation beteiligten Partner über die Erfolgswirkung ihrer Einbringung durch steuernde Prozessinformationen. Bei einem nicht ausreichend vorhandenen Integrationsbewusstsein sind die Nachfrager auch bei vorhandener Problemevidenz nicht bereit, sich in der vom Dienstleister gewünschten Weise in den Prozess der Leistungsdefinition und -vereinbarung einzubringen, da der Kunde die Gestaltungsaufgabe der Konzeptentwicklung freiwillig an den LDL überträgt. Prozessinformationen werden zu spät oder in unpräziser Weise eingebracht, Mengengerüste und Leistungsspezifika sind nicht präzise ausgearbeitet. Integrationstransparenz beschreibt die Fähigkeit und die Motivation des Kunden, sich in einer zielführenden Weise in den Kundenintegrationsprozess einzubringen. Aus der Sicht von LDL ergibt sich die Herausforderung, ein ausreichendes Niveau an Integrationsbewusstsein und Integrationstransparenz der an der Kooperation beteiligten Partner zu erzielen. Dabei ist anzunehmen, dass durch die Schaffung von Integrationsbewusstsein leichter ist als der Aufbau von Fähigkeiten und Kompetenzen. Das Niveau der Kundenbeteiligung wird ist daher auf Basis der Integrationskompetenz zu steuern. Problemevidenz und Integrationsbewusstsein bilden die Voraussetzung für eine erfolgreiche Beteiligung der Kunden an der Leistungsdefinition und -vereinbarung und sind – sofern nicht bereits vorhanden – durch geeignete Maßnahmen aufzubauen. Daraus lässt sich Hypothese 2 über die Integrationsevidenz in horizontalen Transportkooperationen ableiten.

Hypothese 2 (Integrationsevidenz): Die Integrationsevidenz der Akteure einer horizontalen Transportlogistikkooperation kann durch den Aufbau von Integrationsbewusstsein gesteigert werden. Dabei determiniert die vorhandene Integrationstransparenz der Akteure das Niveau der erreichbaren Integrativität in horizontalen Transportkooperationen.

4. FAZIT UND AUSBLICK

Ziel des vorliegenden Beitrags war es aufzuzeigen, wie die Herausforderungen von Logistikdienstleistern (LDL) bei der Zusammenarbeit mit horizontalen Verladerkooperationen im Transport konzeptionell erfasst werden können. Durch die Darstellung der Zusammenarbeit von LDL und Verladern als Kundenintegrationsprozess konnte gefolgert werden, dass insbesondere die Steuerung der Integrativität in Abhängigkeit der Problemevidenz und der Integrationsevidenz eine Herausforderung für LDL darstellen.

Mit dem Konzept der Kundenintegration in individuellen Dienstleistungen konnte ein geeigneter Ansatz zur Systematisierung der Herausforderungen von LDL bei der Leistungsdefinition und -vereinbarung mit horizontal kooperierenden Kunden aufgezeigt werden. Die entwickelten Thesen geben erste Hinweise darauf, wie die Kundenbeteiligung bei der Leistungsdefinition und -vereinbarung in horizontalen Transportkooperationen seitens des LDL zu steuern ist. Im weiteren Forschungsprozess ist das entwickelte Konzept auf konkrete Ausprägungen von horizontalen Transportkooperationen zu übertragen um die dort vorliegenden spezifischen Merkmale und Anforderungen zu berücksichtigen. Dabei ist insbesondere eine Konkretisierung der Anforderungen an die Kundenintegrationsprozesse im Bereich des Straßengüterverkehrs und im Bereich des Intermodalverkehrs Straße-Schiene anzustreben, wenn der eingangs skizzierte Anwendungsfall weiter untersucht werden soll, der eine Versorgung osteuropäischer und russischer Produktionsstandorte der Automobilindustrie beinhaltet.

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ИННОВАЦИОННОЕ ПРЕДСТАВЛЕНИЕ ТРАНСПОРТНОЙ ЛОГИСТИКИ

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Аннотация: Системно представлен обширный теоретический и практический материал по транспортной логистике и управлению цепями поставок (SCM). Развитие транспортной и информационной логистики оказывает существенное влияние на формирование облика SCM как новой парадигмы логистики. Статья посвящена инновационному представлению транспортной логистики - этапу формирования транспортных и информационных логистических технологий на основе практической реализации документарно-операционной парадигмальной (ДОП) -теории транспортной логистики.

Цель статьи (Purpose of the paper)
Современный научно-технический прогресс предполагает создание интеллектуального продукта как результата инновационной деятельности.
Основное отличие инновации как процесса преобразования знаний и идей в товары или услуги (технологии) состоит в создании потребительской ценности. Научно-техническая новизна инновационных продуктов и технологических процессов является обязательным свойством инновации.

Метод исследования (Research/application methodology)
Продуктовые и процессные (технологические) инновации, которые выделяются при классификации инноваций, резко различаются по структуре «цикла жизни».
Инновационное представление транспортной логистики основано на отличии жизненного цикла инновационной технологии, представляющего собой процесс превращение знаний и идей в деньги, от жизненного цикла инновационного продукта как проекта требующего значительных инвестиций.

Структура изложения материала (Design of the paper)
Особенности транспортной логистики, как основного компонента SCM, были впервые представлены на DR-LOG'10. Знания и идеи транспортной логистики сформулированы в документарно-операционной парадигмальной (ДОП) - теории транспортной и информационной логистики.
Инновационное представление транспортной логистики базируется на классическом определении «логистической технологии» как стандартной (стандартизированной) последовательности действий выполнения логистической функции в функциональной области логистики (или алгоритм процесса в логистической системе), поддерживаемых соответствующей информационной системой и воплощающих определенную логистическую концепцию.

Основные результаты (Main results)
Транспортная и информационная логистика представляется на трех иерархических уровнях абстрагирования:

- верхний уровень - логистика как наука,
- средний уровень (с повышением детальности описания) - логистика как инструмент управления
- нижний уровень – логистика как вид деятельности.

Каждый уровень абстрагирования логистики сверху и снизу поддерживается научной или нормативно-правовой средой:

- Когнитивно-гносеологическая (онтологическая, эпистимологическая) системная среда.
- Предметная (проблемная) нормативная правовая среда логистики.
- Нормативная правовая среда, регулирующая хозяйственную деятель-ность (на транспорте).
- Общегражданская нормативная правовая среда (экономика).

Научная новизна (Academic contribution)

В статье авторы предлагают схему позиционирования и структурирования транспортной, информационной и других разделов логистики, как областей научно-прикладных исследований, основанную на теоретико-множественном подходе к системной интеграции логистический действий (активностей).

Схема представляет собой четырехкратное пересечение базовых множеств: транспорт $\mathbf{T=\{t_i\}}$, логистика $\mathbf{L=\{l_j\}}$, информатика $\mathbf{R=\{r_e\}}$, системный подход $\mathbf{S=\{s_k\}}$.

Практическая значимость (Managerial insights)

Авторы сформулировали логистические концепции (ЛК), которые подтверждают работоспособность ДОП-теории логистики в рамках SCM как парадигмы логистики:

- ЛК электронизации межтранспортного документооборота для создания логистических центров в транспортных коридорах и припортовых транспортных узлах;
- ЛК транспортно-логистического сорсинга:
- ЛК обеспечения безопасности интермодальных перевозок и облегчения внешнеэкономической деятельности.

Новые ЛК разработаны авторами на основе формального описания SCM, анализа новых нормативных правовых документов (федеральных законов), направленных на поддержку среднего и малого бизнеса, международных соглашений, связанных с упрощением процедур таможенного контроля при международных перевозках и других этапах внешнеэкономической деятельности.

INNOVATIVE REPRESENTATION OF TRANSPORT LOGISTICS

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Article purpose (Purpose of the paper)
Modern scientific and technical progress assumes creation of an intellectual product as result of innovative activity. The basic difference of an innovation as process of transformation of knowledge and ideas in the goods or services (technology) consists in creation of consumer value. Scientific and technical novelty of innovative products and technological processes is obligatory property of an innovation.
Research method (Research/application methodology)
Grocery and process (technological) innovations which are allocated at classification of innovations, sharply differ on structure «life cycle».
Innovative representation of transport logistics is based on difference of life cycle of the innovative technology representing process transformation of knowledge and ideas in money, from life cycle of an innovative product as project demanding considerable investments.
Structure of a statement of a material (Design of the paper)
Features of transport logistics as basic component SCM, for the first time have been presented on DR-LOG ' 10. Knowledge and ideas of transport logistics is formulated in dokumentarno-operational paradigmal (DOP) - theories of transport and information logistics.
Innovative representation of transport logistics is based on classical definition of "logistical technology» as standard (standardised) sequence of actions of performance of logistical function in functional area of logistics (or algorithm of process in logistical system), supported by corresponding information system and embodying the certain logistical concept.
The basic results (Main results)
The transport and information logistics is represented at three hierarchical levels of abstraction:
- Top level - logistics as a science,
- An average level (with increase of detail of the description) - logistics as the management tool
- The bottom level - logistics as an activity kind.

Each level of abstraction of logistics from above and from below is supported by the scientific or is standard-legal environment:
- Kognitiv-gnoseological (ontological, epistimological) the system environment.
- The subject (problem) standard legal environment of logistics.
- The standard legal environment regulating economic activities (on transport).
- The civil law standard legal environment (economy).

Scientific novelty (Academic contribution)
In article authors offer the scheme of positioning and structurization transport, information and other sections of logistics, as areas scientifically-applied researches, based on the theoretical-multituderal approach to system integration logistical actions (activities).
The scheme represents quadruple crossing of base sets: transport $\mathbf{T = \{t_i\}}$, logistics $\mathbf{L = \{l_j\}}$, computer science $\mathbf{R = \{r_e\}}$, system approach $\mathbf{S = \{s_k\}}$**.**
The practical importance (Managerial insights)
Authors have formulated logistical concepts (LC) which confirm working capacity of the DOP-theory of logistics within the limits of SCM as logistics paradigms:
- LC electronic intertransport document circulation for creation of the logistical centres in transport corridors and припортовых transport knots;
- LC transportno-logistical soursing:

- LC safety maintenance intermodal transportations and simplification of foreign trade activities.

New LC are developed by authors on the basis of formal description SCM, the analysis of new standard legal documents (federal laws), the average directed on support and a small-scale business, the international agreements connected with simplification of procedures of the customs control at the international transportations and other stages of foreign trade activities.

1. ВВЕДЕНИЕ

В современной экономике инновации представляют собой эффективное средство конкурентной борьбы, позволяющее создать конкурентоспособную продукцию или технологии, имеющую высокую степень наукоемкости и новизны. Современный научно-технический прогресс немыслим без интеллектуального продукта, получаемого в результате инновационной деятельности.

Официальная российская терминология в области инновационной деятельности [1] дает следующее определение «Инновация (нововведение) - конечный результат инновационной деятельности, получивший реализацию в виде нового или усовершенствованного продукта, реализуемого на рынке, нового или усовершенствованного технологического процесса, используемого в практической деятельности».

Таблица 1. Особенности содержания понятия «инновация и других понятий

Понятия (вид деятельности)	Особенности содержания понятий	
	Вид деятельности	Инновация
Творчество	Генерация новых идей.	Претворение этих новых идей в жизнь.
Изобретение	Создание новой концепции.	Выделение практической ценности изобретения и превращение его в успешно продаваемый продукт.
Наука (открытие)	Превращение денег в знания и идеи.	Превращение знаний и идей в деньги.
Хозяйственные операции	Операции создают сегодняшние доходы.	Инновации создают завтрашние доходы.

С термином «инновация» связаны такие понятия как «изобретение», «наука (открытие)», «творчество» и др. Особенности содержания этих понятий показаны в табл.1.

Из анализа сопоставлений, представленных в табл.1, определяется основное отличие инновации как процесса преобразования знаний и идей в товары или услуги (технологии), имеющие потребительскую ценность. Непременным свойством инновации является научно-техническая новизна инновационных продуктов и технологических процессов.

При классификации инноваций [2,3] выделяют *продуктовые и процессные (технологические) инновации*, которые резко различаются по структуре «цикла жизни». «Цикл жизни» инновации - совокупность взаимосвязанных явлений, процессов, работ, образующих законченный круг развития в течение какого-либо промежутка времени, когда инновация обладает активной жизненной силой и приносит производителю и/или продавцу прибыль или другую реальную выгоду.

Инновация *продукта* является реализованным на рынке результатом, полученным от вложения капитала (инвестиций) в новый продукт. При всем разнообразии рыночных продуктовых новшеств важным условием для их практической реализации является *привлечение инновационных инвестиций в достаточном объеме*.

Жизненный цикл инновационного продукта состоит из семи стадий (разработка продукта, выход на рынок, развитие, стабилизация, уменьшение, подъем, и падение рынка), часть которых в начале и конце цикла *требует значительных инвестиций*: поиск инновационных идей, оценка их перспективности, разработка и экспертиза бизнес-плана, экспериментальное производство, корректировка выхода и поддержание продукта на рынке.

Инновационное представление транспортной логистики основано на отличии жизненного цикла инновационной технологии, представляющего собой процесс превращение знаний и идей в деньги, от жизненного цикла инновационного продукта как проекта требующего значительных инвестиций.

Особенности транспортной логистики, как основного компонента SCM, были впервые представлены на DR-LOG'10 [4]. Знания и идеи транспортной логистики сформулированы в документарно-операционной парадигмальной (ДОП) - теории транспортной и информационной логистики [5].

Инновационное представление транспортной логистики базируется на классическом определении «логистической технологии» как стандартной (стандартизированной) последовательности действий выполнения логистической функции в функциональной области логистики (или алгоритм процесса в логистической системе), поддерживаемых соответствующей информационной системой и воплощающих определенную логистическую концепцию [6].

Создание *инновационных технологий вообще и транспортных логистических технологий в частности*, представляет собой процесс превращение логистических знаний и идей в деньги на основе жизненного цикла, состоящего из четырех стадий:

- разработка новой транспортной логистической технологии и ее оформление в виде нормативно-технологического документа;
- реализация новой транспортной логистической технологии с использованием информационной системы;
- выход новой технологии и формирование соответствующего сегмента на рынке транспортных услуг;
- падение спроса и модернизация логистической технологии в соответствии с требования рынка транспортных услуг.

По этой схеме ниже изложено инновационное представление транспортной логистики.

2. ТЕОРЕТИЧЕСКИЕ ОСНОВЫ ТРАНСПОРТНОЙ ЛОГИСТИКИ

Проблеме позиционирования и идентификации транспортной логистики уделено значительное внимание в отечественной литературе. Однако практически во всех публикациях транспортная логистика рассматривается как вид деятельности, а информационная логистика – как среда управления.

В этих и других методологических разработках транспортная логистика представляется в «двухкомпонентном» составе [6,7]:

- одна часть - логистика транспорта, присутствие на транспорте основных разделов логистики (снабжения, складирования, сбыта и т.д.);
- другая часть - транспортное обеспечение логистики (выбор транспортного средства/перевозчика, организация перевозок и т.п.).

Такой подход справедлив и уместен, когда транспортная логистика рассматривается, как вид (область) деятельности, хотя логистика может рассматриваться еще, как минимум, в двух ипостасях (уровнях абстрагирования): как инструмент управления и как область науки.

Непротиворечивость приведенных выше формализованных представлений о логистике, как сфере деятельности, а также изложенных в настоящей работе теоретических положений о транспортной и информационной логистике, как области науки и некоторых концептуальных и технологических разработок для логистики, как инструмента управления, представлена на рис.1. Верхний уровень абстрагирования составляет логистика как наука, более низкий уровень (с повышением детальности описания) составляет логистика как инструмент управления и еще ниже – логистика как вид деятельности. Каждый иерархически расположенный уровень абстрагирования логистики сверху и снизу поддерживается научной или нормативно-правовой средой:

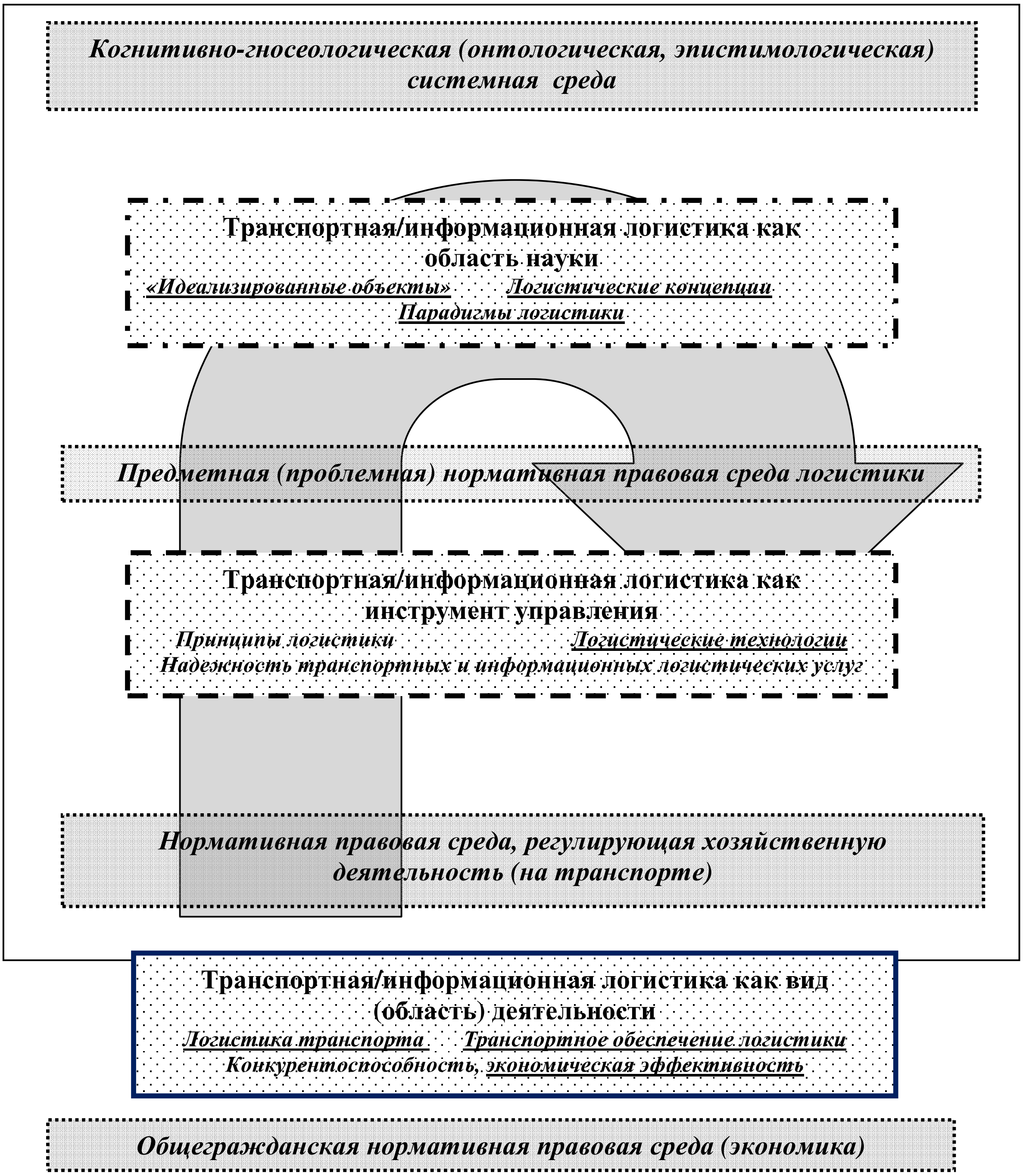


Рис.1. Уровни абстрагирования логистики.

- Когнитивно-гносеологическая (онтологическая, эпистимологическая) системная среда.
- Предметная (проблемная) нормативная правовая среда логистики.
- Нормативная правовая среда, регулирующая хозяйственную деятельность (на транспорте).
- Общегражданская нормативная правовая среда (экономика).

Наполнением каждого из перечисленных уровней абстрагирования логистики составляют соответствующие методические компоненты:Рис.4.4. Уровни абстрагирования логистики.

Транспортная/информационная логистика как область науки:

- «Идеализированные объекты»;
- Логистические концепции;
- Парадигмы логистики;

Транспортная/информационная логистика как инструмент управления:

- Принципы логистики;
- Логистические технологии;
- Надежность транспортных и информационных логистических услуг;

Транспортная/информационная логистика как вид (область) деятельно-сти:

- Логистика транспорта;
- Транспортное обеспечение логистики;
- Конкурентоспособность;
- Экономическая эффективность.

Обзор и анализ научной или нормативно-правовой среды показывает на неоднородность разработанности ее уровней.

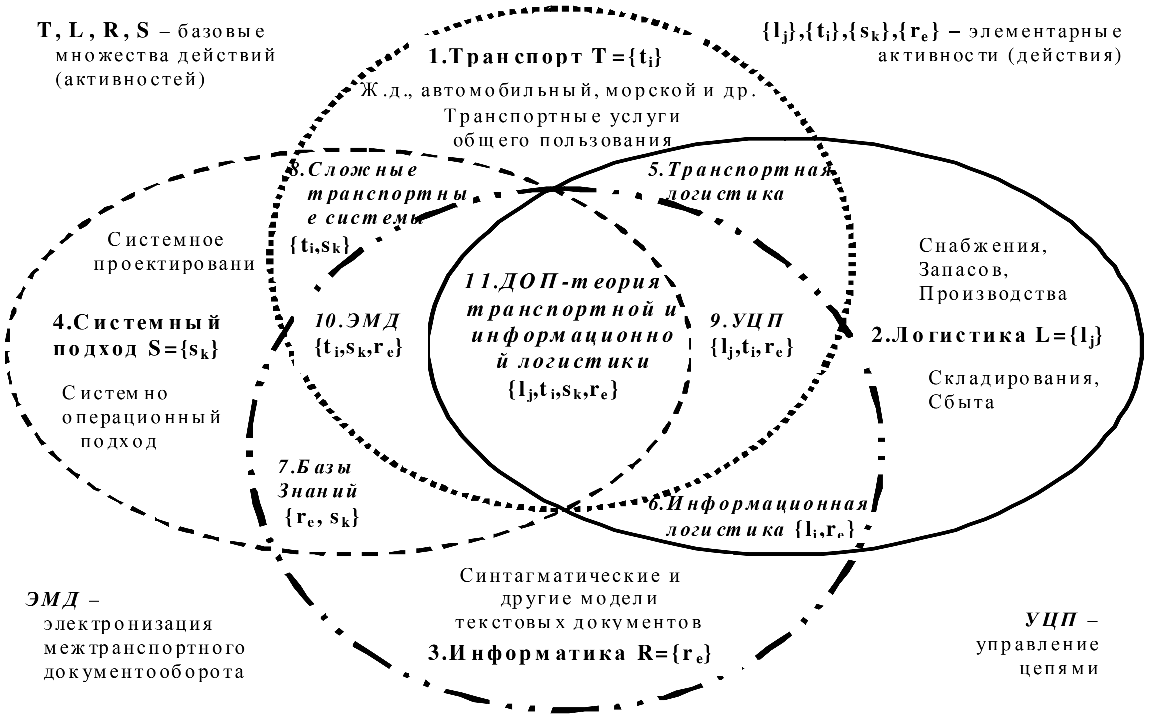
Методологические разработки в области формализации когнитивно-гносеологической (онтологической, эпистимологической) системной среды явились хорошей базой для формализованного представления «идеализированных объектов» ДОП-теории транспортной и информационной логистики, логистических концепций и парадигмы логистики.

За исключением сформулированных в транспортных стратегиях основ-ных направлений развития транспортной и информационной логистики, официально практически не проработана предметная (проблемная) нормативная правовая среда логистики. В достаточной степени проработаны общегражданская нормативная правовая среда (экономика) и нормативная правовая среда (уставы, кодексы, правила перевозок), регулирующая хозяйственную деятельность основных видов транспорта.

На рис.2 представлена схема позиционирования и структурирования транспортной, информационной и других разделов логистики, как областей научно-прикладных исследований, основанная на теоретико-множественном подходе к системной интеграции действий (активностей).

Исходя из проведенных исследований даны следующие определения:

Транспортная логистика - наука о системной интеграции транспортных и логистических активностей (действий хозяйствующих субъектов) в форме транспортно-логистических услуг для оптимизации грузовых и транспортных потоков (доставки с наименьшими затратами необходимого количества грузов (партий ресурсов, продукции) в установленное время и в установленное место) с использованием общественного транспорта на основе действующего законодательства.



Теоретико-множественный подход к системной интеграции действий (активностей)

3.$\{r_e\}$- информационные процессы **1.$\{t_i\}$-** транспортные процессы
4.$\{s_k\}$- операции в сложных системах **2.$\{l_j\}$-** логистические операции (функции)
8.$\{t_i,s_k\}$- системное проектирование **5.$\{l_j,t_i\}$-**транспортно-логистические технологии
7.$\{l_j,s_k\}$- модели знаний. **6.$\{l_j,r_e\}$-**информационно-логистические технологии
10.$\{t_i,s_k,r_e\}$-расширение ЭМ ВОС **9.$\{l_j,t_i,r_e\}$-**логистические концепции
11.$\{l_j,t_i,s_k,r_e\}$- Абстрактные (идеализированные) объекты документарно-операционной парадигмальной (ДОП)-теории транспортной и информационной логистики: ***Эталонная документарно-операционная модель транспортно-логистических услуг (ЭДОМ ТЛУ), Расширенная эталонная модель взаимодействия открытых систем (РЭМ ВОС), «дисциплинарная матрица» парадигм логистики, Электронный логистический паспорт, синтагматические конструкции предложений нормативных документов, математические логические модели на основе исчисления предикатов.***

Рис.2. Области научно-прикладных исследований.

Информационная логистика - наука о системной интеграции информационных и логистических активностей (действий хозяйствующих субъектов) в форме информационно-логистических услуг для координации транспортных потоков с целью минимизации прямых и косвенных затрат на информационное сопровождение и доставку с необходимого количества грузов в установленное время и в установленное место с использованием информационных сетей общего пользования на основе действующего законодательства.

3. ТРАНСПОРТНО-ЛОГИСТИЧЕСКИЕ КОНЦЕПЦИИ И ТЕХНОЛОГИИ

В целях подтверждения работоспособности ДОП-теории логистики в рамках SCM/УЦП как парадигмы логистики сформулированы логистические концепции и на их базе разработаны логистические технологии [5]. В табл. 2 представлено описание компонентов трех логистических концепций (ЛК), сформулированных на основе формального описания УЦП, как новой нарождающейся парадигмы логистики, анализа новых нормативных правовых документов (федеральных законов), направленных на поддержку среднего и малого бизнеса, и международных соглашений, связанных с упрощением процедур таможенного контроля при международных перевозках и других этапах внешнеэкономической деятельности:

Логистические технологии (ЛТ), воплощающие концепцию электронизации межтранспортного документооборота (ЭМТД) для создания логистических центров в транспортных коридорах и припортовых транспортных узлах, показаны в табл. 3. В табл. 4. представлено описание ЛТ, воплощающих ЛК транспортно-логистического сорсинга (ТЛС): интерактивного застрахованного взаимодействия участников в логистической цепи (ИЗВ), минимизации оттока финансов (МОФ) и интегрированного управления логистическими рисками (ИУЛР). На основе Рамочных стандартов безопасности и облегчения мировой торговли разработаны предложения по формулировке ЛК обеспечения безопасности интермодальных перевозок и облегчения внешнеэкономической деятельности (ОБИПиВЭД) и ЛТ, воплощающих эту концепцию:

- комплексного управления цепью поставок товаров (КУЦП);
- обеспечения безопасности интермодальных перевозок в рамках международного таможенного сотрудничества (БИП);
- облегчения ВЭД (международной торговли) логистическим центрам и другим участникам ВЭД в статусе Уполномоченного экономического оператора (УЭО).

Таблица 2.

Логистические концепции в рамках УЦП как новой парадигмы логистики

Категории, компоненты дисциплинарной матрицы	***Логистические концепции в рамках УЦП как новой парадигмы логистики***		
	Электронизации межтранспортного документооборота (ЛК ЭМТД)	***Транспортно-логистического сорсинга (ЛК ТЛС)***	***Безопасности интермодальных перевозок (БИП) и облегчения ВЭД***
1.«Ценности»: факторы НТП	Ориентация на цель, электронизация документооборота,	Ориентация на цель, количественная оценка цели, «ценность»	Ориентация на цель, электронизация документооборота, сквозные бизнес-процессы
2.«Символические обобщения»: теория.	Расширенная эталонная модель взаимодействия открытых систем	Эталонная документарно-операционная модель ТЛУ, синтагматические модели нормативных правовых документов	Системность, стандартизация, неразрушающий контроль отправок
3.Концептуальная схема проблемы, предметной области	Электронизация документооборота на основе международных стандартов, электронный логистический паспорт	Взаимное страхование, саморегулирование, другие механизмы некоммерческих организаций, основанных на членстве	Одновременное обеспечение безопасности отправок и облегчение ВЭД
3.1.Порождающая идея, ведущий замысел ЛК.	Минимизация числа прикладных программ ЭОД (конверторов) при большом числе участников ЭОД, использование кодированных данных (справочников)	Минимизация оттока прибыли из отрасли, обеспечение конкурентоспособности малого и среднего бизнеса	Минимизация рисков по каждой отправке, облегчение таможенных формальностей для законопослушных участников ВЭД
3.2. Базисные понятия-концепты (лексикон)	Элемент данных, Состав-ной элемент данных , Квалификатор, С егмент, UNSM, Справочники и синтаксис UN/EDIFACT.	Общество взаимного страхования, саморегулируемая организация, превентивные мероприятия, логистические риски.	Комплексное управление цепью поставок товаров (КУЦПТ); Уполномоченный экономический оператор (УЭО).
3.3 Конструкты (варианты)	Удаленный терминал, рабочая станция, узловой конвертор	Застрахованные риски, гарантии по обязательствам	Состав рисков оценки опасности отправки, виды неразрушающего контроля
3.4. Модель постановки задачи (перевод базовых концептов в конструкты).	Информационный логистический центр, инструкция взаимодействия контрольных органов в пунктах пропуска.	Программа обновления основных средств хозяйствующих субъектов, единый страховой продукт, система слежение ГЛОНАСС/GPS.	Электронные логистические манифесты, автоматизированные пункты пропуска, КИСУ участников ВЭД
3.5. Методы решения проблемы (ЛК как самостоятельная форма знания).	-ЭОД на базе стандартов UN/EDIFACT; -Уведомление о подходе транспортного средства; -Согласованный ввод данных в пунктах контроля.	-Интерактивное застрахованное взаимодействие участников в ЛЦ; -Минимизации оттока финансов; -Интегрированное управление логистическими рисками.	-Комплексное управление цепью поставок товаров; -Обеспечение безопасности интермодальных перевозок в рамках международного таможенного сотрудничества; -Облегчение ВЭД ЛЦ и другим участникам ВЭД.
4. Нормативное правовое поле.	Рекомендации ЕЭК ООН: № 18: Меры по упрощению процедур международной торговли (2001). № 25: Использование стандарта ООН для электронного обмена данными в управлении, торговле и на транспорте (ЭДИФАКТ ООН) (1996). № 26: Коммерческое использование соглашений об обмене для электронного обмена данными (1996). № 33: Рекомендация и Руководящие Принципы по Созданию Механизма "Единого Окна" (2005).	ФЗ о некоммерческих организациях, основанных на членстве: ФЗ "О некоммерческих организациях" от 12.01.96 N7, ФЗ "О саморегулируемых организациях" от 01.12.07. N 315, ФЗ «О взаимном страховании» от 29.11.07г. N 286 ФЗ "О потребительской кооперации в РФ" от 21.03.02 N 3085-I, ФЗ "О негосударственных пенсионных фондах" от 10.01.03 г. N 75	Рамочные стандарты безопасности и облегчения мировой торговли всемирной таможенной организации (РСБ ВТО) Система Регистрации и Идентификации Экономических Операторов (Хозяйствующих Субъектов) ЕС (Economic Operators' Registration and Identification - EORI). Постановление КЕС № 312/2009 от 16.04.2009г.

Таблица 3.

Логистические технологии, воплощающие концепцию ЭМТД

Компоненты ЛТ	***Воплощаемая ЛК электронизации межтранспортного документооборота (ЭМД)***		
Логистические технологии (ЛТ)	***ЛТ электронизации межтранспортного документооборота (ЭМД)***	***ЛТ электронного логистического. сопровождения (ЭЛС)***	***ЛТ согласованного ввода данных (СВД)***
1. Стандартная последовательность логистических действий	1.Прикладной процесс в КИСУ ЛС. 2.Формирование блока данных в тело ЭСД. 3.Препроцессорная обработка файла. 4.EDIFACT-конвертирование. 5.Оформление конверта ЭС. 6.Обработка ЭС EDI-UA в узле ЭП.	1.Оформление перевозчиком комплекта нифеста документов 2.Формирование лектронного логистического манифеста (ЭЛМ) в ИВЦ 3.Передача ЭЛМ в пункт пропуска, перевалки и назначения 4.Выод ТС на маршрут. 5.Оформление документов в пункте пропуска.	1 Пограничный контроль (виза) 2 Транспортный контроль (транспортные средства, груз, рейс и водитель) 3 Ветеринарной и фитосанитарный контроль (товар, сертификаты) 4 Таможенный контроль (товар, транзит) 5 Оформление сопроводительных документов (CMR, Invoice, TIR, сертификаты)
2.АИС, поддерживающая ЛТ.	ЭОД-агент пользователя (EDI-UA), Конвертор ЭДИФАКТ, импорт-экспорт загрузочных файлов КИСУ, взаимодействие ИЛЦ, АРМ грузотправителя, ЦФТО ОАО РЖД, АИС морского порта типа ESCALE.	КИСУИВЦ, АРМ перевозчика с выходом на узел ЭП, EDI-сервер и ЛВС пункта пропуска, АРМ в постах контрольных органов в МАПП.	EDI-сервер и ЛВС пункта пропуска, АРМ в постах контрольных органов в МАПП.

Таблица 4.

Логистические технологии, воплощающие концепцию ТЛС

Компоненты ЛТ	***Логистическая концепция транспортно-логистического сорсинга (ЛК ТЛС)***		
Логистические технологии (ЛТ)	***Интерактивного застра-хованного взаимодей-ствия участников* (ИЗВ)**	***Минимизации оттока финансов* (МОФ)**	***Интегрированного управления логистическими рисками* (ИУЛР)**
1. Стандартная последовательность логистических действий	1.Заявка перевозчика на взаимное страхование 2.Оформление полиса взаимного страхования. 3.Установка системы слежения ГЛОНАСС/GPS GSM/GPRS. 4.Формирование ЭЛМ 5.Выход ТС на маршрут. 6.Обмен данными с ЦПМ ОВС и диспетчером АТП.	1.Придание Ассоциации (союзу) статуса СРО. 2.Учреждение ОВС. 3.Учреждение некоммерческого ИЛЦ. 4.Разработка хозяйственно-экономических программ на основе инвестиционного потенциала НКО, основанных на членстве.	1.Формирование схемы операции (ЛО и ЛФ в ЛС, ЦП). 2.Оценка рисков в ЛО и ЛФ. 3.Выбор подходов, методов и средств реализации способов воздействия на риск. 4.Формирование Правил взаимного страхования на основе средств воздействия на риск. 5.Взаимное страхование.
2.АИС, поддерживающая ЛТ.	КИСУ ОВС, АРМ перевозчика с выходом на узел ЭП, Бортовой комплекс ГЛОНАСС/GPS GSM/GPRS, блоки кодированных сообщений для обмена с ЦПМ и АТП.	КИСУ Ассоциации (союзу) со статусом СРО, КИСУ ИЛЦ, КИСУ членов СРО, оргдокументы программ.	Информационно-аналитическая подсистема КИСУ перевозчика, КИСУ ОВС.

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DIE ROLLE DER INTEGRATOREN IN DER INTERNATIONALEN SUPPLY CHAIN

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Abstract: The modern extended supply chain understanding has substituted the traditional supply chain model which is characterized by one-directional movement as values are transferred and added along the chain with a gradual upstream to downstream velocity. It means that the question of integration is more sophisticated as an application of integration technologies and discrete activities. The system approach allows finding a new way of solving the complex task of international supply chain integration. The proposed concept has been proved hence the expert method and has been applied on real life business.

1. ZU DER THEORIE DER SUPPLY CHAIN INTEGRATION

Die Integrationsforschung im Rahmen des Supply Chain Managements (SCM) widmet sich seit den 90ern der Untersuchung der kausalen Beziehungen zwischen den Integrationstechniken und der Leistungsfähigkeit der SC. Die konventionellen SCM-Technologien wie VMI, ECR oder CPRF streben nach koordinierten und kollaborativen Beziehungen in den Supply Chains und erreichen gezielte Integrationseffekte in der Logistik. Mittlerweile ist die Zeit des traditionellen Supply-Chain-Models mit seinen linearen Objektbewegungen als graduelle Wertschöpfung vorbei. Daher ist die Integrationsaufgabe differenzierter und anspruchsvoller als das gemeinsame Bestandsmanagement und die kooperative Nachfrageprognose oder eine Transparenz der Warenbewegung.

Die moderne Supply Chain mit einem hohen Grad der Innovation und Kundenorientierung umfasst die unternehmensübergreifenden Logistik- und Produktionsprozesse, Prozesse der Forschung und Entwicklung eines Produktes oder Verfahrens, PLZ-verbundener Service, begleitende Finanz- und Informationsflüsse und Beziehungen. Die Heterogenität und hohe Zahl der Elemente und Beziehungen in den modernen Supply Chains charakterisieren sie als ein komplexes dynamisches System. Die Integration dient vor allem einer Komplexitätsreduktion in diesem System. Die Supply Chain Integration (SCI) im Kontext des SCM bezeichnet traditionell eine unternehmensübergreifende Integration der materiellen und elektronischen Flüsse mit dem Ziel der Effizienzsteigerung der gesamten Supply Chain, was wiederum zu einer Sicherung der Wettbewerbsvorteile aller Partner in der Supply Chain führen soll. Die Integrationsbestrebungen der Supply-Chain-Partner konzentrieren sich somit auf die Faktoren, die Wettbewerbsvorteile mit sich bringen. Diese betriebswirtschaftlichen Determinanten (oft auch schwer operationalisierbar) sind Kosten, Zeit, Qualität und Flexibilität.

Aus dieser Sicht wird die SCI häufig auf die Verknüpfung der Informationssysteme zweier oder mehrerer Unternehmen bzw. die Einführung eines gemeinsamen, einheitlichen Systems für den Datenaustausch reduziert. Die Harmonisierung der Informationsflüsse (z.B. anhand der EDI) ist oft mit einem hohen Investitionsvolumen und Akzeptanzwiderstand verbunden. Die Instrumente des eBusiness, wie z.B. elektronische Marktplätze als dezentrale vs. zentralisierte Informationssysteme, dienen als Integrationsplattformen für die Unternehmen unterschiedlicher Wertschöpfungsstufen, unterliegen jedoch Sicherheitsbeschränkungen und Autorisierungshierarchien und erfordern eine umfassende Integration mit den unternehmensbezogenen EDV-Systemen (IKS, PPS, CIM-Systemen).

Die Integration ist dennoch ein viel breiteres Phänomen als die physische Verknüpfung der internen oder externen Unternehmenstätigkeiten. Die Integration im Sinne der Einbindung und Verbindung der Systemelemente, um einen für diesen Zeitpunkt optimalen Systemzustand zu erreichen, ist der Vorgang der Zusammenfügung der neuen oder bisher getrennten Prozesse und Strukturen, mit dem Ziel, synergetische Effekte („Das Ganze ist mehr als die Summe der einzelnen Elementen!“) zu aktivieren.

Die Integration als Vereinigung von Systembestandteilen ist ein komplexer kontinuierlicher Prozess, der aus Teilprozessen der Partnerauswahl, Entwicklung, Anpassung, Moderation, usw. besteht. Kommunikation und Beziehungsaufbau, was zu langfristigem Vertrauen und besserem Verständnis führt, sind wesentliche Bestandteile der Integration des sozialen Gestelles der Supply Chain.

Vor dem Hintergrund der Globalisierung von Geschäftsbeziehungen ist die Komplexität der Kontextfaktoren deutlich gestiegen. Spricht man von einer globalen Supply Chain, gewinnt die Kunst des internationalen Agierens an Bedeutung. Interkulturelle Kompetenz, Kenntnis der Sprache und der Mentalität, so wie Spezifitäten der Geschäftsbedingungen und Arbeitskultur bezüglich der Supply Chain-Partner sind unverzichtbare Erfolgsfaktoren.

Von der Einbindung der neu ausgesuchten Partner bis deren engen Integration in die Supply Chain ist es ein langer Weg. Einen besonderen Koordinationsaufwand benötigen die kleinen und mittelständigen n-Tier-Zulieferer oder Dienstleister aus den Entwicklungsländern oder Ländern der ehemaligen Sowjetunion. Das Optimierungspotenzial an den Schnittstellen der so genannten Ost-West Supply Chain ist noch weiter auszuschöpfen.

2. RESULTATE DER EXPERTENBEFRAGUNG

Die Ost-West Kooperationserfahrungen zeigen mehrere Problemfelder auf der landspezifischen Ebene auf: In der Organisationsentwicklung, Managementstruktur, Businesskultur, Produkt- und Servicequalität, Produktionsprozessen, etc. Daraus resultieren Informationsverluste und Asymmetrien, Konflikte und Missverständnisse, unnötige Verspätungen und Dublierung der Funktionen, etc., was im Endeffekt zu erheblichen Beeinträchtigungen der Wettbewerbsfaktoren Kosten, Zeit, Qualität und Flexibilität führt.

Um die Systemintegration angesichts dieser Faktoren dosierend und individuell zu steuern, wurden die Integrationsfunktionen zu einem Integrator institutionalisiert.

Die Befragung der Unternehmen der Produktions- und Logistikbranche im Zeitraum von 2006 bis 2010 hat ein Interesse an SC-Partnerschaften mit Russland und der Ukraine, welches hauptsächlich in den ingenieurs- und informationstechnischen Bereichen liegt, und eine Nachfrage nach integrationsspezifischen Dienstleistungen gezeigt. Diese sollen eine reibungslose Integration der neuen internationalen Partner in die SC ermöglichen und die Entwicklung der bestehenden Beziehungen zwischen den Partnern fördern.

Die Resultate der Untersuchung haben gezeigt, dass besonders die kleinen und mittelständigen Unternehmen aus den globalisierten Branchen wie der Luftfahrt einen Bedarf an derartigem Service haben. Auch viele Großunternehmen sind bereit diese Kompetenzbereiche zu outsourcen bzw. intern erst gar nicht aufzubauen oder mit externer Hilfe zu entlasten und qualitativ zu verbessern. Die Befragten zeigten eine Bereitschaft die eine oder der andere Funktion eines Integrators in Anspruch zu nehmen und dadurch die Schlüsselgrößen Kosten, Zeit, Qualität und Flexibilität zu verbessern.

3. ROLLE DES INTEGRATORS IN DER INTERNATIONALEN ZUSAMMENARBEIT

Der Integrationsprozess beginnt mit der Intensivierung der Zusammenarbeit einzelner Marktakteure und dem Aufbau von Vertrauen und Verständnis untereinander. Als Träger der spezifischen Kompetenzen, interkulturellen und fachlichen, und durch den Zugriff auf die eigenen Kontaktnetzwerke und Datenbanken tragen die *Integratoren* zu einer Verringerung der Risiken und der Transaktionskosten bei.

Die Integrationsleistungen der *Integratoren* fördern unter anderem einige makroökonomische Effekte. Diese entsprechen der Erfüllung der strategischen Ziele der Kooperation zwischen Russland und z.B. der EU, aber auch den eigenen politisch-wirtschaftlichen Zielen, wie etwa technologische Modernisierung.

Als eine neutrale Stelle überwacht der *Integrator* die Bewahrung der individuellen Ziele der SC-Akteure, sowohl auf der Mikro-, als auch der Makro-Ebene. Zielkonflikte im System werden vermieden oder dank der individuellen Behandlung jeder Beziehung in der SC ausgeglichen.

Das Konzept wurde erfolgreich für den nationalen Bereich der Ukraine umgesetzt und im Bezug der globalen logistischen Ketten erprobt. Die effektive Integration des Partners in die SC durch den gezielten Einsatz des Integrators an den SC-Prozessen, wie z.B. Forschung und Entwicklung, wurde in den durchgeführten Projekten realisiert.

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РОЛЬ ИНТЕГРАТОРОВ В МЕЖДУНАРОДНЫХ ЦЕПЯХ ПОСТАВОК

1. К ТЕОРИИ ИНТЕГРАЦИИ ЦЕПИ ПОСТАВОК

Исследование феномена интеграции в теоретических рамках управления цепями поставок в 90х годах было посвящено изучению каузальных отношений между различными инструментами интеграции и производительностью цепей поставок. Традиционные технологии управления цепями поставок типа VMI, ECR или CPRF служат достижению координированных и кооперированных отношений в цепях поставок. Их целенаправленное использование позволяет достичь интеграционных результатов на определённых отрезках логистической цепи. Между тем, классическая модель цепи поставки с её однонаправленным перемещением объектов в ходе поступательного наращивания стоимости осталась в прошлом. Следовательно, и задачи интеграции выходят далеко за рамки совместного управления запасами и прогнозирования спроса или достижения прозрачности движения товаров.

Современная цепочка поставки, сориентированная на запросы клиентов и внедрение инноваций, включает в себя межорганизационные производственно-логистические процессы, инженерно-техническую и научную деятельность по разработке продукта или технологий, сервисные услуги на протяжении всего жизненного цикла продукта, сопутствующие финансовые и информационные потоки. Гетерогенность и многочисленность элементов и переменных связей в цепи поставки позволяет охарактеризовать её как сложную динамическую систему. Интеграция служит, прежде всего, уменьшению сложности системы.

Под интеграцией цепи поставки в контексте управления цепями поставок, как правило, понимается интеграция смежных материальных и информационных потоков с целью увеличения экономической эффективности всей цепочки, что, в свою очередь, должно привести к улучшению конкурентоспособности всех её участников. При этом интеграционные усилия партнёров сконцентрированы на факторах, влияющих на их конкурентоспособность. Этими экономическими параметрами, зачастую слабо операционализируемыми, являются Затраты, Время, Качество и Гибкость.

Интеграция цепей поставок часто сводиться к мероприятиям по стыковке информационных систем двух или более организаций или внедрению единой для участников цепи системы обмена данными. Гармонизация информационных потоков между участниками или их „информационная интеграция“ сопровождается значительным объёмом инвестиций и часто наталкивается на неприятие подобного нововведения внутри отдельных организаций. Инструменты электронной коммерции, такие как, например, электронные рынки, служат интеграционными платформами для компаний, стоящих на различных ступенях создания добавленной стоимости, однако при этом требуют повышенного внимания к мерам безопасности данных и авторизации доступа, а также к совместимости с внутренними системами.

Всё же, понятие интеграции – шире, чем физическая состыковка внутренней и внешней коммерческой деятельности компаний. Интеграция в смысле соединения и объединения элементов в систему, с целью достижения оптимального на определённый момент времени состояния системы, - это связка воедино новых или доселе разделённых процессов и структур. Данное системообразующее явление активирует известные синергетические эффекты, ведь „целое – это нечто большее, чем сумма отдельных элементов“.

Объединение системных элементов - это сложный и продолжительный процесс непрерывного свойства, состоящий из таких частей, как выбор партнёра, его развитие, приспособление, сглаживания диспропорций и т.д. Интенсивная коммуникация и становление партнёрских взаимоотношений способствуют развитию доверия и взаимопонимания, что является залогом успешной интеграции социальной основы цепи поставок.

Вследствие глобализации коммерческой деятельности наблюдается повышенный рост сложности контекстных факторов. В случае глобальных цепей поставок на первый план выходят компетентность в кросс-культурных взаимоотношениях, знание языка, менталитета и особенностей условий работы.

От присоединения выбранного партнёра в цепь поставки до полной его интеграции – долгий путь. В особых координационных усилиях при этом нуждаются малые и средние предприятия из развивающихся стран или стран бывшего СССР, стоящих на периферийных ступенях цепи поставки. Оптимизационный потенциал в точках стыковки в так называемых восточно-западных цепях поставок далеко не исчерпан.

2. РЕЗУЛЬТАТЫ ОПРОСА ЭКСПЕРТОВ

Опыт сотрудничества „между востоком и западом“ выявил многочисленные, специфические для той или иной страны проблемы в области производственных процессов, организационного развития, управленческой структуры, культуры бизнеса, уровня качества. Вызванные диспропорции приводят к информационной асимметрии, дублированию работ, конфликтам, сбоям и запаздываниям в системе, что в результате наносит вред параметрам конкурентоспособности Затратам, Времени, Качеству и Гибкости. С тем, чтобы реализовать индивидуальное управление интеграцией, интеграционные функции были институализированы в виде так называемого Интегратора.

В процессе опроса предприятий производственно-логистической отрасли с 2006 по 2010 год была выявлена заинтересованность в привлечении российских и украинских партнёров в европейские сети поставок, а также спрос на интеграционные услуги, которые призваны способствовать беспрепятственной интеграции участников цепи поставки из разных стран.

Результаты исследования показали, что особенно малые и средние предприятия в цепях поставок таких глобальных и наукоёмких отраслей, как например, авиастроение, нуждаются в интеграционных услугах. Также крупные предприятия выразили готовность прибегнуть к услугам внешних Интеграторов, в том числе по причине отсутствия подобной компетентной области и сосредоточению на своей основной деятельности. Целью применения тех или иных функций интеграции является желание улучшить параметры Затраты, Время, Качество и Гибкость.

3. РОЛЬ ИНТЕГРАТОРА В МЕЖДУНАРОДНОМ СОТРУДНИЧЕСТВЕ

Процесс интеграции начинается с интенсивного сотрудничества актёров на международном рынке, генерирования системообразующих связей через развитие доверия и взаимопонимания. Являясь носителем специфических компетенций, как кросс-культурных, так и профильных, и владея собственной сетью контактов и необходимой информацией, Интеграторы гарантируют снижение рисков и упрощение трансакций в цепях.

Инициируя и управляя интеграцией, Интеграторы вносят свой вклад в реализацию общих макроэкономических эффектов, например, в рамках стратегических целей сотрудничества между странами. В то же время они способствуют достижению индивидуальных целей участников интеграции, таких как рост и техническая модернизация или выход на новый рынок.

Концепция Интегратора была успешно внедрена применительно к украинским участникам международных логистических цепочек (при создании интегратора EUA), а также реализована на процессе „исследование и разработка“ в международных цепочках поставок. Её эффективность доказана в работе над различными проектами.

PROVIDING FREIGHT SHIPPING SERVICES BY TRANSPORTATION AND LOGISTICS COMPANIES

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Purpose of the paper
In this paper we summarize theoretical and practical findings on providing freight shipping services by a new form of shipping organization i.e. transportation and logistics companies (TLC) that have no or few fixed assets. Their main commercial asset is information about vehicle transportation market, methods and ways of providing high quality, cost effective freight transportation services in the shortest possible time.
Research/application methodology
In the course of the study we used a system approach as the general learning method and the fundamentals of the system, process, functional, cybernetic and comprehensive approaches to system generation as well as logistics and system analysis methods, economic and mathematic simulation and expert estimation. Such methods as observation, description, measurement and experiment served as the empirical basis of the research.
Design of the paper
The paper is structured as follows. The introduction justifies the choice of the research topic and proves that it is timely and important. The up-to-date literature survey addresses the experience in organizing physical distribution and the specifics of managing different stages of the transportation process described by researchers and experts in the logistics and transportation area. Further we provide the research methodology as the total of system, process, functional, cybernetic and comprehensive approaches to system generation as well as methods of logistics and system analysis. The research results are the introduction of a novel form of shipping organization i.e. transportation and logistics company (TLC), defining of its role and place in the transportation system of the Russian Federation. We conclude the paper by summarizing the main findings made over the course of the research work.
Main results
As a result of analyzing theoretical research works and practical experience of Russian and foreign companies working in the field of vehicle logistics a novel form of shipping organization i.e. transportation and logistics company (TLC) has been introduced. This type of company offers a number of competitive advantages over the conventional logistics companies. TLCs often have no fixed assets and perform single or multiple logistic functions relying on international standards. Such companies manage supply chains or their parts, spare their clients from doing something out of their scope of work, speed-up movement of commodity flows, reduce transportation costs as well as the number of cases when cargo is lost and damaged. Generalization of theoretic research results and practical experience has enabled the author to classify logistics companies in terms of complexity of provided services and degree of integration and define the place of TLCs in the Russian transportation system. Based on the classification TLCs refer to an interim stage of the 2-3PL-logistics services provider. They have no or few fixed assets. The main commercial asset is information about the vehicle transportation market, methods and ways of providing high quality, cost effective freight transportation in the shortest possible time.

Academic contribution

The most significant, scientifically novel result is an introduction of a new form of shipping organization i.e. transportation and logistics company. Its main difference from conventional methods of organizing the transportation process is that it uses logistics technologies to organize and manage commodity, transportation and the accompanying information, service and financial flows. We have also provided its definition and formulated the task of shipment routing as simulation of optimal movement of cargo traffic in supply chains.

Managerial insights

The practical relevance is not defined. The research has significant theoretical importance and scientific novelty.

ОРГАНИЗАЦИЯ ГРУЗОПЕРЕВОЗОК АВТОТРАНСПОРТНЫМИ ЛОГИСТИЧЕСКИМИ ПРЕДПРИЯТИЯМИ

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Аннотация: В статье представлен теоретический и практический материал по организации грузоперевозок автотранспортными логистическими предприятиями как новыми формами организации перевозочного процесса. Описано, что произошла трансформация организации автотранспортных перевозок в сторону ухода от обслуживания собственным транспортом предприятий и транспортом АТП к передаче всех функций по управлению грузопотоком АТЛП, которое не обладает или обладает незначительным объемом реальных активов, основной коммерческий актив – информация о рынке автотранспортных перевозок, методах и способах организации перевозки грузов заказчика на качественно высоком уровне, в короткие сроки и с минимальными затратами.

1. ВВЕДЕНИЕ

Важнейшим фактором экономического роста в России в условиях становления многоукладной экономики, интенсивного развития рынка транспортных услуг, усиления конкуренции в сфере товародвижения и перевозок грузов, существенных изменений в системе организационно-экономических взаимоотношений между участниками транспортного процесса при одновременном усилении интеграционных тенденций в мировой экономике становится создание и развитие новых форм и способов организации автотранспортных перевозок, взаимодействующими с отдельными сферами предпринимательства в регионах. При этом первостепенное значение приобретает разработка методологических основ управления ими, включая методы планирования и управления бизнес-процессами, принятия управленческих решений для достижения целей их функционирования.

2. ОБЗОР ЛИТЕРАТУРЫ

Теоретическая сложность и практическая значимость проблемы организации автомобильных грузоперевозок привлекли внимание большого числа исследователей в России и за рубежом. Разнообразным аспектам этой проблемы посвящены научные труды Б.А. Аникина, В.П.Бычкова, В.С. Лукинского, В.П.Миронюка, Л.Б. Миротина, Ю.М. Неруша, К.И. Плужникова, В.И. Сергеева, А.А. Смехова, С.Э. Схановой, Н.А.Троицкой, А.А. Чеботаева и др. В этих трудах широко обсуждаются вопросы организации товародвижения и раскрываются особенности управления перевозочным процессом на отдельных его стадиях. Однако они не содержат рекомендаций по эффективному управлению автоперевозочным процессом в современных условиях интеграции, ориентации на потребителя, специализации на ключевых компетенциях и все большего проникновения в деятельность компаний и управление ими информационных технологий.

3. МЕТОДОЛОГИЯ ИССЛЕДОВАНИЯ

В процессе исследования использовались системный подход как общий метод познания, основные положения системного, процессного, функционального, кибернетического и комплексного подходов к построению системы, методы логического и системного анализа, экономико-математического моделирования и экспертных оценок.
Анализ осуществлялся на основе результатов практических исследований функционирования АТЛП ЦЧР с использованием методических разработок автора и таких методов эмпирического исследования, как наблюдение, описание, измерение и эксперимент.

4. РЕЗУЛЬТАТЫ

Анализ теоретических исследований и практики деятельности отечественных и зарубежных компаний в области организации автотранспортных грузоперевозок позволил автору выявить принципиально новую форму организации грузоперевозок автомобильным транспортом - автотранспортное логистическое предприятие (АТЛП), обладающее рядом конкурентных преимуществ относительно традиционных автотранспортных предприятий (АТП), имеющих в своем активе многочисленный парк подвижного состава и ремонтно-эксплуатационные службы. АТЛП, зачастую не имеющие реальных активов и выполняющие на базе международных стандартов отдельные или комплексные логистические функции, а также управление логистическими цепями и их звеньями, освобождают клиентов от несвойственных работ, способствуя ускорению движения товароматериальных потоков, сокращению транспортных издержек, уменьшению потерь и порчи грузов [7,8]. Автором установлено, что АТЛП осуществляет организацию грузовых автотранспортных перевозок с расчетом альтернативных вариантов маршрутов, частоты доставки грузов, подвижного состава, экспедирование, грузонакопление и переработку, маркировку, пломбирование, оформление товарно-транспортных документов, переадресацию грузов, реализацию невостребованных грузов и т.п. с гарантией сохранности, на условиях и в сроки, обусловленные договорными обязательствами. Т.е. АТЛП берет на себя выполнение функций логиста компании-заказчика.

Маршрутизация грузоперевозок – наиболее эффективный способ организации оптимального продвижения грузопотоков по логистическим цепям. Если определены и используются рациональные маршруты и на них строго соблюдаются сроки поставок, то товарно-производственные запасы участников процесса товародвижения могут быть сокращены в 1,5-2 раза. Роль маршрутизации заключается также в том, что участники цепочки поставок получают возможность составления реальных проектов по текущим планам и обеспечить эффективную организацию работы с оперативными заявками на транспорт.

На практике в деятельности АТЛП применяются детерминированные модели маршрутизации. Алгоритм такой задачи формулируется следующим образом. При наличии центрального терминала и дистрибутивной сети необходимо обслужить всех клиентов. Если транспортные средства должны осуществить доставку товаров всем клиентам, то можно записать:

$$x_{ij}^{k} = \begin{cases} 1, \text{при доставке из пункта i в пункт j} \\ 0, \text{в ином случае} \end{cases} \quad (1)$$

где i,j – номера пунктов доставки товара;

k – номер транспортного средства.

Целевая функция минимизации имеет вид

$$Z = \sum_{k=1}^{p} \sum_{j=1}^{n+1} \sum_{i=1}^{n+1} c_{ij} x_{ij}^{k} \quad (2)$$

где c_{ij}- вектор затрат на доставку из пункта i в пункт j.

Чтобы учесть реальные условия при разработке маршрутов, необходимо предусмотреть такие ограничения, как доставка определенным типом транспорта (формулы 3-4), связность маршрута (формула 5), наличие терминала (6), продолжительность рабочего дня (формула 7), грузоподъемность транспортных средств (8):

$$\sum_{k=1}^{p} \sum_{i=1}^{n+1} x_{ij}^{k}, i = 1, n \quad (3)$$

$$\sum_{k=1}^{p} \sum_{j=1}^{n+1} x_{ij}^{k}, i = 1, n \quad (4)$$

$$\sum_{j=1}^{n+1} x_{ij}^{k} = \sum_{i=1}^{n+1} x_{ji}^{k} \quad (5)$$

$$y_i - y_j + (n+1) \sum_{k=1}^{p} x_{ij}^{k} \leq n, i \neq j, i, j = 1, n, y_i > 0 \quad (6)$$

$$\sum_{n=1}^{n+1} \sum_{i=1}^{n+1} c_{ij} x_{ij}^{k} \leq T^{k}, k = 1, p \quad (7)$$

$$\sum_{n=1}^{n+1} \sum_{i=1}^{n+1} q_{ij} x_{ij}^{k} \leq Q^{k} \text{ Qk} \quad (8)$$

где T – продолжительность рабочего дня; q – масса груза, которую нужно доставить в пункт i; Q – грузоподъёмность k-ого транспортного средства.

Табл. 1 – Типология логистических предприятий

Параметр	Типы логистических предприятий					
	1PL	2PL	АТЛП	3PL	4PL	5PL
Описание	Грузовладелец	Транспортные компании, грузовые терминалы, склады, экспедиторы, таможенные брокеры	Транспортные компании, оказывающие помимо грузоперевозок другие логистические услуги	Фирмы, оказывающие комплексный сервис	Интеграторы полного цикла	Интеграторы полного цикла на базе Интернет
Оказываемые услуги	-	Одна из функций (исходя из сферы деятельности)	Одна из функций или несколько (исходя из сферы)	Многофункциональность	Интегрированная многофункциональность, комплексность услуг	
Доступ к рынкам сбыта	Местный, регион	Местный, регион	Местный, региональный, межрегиональный	Межрегиональный	Глобальный, доставка «от двери до двери»	Глобальный, посредством Интернет
Взаимоотношения в ЦП	-	Разовые сделки, годовые контракты	Разовые сделки, контракты, долгосрочные отношения (от 3-х лет)	Долговременные отношения (3-5 лет)	Стратегическое партнерство	Виртуальное предприятие
Конкурентоспособность	-	Разрозненная	Разрозненная, стремление к кооперации	Кооперации посредников, альянсы	Несколько крупных альянсов на рынке	
Ключевые компетенции	Много активов, минимум рисков	Много активов, выполнение ключевых операций	Владение информацией, выполнение ключевых операций	Смещение от владения активами к владению информацией	Управление информацией, интеграция на основе ИТ	Управление информацией в ЕИП
Ценность компании для клиента	-	Снижение издержек за счет оптимизации отдельных функций	Снижение издержек за счет оптимизации отдельных или нескольких взаимосвязанных функций	Снижение издержек благодаря комплексной оптимизации бизнес-процессов	Снижение издержек и оптимизация процессов путем интеграции ЦП	Снижение издержек и оптимизация процессов на базе ИТ в ЕИП

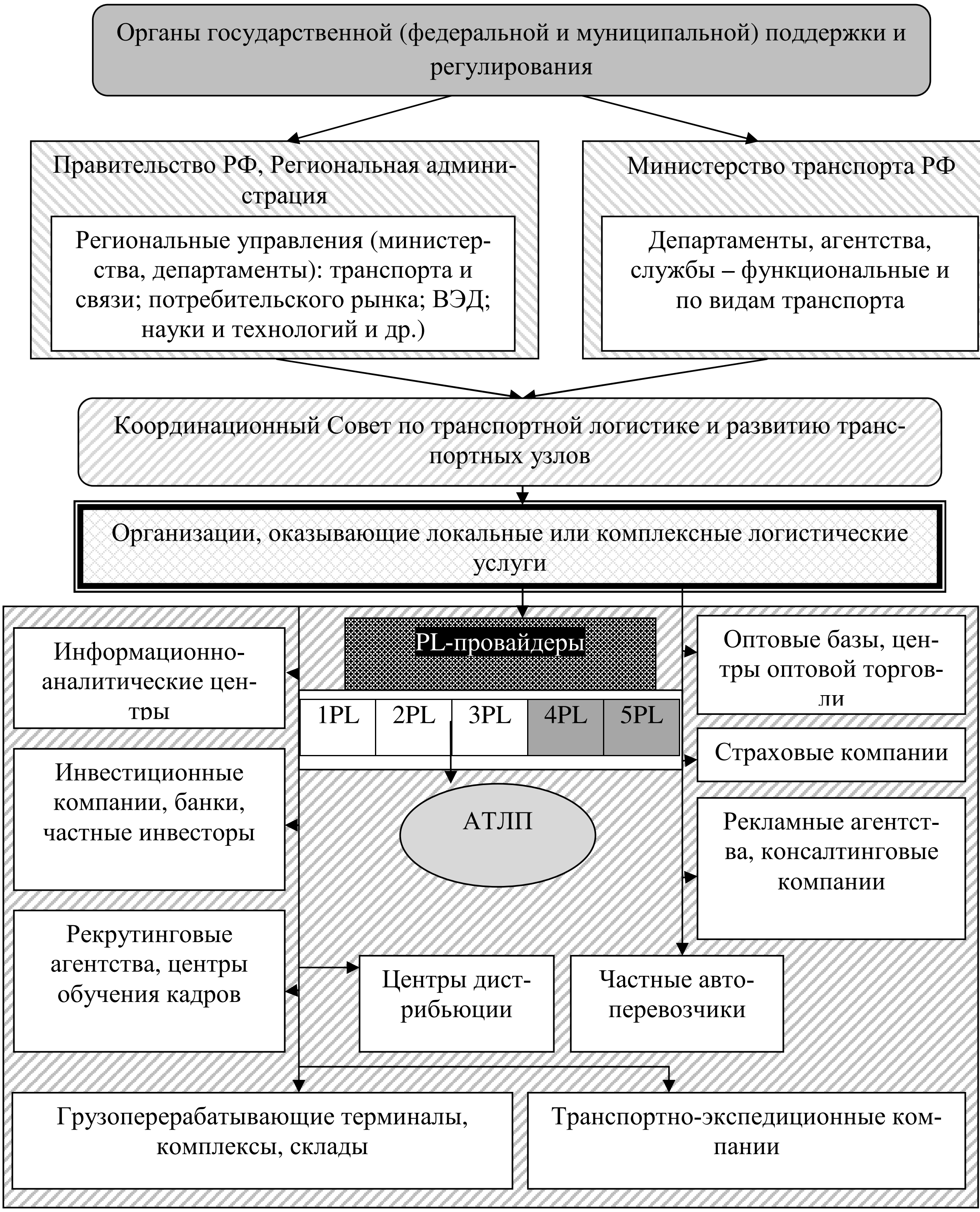

Рис.1 - Место АТЛП в транспортной системе РФ

Обобщение теоретических исследований [1-6,9] и практического опыта позволило автору выявить классификацию логистических компаний по уровню комплексности предоставляемых услуг и глубине интеграции (табл.1) и определить место АТЛП в транспортной системе РФ (рис.1). Исходя из них, АТЛП, выделяемое автором в качестве новой формы организации автотранспортных перевозок, можно отнести к промежуточной стадии 2-3PL-провайдера логистических услуг. Отличительной чертой АТЛП является максимально детализированное планирование перевозок на основе прогноза грузопотоков, позаявочное слежение за движением автотранспортных средств, временем доставки продукции, оптимизация движения и хранения сырья, материалов и готовых изделий, детализированное сальдирование и контроль движения капитала.

5. ЗАКЛЮЧЕНИЕ

Функционирование АТЛП заключается в организации и осуществлении транспортно-экспедиционных операций по отправлению и прибытию грузов с использованием автомобильного транспорта различной структуры (подвижного состава). Указанные операции осуществляются как непосредственно у грузоотправителей, так и в пунктах отправления грузов автотранспортом, в транспортных узлах при перевалке грузов, в пути следования и у грузополучателя. АТЛП освобождают клиентов от несвойственных им работ, способствуя ускорению движения товароматериальных потоков, сокращению транспортных издержек, уменьшению потерь и порчи грузов.

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SUSTAINABLE SUPPLY CHAIN DESIGN – A TRIPLE BOTTOM APPROACH

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Abstract: Future Supply Chain Management strategies need to incorporate besides the economic perspective, a social as well as an ecological perspective too. The combination of these three perspectives is known as triple bottom line, which is the key to sustainable management. The following paper discusses the needs for a triple bottom line oriented Supply Chain Management and proposes a sustainable Supply Chain Management approach including economic, ecological and social parameters.

1. INTRODUCTION

Over the last few decades the focus on being more sensitive to the environment has increased continually. Ecology is a societal megatrend [19] that will substantially affect the future management of supply chains, although experts are uncertain about how dire the situation is for our environment. Nevertheless it seems that there is a common agreement that the negative impact of logistics and supply chain management, known as ecological footprint, needs to be reduced [e.g. 3]. Showing and being social responsibility is not a new phenomenon.

While the basic thoughts of sustainability has been well proven in the field of forestry [see e.g. 5], and in the 1970's, it was called social marketing, followed by eco-marketing and society-oriented marketing in the 1980's and 90's. The environmental aspect of the discussion has been introduced to the business world in the 1970's by the Club of Rome report "Limits to growth" and later on by the Brundtland-report "Our common future" [e.g. 2; 13].

The basic idea of all these streams has been to include also goals for the common welfare to the profit-oriented goal system of companies. Today, governments, stakeholders and the media demand from companies to take over responsibility for the social consequences of their actions. Corporate Social Responsibility (CSR) becomes an important competitive advantage.

Acting in a sustainable manner means for firms in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. And for Dunphy et al. [8] it is the responsibility of the companies of the world to proceed in a sustainable manner. To act in a sustainable manner is the key message for the future. This means for logisticians and supply chain managers to re-assess their logistics and supply chain systems also from a sustainability point of view.

This is due to the fact that logistics and Supply Chain Management (SCM) are facilitators of globalisation and consequently have to deal with the negative impacts of globalisation, such as global warming or the climate change [13].

In this paper, a conceptual framework is developed and discussed that confronts logistics and SCM with the notions of sustainability from three angles – the economic, the social and the environmental view. This is known as the (extended) triple bottom line [e.g. 9, 10].

2. TRANSFORMING A SUPPLY CHAIN INTO A SUSTAINABLE SYSTEM

When transforming a supply chain into a sustainable environmental system, Srivastava [27] suggests the integration of environmental thinking into product design, sourcing and supplier selection and the delivery of the final product to its end users as well as into return management.

Taking the holistic supply chain view, Braungart et al. [1] propose the cradle-to-cradle-approach, also known as life cycle assessment that is a technique to assess each and every impact associated with all the stages of a process from raw materials through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling [30]. Based on this, the sustainable management of supply chains can then be defined as an input/output process, where resources, materials and energy are the inputs and air emissions, emissions to water, waste, products and co-products are the outputs [18].

Being actively involved in sustainable management has been recently discussed by Hockerts and Wüstenhagen [15] who examined the phenomena of environmental entrepreneurship. Thereby the authors differ between large corporations (= Greening Goliaths), which include step by step the sustainable agenda into their corporate strategy and small firms (= Emerging Davids) where the consideration of the environment is the main business model. According to their notions, global retailers fall into the category of Greening Goliaths as these companies are very large and the environmental objective is a complementary element of the main strategy. Their model can also be seen as a diffusion model of sustainable innovation, where at the end of the day, the overall goal is to have a sustainable transformed industry.

Looking at the motivation why companies are getting engaged in especially in environmental sustainability, we were able to see the following:

- Legal regulations like waste management, like the Waste Electrical and Electronic Equipment Directive of the European Union (2002/96/EC) [31] that imposes companies to set up an infrastructure for collecting such waste, can also force companies to act green. Even though such systems create additional costs, companies are forced to reduce waste, which in the long run has positive effects on the economic and ecological bottom line. Nakao et al. [25] have thereby identified a positive relation between the financial and ecological sustainability, even though other studies [5] doubt the positive effects or claim that this relation cannot be established [32].
- The intrinsic motivation of the entrepreneur or top management of global acting retailers can be a driving force [21] though critical voices again see the inability of managers to identify green issues as a sound economical business opportunity [29]. Also external stakeholders can influence the environmental attitude [7; 20; 23].
- The inclusion of environmental dimensions into will be relevant if this leads to a competitive advantage [26]. Either because it really pays to become green [14] or because it leads to a better image of the companies [16; 24] or as being environmental is a customer requirement [11].
- Again, the question remains whether or not environmental/sustainable management of supply chains pays. Here Markley and Davis [22] have proposed a conceptual framework that the inclusion of sustainability into the management of supply chains is positively related to the profitability of a firm.

From that point of view, sustainable SCM requires to take into account that

a) it is necessary to improve the productivity of SCM by achieving a better output with the same input basically through improved process execution and improved technology as this helps to preserve the natural resources (= efficiency);

b) it is necessary to use renewable energy (e.g. wind or solar energy) for supply chain operations instead of relying on limited resources (e.g. crude oil) so that the same (or higher) amount of resource input achieves the same output (= consistency);

c) it is necessary to radically change customer requirements and behaviour as it will not be enough to improve efficiency and to substitute energy sources if the same level of resource consumption continues (= sufficiency).

3. A TRIPLE BOTTOM LINE APPROACH FOR SUSTAINABLE LOGISTICS AND SUPPLY CHAIN MANAGEMENT

3.1 General considerations

The Stern Review on the Economics of the Climate Change [28] showed that production and transportation account for more than 40 % of the total emission of greenhouse gases in the world. Reasons for the negative contribution of transport to the changes in world climate are current global sourcing practices and low-cost international transport. Political systems have already reacted to this by setting up goals to reduce the emissions of greenhouse gases by 20 % when compared to 1990 levels. It is expected that a reduction in the use of transport systems will lead to a reduction in greenhouse gas emissions.

One possibility to address this issue as a company is to reduce the number of transports and/or to eliminate its transport function. However, for some companies the transport function comprises a core component of their value structure and can therefore not be eliminated. Retailers or logistics third party providers who perform their transport functions either in-house or in close collaboration with logistics service providers will need to address how this political goal will be incorporated into their business model. The example of DHL Germany has shown that management plays a major role by transforming a transport system into a sustainable system. The example has also shown that the transformation activities are not only related to the company itself. They also require exchange activities between a company's suppliers and customers, which leads to a supply chain management perspective [see 4].

So when a company aims at developing and managing sustainable supply chains, two issues need to be taken into consideration:

1) A company's supply chain consists of many actors, including suppliers, customers and logistics service providers, who are all active members in the supply chain. Therefore it is necessary to focus on the inter-organisational and cross-boundary elements when including sustainability into supply chain concepts. An internal sustainability optimization is not satisfactory.
2) The single economic bottom line approach needs to be widened to further incorporate humanitarian and environmental objectives, such as safety, security, reliability, avoidance and reduction of waste and pollution, minimal use of material and resources as well as minimal energy consumption – also known as triple bottom line.

Consequently is 'sustainability' understood as the principle of ensuring that our actions today do not limit the range of economic, social and environmental options open to future generations" [10]. This means that the present and future management of supply chains shall not harm the future state of the society. Sustainability puts economic, social and environmental elements together, which is also known as the triple bottom line as suggested by Elkington [10] or Dyllick and Hockerts [11] as follows:

1) <u>Economy/Profit</u>: The economic dimension does not refer only to profitability. At any time, economically sustainable companies deliver cash flows that are sufficient to maintain liquidity and offer a constant, above average return to the shareholders.

2) Ecology/Planet: In the past, the environmental dimension has had the largest impact on sustainable development, as an eco-system represents the ultimate profit line. Dyllick and Hockerts [11] define an ecologically sustainable company as a company that uses natural resources that are consumed at a rate below natural reproduction or at a rate below the developments of substitutes. Ecologically sustainable companies do not cause emissions that harm the environment, but are companies where managers limit the use of any type of resources as necessary and minimise any waste as much as possible. From a company point of view, it might also be clear, that the input into the companies' production systems are often natural resources, the output is not only a final product but also pollution and other forms of waste. An ecologically sustainable company can be characterised as a company that has incorporated ecological considerations in its daily operations as well as in its strategic planning.
3) Equity/People: The 'people' dimension could best be characterised as the company's social responsibility. The social dimension refers to a growth strategy without decreased job quality and it reflects internal as well as external effects. According to Dyllick and Hockerts [11], socially sustainable companies increase the human capital of individual partners as well as advancing the societal capital of their communities, in which they operate.

3.2 A framework for triple-bottom-line supply chain management

So far, logistics and SCM have been optimized by balancing the interplay between service levels and costs, meaning that companies have focused on providing a certain customer service level at minimal costs (= economic view). When optimizing supply chain design, requested customer service levels are balanced against costs. This perspective gives stability in decision making.

It is, however, necessary to revise this view of economic efficiency, in the light of increasing demands on sustainable SCM. The aim of sustainability in this context is to reach supply chain networks that are simultaneously capable of creating profit, respecting the environment and protecting human health and ethics [see e.g. 12]. Transferring the triple bottom line approach to SCM means a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional changes are made consistent with future as well as present supply chain needs. This means that optimal supply chain design needs to be balanced against ecological and/or social parameters as well.

The design of sustainable supply chains will therefore incorporate a new set of decision parameters which will cause disruption to the current balance. In the future, sustainable supply chains will be organized, planned and controlled with a view to balancing costs against ecological dimensions against social dimensions and against required customer service levels.

Table 1 presents an overview to sustainable supply chain processes that are measured in a triple bottom line approach.

Supply chain activities	**Triple bottom line dimensions**		
	Environment/Planet	**Equity/People**	**Economy/Profit**
Sourcing	Supplier evaluation and selection based on environmental profile, e.g. ISO 14000 Consolidation of shipments Sharing of information Use of eco-efficient transport modes Reuse of transport packaging materials Cooperation with suppliers to reduce environmental impacts	Supplier evaluation and selection based on social profile Training and education of logistics employees Ensuring codes of conduct at suppliers, e.g. safe working conditions, no child labour, and no abuse of union rights	Transport savings Costs of supplier evaluation and monitoring Costs of internal and external audits of suppliers' compliance with codes of conduct Improved quality of products Reduced risk of damage to brand
Production	Elimination of waste and overuse of resources in the production process Environmentally friendly packaging Green design and manufacturing Eco-efficient production, e.g. waste from one company becomes input to another Replace hazardous materials and processes Recycling materials from used products	Automation of physical heavy work Minimization of specialised, repeating work Prevention of work accidents Warehouse layout, that minimise picking distances In-service training of employees Improved staff recruitment and retention Job rotation and job enrichment	Improved working conditions may increase productivity Savings through resource minimization Economical gains through new product development Costs of certification, documentation and reporting
Distribution and reverse logistics	Choice of environmentally friendly distribution channels Choice of environmentally friendly types of transport Substitute information technology for physical transport Design effective return systems Reuse packaging materials	Reduced traffic congestion Education in energy saving driving Automation of loading and unloading Respecting driving and resting time rules	Savings due to consolidation of shipments to customers Savings due to increased capacity utilization of transport modes Higher prices for eco-friendly products Savings through increased reuse of materials and components

Table 1. A triple bottom line designed supply chain.

In this model, ecological, social and economic aspects of SCM processes are integrated that ensures the achievement of economic, social and ecological profitability.

The design options include all supply chain levels – upstream, internal and downstream. Focusing especially on the exploitation of raw material, the production of final products and sustainability can be realized by:

- Efficient transport design
- The use of ecological packaging material
- Supplier selection and evaluation based on social and ecological profiles
- Eco-efficient product design
- Waste management
- Training of people

Looking at the downstream side, actions include:

- Efficient transport design of distribution channels
- Use of environmental friendly transport means
- Informing final customers about sustainable products

Reduced resource utilization while returning productsOverall, supply chain decision makers will ask the question of how to tackle this challenge of combining SCM with sustainability. Halldorsson et al. [13] suggest therefore three alternatives:

- Integration of sustainability with SCM so that sustainability is fully consistent with SCM
- Aligning sustainability with SCM so that sustainability is complementary to the traditional SCM focus on costs and service
- Replacing SCM by sustainability so that traditional SCM concept is replaced by an alternative approach to cope with the environmental and social aspects.

It should be noted that the nature of the argument amongst these three options varies. First, the degree to which SCM is expected to change increases gradually. Second, whilst the first two assume that current SCM theories and practice are part of the solution, the third is of a more radical nature and implies that SCM is actually amongst the root causes of the problems of the sustainable agenda [see 13].
However, sustainable SCM is also affected by macro-level factors such as the industry in which the company is acting or the position within the supply chain. It may be more difficult to include sustainability as a third party logistics provider than for an industrial company. It seems also that size and power matters. The larger the company the higher the possibility to influence to the total chain whether or not to go into the sustainable direction. The higher the financial potential of the company the higher the potential to engage in social and ecological issues.

Finally the social surrounding conditions in which a company is embedded also influence the sustainability agenda of the company [17]. Legal restrictions affect the way how sustainable companies are acting. While the European Union forces companies to a quite high level of sustainability, offshoring still allows moving certain activities to countries with a lower sustainability attitude. For our common supply chain future, we need to have common sustainability standards in the whole network.

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ЛОГИСТИЧЕСКИЕ СИСТЕМЫ И ИХ ВЗАИМОДЕЙСТВИЕ С ОКРУЖАЮЩЕЙ СРЕДОЙ

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Аннотация: В статье системно представлено многообразие факторов, влияющих на характер взаимодействия логистических систем с окружающей средой. Определены категории макрологистической и микрологистической окружающей среды. Детерминированы условия устойчивого развития логистической системы.

LOGISTIKSYSTEME UND IHRE ZUSAMMENWIRKUNG MIT DER UMWELT

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Article purpose
Article purpose consists in formation of scientifically-methodical recommendations to studying the specificity of cooperation of logistical systems – participants of supply chains - with surrounding environment, formalisation of these relations for the purpose of optimisation for a problem solving of designing the logistical systems.

Research method
Theoretical and methodological basis of research have assembled by fundamental and applied researches in the field of economic theories, logistics and supply chain management, designing of logistic systems, the general theory of systems of Russian and foreign scientists and experts. Object of research are logistical systems of the business structures. Subject of investigations is economical and managerial cooperation of logistical systems in supply chains among themselves, and also with a logistical infrastructure and surrounding environment as a whole.

Design of the paper
The work consists of the introduction, three subsections and the literature list (7 sources). In article dialectic communication of external and internal environments of logistical systems is revealed; kinds of their cooperation with surrounding environment from the ecological, natural, social, economic points of view are defined.
Environment properties micrological (micro logistics environment) and macrological (macro logistics environment) are considered. In article described technological (various

kinds of cooperation between materials, a work in progress and finished goods with the machines and mechanisms, between machines and mechanisms of various stages in logistical process, directed on improving of work technicians and perfection of quality of logistical service of consumers) and economical (set of the economic relations concerning the most logistical system and defining possibilities of logistical system to carry out processes of supply, support of manufacture, distribution, and firm, not specified by kind – to function effectively in the market) constituents from the specified environments. This environment creates logistical potential of the national economics, improves possibilities for effective international economic relations in the conditions of economic globalisation.
In article is formulated the condition of a sustainable development of logistical systems – that is the logistical system is capable to a sustainable development in the case that the sum of positively influencing factors micrologistical and macrologistical environments is greater than sum negative influencing factors micrologistical and macrologistical environments, the factors destroying logistical system from within and expenses of energy which is necessary for spending to a logistical system for counteraction to external factors.

The basic results
Strategy of logistical coordination in chains of supply with an allowance for features of cooperation of logistical systems with environment is developed; scientifically-methodical recommendations about designing of logistical systems with maintenance of their steady functioning with technological, information, managerial and economic accordance of logistical processes are formulated.

Academic contribution
Academic contribution is proved by the expediency of a new scientific direction (logistical environics) - complex interdisciplinary research of cooperation process of logistical systems with environment from ecological, social, economic, managerial-technological, technical and natural-scientific positions that represents applied supplement to the initial approach of designing logistical systems.

Managerial insights
The practical importance of work is caused by its orientation on a substantiation of changes in logistical systems taking into account modern standards of cooperation in the integrated logistical chains; a possibility of application of the results received in educational process within the limits of preparation of methodical maintenance of a speciality «Logistics and Supply Chain Management» and also by granting consulting services concerning Supply Chain Management.

1. ВВЕДЕНИЕ

Процесс усложнения логистических систем в условиях реализации парадигмы управления цепями поставок (Supply Chain Management) ставит значительное число проблем как теоретического, так и практического характера. Обращения к теоретическому анализу позволяет уточнить типологию логистических систем в цепях поставок, выявить их специфические свойства в новых условиях и сформулировать адекватные требования к проблеме проектирования логистических систем. К этой проблеме автор данной статьи обращался в одном из своих выступлений на традиционной германо-российской конференции по логистике [3]. Обращение к вопросу обеспечения надежности логистических систем и резервирования логистических каналов, позволяющие повысить надежность цепей поставок за счет системного управленческого фактора [2], а также рассмотрение экологических, организационных и технологических сторон процесса формирования возвратных потоков в логистических системах [4] позволили сделать вывод о проблеме более высокого порядка.

По нашему мнению, не все аспекты проектирования логистических систем и их устойчивого функционирования получили в настоящее время соответствующее освещение в научной литературе. Так, более подробного изучения требуют специфические проблемы взаимодействия логистических систем с окружающей их средой. Выявление этих закономерностей, несомненно, будет способствовать адекватному ответу на требования глобализации современной экономики и дополнит существующую базу проектирования логистических систем.

2. ВИДЫ ВЗАИМОДЕЙСТВИЯ ЛОГИСТИЧЕСКИХ СИСТЕМ И ОКРУЖАЮЩЕЙ СРЕДЫ

Логистическая система, как и каждая материальная система, существует в конкретной окружающей среде, которую составляет все, что находится вне рассматриваемой системы. К окружающей среде относятся внешние по отношению к ней объекты, которые участвуют в формировании ее интегративных свойств опосредованно, через отдельные компоненты своих систем или системы в целом.

Каждая открытая система постоянно обменивается с окружающей средой веществом, энергией, информацией – всем, необходимым для обеспечения своей жизнедеятельности, роста, развития и совершенствования. Материальная система не может существовать вне окружающей среды, не может оставаться индифферентной к воздействию со стороны окружающей среды. Ели окружающая среда благоприятна, система может успешно развиваться, под действием отрицательно действующих факторов внешней среды система может разрушиться.

Окружающую среду можно определить как объективный материальный мир, существующий вне данной системы во всем многообразии своих проявлений, непосредственно и опосредованно влияющих друг на друга.

Окружающую среду логистических систем будем называть макрологистической окружающей средой. Наряду с внешней существует и внутренняя среда системы, которая состоит из вышестоящих уровней подсистем и элементов системы и процессов взаимодействия между ними, а также взаимодействия с окружающей средой. Внутреннюю среду логистической системы будем называть микрологистической средой.

Существует диалектическая связь (единство и борьба) внешней и внутренней сред. Окружающая среда создает системы, а каждая система формирует свою внутреннюю среду, которая может развиваться только в единстве с внешней средой.

Внутренняя среда хозяйственных (логистических в том числе) систем – понятие относительное, в значительной мере зависящее от принятой системы управления. Все зависит от точки зрения на систему относительно среды, то есть одна и та же среда может быть как внешней, так и внутренней. Внешние хозяйственные связи бизнес - системы становятся внутренними связями той системы (региональной или национальной экономики), в которую входит данный объект.

Выявить, что представляют собой внешняя и внутренняя среды логистической системы, весьма сложно, поскольку она сама является совокупностью ряда естественных (люди, природа, сырье) и искусственных (здания, сооружения, машины, механизмы) подсистем с присущими каждой из них экологической, природной, социальной, экономической и другими средами.

Взаимодействие определяет основное содержание любой среды, нацеливает на выполнение конкретной работы, действия. Состав среды обусловлен видом взаимодействия элементов системы между собой и системы с окружающей средой.

Виды взаимодействия зависят от цели, к которой стремится система. Такими целями в логистической системе могут быть создание четкой организационной структуры и собственно организация процесса управления материальным и сопутствующими ему потоками; достижение высокого качества поставки; осуществление эффективных логистических функций и операций; рациональное управление всеми перечисленными выше взаимодействующими процессами.

3. ТИПОЛОГИЯ МИКРОЛОГИСТИЧЕСКОЙ И МАКРОЛОГИСТИЧЕСКОЙ ОКРУЖАЮЩЕЙ СРЕДЫ

В соответствии с поставленными целями в процессе взаимодействия внутренних функциональных подсистем логистических систем и логистических систем между собой формируются и соответствующие среды.

Микрологистическая окружающая среда (micro logistics environment) - это различные виды взаимодействий между руководителями и специалистами, работающими в подразделениях логистической системы, направленные на создание ее рациональной организации. Эта среда предполагает создание рациональной структуры подбора и расстановки кадров, ориентированных на систематическое развитие и совершенствование логистических систем;

организацию основного и вспомогательных логистических процессов; эффективное использование транспортно-складских мощностей; сокращение длительности цикла выполнения заказа; логистическую координацию взаимоотношений с поставщиками, потребителями и логистическими посредниками; рациональное решение экологических проблем.

Микрологистическая окружающая среда является составной частью макрологистической окружающей среды (macro logistics environment) – экономическая, политическая, социально-культурная в условиях которой функционирует конкретная логистическая система и которая характеризует совокупность условий организации процесса товародвижения.

Микрологистическая окружающая среда включает различные виды взаимодействия (трансакций) между руководителями, менеджерами и функционерами самой логистической системы, также взаимодействие со специалистами других функциональных подразделений, направленные на реализацию иерархии всех поставленных задач. Данная среда стимулирует постоянный поиск оптимальных вариантов организации логистических процессов, использование инновационных технологий, рациональное использование ресурсного потенциала фирмы, реализацию оптимальных форм логистического менеджмента.

Технологическая составляющая микрологистической среды представляет собой различные виды взаимодействий между материалами, незавершенным производством и готовой продукцией с машинами и механизмами, между машинами и механизмами различных этапов логистического процесса, направленные на улучшение работы техники и совершенствование качества логистического обслуживания потребителей. В разных отраслевых производственных структурах существует своя специфичная, характерная именно для данной отрасли технологическая среда.

Технологическая составляющая макрологистической окружающей среды - это различные виды взаимодействий, связанные с развитием техники и технологии, с насыщением общества техническими системами, ростом влияния машин, механизмов и другой техники на окружающую среду. В этой сфере происходит развитие инновационных технологий, создание более производительных машин, механизмов, оборудования, транспортных средств, а также технических систем, предназначенных для обеспечения экономической безопасности страны.

Экономическая составляющая микрологистической среды это совокупность экономических отношений, имеющих отношение к самой логистической системе и определяющих возможности логистической системы осуществлять процессы снабжения поддержки производства, распределения, а фирмы в целом – эффективно функционировать на рынке.

Экономическая составляющая макрологистической среды является важным элементом экономической среды национальной экономики и тесно связана с ней. Экономическая составляющая макрологистической среды - это различные виды взаимодействия (трансакций) между логистическими системами в процессе производственно-хозяйственной деятельности фирм и предприятий, распределения, обмена и потребления готовой продукции. В этой среде создается логистический потенциал национальной экономики, повышаются возможности эффективных международных экономических отношений в условиях глобализации мировой экономики.

Значение любой материальной системы состоит не в самом факте ее существования как материального объекта, а в ее взаимодействии с окружающей средой. Появление, развитие, совершенствование систем, их разрушение - все это связано с характером их отношений с другими системами, окружающей средой. Взаимодействие, определяет существование, структурную организацию и свойства всякой материальной системы. Взаимодействия внутри логистических систем, а также самих систем с окружающей средой сложны, многовариантны и носят строго целенаправленный характер.

Множество логистических систем, а также микро – и макрологистических окружающих сред существует только в постоянном взаимодействии между собой. Чем более сложной является логистическая система или среда, тем более разнообразны и дифференцированы их взаимосвязи и свойства. От характера этих взаимодействий зависят степень, уровень организации логистической системы, ее качество, надежность, устойчивость, способность к развитию.

4. УСЛОВИЯ УСТОЙЧИВОГО РАЗВИТИЯ ЛОГИСТИЧЕСКИХ СИСТЕМ

Для каждой системы характерны свои виды вещества, энергии и информации, определенные их объемы, которые можно назвать воздействующим фактором, преобразующим систему. Именно воздействующий фактор, обладающий необходимым и достаточным количеством вещества, энергии и информации, способен приводить в движение, видоизменять, способствовать развитию и совершенствованию системы.

Представим логистическую систему как результат взаимодействия факторов микро – и макрологистической сред. Логистическая система испытывает воздействие следующих факторов:

x_i – факторы макрологистической окружающей среды, положительно воздействующие на логистическую систему;

$x`_i$ - факторы макрологистической окружающей среды, отрицательно воздействующие на логистическую систему;

y_i – факторы микрологистической окружающей среды, позволяющие логистической системе оказывать влияние на окружающую среду;

$y`_i$ - факторы микрологистической окружающей среды, не позволяющие логистической системе оказывать влияние на окружающую среду;

z_i – энергия, которая затрачивается логистической системой на противодействие внешним факторам;

$z`_i$ - факторы, разрушающие логистическую систему изнутри.

В этом случае условие устойчивого развития логистической системы будет следующее:

$$\Sigma (x`_i + y`_i + z_i + z`_i) < \Sigma (x_i + y_i) \quad (1)$$

Логистическая система способна к устойчивому развитию в том случае, если сумма положительно воздействующих факторов микрологистической и макрологистической окружающих сред больше суммы отрицательно воздействующих факторов микрологистической и макрологистической окружающих сред, факторов, разрушающих логистическую систему изнутри и затрат энергии, которую необходимо затратить логистической системе на противодействие внешним факторам.

Итак, логистика стремится к регулированию всего процесса изготовления продукции и оказания услуг от доставщика ресурсов до потребителя конечной продукции. Следует заметить, что рыночная экономика в целом и сфера распределения и обращения в особенности чрезвычайно чувствительны к инородным структурам, искусственно привнесенным в экономическую систему. Логистика непротиворечиво вписалась в современную рыночную экономику, т.е. она оказалась востребована всем ходом развития экономики.

Сколь велика доля материально-технического обеспечения и транспортировки в затратах времени на доставку товаров от первичного поставщика до конечного потребителя, доказывают данные, согласно которым лишь 2 % суммарного времени всего цикла приходится собственно на производство, 5 % – на транспортировку, 8 % – это подготовительно-заключительное время и 85 % – время пролеживания материалов и изделий. В западных странах и Японии доля расходов на материально-техническое обеспечение и транспортировку составляет до 20 % валового национального продукта, или 30-40 % стоимости конечного продукта. Почти половина этих расходов приходится на хранение и содержание запасов материальных ресурсов [6].

Основной экономический эффект логистики достигается за счет сокращения объемов запасов материальных ресурсов и времени доставки товаров. В отличие от прежних методов изолированного управления грузовыми перевозками и складским хозяйством главным преимуществом комплексного управления является оптимизация суммарных затрат по продвижению я хранению ресурсов. По экспертным оценкам, применение методов логистики позволяет снизить уровень запасов на 30-50 % и сократить время движения продукции на 25-45 % [6].

Макроэкономический аспект логистики заключается в повышении эффективности общественного производства за счет сокращения затрат в сфере обращения, прежде всего материально-технического обеспечения и транспорта, с которыми связано, как мы уже указывали, до 98 % времени и до 40 % ресурсов, возникающих в процессе воспроизводства. Практически поиск путей сокращения затрат осуществляется по следующим направлениям:

- совершенствование управления сферой обеспечения, хранения и сбыта продукции;
- оптимизация хозяйственных связей путем улучшения маркетинговой деятельности и взаимодействия поставщиков, потребителей и посреднических структур;
- положительные изменения технологии движения материальных потоков.

Сфера обращения представляет собой большую динамическую систему и в соответствии с этим может быть охарактеризована следующими признаками:

- большое число показателей, определяющих процесс функционирования системы и его результаты;
- целенаправленный характер функционирования;
- организация взаимодействия отдельных элементов системы с учетом заданной иерархии для достижения поставленных целей;
- принятие управленческих решений и управление функционированием системы в условиях риска и неопределенности.

Логистика предполагает рассматривать систему обращения во всей ее сложности и многообразии. Исследование же развития и функционирования больших систем требует системного подхода. Иной подход здесь просто невозможен. Можно сказать, что логистический подход – это системный подход к исследованию социально-экономических и человеко-машинных систем. Особенность его применения состоит в том, что каждое состояние исследуемого объекта и их совокупность рассматриваются во взаимосвязи, преемственности и развитии, в переходе к качественно новому состоянию. Сложные объекты при этом исследуются как иерархически построенное единство открытых систем, причем любые обоснованные решения должны учитывать их влияние на смежные элементы и связи.

Логистический подход представляет собой совокупность определенных приемов, способов в изучении объектов логистического менеджмента и в воздействии на них с целью достижения искомых результатов. Применение логистического подхода к проектированию развития экономических систем предполагает решение следующих задач:

- постановка целей развития и нахождение их оптимального сочетания;
- определение путей и средств достижения этих целей через выявление связей и исследование взаимодействия учитываемых факторов и рассматриваемых объектов в количественной форме;
- взаимоувязка целей и средств их достижения с потребностью в ресурсах, учитывая ограниченность последних.

С точки зрения интегрированной логистики логистический подход представляет собой многокритериальную оптимизацию бизнес-процесса: так, конструкторам следует учитывать требования технологичности, транспортабельности, утилизируемости на стадии разработки новой продукции, а разработку тары следует проводить с учетом особенностей грузопереработки на различных видах транспорта. Главные инструменты логистического подхода – анализ и синтез исследуемой системы. Анализ системы позволяет выявить наиболее существенные факторы, дает их характеристику, количественную оценку взаимодействия друг с другом, определяет влияние их на параметры исследуемой системы. Синтез обеспечивается в процессе разработки и функционирования формализованной модели исследуемых параметров системы; эта модель объединяет факторы в динамике развития рассматриваемой системы.

На микроуровне логистический подход вносит изменения во многие представления об экономике фирмы и организации производственного процесса:

- задача полной загрузки мощностей заменяется задачей минимизации сроков прохождения оборотных средств через предприятие;
- изначально могут предусматриваться резервные мощности для быстрого реагирования на изменения рыночного спроса (разумеется, это не означает наличие простаивающих мощностей. Под резервом понимаются возможности кооперации, приобретения услуг по изготовлению продукции или осуществлению определенных производственных операций);
- односторонняя ориентация на снижение издержек как метод конкуренции заменяется стремлением к наиболее высокому уровню логистического обслуживания (предоставления необходимого товара, установлен-

ного качества, в заданном количестве, в условленное место, к ранее оговоренному сроку, при оптимальных издержках);

- замена материальных запасов информацией о возможности их оперативного приобретения на приемлемых условиях (традиционный агент по снабжению превращается в брокера по информации);
- отсутствие технологических ограничений снижения размера партии изготовляемой продукции и определение ее из условий объема поставок потребителям.

Исходя из вышеизложенного, можно утверждать, что формализованное описание процесса взаимодействие логистических систем с окружающей средой требует проведения комплексного междисциплинарного исследования с экологических, социальных, экономических, организационно-технологических, технических, естественно-научных позиций. Складывается новое научное направление (для него может быть предложен термин: логистическая энвироника), представляющее собой прикладное дополнение к каноническому подходу [5] проектирования логистических систем.

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THE IMPACT OF EU EMISSIONS TRADING ON AIRCRAFT INVESTMENTS

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Abstract
Expanding growth of air transportation and an increased awareness of the global climate change have focused political attention on the environmental consequences of aviation and European airlines are the first to feel the effects of stricter environmental regulation in transportation. Investments in modern aircraft are an option to react on the regulation, but a review of the existing literature has shown contradictory views on the effects of regulatory uncertainty on investment behavior. Some authors argue that companies apply a wait-and-see strategy in the light of regulatory uncertainty, while others point out that this uncertainty is more likely to let companies act as a first-mover to gain competitive advantages. Using Miliken's taxonomy of uncertainty we analyze the existence of regulatory uncertainty in the current EU proposal to include aviation into the EU Emission Trading Scheme. State uncertainty is identified to be low and is not expected to postpone investments. Effect uncertainty about permit price trends as well as the cost and competition effects should not be underestimated and rather facilitates a wait-and-see strategy of airlines. But due to the fact that other response options with significant effects on the emission level are rare, in a highly competitive environment investments in modern aircrafts are important to gain long-term advantages compared to competitors.

1. INTRODUCTION

International aviation is growing rapidly and held responsible to contribute to about 2% of the global anthropogenic CO_2 emissions. In answer to the increasing public and political awareness of aviation's influence on climate change, from 2012 the European Union aims to include all air traffic on their territory into the existing **EU Emission Trading Scheme** (EU ETS) [10]. The aviation industry is the first transport sector that feels the effects of an increasing ambition to tighten environmental regulation in transportation. Further transport sectors like maritime traffic are already in discussion to be involved in future regulations.

The airlines concerned face much uncertainty about the effects of the current EU proposal and upcoming regulatory measures [15]. This specific type of uncertainty is referred to as **regulatory uncertainty** and does beside the existing uncertainties regarding the high volatility of fuel prices or shifting demands, significantly influence business decisions. Thereby the flexible mechanisms of emissions trading allow companies to choose between a greater emphasis on improvements in their own business activities by reduction strategies, focus on a trading strategy by selling and buying emission permits or pursue an offset strategy with the intention to shift additional costs to the customers [15]. Regardless of all these strategic response options, given that emission targets are becoming more and more ambitious, investments in modern aircraft are essential to reduce the long-term cost of the regulation.

Some research has been conducted on how regulatory uncertainty influences the investment decision of a firm. One stream in literature argues that companies apply a wait-and-see strategy when facing regulatory uncertainty and are likely to postpone investment activities until better information of the future state exist. The opposing view is that particularly in the light of regulatory uncertainty companies can benefit from performing investments proactively and act as a first mover to gain competitive advantages. With regards to the current proposal of including aviation into the EU ETS, the question arises whether emission trading generally triggers investments in aviation or not. The paper aims to answer the following questions: What are the impacts of the planned inclusion of aviation into the EU ETS and which managerial implications on company level might result? Which regulatory uncertainties are to be expected from the current proposal and what might be the influence on the investment activities of airlines?

The paper is set out as follows: In section 2 the EU proposal of including aviation into the existing EU ETS and the expected economic and ecologic impacts of the regulation are described. Section 3 discusses the influence of regulatory uncertainty on investment activities. These ideas are picked up in section 4 to identify to what extent regulatory uncertainties resulting of the current EU proposal might affect investments in aviation. Section 5 concludes the paper.

2. THE INCLUSION OF AVIATION INTO THE EU ETS

a. Background

Emissions trading is a market-based approach using transferable emission rights to allocate the pollution-control burden among firms or individuals [6]. In this context the Government acts as the owner of an environmental medium and establishes a tolerable overall level of pollution. Emission permits are created corresponding to this cap and represent the right to emit a certain amount of a pollutant. Firms that keep their emission level below the assigned level may sell their unused permits to other polluters that are in need of further emission permits. This flexible policy instrument provides long-run incentives to search for and invest in abatement technologies, if emission targets are successively enhanced [11].

In 2008 the European Union released a directive on including the aviation sector in the European Emissions Trading Scheme [10]. From 2012 the EU ETS will cover all flights departing from or arriving at EU airports. The cap level for the first period will be fixed at 97% of 2004 to 2006's average historical CO_2 emissions and will be lowered to 95% after 2013. Initially 82% of the permits are allocated free of charge by applying a sector-wide benchmark value. This benchmark will be calculated by dividing the overall CO_2 cap by the total tonne-kilometers of all concerned airlines in the monitoring period. Another 15% of the total amount of permits will be auctioned and a special reserve of 3% of permits is kept for market entrants or fast-growing airlines. Trade in the proposed scheme is restricted, meaning that airlines are able to purchase permits from other trading sectors, but are not allowed to sell to them. However, airlines are able to use certified emission reductions and emission reduction units from the flexible mechanisms the Kyoto Protocol offers, up to 15% of the individual allocated amount of permits [1, 22].

b. Economic and ecologic impacts of the EU ETS

Recently several studies have been published that examine the possible impacts of an Emissions Trading Scheme on the aviation sector. Most of the literature focuses on the economic impacts and more precise on changes in travel demand, companies' costs, air fares and distortion in competition, while some center on the impacts of the regulation on future emission levels [1, 2, 17, 21, 22, 25, 26, 27].

Anger (2010) applies a macroeconomic dynamic simulation model which analyses the interactions between air transportation and the business environment [1]. The results of the simulation suggest that even for a permit price of €40 and full cost pass-through, by 2020 there will only be a slight decrease in travel demand of 0.98%. Depending on the permit price (€5, €20 or €40) the absolute CO_2-emission level will diminish in response to the regulation by a measure of 0.3%, 3.4% or 7.4% [1]. Anger argues that these emissions reductions are mainly due to supply-side effects and not related to demand reductions. Airlines are expected to realize windfall profits and the higher the permit price the more investment activities are pursued to increase fuel efficiency.

Similar results are found by Wit et al. (2005), who use a simulation model that aims to forecast environmental and economic impacts on the aviation industry under different policy constraints [27]. Their estimates show that a decrease of the transport volume by 2.1% compared to the business-as-usual case is expected for a permit price of €30 and under the assumption that all costs are fully passed through. Supply- and demand-side effects on emission reductions within the aviation sector are believed to be marginal and highly depend on permit prices and the potential to realize windfall profits by shifting additional costs to the customer. Most likely airlines will purchase the majority of needed emission permits from other sectors within the EU ETS, since abatement costs are expected to be much lower in other industries [27]. These findings coincide with the results of Vespermann/Wald (2010) and Vespermann/Wittmer (2010). Aviation is considered to be a strong net buyer of emission permits and will therefore induce emission reductions in other sectors. These trading activities come along with a significant financial burden for the industry, which is expected to average to about €3 billion from 2012-2020 or 1.25% of the total industries' cost base [25, 26].

To our knowledge no research has been conducted on the effects that the planned EU Emissions Trading Scheme might have on investment activities in the aviation sector. In order to approach the problem, we first present two different perspectives on the relation of regulatory uncertainty and investments discussed in literature. Afterwards we analyze potential regulatory uncertainties the current proposal induces and the effects these might have on investments in the aviation sector.

3. REGULATORY UNCERTAINTY AND INVESTMENTS

a. Regulatory uncertainty

Coping with uncertainty in business decisions is a fundamental problem for companies and has led to a variety of concepts and terminologies in literature [16, 24]. In decision theory uncertainty refers to a situation where the current state of knowledge of a decision maker is such that the probabilities to possible outcomes are unknown, opposed to risk situations where probabilities can be assigned to possible outcomes [8, 14]. Lawrence and Lorsch (1967) state that uncertainty consists of three components: the lack of clarity of information, the general uncertainty of causal relationships and the long time span of definitive feedback to the measures taken [16]. This view is generally shared by Duncan (1972), but in addition he suggests to distinguish between internal and external uncertainties in the organizations' environment [8]. Following this concept, the environment consists of all physical and social factors within the boundaries (internal) or outside the boundaries (external) of an organization, that are taken directly into consideration in the decision-making behavior of individuals in the organization. Factors comprising the internal environment are personnel components (educational skills, behavior), functional components (interdependence of organizational units) or level components (organizational objectives and goals). From an external point of view an organization's environment is affected by customer, supplier and competitor components, as well as technological and socio-political factors like government regulatory control over the industry [8].

Engau and Hoffmann (2010) define **regulatory uncertainty** as the uncertainty associated with the actions of governmental agencies that create and enforce regulations and leads to a firm's inability to have a clear understanding of the future state of the regulatory environment [9]. To understand the effects this uncertainty has on the internal environment of an organization, it is useful to employ a wider definition of the term regulatory uncertainty. The taxonomy of Miliken (1987) suggests recognizing the multidimensional nature of uncertainty by breaking it down into three types [18]:

- **State uncertainty** refers to the inability of an organization to predict its future organizational environment or a particular component of the environment.
- **Effect uncertainty** is defined as the inability to predict what the nature of the impact of a future state of the environment or an environmental change will be on the organization.
- **Response uncertainty** is associated with the question which response options are available to the organization and what the outcome of each might be.

Following this taxonomy, regulatory uncertainty refers to the inability of an organization to predict the future regulatory environment, the lack of knowledge about the impact of a regulatory event or change on the organization and the inability to choose the appropriate response option and predict the associated outcome.

b. Postponement versus promotion of investments

Companies respond to regulatory uncertainty by pursuing at least one of the following strategic responses. Companies can **disregard** regulatory uncertainty and continue with business-as-usual. They can **reduce** this uncertainty through further investigations or by lobbying external institutions. Another response is to **adapt** to regulatory uncertainty by cooperating with companies that are also affected by the regulation or increase flexibility to enlarge the range of strategic options. Furthermore companies can **avoid** regulatory uncertainties, by withdrawing from certain markets or defer decisions and wait for more certainty [9].

Postponement of investment activities is a response-option of companies to delay activities until the latest possible point in time. The idea behind is that the delay leads to the availability of more accurate data, which allows the reduction of uncertainties [28]. There are diverse motivations for companies to continue with an existing asset rather than replacing it with the best available technology [5]. In the light of regulatory uncertainty companies tend to postpone replacements, when they expect that the performance of new technology alternatives continuously improves over time [13]. In addition the postponement of an investment allows learning from first-movers to reduce uncertainties associated with the investment.

With regards to Emissions Trading Paulsson and von Malmborg (2004) take an institutional economics approach to analyze the effects of the EU ETS on company behavior in the Swedish energy sector, which they believe to be largely influenced by the relations between the national government, environmental organizations and the industry. Their findings reveal that companies act passively in the face of emissions trading and that ambiguous government policies prevent companies from making long-term strategies on emission reductions. Beside the fact that the companies are unaware of flexible environmental regulations and still expect command and control measures, vague governmental policy with no clear path to follow and the missing dialogue between the parties are reasons why companies tend to postpone decisions [19].

Traditional **discounted cash-flow (DCF) approaches** act on the assumption that an investment is advantageous as long as the net present value is positive. Regulatory actions influence the series of discounted cash flows of investment projects in two ways: At first the purchase of emission permits results in additional payoffs and reduced cash flows. As these emission costs are uncertain in the future, the level of regulatory uncertainty also needs to be taken into account (either by increasing the discount factor or including a risk premium in the cash flows). However, the DCF approaches neglect that the management may have valuable flexibility to alter its initial strategy during the investment phase and realize future opportunities or beware of possible threats.

Real options theory transfers the idea of financial options to investment decisions. The real option offers the management the right to make decisions about the investment at a later date (e.g. wait-options) [7]. This option to wait is especially dependent on the form of reversibility a certain asset has. If there is a high level of irreversibility in the investment, the flexibility to change the investment in terms of an alternative use is low. Schwark (2009) suggests to compare the flexibility of resource commitment with the degree of regulatory uncertainty to predict the investment behavior. If regulatory uncertainty is high and the flexibility of an investment is low, the option value of waiting is highest and companies tend to favor postponement strategies. The opposite strategic response is conceivable under low regulatory uncertainty and high flexibility, as in this case the option value of waiting is low and companies are believed to perform investment activities immediately. For the other combination high flexibility and high uncertainty incremental investments could be an alternative, which are done step by step until regulatory uncertainty resolves. If regulatory uncertainty and flexibility are both low, companies prefer strategies to adapt to uncertainty [23].

The opposite stream in literature argues that regulatory uncertainty increases the likelihood of companies to **perform investments proactively**. Aragón-Correa and Sharma (2003) explain how certain characteristics of the general business environment, like uncertainty, complexity and munificence affect proactive environmental strategies [3]. Their concept bases on the **resource-based view of the firm**, which posits that firm's resources need to be valuable, rare, imperfectly imitable and not substitutable. To gain a competitive advantage relative to rival firms companies that face high regulatory uncertainty need to secure and develop resources and act as a first-mover when it comes to the realization of investments [4]. Rugman and Verbeke (1998) use the resource-based view perspective to analyze the interactions between firm's competitiveness and environmental regulation. The flexibility of resource commitments in terms of alternative uses is an essential factor in determining the success of environmental improvements, if it promises high leverage potential to both financial and environmental performance [20].

Hoffmann et al. (2009) also refer to the principles of the resource-based view of the firm and show in a case study of the German power industry that companies do not necessarily postpone investment decisions when facing high regulatory uncertainty [12]. They trace this fact back to three motivations: securing competitive resources, leveraging complementary resources and alleviating institutional pressure. According to the second motivation, investments are more feasible, if there are other appropriate resources in use that complement with the new resource. An example is an existing pit beside a power plant currently being planned. In this case the decision maker would be more willing to pursue the investment despite regulatory uncertainty by leveraging complementary resources. Institutional pressure can under certain circumstances motivate a company to invest although regulatory uncertainty exists. Beside the pressure regulatory institutions excerpt on the business, there are various pressures from other stakeholders in the external environment. A proactive investment in modern technology might make certain activities more acceptable to the public and strengthen a companies' position as acting sustainably [12].

In summary there is no consensus on the issue whether or not regulatory uncertainty generally triggers investments or not. The review of both literature streams reveals that flexibility and reversibility are important drivers in the investment decision. Since these factors are sector-specific and subject to the design of the regulation, in the following chapter we focus on the influence specific characteristics of the aviation sector might have on investments and to which extent these are influenced by regulatory uncertainties of the current proposal.

4. INFLUENCE OF REGULATORY UNCERTAINTY ON AIRCRAFT INVESTMENTS

a. State uncertainty

Airlines would experience state uncertainty when they perceive the current or future regulation to be unpredictable or do not understand how components of the regulation might be changing. With regard to the current proposal the European Union has fixed the main conditions of the scheme until 2020, so that the airlines concerned have a clear picture of what is regulated, which activities are involved in or excluded from the regulation.

However, there are still some conditions that have yet not been fixed. The technical benchmark measured in kg CO_2 per tonne-kilometer (carbon efficiency) is taken to allocate the free permits and essential in the context of an airline's investment strategy. Since the benchmark for the first period is calculated by taking the EU-wide emissions cap for aviation divided by the total tonne-kilometers flown by all airlines in 2010, to date this value has not been published. Airlines that are able to lower their specific emission value below this benchmark can attract more free permits than they initially have applied for. This would lower the costs for the purchase of auctioned permits and in addition airlines could realize windfall profits by selling unneeded permits. Investment projects that increase carbon efficiency could therefore be more profitable. The publication of a sector-wide benchmark would furthermore increase transparency and institutional pressure from stakeholders could apply some pressure to facilitate investments.

The method to allocate free-permits is believed to be disadvantageous to some airlines. In 2010 the volcanic disruption has stopped flight activities and therefore especially airlines from Northern Europe performed lower transport activity. Lufthansa argues that this fact and extreme weather conditions make the reference period not representative. Another important factor that still needs clarification is the amount of certified emission reductions from Joint Implementation and Clean Development Mechanisms that can be taken into account. In 2012 an amount of up to 15 % of an airline's allocation can be used, but it is uncertain how this will be handled from 2013. The amount is essential, since a widespread use of flexible mechanisms would diminish the willingness to invest and revert to trade instead of reduction.

Airlines that are currently outside the scope of the EU ETS (whole or partially) face state uncertainty about the future extension of an Emission Trading Scheme. Some airlines fear competitive disadvantages for European carrier and demand a global sectoral approach that includes all international flights into an Emissions Trading Scheme. Especially US airlines fear that in the long-run future regulatory actions could be taken by the US government, who tempt to follow the EU legislation. The big four US airlines responded to this threat and filed an action challenging the legality of the ETS to reduce regulatory uncertainty by influencing the authorities.

In summary, even though there are still some conditions that need to be fixed, the degree of state uncertainty until 2020 can be regarded as low. A postponement of investments due to state uncertainty is not expected, because there is no valuable option to wait for a change of the regulation components. The persistent critical factor in the short-run is the publication of the benchmark value. If the setting is ambitious, the realization of further investments is feasible.

b. Effect uncertainty

In the context of regulatory uncertainty effect uncertainty refers to an inability to predict what the nature of the impact of the regulatory change or event might be on the organization, as well as to the uncertainty about the severity and timing of impact [18]. For the airlines included the expected permit prices are an important factor to estimate the degree of effect uncertainty. The ongoing trade with emission allowances is characterized by a high volatility and price crashes, as can be seen in Fig. 1.

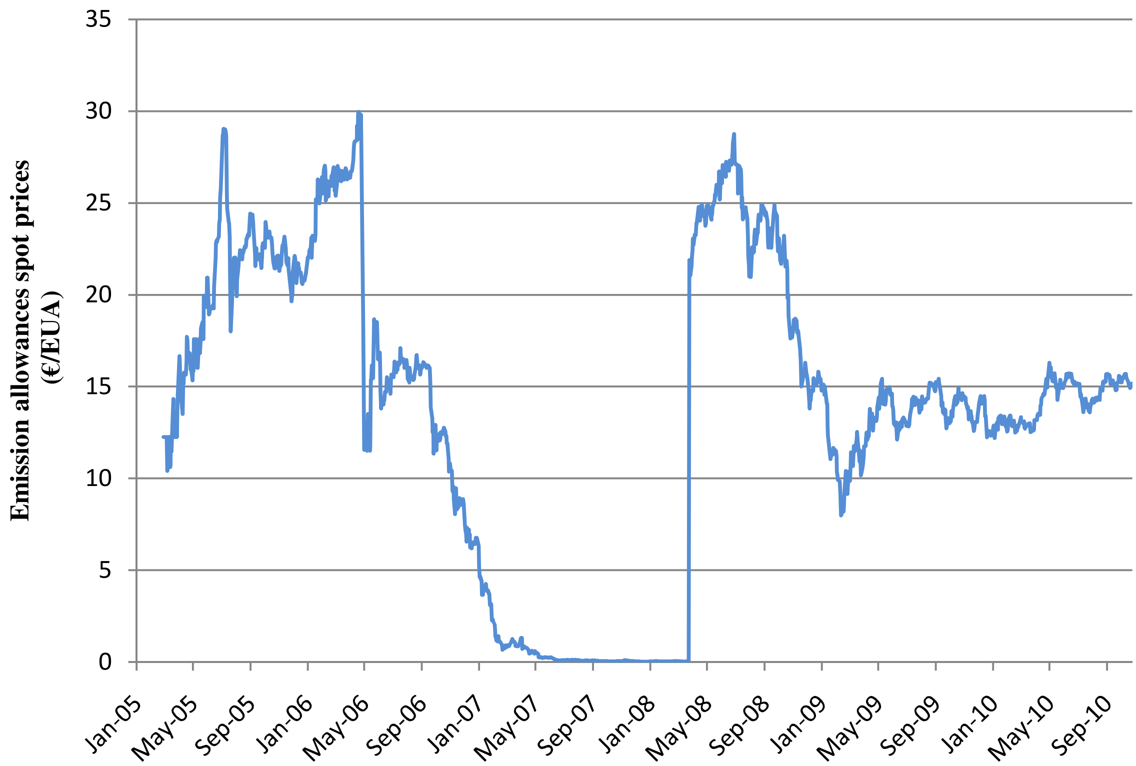

Fig. 1 Emission allowances spot prices (Source: European Energy Exchange, www.eex.com)

Prices increased from €12 per allowance in March 2005 to €30 in April 2006 before crashing down to practically zero by the end of 2007. The price crash was triggered by an over-allocation of the EU, who did not have reliable information about firms' actual and projected emissions. It seems that the European Union had learned from the generously set emissions cap in the pilot phase and has tightened the emission targets for the aviation sector in order to avoid further price crashes due to over-allocation. For 2012 the cap level is set at 97% of 2004-2006 emissions, with a reduction to 95% until 2020. In addition the special reserve for new market entrants limits the total emissions for the established airlines.

Scheelhaase/Grimme (2007) show that financial impacts of the proposed scheme on the airlines mostly depend on the structure of the business model [21]. For Full Service Network Carrier the ratio of emissions costs to overall traffic revenues from flights subject to the EU-ETS amounts to 1%, compared to a cost portion of up to 3% for Low Cost Carrier. Beside differences in the individual cost and revenue structure of these airlines, a reason for this relative competitive disadvantage is that flights of Low Cost Carriers in most of all cases are subject to the EU-ETS. Disadvantages are also expected for European airlines compared to their Non-EU counterparts. Non-European airlines receive a higher share of free permits, since they operate exclusively with their efficient long-haul fleet and operate their short-haul flights solely outside the scope of the EU ETS [22]. In addition they are more flexible to avoid the regulation by redirecting international traffic flows to nations which are close to EU territory, but not covered under the scheme. This is especially conceivable for long-haul flights from North America to Asia with an increasing use of Hubs in Eastern Europe and the Middle East [25].

From a cost perspective emission permits can be viewed as equivalent to carbon taxes. Both policies are operating to raise the prices of fuel. Since activities to reduce fuel and CO_2 are complementary, the uncertainty of emission permit price trends needs to be seen in addition to the volatility of fuel prices, when it comes to the assessment of investments. In fig. 2 kerosene spot prices and aircraft orders received by Boeing and Airbus for the timeframe 2007 to 2010 are compared, in order to derive how airlines responded to fuel price uncertainties in the past few years.

As argued by Schwark (2009), a typical response option to high uncertainty are incremental investments, which are done step by step until uncertainty has been resolved [23]. Aircraft orders in fig. 2 leads one to suspect that after a period of highly volatile fuel prices and uncertainty due to an economic downturn at the end of 2008, orders declined and airlines rather applied a wait-and-see strategy than investing proactively. This would strengthen the argument that high regulatory uncertainty tends to favor postponement of investments.

c. Response uncertainty

The third type of uncertainty is associated with the questions which response options are available and how airlines can predict the consequences of a response choice in order to react appropriately to the regulation.

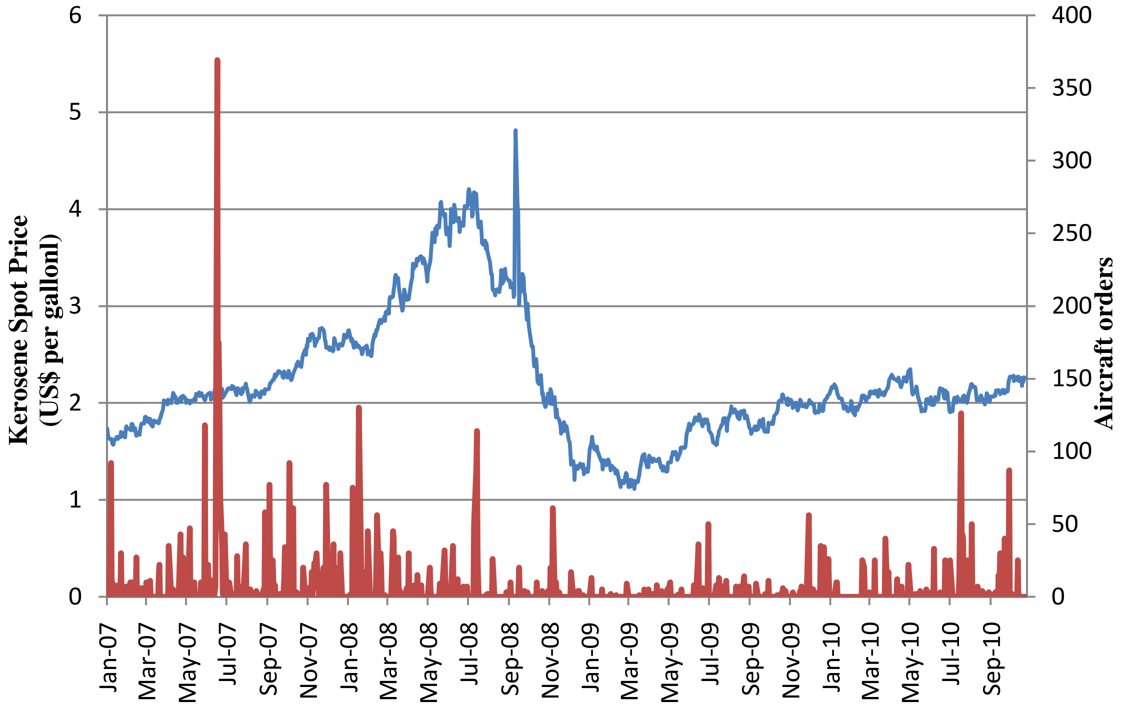

Fig. 2 Kerosene spot prices and aircraft orders
(Sources: US Energy Information Administration http://www.eia.doe.gov/, Airbus and Boeing orders & deliveries www.airbus.com, www.boeing.com)

It is to be expected that the introduction of an ETS in Aviation will have an effect on the cost and revenue structure of the airlines and furthermore influence the competitive situation in the market. Consequently this development does have a number of strategic and operational implications for the management. Companies can choose to reduce emissions in their business activities through innovation or compensate the emissions caused e.g. by trading emission permits. Compensation leaves a company's assets and competencies unchanged and instead of improving own technological assets the company benefits from emission-reduction technologies developed by others [15].

To evaluate reduction options the ASIF approach allows to derive four main drivers of the absolute emission level (Activity, Structure, Intensity and Fuel Type), which provide a starting point for emission reduction measures. A reduction of emissions can be reached by adjusting the **activity**, by either reducing the distance-related portion (kilometer) or the weight-relevant part (tonnes) of the activity. In times of increasing air travel demand emission reductions from activity changes seem to be unlikely, since these would induce demand-side effects. Short-term **structural changes** in the network structure of an airline, for example by dislocating activities outside the European Union are demanding, since airport slots and hub capacities are scarce resources. Some authors have analyzed the possibility of artificial stops in Non-EU countries due to the regulation [2, 26, 27]. Although airlines could reduce their emission costs with these kinds of stops, they face difficulties with longer travel times for the passengers, as well as additional ground handling and fuel costs that do not outweigh emission cost savings. The **intensity** of an aircraft use can be affected by operational and strategic measures. In the short-run airlines are able to reduce emissions by adjusting cruise speed or flight levels and install end-of-pipe technologies. Most of these types of improvements have, due to the increasing fuel cost pressure, already been exhausted or incur high abatement costs. Contrary to energy producers airlines are limited in switching fuels to reduce their emissions. Research on alternative fuels with a lower CO_2 emission content is ongoing, but currently **fuel type switches** are not a serious option for airlines.

Given these limited response options it seems obvious that the main potentials to significant emission reductions lie in long-term investments in modern aircrafts. The flexibility of an aircraft investment is high, because they represent mobile resources that allow an alternative use on other routes or markets. In addition there is a well-organized and standardized second-hand market for aircrafts with good resale prices, making the investment project less irreversible. Due to limited reduction options the response uncertainty is low and in this case from a real options perspective an option to wait is less valuable with regards to alternative reduction measures. Taking a resource-based view the high competition in the market necessitates valuable resources to gain competitive advantage, so that the proactive performance of investments is conceivable.

5. CONCLUSION

Environmental regulations in the transport sector seem to increase in the near future and the European airlines are the first to feel the effects of this development. Investments in modern aircraft are an option to react on the planned inclusion of aviation into the EU Emission Trading Scheme, but the review of existing literature on the effects of regulatory uncertainty on investment behavior has shown contradictory views. It became obvious that flexibility of an investment and the degree of uncertainty are essential determinants. Based on Miliken's taxonomy of uncertainty we investigated the existence of regulatory uncertainty in the current EU proposal. State uncertainty was found to be low and would not be a reason to postpone investments. Effect uncertainties arising from volatile permit prices and competitive distortions are of significance and are believed to facilitate a wait-and-see strategy of airlines with regard to investments. We have shown that there is a variety of response options available, but compared to other sectors the potentials to reduce the emission level are limited. In a high competitive environment proactive investments in modern aircrafts are essential to gain competitive advantages and fulfill future regulatory actions.

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SYSTEMIC CHALLENGES FOR ENERGY SUPPLY CHAINS

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Abstract: Innovation in current interconnected world – characterised by evolving opportunities and threats – is distinctly challenging. The present paper aims to address logistic processes and innovation in energy supply chains. Innovation tackling sustainability, security and development in a complex world will come to life within interwoven organisations' networks that properly deal with diversity and complementarity of knowledge, resources and assets. Today and in the decades to come, energy sources will represent a huge challenge for effective, sustainable and innovative logistic processes and networks.

1. INTRODUCTION

Innovation and the concomitant evolution of social and physical technologies coordinated under evolving business plans [1] play a central role in today's economy and can be viewed as a complex processes arising out of systemic interaction between actors and stakeholders involved in the production, diffusion and use of new and economically-useful knowledge [2]. The systemic approach interprets innovation as an iterative matching of technical possibilities to market opportunities, through both market and non-market interactions, feedbacks and learning processes throughout research and development (R&D), production and logistic networks, rather than as a one-way, linear flow from R&D to new products [3].

Innovation in an intertwined world impregnated with external knowledge and characterised by evolving and cyclical opportunities and threats is distinctly challenging. The most capable of identifying and absorbing useful external knowledge and thus adaptable to new contexts will have greater surviving chances. Innovation can be defined as the economically-useful combination of capabilities [4], based on an evolutionary routine both path- and context-dependent. In present evolving world, innovation along organisations' networks has an essential role in obtaining and sustaining competitive advantage.

The present paper aims to address logistic processes and innovation in energy supply chains. The evolution of energy supply chains represents one of the most relevant challenges to our contemporary society. Nevertheless the dynamics of this evolution are conditioned by a broad array of positive and negative feedbacks [5]. Suitable structures and policies should be pursued in order to deal properly with these feedbacks. Finally some systemic challenges, insights, scenarios and prospective actions will be outlined.

2. SYSTEMIC PERSPECTIVE AND INNOVATION

Due to the identification and obtainment of new and attractive markets as well as high quality/low cost sources, current evolutionary paths are compelled to the development and further improvement of processes and networks that connect demand and supply fronts. This connective function has intensified strategic relevance of logistics. Supply chain is a network of organisations that are involved, through upstream and downstream linkages, in the diversified processes and activities that produce value in the form of products and services to the ultimate customer [6].

Additionally, the on-going removal of trade barriers and technological progresses in transport and communication fields allowed many supply chains to expand out of their national borders, to exploit new markets and to locate business processes in different countries [7]. Furthermore, the relative importance of developing economies as engine of demand growth may shift more dramatically and quickly than expected [8]. Today's booming consumption seems irreversible and is dependent on formal and informal international cooperation, sovereign states, multiple non-state actors [9].

Effective, sustainable and innovative processes connecting logistic partners within global supply chain have to take into account aspects like: long-term and systemic view, customer's complex and bounded behaviour, growing demands for service level (and expanded products), development of a suitable organisational structure, dependence on trustful partnership, suitable flow of information, and, finally, reliance on international cooperation and cross-cultural competences. Here, it will be argued that to achieve effectiveness is necessary to pursue efficacy – represented by a strategic approach, producing the right outputs in line with present and future market needs – and at the same time to quest efficiency – optimizing resources spent in achieving a desired effect. In a systemic view, sustainability comprises maintaining effectiveness along time as well as preserving (and even enhancing) economic, social and environmental resource base.

The connection and further integration of demand and supply must be congruent with strategic choices that determine which activities and processes an organisation will perform and how they will be design and coordinated. In fact, business strategy is about how to combine and fit activities and processes to obtain and sustain competitive advantage [10]. Furthermore to preserve this advantage the organisation has to be unique; and, to generate and sustain uniqueness, its resources must be [11]: (i) valuable, in the sense that it exploits opportunities and/or neutralises threats in firm's environment; (ii) rare among a firm's current and potential competitors; (iii) imperfectly imitable, either through unique historical conditions, causal ambiguity, or social complexity; and (iv) singular, without strategically equivalent substitutes.

Systems thinking can uncover the systems complexity by revealing what underlying structures exist, how complex problems are generated and which/how factors influence them over time [12]. Forrester [13] vigorously argued that more attention must be placed on processes, systems, structures and policies design and plan, instead of purely on the contingencial day-to-day decision making. On the same way, systems approach tries to overcome the existent role of uncertainty and cognitive limits regarding firms' or individuals' ability to gather and process information, its bounded rationality [14]. Systems thinking require us to examine issues from multiple perspectives, to expand the boundaries of our mental models, to consider the long-term consequences of our actions, including their environmental, cultural, and moral implications [15].

The scaffolding of evolutionary economics [4] conceptualises a piece of knowledge as a recipe in which a list of potential ingredients, encompassing both social and physical technologies as well as business processes are included [16]. This idealised recipe details how to combine ingredients – in which proportions, in what order, under what circumstances – to achieve a desired end [16]. This conceptualization of knowledge leads to recall innovation as a process of searching for new recipes. The exploration of space for possible combinations of ingredients, or recipes, for new and better alternatives involves not just the search for the best combinations but also the quest for the most effective integration methods [16].

Innovation activity results from interactive relationships between institutional and organisational elements of science, technology and business, which together could be called systems of innovation [17]. Furthermore innovation is one of the key factors to an enterprise's long-term prosperity [18-19] and normally it is characterised by uncertainty about future markets, technology potential, policy and environments. In fact, business innovation is the most important driver to growth on economic welfare over time [20-23]. It could be defined as [24] the creation of new products, processes, knowledge or services by using new or existing scientific or technological knowledge, which would provide a degree of economically-useful novelty either to the developer, the industrial sector, the nation or the world.

3. ILLUSTRATIVE CASE

The following section comprises the illustrative case tackling the following issues: existing and forthcoming complex environment, technologies, logistic systems, sources and markets. Furthermore the joint-evolution and balance between actors, stakeholders and contexts will be addressed, including insights about long-term strategy, structures, policies and decision making based on expected market evolution and logistic networks. In the following exemplification current energy shortage scene and concerns about climate change mitigation are the activation triggers that motivate and compel the system to respond.

Energy supply and climate change are not just economical and environmental issues, being connected to fundamental social geopolitical challenging topics. Many decisions of critical importance for both global climate and transition to a low-carbon economy will take place outside the climate policy community, in the fields of energy, security, trade, investment and development cooperation [25]. On top of that, multinational businesses are oftentimes better positioned than governments to deal with some of the most complicated global challenges. The paramount goal of sustainability investing is to seize the opportunities, not just avoid the risks, and furthermore to drive profitability and competitive positioning [26]. Energy security and investment issues are becoming a top priority at the national and international level, and will remain so as long as current international geopolitical uncertainties continue to fester and the resource requirements of emerging powers continue to grow [25].

On this context most of the new energy sources (e.g. modern biomass) are still undergoing large-scale commercial development with small market-share. On this grouping, biofuels are referred to liquid or gaseous fuels for the transport sector that are predominantly produced from biomass. Biofuels are generally considered as offering many advantages, including aspects of sustainability, reduction of net greenhouse gas emissions, regional development and supply security [27]. One of them, ethanol or bioethanol is a petrol substitute/additive derived from alcoholic fermentation of sucrose or simple sugars, which are produced from biomass by hydrolysis process [28].

Policies are available to governments to realise mitigation of climate change, but effectiveness of policies depends on national circumstances, their design, interaction and implementation. Particularly, integrating climate policies in broader development policies, suitable regulations and standards have central role [29]. Moreover there are three main issues when considering how trade and investment policy objectives might influence the ability and inclination of nations – particularly developing countries – to collaborate on effective climate change efforts [25]: (i) liberalisation, carried out properly, can provide the means, and the necessary goodwill, for developing countries to address mitigation and adaptation; (ii) rules can act as aids or obstacles to climate change efforts; and (iii) relations can constitute a platform for wider cooperation. In global terms, biofuels represent an alternative that could equilibrate the polluter generation with long-term contribution to environment conditions improvement. Furthermore, it can also be positive for: energy security, balance of trade improvement, and employment in rural areas [29].

As for [30] 'transport is trickier, because car ownership is *rocketing* and the demand for fuel is fairly inelastic. If people want to drive they are going to drive, unless governments jack up petrol prices to levels that are politically unacceptable. So for emissions to fall in the transport sector, new technologies, such as more efficient biofuels or electric cars, are needed'. And, 'given a big research and development (R&D) effort in this sector, there is a good chance that those will be forthcoming'. Of course, this implies that barriers to development, acquisition, deployment and diffusion of technologies and to market access are effectively addressed [29].

Finally, the higher the market prices of fossil fuels, the more low-carbon alternatives will be competitive, although price volatility still represents a disincentive for investors [29]. Furthermore, policies that clearly inform the implicit carbon and environmental footprint could create fundamental incentive for producers and consumers to invest and freely choose low-emissions products, technologies and processes. Information instruments (e.g. awareness campaigns) might promote informed choices and possibly contribute to behavioural change [29].

Nevertheless, production and distribution of biofuels imply important challenges for supply chain design, planning and integration. The following aspects have to be properly considered: production, processing, and logistic technical and economic characteristics; taxes, monetary policies and fiscal incentives in different regions/countries. Clear commitment to existing or forthcoming public-private frameworks would also ensure fair partnering in strategic logistic projects. These projects would include the necessary infrastructure for transportation, intermediary and regulatory stocks, intermodal terminals and further interfaces.

Regarding to environmental issues and the integration within existing natural systems, it is *obligatory and critical* to ensure and enhance holistic sustainability, from feedstock till final consumption. Most important, a long-term communication channel along actors and stakeholders has to be created and maintained, including periodic inspections and certification. Clear foundations for the cited holistic sustainability are: establishment of stable and optimal production zoning, ensuring minimal impact on the environment (e.g. reuse of degenerated areas like pasturage); development of human capital; as well as macro- and micro-logistic integration.

Taking into consideration logistics, marketplace and context characteristics, it is reasonable to consider that a network of organisations would better tackle the existing and forthcoming systemic challenges. This claim is based on the necessary integration of diversified and complementary (in terms of knowledge, resources and assets) actors in order to improve awareness, flexibility and innovativeness. Furthermore, it could be expected the occurrence of cross-pollination across firms and markets, impelling current promising technologies forward market-driven innovations.

Considering long-term investments involved, future technological transitions should be foreseen in advance. In fact, predicting, sensing, acting and taking advantage of forthcoming innovation waves, like: cellulosic ethanol, hydrogen production from ethanol reform and environment-friendly fuel cells would represent a relevant task for the idealised network. Research efforts in technology developments, integration of markets and sources as well as logistic processes and networks should be actively allocated, thus supporting technology- and market-driven innovations.

4. CONCLUSIONS AND FUTURE RESEARCH

Innovation tackling sustainability, security and development in a complex world will come to life within interwoven organisation's networks that properly deal with diversity and complementarity of knowledge, resources and assets. Together with suitable business context, systems structures and policies, they should guide joint-strategies that would underpin the share of trust, risks and profits. Logistics could support innovation impulse through experience and knowledge sharing in supply/demand fronts and throughout linkages inherent to these flows and nodes.

In this moment of substantive transformations it is mandatory to suitably approach the sight of opportunities embedded on the green, innovative and networked economy. Today and in the decades to come, biofuels and other new sources of energy represent a huge challenge for effective, sustainable and innovative logistic processes and networks. In which way, in what order, under which circumstances and how actors (e.g. feedstock's holders, processing firms, research and development, logistic firms, energy groups) and stakeholders (public, governing entities and regulatory agents) will act to achieve the desired end are still open questions.

Prospective research, considering the multitude of direct and indirect effects as well as private and public actors/stakeholders that should be involved in order to deal with existing complexity, is definitively a huge challenge. This applied research could follow a 4-phase structure: (i) identification of potential partners and collaboration frameworks; (ii) identification of main focus considering business interests; (iii) development of customised descriptive model and evaluation framework, and (iv) proposition of strategic implementation roadmap, including feasible actions toward increasing competitive advantage.

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USING DEA MODEL TO MEASURE THE IMPACT OF CAPACITY ON TOTAL TRANSPORT PRODUCTIVITY

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Abstract: This paper introduces Data Envelopment Analysis (DEA) as a method to evaluate total transport productivity and analyzes the impact of transport capacity provision on the total transport productivity. As transport services are generally multi-stage production processes, the definition of productivity will be given by an additive composition. For this reason, the basic DEA-CCR-model is modified based on an established additive integrated DEA approach. Given that the provided transport capacity constitutes an output of the internal service production, it is also an input of the ex post production of transport services. Since we want to analyze the impact of transport capacity, we use a generalized integrated DEA approach. Using data from 25 European airlines in 2007, we are able to measure the total transport productivity and may suggest whether the airlines should concentrate to maximize the transport capacity ex ante or if they should strengthen marketing activities to attract more customers in order to maximize the ex post productivity.

1. INTRODUCTION

Global markets, the introduction of products with short life cycles as well as increased expectations of customers require more attention on logistic services. Improvements in transportation technologies have forced the continuous optimization of logistic services [16]. The need to measure the performance of logistic services increases the importance of the development of a large number of quantitative performance indicators. The total productivity concept is used to manage production efficiency [10] and constitutes an adequate ratio of how efficiently input resources are transformed into economic outputs. As logistic service processes are characterized by multi-stage production processes, it is not possible to store the output of services during periods of low demand to use it in periods of high demand [6]. Considering transport processes, an example of such non-storable output is the provided transport capacity. In case that a part of this capacity is not concurrently consumed, it may have an impact on the total transport productivity.

Recent works have analyzed the total productivity of transport processes using Data Envelopment Analysis (DEA) like Cowie (1999) [8], Karlaftis (2004) [13], Yu (2008) [19], Chiou, Lan and Yen (2010) [6] or Steven and Egbers (2010) [18]. As all research concentrates on the measurement of total productivity of several transport processes such as railways, transit systems, public transport or airlines, none of these studies analyses the impact of transport capacity on total productivity in detail. For this reason, this paper aims to answer the following questions: How can productivity ratios be designed to consider appropriately multi-stage transport processes? And what is the impact of the provided transport capacity on total transport productivity?

Therefore, the remainder of this paper proceeds as follows: After a description of the constitutive attributes of logistic services, section 2 defines an appropriate ratio describing the total productivity of logistic services. Within section 3, we specify the total transport productivity and discuss the influence of the transport capacity. To measure the total transport productivity as well as the influence of the capacity level on total transport productivity, section 4 introduces the methodology of the integrated additive CCR model and the generalized integrated additive CCR model. The applicability of the approaches proposed is evaluated with a numerical example in section 5 based on an adaptive dataset of 25 European airlines in 2007.

2. LOGISTIC SERVICES AND TOTAL PRODUCTIVITY

The measurement of logistic service productivity is more difficult than the measurement of the traditional **manufacturing productivity** concept. As the latter has been designed for production of physical goods, this concept is based on the assumption of separate production and consumption processes where customers are not involved in the production processes [10]. For this reason the aim of this section is to give a constitutive definition of productivity in the logistic service context [1].

Generally **services** are characterized by simultaneous production and consumption processes with customer participation. Therefore inputs resp. resources like staff or operating facilities are employed to produce the output in form of services [10]. Since the basic **logistic services** are transportation, handling and storage, the output of these service processes are intangibles resulting in changes of local, quantitative or temporal properties of logistic objects. Thus the service production process is a multi-stage process, in which at first internal inputs are combined to provide the capacity of logistic services. In the second step, by using the provided capacity, the location (in case of transportation) or the amount of logistic objects (regarding handling processes) will be transformed [7]. According to these characteristics of service production, logistic services are defined from an input-, process- and output-oriented point of view [17, 14]:

- **Input-oriented definitions** concentrate on both the promise to provide logistic services by human work and the allocation of equipment like transport vehicles or storage capacity.
- In contrast, **process-oriented definitions** focus on the performance of service delivery through the combination of internal and external factors. The

external factor constitutes a logistic object in this context like raw material or intermediate goods, which can be stored or delivered.

- Finally, **output-oriented definitions** refer to the benefit for the customer generated with logistic services. This success results from a modified local, quantitative or temporal availability of logistic objects.

To ensure the efficiency of logistic services, it is necessary to analyze the relation between inputs and outputs and therefore the productivity of logistic services. As shown in fig. 1, **productivity** is generally defined as a ratio of outputs achieved and inputs used. This ratio gives information about the yield of factor input, which is transformed to produce the desired output. As in manufacturing-oriented productivity concepts the inputs are e.g. given by the amount of staff, equipment or raw materials, the outputs can be measured in terms of volume or quantity (e.g. m, m^3 or kg) [2].

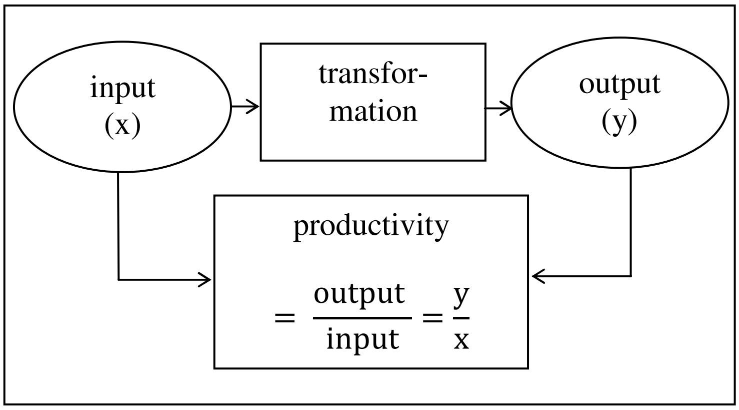

Fig. 1: Manufacturing-oriented productivity

There exist several contributions concerning the measurement of **service productivity**. For example Blois (1984) [4] states the different inputs and outputs of services to measure the productivity and explains the interrelationship between productivity and effectiveness in service firms. Armistead, Johnston and Slack (1988) [1] analyze the strategic determinants of service productivity. Beyond that, they point out the relation between productivity and demand and analyze the integration of the customer within the service production process. Johnston and Jones (2004) [12] analyze the multi-stage service production process as they explain the relationship between operational and customer productivity. Grönroos and Ojasalo (2004) [10] define service productivity as a function of internal, external and capacity efficiency and divide the service production process into three stages termed as back office (where the service provider produces the service in isolation), service encounter (where the service is produced by both the service provider and the customer) and in isolation (where the customer produces the service alone by using the provided infrastructure). In accordance with the approach developed by Corsten and Gössinger (2007) [7], to define the productivity of services, we distinguish between an ex ante productivity ratio and an ex post productivity ratio as shown in fig. 2. While the ex ante productivity ratio only considers the internal production of services, the ex post productivity ratio also includes the influence of demand so that this ratio contains information about the consumption of the provided capacity.

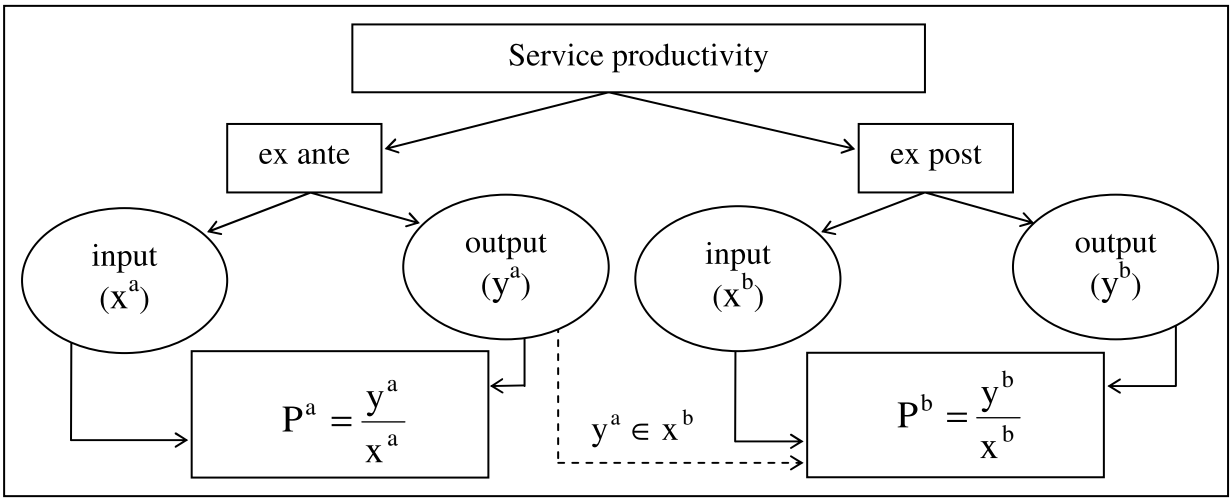

Fig. 1: Service-oriented productivity concept

As we want to maximize the service productivity we make the assumption that the service productivity is the sum of ex ante productivity which is given by the ratio of ex ante output (y^a) and ex ante input (x^a) and of the ex post productivity defined as the ratio of ex post output (y^b) and ex post input (x^b). The service productivity can then be formulated as follows:

$$P = P^a + P^b = \frac{y^a}{x^b} + \frac{y^b}{x^b} \tag{1}$$

Since we want to consider the multi-stage character of services, we make the assumption that the ex ante output is an input value of the ex post productivity and therefore an element of the input vector x^b.

3. TOTAL TRANSPORT PRODUCTIVITY AND THE IMPACT OF TRANSPORT CAPACITY

To analyze the total transport productivity and the impact of capacity, we define a ratio describing the productivity of transport processes. Corresponding to the definition of service productivity in the previous section, the transport productivity can be illustrated by the following ratios displayed in fig. 3: We distinguish between ex ante transport productivity as the ratio of outputs like transport capacity (y_1^a) and inputs, like both staff (x_1^a) or fleet size (x_2^a). Considering the influence of demand, the ex post transport productivity is defined as rate of outputs like transported goods (y_1^b) and inputs like working hours of staff (x_1^b) or fuel consumption dependent on the distance (x_2^b).

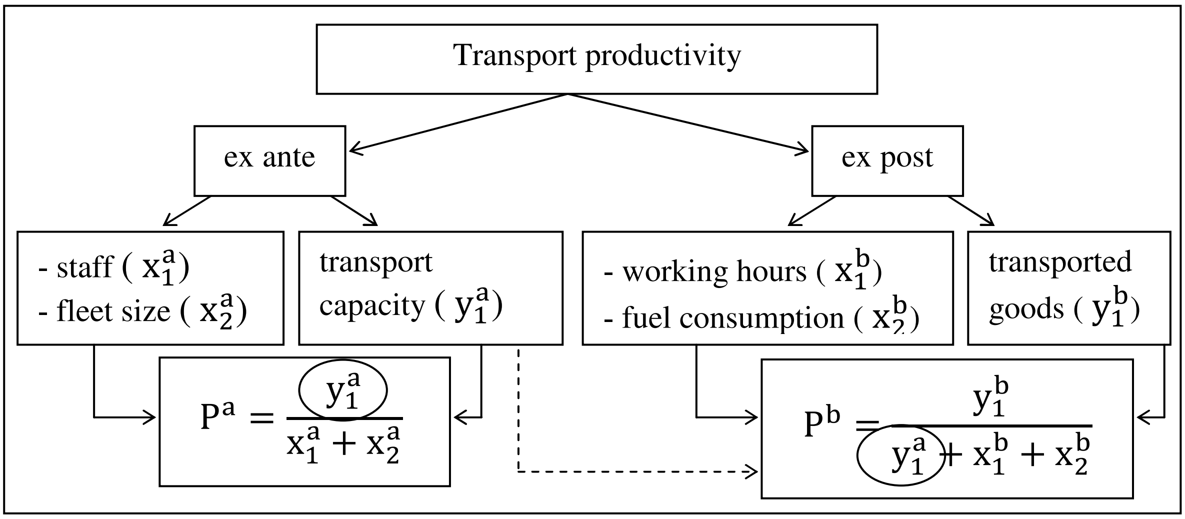

Fig. 3: Transport productivity

In the same way as we formulate the service productivity, the transport productivity may be defined as the sum of ex ante productivity and ex post productivity. It is given by the following equation:

$$P = P^a + P^b = \frac{y_1^a}{x_1^a + x_2^a} + \frac{y_1^b}{y_1^a + x_1^b + x_2^b} \tag{2}$$

The transport capacity given by y_1^a constitutes the output of the ex ante productivity and therefore it is to be maximized, but it also presents an input of ex post productivity. According to the economic principle postulating either a minimization of inputs considering fixed outputs or a maximization of outputs while the inputs are fixed, the transport capacity has to be maximized regarding the ex ante transport productivity, but it has to be minimized as an input of the ex post productivity. The impact of this ambivalent role of transport capacity will be further investigated in the following sections.

4. MEASURING TRANSPORT PRODUCTIVITY AND THE IMPACT OF CAPACITY WITH DEA

Since we want to measure the transport productivity as well as the impact of the provision of transport capacity, we use Data Envelopment Analysis (DEA). The original DEA method under constant returns to scale assumption was developed by Charnes, Cooper and Rhodes (1978) [5]. Recent research has been conducted on the productivity of different transport processes, which are presented in section 4.1. As we want to measure the ex ante and ex post productivity simultaneously, the basic DEA model is extended by an additive integrated composition in section 4.2. Within section 4.3, we introduce a more generalized approach with respect to the assumption of unequal weights of ex ante and ex post productivity. This approach allows measuring the impact of the transport capacity on the total transport productivity.

4.1 Existing DEA models to measure transport productivity

Recently, significant amounts of research have analyzed the transport productivity of logistic services using different DEA approaches. For example, Cowie (1999) [8] analyses the productivity of public and private Swiss railways. He aims to compare the productivity of the private and public sector and assumes that the private sector has greater incentives to extract more from the inputs they obtain. Applying the traditional DEA-BCC model, he distinguishes between technical, managerial and organizational efficiency and concludes that the private sector performs better than the public sector.

Karlaftis (2004) [13] analyses the transport productivity of US transit systems over a five-year period. For the evaluation of transport productivity, he estimates three separate models. He distinguishes between efficiency models and uses the total annual vehicle-miles as "produced output type" and an effectiveness model using total annual ridership as the measure of "consumed output type". Finally the third model analyses the relationship of these two performance dimensions using both annual vehicle-miles and annual ridership as outputs. By using DEA-BCC models and DEA window analysis, he found that systems performing well in one dimension also perform well in the other dimension.

Newer studies analyze the transport productivity by advanced DEA models. Yu (2008) [19] presents an approach to analyze technical efficiency, service effectiveness and technical effectiveness. Technical efficiency measures the success in reducing inputs that are required to produce transit services. Service effectivenes measures the success in attracting maximum ridership from a given set of produced transport capacity and represents the relationship between produced services and consumed services. The third type termed as technical effectiveness measures the success in producing maximum ridership from minimum inputs and considers not only the internal efficiency but also demand effects. Yu applies a two-stage DEA model (TDEA) as well as a network DEA model (NDEA) and evaluates the three performance measures. TDEA approaches are based on an exclusive concept that measures the three ratios in separate models. NDEA approaches allow a representation of both production and consumption technologies in a single model and hence can be applied for analyzing technical efficiency, service effectiveness and technical effectiveness simultaneously.

Beyond that, Chiou, Lan, and Yen (2010) [6] jointly analyze the efficiency and effectiveness for non-storable commodities, because both terms represent distinct aspects of performance. They consider the technical efficiency, the technical effectiveness and the service effectiveness of intercity bus companies by using an integrated DEA model (IDEA) and by a more generalized IDEA approach assuming unequal weights between the performance measures. Based on these latter approaches, in a previous research Steven and Egbers (2010) [18] analyze the transport productivity of airlines by using an additive and a multiplicative integrated DEA-CCR model and pointed out that the order of transport productivity is dependent on the model chosen which is subject to the preferences of the decision maker.

Although all papers evaluate the relative performance of transport services by the distinction between service production and service consumption processes, they do not focus on the allocation of the right amount of transport capacity. But in order to guarantee high transport productivity the transport companies are forced to allocate the right amount of transport capacity ex ante. For this reason, the present paper extends the additive integrated DEA-CCR model by unequal weights for analyzing the right allocation of transport capacity so that the total transport productivity is maximized.

4.2 Additive integrated CCR model

With the use of DEA models, it is possible to measure the relative efficiency of "Decision Making Units (DMUs)", which may be generally regarded as enterprises, divisions or administrative units with common inputs and outputs [5] and can be formulated as:

$$DMU_k := \left(x^a_{1k},...,x^a_{Ik}; y^a_{1k},..., y^a_{Jk}; x^b_{1k},..., x^b_{Rk}; y^b_{1k},..., y^b_{Sk}\right). \tag{3}$$

While x^a_{ik} and y^a_{jk} constitute the ith ex ante input (i= 1,…,I) and the jth ex ante output (j=1,…,J), x^b_{rk} and y^b_{sk} describe the rth ex post input (r= 1,…,R) and the sth ex post output (s= 1,…,S) respectively. According to section 3, the total transport productivity is calculated as the sum of ex ante and ex post productivity, while the transport capacity constitutes the output of ex ante as well as an input of the ex post productivity. Since we want to maximize the total transport productivity as the sum of ex ante and ex post productivity, we asssume that y^a_{jk} is an element of the ex post input vector $x^b_{rk} := \left(x^b_{1k},..., x^b_{Rk}\right)$. The formulation of the additive integrated DEA approach is given below [6].

This model (4) maximizes the ex ante and ex post productivity $P^{add}_o \in [0,2]$ of a transport process o by simultaneously computing the virtual multipliers $v^a_i\,(v^b_r)$ corresponding to the ith ex ante input x^a_{io} (rth ex post input x^b_{ro}) and the virtual multipliers $u^a_j\,(u^b_s)$ corresponding to the jth ex ante output y^a_{jo} (sth ex post output x^b_{so}). The constraints (5) and (6) ensure that there is no other transport process k with an efficiency of more than 100 % considering the same multiplier values for each transport process. Referred to (7) multipliers must be non-negative. If P^{add}_o takes the value two, the transport process o is relatively efficient concerning the ex ante as well as the ex post point of view. Otherwise the considered transport process o is either relatively inefficient concerning the ex ante (while the ex post productivity is maximized) or concerning the ex post point of view (while the ex ante productivity is maximized and equals to one). Finally, it is possible that the transport process o is both ex ante and ex post inefficient.

$$\max_{v^a,u^a,v^b,u^b} P_o^{add} = \left(\frac{\sum_{j=1}^{J} u_j^a y_{jo}^a}{\sum_{i=1}^{I} v_i^a x_{io}^a} \right) + \left(\frac{\sum_{s=1}^{S} u_s^b y_{so}^b}{\sum_{r=1}^{R} v_r^b x_{ro}^b} \right) \tag{4}$$

$$\frac{\sum_{j=1}^{J} u_j^a y_{jk}^a}{\sum_{i=1}^{I} v_i^a x_{ik}^a} \leq 1 \qquad k \in K, \tag{5}$$

$$\frac{\sum_{s=1}^{S} u_s^b y_{sk}^b}{\sum_{r=1}^{R} v_r^b x_{rk}^b} \leq 1 \qquad k \in K, \tag{6}$$

$$v_i^a \geq 0,\ u_j^a \geq 0,\ v_r^b \geq 0, u_s^b \geq 0, \qquad i \in I, j \in J, r \in R, s \in S. \tag{7}$$

4.3 Generalized integrated CCR model

The model mentioned above has adopted an additive composition of ex ante and ex post transport productivity. Moreover, we found out within section 3 that the transport capacity constitutes the output of ex ante and the input of ex post transport productivity. This subsection introduces a more generalized model of the additive CCR model assuming unequal weights [6]. Since we want to analyze the impact of transport capacity on total transport productivity, we are able to give advice if the transport provider should maximize the transport capacity in order to maximize the ex ante productivity or if he should minimize the provision of transport capacity as an input of ex post productivity. The generalized integrated model maximizes the total transport productivity as the sum of weighted ex ante and ex post productivity (8), where we introduce α as the weight for the ex ante transport productivity and $(1-\alpha)$ as the weight for the ex post transport productivity. Constraints (9) – (11) are similar to the prior model, while we introduce an additional constraint (12) that ensures that α takes a value between 0 and 1 so that the total transport productivity value $P_o^{gen} \in [0,1]$ is a convex combination of ex ante and ex post productivity.

$$\max_{v^a,u^a,v^b,u^b} P_o^{gen} = \alpha \left(\frac{\sum_{j=1}^{J} u_j^a y_{jo}^a}{\sum_{i=1}^{I} v_i^a x_{io}^a} \right) + (1-\alpha) \left(\frac{\sum_{s=1}^{S} u_s^b y_{so}^b}{\sum_{r=1}^{R} v_r^b x_{ro}^b} \right) \tag{8}$$

$$\frac{\sum_{j=1}^{J} u_j^a y_{jk}^a}{\sum_{i=1}^{I} v_i^a x_{ik}^a} \leq 1 \qquad k \in K, \tag{9}$$

$$\frac{\sum_{s=1}^{S} u_s^b y_{sk}^b}{\sum_{r=1}^{R} v_r^b x_{rk}^b} \leq 1 \qquad k \in K, \tag{10}$$

$$v_i^a \geq 0, u_j^a \geq 0, v_r^b \geq 0, u_s^b \geq 0, \qquad i \in I, j \in J, r \in R, s \in S, \tag{11}$$

$$0 \leq \alpha \leq 1. \tag{12}$$

Based on the fact that the transport service provider maximizes the total transport productivity, he needs to increase the ex ante transport productivity in the case of an increasing total transport productivity if α raises. If the total transport productivity decreases in respect of an increasing α, the transport service provider has to either reduce the unused transport capacity as an input of the ex post productivity or he raises marketing activities in order to attract new customers. Alternatively, he tries to minimize the remaining inputs to maximize the total transport productivity.

5. NUMERICAL EXAMPLE

To measure both the total transport productivity of airlines and the influence of the capacity level on the amount of total productivity, we use a comprehensive data set comprising of 25 European airlines in 2007 [11]. The following subsection 5.1 describes the analyzed input and output values. Within subsections 5.2 and 5.3 the efficiency results derived from additive integrated as well as from generalized integrated CCR model are presented.

5.1 Description of input and output variables

According to section 3, the following outputs and inputs are used for analyzing the transport productivity of airlines. Corresponding to the distinction between ex ante and ex post logistic service productivity, we distinguish between ex ante inputs and outputs and ex post inputs and outputs. Tab. 1 presents the summary of descriptive data of 25 European airlines in 2007. The ex ante output ble (y^a_{2k}) represents the available tonne kilometer, while there are two ex ante input variables, namely the fleet size (x^a_{1k}) specifying the number of aircrafts per airline as well as the number of staff (x^a_{2k}), like pilots and flight attendants. Beyond that, to analyze the ex post productivity, two output variables specified by the number of passengers (y^b_{1k}) and freight tonnes (y^b_{2k}) are considered. Concerning the ex post input variables we account for the sum of hours flown (x^b_{2k}) and the transport capacity provided (x^b_{1k}) stated as available tonne kilometer. As described in section 3, the latter variable constitutes the output of ex ante as well as the input variable of ex post productivity.

Table 1: Summary of input and output data of 25 European airlines (2007)*

	Mean	Standard deviation	Minimum value	Maximum value
All observations (K= 25)				
Ex ante				
Output:				
• tkm available (y^a_{2K})	5,267,819	6,345,579	40,320	39,949,365
Input:				
• fleet size (x^a_{1K})	91	85	13	562
• number of staff (x^a_{2K})	11,757	14,218	350	97,803
Ex post				
Output:				
• number of passengers (y^b_{1K})	12,396,606	12,802,382	578,754	73,679,209
• freight tonnes (y^b_{2K})	169,849	234,068	93	1,445,183
Input:				
• tkm available (x^b_{1K})	5,267,819	6,345,579	40,320	39,949,365
• flight hours (x^b_{2K})	314,059	317,871	19,455	1,915,077

*** Source: World Air Transport Statistics published by the International Air Transport Association (2007)**

5.2 Efficiency results derived from integrated CCR model

To evaluate the efficiency results, the Efficiency Measurement System Software Version 1.3 [15] is employed. For simplification we apply the CCR model to analyze the total productivity because precise information on the returns to scale of the production function of these 25 European airlines is not available. In line with equation (4), tab. 2 contains the ex ante productivity values (P^a_k), the ex post productivity values (P^b_k) as well as the total productivity value (P^{add}_k) given by the sum of ex ante and ex post productivity. Analyzing the results, DMU 11 (Icelandair) is benchmarked as most productive by the proposed additive integrated CCR model [6]. The additive productivity value ($P_{11}^{add} = 2$) is equal to the sum of scores of ex ante and ex post productivity. An individual analysis of the ex ante productivity and therefore of the provision of transport capacity yields that DMU 3 (Air France), DMU 7 (British Airways), DMU 9 (Finnair) as well as DMU 11 (Icelandair) build the reference. The corresponding productivity values of these airlines equal to one.

Table 2: Efficiency results from integrated CCR model*

		Ex ante (P_k^a)	**Ex post** (P_k^b)	(P_k^{add})
DMU 1	Aegean Airlines	0.3650	**1.0000**	1.3650
DMU 2	Air Baltic	0.4727	0.4995	0.9722
DMU 3	Air France/ KLM	**1.0000**	0.9667	1.9667
DMU 4	Air Malta	0.4457	0.5984	1.0441
DMU 5	Austrian	0.6293	0.6127	1.2420
DMU 6	Belavia	0.1517	0.4119	0.5636
DMU 7	British Airways	**1.0000**	0.8491	1.8491
DMU 8	Czech Airlines	0.3945	0.5217	0.9162
DMU 9	Finnair	**1.0000**	0.7199	1.7199
DMU 10	Iberia	0.7452	0.8696	1.6148
DMU 11	Icelandair	**1.0000**	**1.0000**	**2.0000**
DMU 12	Jat Airways	0.2180	0.4900	0.7080
DMU 13	LOT	0.5330	0.4644	0.9974
DMU 14	Lufthansa	0.7265	**1.0000**	1.7265
DMU 15	Luxair	0.1177	0.5533	0.6710
DMU 16	Malev	0.9572	0.4654	1.4226
DMU 17	Meridiana	0.4786	0.9143	1.3929
DMU 18	SAS Scandinavian	0.8500	0.8144	1.6644
DMU 19	Skyways	0.1355	0.9721	1.1076
DMU 20	Spanair	0.5661	0.7463	1.3124
DMU 21	TAP Air Portugal	0.8018	0.5836	1.3854
DMU 22	Tarom	0.4786	0.4215	0.9001
DMU 23	THY Turkish Airlines	0.7745	0.8889	1.6634
DMU 24	Ukraine International Airlines	0.3715	0.4478	0.8193
DMU 25	Wideroe	0.0860	**1.0000**	1.0860

*** Solved by Efficiency Measurement System (EMS) Software Version 1.3 by Scheel (2000)**

The remaining 21 airlines are technically inefficient on the input side and for this reason are required to either reduce their fleet size or their number of staff in order to be efficient. For example, the ex ante productivity value of DMU 23 (THY Turkish Airlines) is 0.7745 so that this airline is required to reduce the inputs to 77.45% in order to become efficient and to produce the available tonne kilometer. On the other hand, from the ex post point of view the productivity values of DMU 1 (Aegean Airlines), DMU 11 (Icelandair), DMU 14 (Lufthansa) and DMU 25 (Wideroe) equal one, so that these airlines are technically efficient with respect to avoiding unused transport capacity. However, all the rest of the observed airlines are technically inefficient and therefore requested to minimize their idle capacity or to reduce the provided flight hours. Since the airlines want to maximize the total transport productivity, otherwise they are forced to extend their marketing activities to attract both new passengers and customers for the transportation of cargo. Accordingly, taking DMU 7 (British Airways) as an example, the ex post productivity value is 0.8491, so that this airline has to reduce the available tonne kilometer and the flight hours respectively by 15.09% $(= (1 - P_7^b) * 100)$ for being technically efficient.

5.3 Efficiency results derived from generalized integrated CCR model

The total productivity values for each of the 25 European airlines under varying weights (α is ranging from 0.1 to 0.9) are presented in tab. 3.

Table 3: Total Productivity for each airline under various weights*

		α= 0.1	**α= 0.3**	**α= 0.5**	**α= 0.7**	**α= 0.9**
DMU 1	Aegean Airlines	0,9365	0,8095	0,6825	0,5555	0,4285
DMU 2	Air Baltic	0,4968	0,4915	0,4861	0,4807	0,4754
DMU 3	Air France/ KLM	0,9700	0,9767	0,9834	0,9900	0,9967
DMU 4	Air Malta	0,5831	0,5526	0,5221	0,4915	0,4610
DMU 5	Austrian	0,6144	0,6177	0,6210	0,6243	0,6276
DMU 6	Belavia	0,3859	0,3338	0,2818	0,2298	0,1777
DMU 7	British Airways	0,8642	0,8944	0,9246	0,9547	0,9849
DMU 8	Czech Airlines	0,5090	0,4835	0,4581	0,4327	0,4072
DMU 9	Finnair	0,7479	0,8039	0,8600	0,9160	0,9720
DMU 10	Iberia	0,8572	0,8323	0,8074	0,7825	0,7576
DMU 11	Icelandair	**1,0000**	**1,0000**	**1,0000**	**1,0000**	**1,0000**
DMU 12	Jat Airways	0,4628	0,4084	0,3540	0,2996	0,2452
DMU 13	LOT	0,4713	0,4850	0,4987	0,5124	0,5261
DMU 14	Lufthansa	0,9727	0,9180	0,8633	0,8086	0,7539
DMU 15	Luxair	0,5097	0,4226	0,3355	0,2484	0,1613
DMU 16	Malev	0,5146	0,6129	0,7113	0,8097	0,9080
DMU 17	Meridiana	0,8707	0,7836	0,6965	0,6093	0,5222
DMU 18	SAS Scandinavian	0,8180	0,8251	0,8322	0,8393	0,8464
DMU 19	Skyways	0,8884	0,7211	0,5538	0,3865	0,2192
DMU 20	Spanair	0,7283	0,6922	0,6562	0,6202	0,5841
DMU 21	TAP Air Portugal	0,6054	0,6491	0,6927	0,7363	0,7800
DMU 22	Tarom	0,4272	0,4386	0,4501	0,4615	0,4729
DMU 23	THY Turkish Airlines	0,8775	0,8546	0,8317	0,8088	0,7859
DMU 24	Ukraine Int. Airlines	0,4402	0,4249	0,4097	0,3944	0,3791
DMU 25	Wideroe	0,9086	0,7258	0,5430	0,3602	0,1774

*** Solved by Efficiency Measurement System (EMS) Software Version 1.3 by Scheel (2000)**

The results show that DMU 11 (Icelandair) is still benchmarked as most productive regardless of a variation of α ($P_{11}^{gen} = 1$). Furthermore, we distinguish between two types of airlines. The total transport productivity values (P_k^{gen}) of one group increases in case of a rising α (DMU 3, 5, 7, 9, 13, 16, 18, 21, 22).

According to our explanation in subsection 4.2, the airlines should concentrate on optimizing the ex ante productivity and increase their transport capacity in order to maximize the total transport productivity. The other part of airlines (DMU 1, 2, 4, 6, 8, 10, 12, 14, 15, 17, 19, 20, 23, 24, 25) have got a decreasing total productivity value if α rises. These airlines should either minimize their unused transport capacity (as an input value of the ex post productivity) or they are forced to raise the marketing activities in order to attract new customers. Since they should concentrate on the maximization of ex post productivity, they could also minimize the remaining inputs to maximize the total transport productivity.

6. CONCLUDING REMARKS

As transport services are normally non-storable commodities with corresponding multi-stage production processes [6], conventional total productivity concepts do not simultaneously evaluate the ex ante productivity with respect to the internal production of services and the ex post productivity considering the influence of demand. Beyond that, the transport service provider needs to know the ex ante productivity to provide the right amount of transport capacity on the one hand and the ex post productivity to reduce unused transport capacity on the other hand. This paper presents two novel DEA-CCR approaches to measure the total transport productivity and gives an answer to the question of the impact of the provided transport capacity on the total transport productivity. Therefore we have distinguished between an integrated CCR model in consideration of the multi-stage transport production process by assuming an additive composition of ex ante and ex post productivity. As we do not act on the assumption of equal weights, we have introduced a more generalized DEA-CCR model considering unequal weights. Both DEA models are applied to measure the total transport productivity for 25 European airlines in the year 2007. We find that irrespective of using the additive or the generalized integrated DEA-CCR model, Icelandair is benchmarked as most productive. Moreover, we are able to suggest whether the airlines should increase their transport capacity ex ante or if they should strengthen marketing activities to attract more customers in order to maximize the ex post productivity.

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МЕЗОСКОПИЧЕСКАЯ МОДЕЛЬ ПРОЦЕССОВ ОБСЛУЖИВАНИЯ ПАССАЖИРОВ В АЭРОПОРТУ

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Аннотация: Данная работа является продолжением серии статей, опубликованных ранее на конференциях DR-LOG. Все они посвящены разработке и применению так называемого мезоскопического подхода к моделированию потоковых процессов в логистических системах. При создании мезоскопических моделей применяются лаконичные формы, свойственные моделям системной динамики. Высокая точность воспроизведения процессов обеспечивается в этих моделях механизмами планирования событий, аналогичными тем, что применяются в дискретно-событийных моделях. В статье подробно описывается мезоскопическая модель процессов обслуживания пассажиров в аэропорту, в которой центральное место занимают представленные с помощью математических формул стратегии распределения ресурсов.

1. ВВЕДЕНИЕ

Математические – т.е. аналитические и имитационные – модели потоковых процессов в логистике создают с той же целью, что и в других областях науки, техники, экономики и промышленности: их используют в качестве «заменителя» реальной (существующей или создаваемой) системы и с их помощью получают информацию об ожидаемом поведении этой системы практически в любых реализуемых физически условиях функционирования. Хотя в книгах по исследованию операций и имитационному моделированию (см., например, [1], [2] и [3]) можно найти много «стандартных» методов моделирования потоковых систем, все эти методы ещё далеко не полностью отвечают потребностям практических специалистов, работающих в области анализа и проектирования логистических систем. Следствием этого является тот факт, что во многих случаях «расчёт» логистической системы (например, транспортной или складской системы) производится на базе «средних значений» с использованием простых формул, включающих в себя лишь четыре арифметические операции. Причиной того, что многие «книжные» модели на практике применяются крайне редко, является не квалификация специалистов-логистов, а объективные (и, как правило, неустранимые) недостатки традиционных методов моделирования. Именно этот факт побуждает некоторых исследователей искать новые методы моделирования процессов в логистических системах.

Данная работа является продолжением серии статей [4-7], опубликованных ранее на конференциях DR-LOG. Все они посвящены разработке и применению так называемого мезоскопического подхода к моделированию потоковых процессов в логистических системах. В [4] авторы отмечают недостатки двух классов динамических потоковых моделей: непрерывных моделей системной динамики и дискретно-событийных имитационных моделей. Модели первого класса создаются, как правило, в форме обобщённых абстрактных моделей, предназначенных для исследования преимущественно бизнес-процессов, а не конкретных материальных потоков в логистике. Применение обычных имитационных моделей связано с необходимостью очень детального отображения элементов реальной системы, что приводит к большим затратам времени и финансовых средств на всех этапах создания и исследования моделей. Также в [4] поясняется принцип мезоскопического моделирования потоковых процессов и описываются два главных компонента структуры мезоскопических моделей: многоканальный бункер (накопитель, воронка) и элемент задержки потока. В [5] рассматриваются методологические преимущества мезоскопического подхода уже на этапе разработки концептуальных моделей и приводится пример его применения при моделировании пункта перевалки грузов. В [6] проводится сравнение методов программной реализации мезоскопических моделей с применением как обычных инструментов имитационного моделирования (пакетов Vensim и eM-Plant), так и специализированного пакета MesoSim, и показаны преимущества последнего. В [7] показаны возможности применения чётких математических методов для описания стандартных стратегий распределения ресурсов в мезоскопических моделях. В данной работе подробно рассматривается пример мезоскопического моделирования процессов обслуживания пассажиров в аэропорту. В рамках этого примера сравниваются две стратегии распределения ресурсов, основанные на простых расчётных формулах.

2. ОПИСАНИЕ СТРАТЕГИИ РАСПРЕДЕЛЕНИЯ РЕСУРСОВ

Пусть на станции обслуживания (в многоканальном бункере мезоскопической модели) имеется m носителей ресурса. Если распределяемым ресурсом является само время работы носителей ресурса, то их суммарная потенциальная производительность PL, имеющая размерность «объём предоставляемого ресурса в единицу времени», равна величине m, т. е. $PL = m$.

Пусть потребность входного потока i $(i = 1, .., n)$ в отношении производительности станции, т. е. требуемая интенсивность потребления рабочего времени носителей ресурса, определяется числом m_i, равным числу носителей, которые должны быть выделены данному потоку. Суммарная потребность всех потоков в отношении производительности станции есть

$$BD = \sum_{i=1}^{n} m_i = m.$$

Если фактически станция обеспечивает для каждого потока пропускную способность $\mu_i (i = 1,..,n)$, то общая интенсивность потребления ресурса равна

$$R = \sum_{i=1}^{n} (\tau_i \cdot \mu_i),$$

где τ_i есть среднее время обслуживания единицы объёма потока, например, заявки в системе массового обслуживания.

Решить задачу распределения ресурсов означает найти значения $\mu_i (i = 1,..,n)$ при соблюдении условия $R \leq PL$.

Рассмотрим стратегию, которая гласит: пропускная способность μ_i по отношению к каждому входному потоку $i \, (i = 1,..,n)$ должна быть пропорциональна его потребности, т. е. величине m_i. Введём неизвестную пока величину X и запишем это условие в виде:

$$\mu_i = X \frac{m_i}{m}.$$

Так как выполняется условие $R = PL$ (распределяется весь доступный ресурс), то имеет место соотношение

$$R = \sum_{i=1}^{n} (\tau_i \cdot \mu_i) = \frac{X}{m} \cdot \sum_{i=1}^{n} (\tau_i \cdot m_i) = m,$$

на основании которого определяем величину X

$$X = \frac{m^2}{\sum_{i=1}^{n} (\tau_i \cdot m_i)}$$

и получаем окончательный результат

$$\mu_i = m_i \cdot \frac{m}{\sum_{i=1}^{n} (\tau_i \cdot m_i)}.$$

Последняя формула для расчёта величины μ_i применена в представленном ниже примере моделирования. Более общая постановка задачи распределения ресурсов бункера мезоскопической модели, в которой учитываются нормы потребления ресурсов объектами входных потоков, изложена в [7].

3. ПОСТАНОВКА ЗАДАЧИ МОДЕЛИРОВАНИЯ

Моделируется процесс регистрации пассажиров и сдачи багажа в аэропорту. В модели рассматривается процесс общей длительностью 240 минут (4 часа), в течение которого полностью реализуется регистрация пассажиров, вылетающих тремя рейсами. Группа пассажиров, вылетающих одним рейсом, представляется в модели в виде т. н. потока. Параметры трёх моделируемых потоков пассажиров показаны в таблице 1.

Таблица 1. Параметры моделируемых потоков

Параметр	Поток 1 (Pax 1)	Поток 2 (Pax 2)	Поток 3 (Pax 3)
Количество пассажиров в потоке	600	300	150
Момент начала фиксации входного потока [мин]	0	30	60
Длительность входного потока [мин]	180	180	180
Момент окончания фиксации входного потока [мин]	180	210	240
Момент начала регистрации пассажиров [мин]	90	120	150
Длительность процесса регистрации пассажиров [мин]	90	90	90
Момент окончания регистрации пассажиров [мин]	180	210	240
Среднее время регистрации одного пассажира [мин]	1,0	0,75	0,5
Расчётные затраты времени работы персонала на регистрацию пассажиров [чел-мин]	600	225	75

Для моделирования динамики соответствующих трёх входных потоков применена одна и та же схема распределения числа пассажиров во времени, показанная на рис. 1. Предполагается, что в такой «мезоскопической» форме могут быть представлены реальные статистические данные о процессе прибытия пассажиров на регистрацию. Каждая ступенька функции *differential* относится к 10 минутам времени процесса прибытия пассажиров и показывает процент от общего числа пассажиров одного потока, прибытие которых ожидается в течение данных 10 минут. Кусочно-линейная фунция *cumulative* является результатом интегрирования функции *differential*. Результатом применения функции *differential* для конструирования трёх описанных в таблице 1 потоков является общий процесс прибытия пассажиров на регистрацию длительностью 240 мин, показанный на рис. 2.

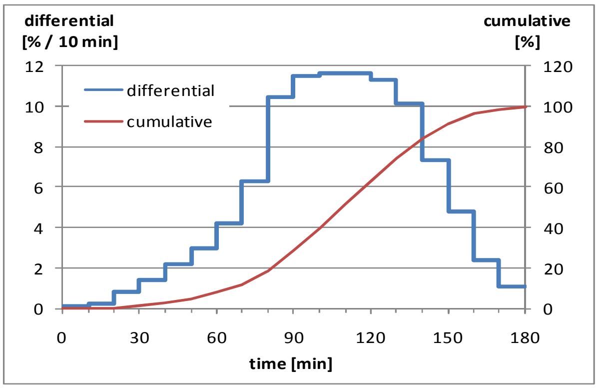

Рис. 1. Базовая модель входного потока

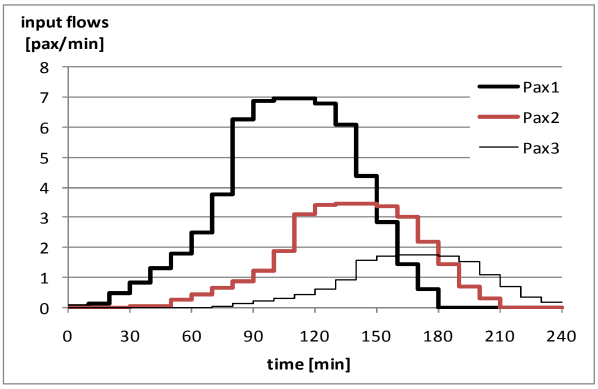

Рис. 2. Графики интенсивности трёх входных потоков

Первой особенностью организации процесса обслуживания является предположение о том, что каждая группа пассажиров образует отдельную очередь ожидания, а одновременно работающие стойки регистрации в определённой пропорции могут обслуживать пассажиров из всех трёх очередей (см. структуру системы массового обслуживания на рис. 3). Вторая особенность заключается в том, что число одновременно работающих стоек регистрации m является переменной величиной, отображающей общий объём ресурсов, выделенных для обслуживания пассажиров. Таким образом, задача оценки требуемого объёма ресурсов заключается в определении величины m, а задача распределения ресурсов заключается в определении правил обслуживания пассажиров на m одновременно работающих стойках регистрации. Независимо от своих особенностей, каждый конкретный алгоритм управления ресурсами, объединяющий в себе эти две задачи, должен быть сориентирован на то, чтобы обслуживание пассажиров каждого потока i $(i = 1,2,3)$ завершилось к моменту времени t_i^{end}, показанному в таблице 1. В соответствии с мезоскопическим подходом предполагается, что алгоритм управления ресурсами активируется в т.н. моменты принятия решений. В данной модели принято, что такие моменты наступают «в соответствии с регламентом», т. е. регулярно с интервалом в 10 минут.

4. РЕШЕНИЕ ЗАДАЧИ МОДЕЛИРОВАНИЯ

Основной целью разработки данной модели являлась демонстрация применения принципов мезоскопического моделирования, в особенности, в части управления ресурсами исследуемой системы. В принципе, данную модель можно реализовать программно путём использования пакетов как для непрерывного (например, Vensim), так и для дискретно-событийного (например, AnyLogic или ExtendSim) моделирования. При этом принцип гибкого распределения пассажиров между m одновременно работающими стойками регистрации значительно легче реализовать с помощью пакета для непрерывного моделирования. «Настоящую» мезоскопическую модель (т. е. модель с динамическим планированием событий для кусочно-непрерывных процессов) [7] лучше всего создавать с помощью раздела Discrete Rate пакета ExtendSim или с помощью специализированного пакета MesoSim (рис. 4).

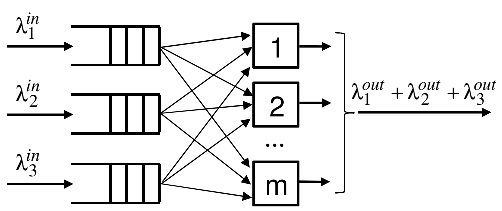

Рис. 3. Концептуальная модель в виде системы массового обслуживания

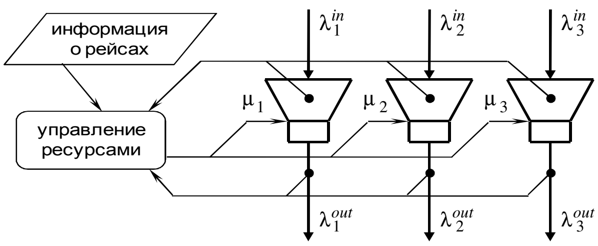

Рис. 4. Исполняемая мезоскопическая модель в нотации MesoSim [6]

В дальнейшем будут показаны два варианта модели, в которых для распределения ресурсов применён принцип «каждому – пропорционально его потребности» (стратегия №4 в [7]), но которые отличаются методом определения этой потребности в момент принятия решений, т.е. методом определения величины m (см. таблицу 2). При моделировании варианта 1 стратегия управления ресурсами основывается на измеряемой величине: текущей длине очереди B_i (см. расположение точек измерения в модели, показанное на рис. 4). При моделировании варианта 2 считается известным общее запланированное количество пассажиров в потоке n_i^* и учитывается другая измеряемая величина: количество обслуженных пассажиров n_i на текущий момент времени t.

Таблица 2. Расчётные формулы для двух вариантов стратегии управления ресурсами

Описание переменных	Стратегия 1	Стратегия 2
Время до момента окончания обслуживания (t - текущий момент времени)	$\tau_i^{rest} = t_i^{end} - t$	
Количество пассажиров, которые ещё должны быть обслужены (n_i^* - общее запланированное количество пассажиров в потоке; n_i - количество обслуженных пассажиров на момент времени t)		$B_i^{rest} = n_i^* - n_i$
Требуемая средняя интенсивность обслуживания (B_i - длина очереди на момент времени t)	$\mu_i^* = \frac{B_i}{\tau_i^{rest}}$	$\mu_i^* = \frac{B_i^{rest}}{\tau_i^{rest}}$
Потребность одного потока (τ_i - среднее время обслуживания одного пассажира)	$m_i^* = \tau_i \cdot \mu_i^*$	
Общая расчётная потребность (число стоек перед округлением до целого)	$m^* = \sum_{i=1}^{3} m_i^*$	
Реальный объём ресурса (число стоек после округления до целого)	$m = Int(m^* + 1)$	
Вспомогательная сумма	$S = \sum_{i=1}^{3} (m_i^* \cdot \tau_i)$	
Реальная интенсивность обслуживания (пропускная способность канала бункера)	$\mu_i = \frac{m_i^* \cdot m}{S} = \mu_i^* \cdot \frac{m \cdot \tau_i}{S}$	

Результаты моделирования двух стратегий управления ресурсами отличаются друг от друга радикально, хотя основное условие – закончить регистрацию к моменту времени t_i^{end} – выполняется в обоих случаях (см. рис. 5). Очевидно, что более эффективной является стратегия 2: максимальная длина каждой очереди пассажиров снижается на 40% по сравнению со стратегией 1, а максимальное число одновременно работающих стоек снижается с 14 до 10.

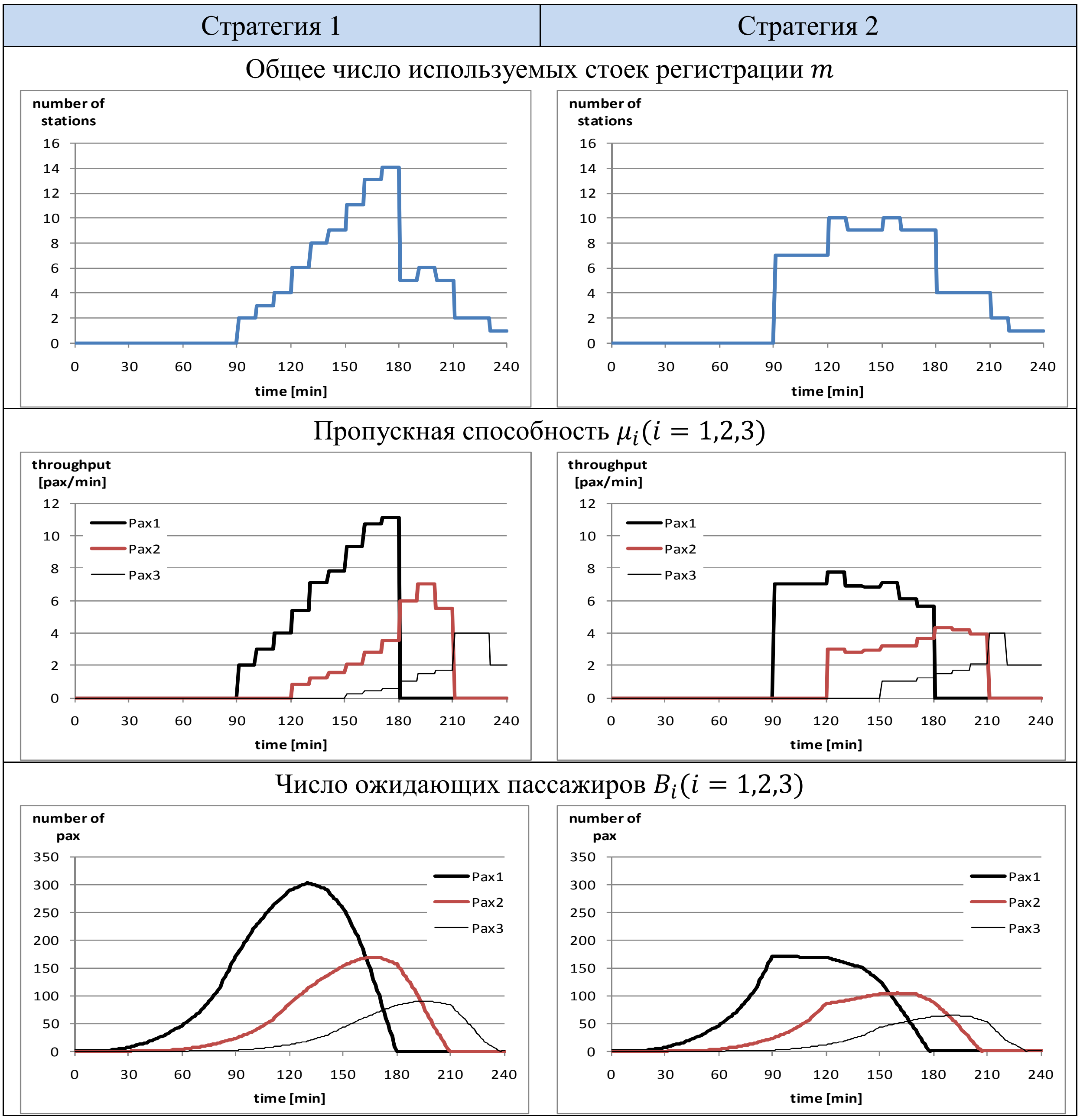

Рис. 5. Результаты мезоскопического моделирования

5. ВЫВОДЫ

Представленная модель обладает признаками, характерными для мезоскопического подхода к моделированию потоковых систем:

- входные потоки системы задаются не с помощью «законов распределения интервалов времени между событиями», а численно (графически) в виде кусочно-непрерывных графиков интенсивности;

- для представления неоднородных потоков применяется понятие «порция» (например, группа пассажиров, вылетающих одним рейсом), которое, как правило, не определяется в рамках других концепций моделирования;
- время обслуживания объектов входного потока задаётся не как случайная величина, а как константа, равная среднему времени обслуживания;
- управление ресурсами (и, тем самым, потоками) системы реализуется не непрерывно, а лишь в моменты возникновения ситуаций принятия решений;
- стратегии управления ресурсами описываются не только с помощью алгоритмов, но в значительной степени – в виде аналитических моделей (расчётных формул).

Такт времени, равный 10 минутам, был выбран только для упрощения описания модели и результатов её обработки. В принципе, в мезоскопической модели могут быть сформулированы любые внешие или внутренние условия возникновения ситуаций принятия решений. Например, могут быть заданы «критические» значения для длины отдельной очереди или общего числа ожидающих пассажиров в зоне регистрации, при достижении которых срочно предпринимаются действия, направленные на повышение интенсивности процессов обслуживания пассажиров.

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ОПТИМИЗАЦИЯ МАРШРУТОВ РАЗВОЗКИ ГРУЗОВ В СЕТЯХ ПОСТАВОК МЕТОДАМИ КЛАСТЕРНОГО АНАЛИЗА

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Аннотация: Рассмотрена задача оптимальной маршрутизации в сетях поставок, посредством разбиения множества потребителей на оптимальную совокупность подмножеств, или кластеров, для каждого из которых затем строится оптимальный маршрут объезда потребителей одним транспортным средством. Для решения данной задачи привлечены методы кластерного анализа. Методы кластерного анализа лишены недостатков существующих методов, например, метода Свира, и показали свою эффективность при поиске наилучшего разбиения.

OPTIMIZATION OF ROUTE DELIEVERIES CARGO IN SUPPLY CHAINS BY CLUSTER ANALYSIS

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Purpose of the paper
In given study is considered transport analysis of the transportation cargo from supplier to consumers and/or back. The transport analysis puts its purpose a choice the best-routes on set of suppliers and set consumers, decision of the transport problem of the fastening supplier for each consumer and formation schedule of transportation. Amongst this list of the problems the problem for partition the whole of consumers of the cargo into collection of subsets of consumers must be solved in the first place. Herewith inwardly each subset the delivery cargo to consumers must be realized by means of organization of the recirculating route, which is made by one transport facility. The problem of the partition the of the consumers on subsets, or on groups of the consumers, is solved by means of the method Clarke – Right or Sveer's method. These methods are heuristic and do not guarantee that the good partition whole set of consumers on groups will is found. In persisting article the solving of the routing problem i.e. problem of the partition set of consumers on collection of subsets is offered by means of methods of the cluster analysis methods.
Research/application methodology
In given article the problem of the partition set of consumers on collection of subsets of the same consumers dares by means of methods of the cluster analysis. As a result using the

cluster analysis methods the groups of objects, or clusters, which unite between itself on that or other principle resemblance are formed. As a measure of resemblance of any objects (or consumers) some metric can be used. If the metric is Euclidean distance, then each object of the set of consumers can be considered as a point of m-dimensional space. The distance between two clusters is measured by the distance between nearest objects which belong to the different clusters. The quality of the partition on clusters is valued by the quality functional. The best partition is considered such partition under which the quality functional is reached extremum value. Part consumers set into clusters is produced by hierarchical agglomeration.

Design of the paper

The problems of the transport analysis and the content list of the solving problems are analysed in section 1. The Section 2 are dedicated to thumbnail sketch of the methods of the cluster analysis, choice of the metrics in multi dimensional space of the typical features of objects and methods of the association objects into clusters. In section 3 are considered concrete example of the delivery cargo from one centre to the set of the consumers of the cargo. The procedure of the partition whole asset of the consumers into clusters and concrete results of the cluster analysis on partition set of 21 consumers into five cluster are described. The sign of the stop of the procedure of clusterizations is the total volume of the demand of the consumers in each cluster, which must not exceed cargo-carrying capacity of one car. The conclusion and resolution on the paper are given in section 4.

Main results

The methods of the partition set of consumers on clusters are described. The comparison the results, have been received by means of considered cluster analysis methods and by Sveer's method are shown that the last one does not allow to reach even a good partition of the set of customers. Moreover in row of the events, the groups of the consumers received by Sveer's method have to divide into new clusters again and the total demand in which cluster lead to the unload of the transport facility. Besides Sveer's method do not allow to broke clusters into several new clusters if they are laid up one the one direct coming from the centre. Methods of the cluster analysis have shown its efficiency for the decision of the routing problem.

Academic contribution

The methods of the cluster analysis described in this article are used for decision of the routing problems for the first time. Then, after the partition of the consumers into clusters, the best-route of the delievery cargo onto consumers of each clusters is worked out.

Managerial insights

The decision of the problem of the partition the set of the consumers onto clusters is the first task among the problems solved within the framework of transport analysis route deliveries cargo. The quality of the solving partition problem onto clusters is condition the optimal rout inwardly of each cluster, its cost, time and timetable of the delivery cargo.

1. ВВЕДЕНИЕ

Одной из основных задач поддержки принятия решений в логистическом менеджменте сетями поставок является анализ транспортировки грузов от поставщиков к потребителям и обратно. Транспортный анализ ставит своей целью выбор оптимальных маршрутов на множестве поставщиков и потребителей, решение транспортной задачи закрепления поставщиков за потребителями и составление графиков перевозки. Решение этих задач позволяет повысить эффективность использования транспортных средств при одновременном удовлетворении запросов потребителей с высоким уровнем качества обслуживания.

Логистические решения о транспортировке могут приниматься как на оперативном, так и на стратегическом уровне. Стратегические решения по проектированию грузовых автомобильных перевозок устанавливают постоянные маршруты, стабильные связи между поставщиками и потребителями и постоянные графики перевозки, которые будут использоваться на протяжении многих месяцев. Оперативные решения определяют решения указанных задач на ближайшие дни и недели. Анализ транспортировки, маршрутов и графиков перевозок, является необходимым инструментом для планирования и проектирования сетей поставок, который особенно важен для малых фирм, занимающихся перевозкой мелкопартионных грузов во внутригородских перевозках.

Полная проблема оптимальной маршрутизации включает в себя решение следующих задач:

1) Сбор данных о потенциальных потребителях и заказчиках грузов, к которым относятся:
    - пространственное размещение поставщиков и потребителей грузов,
    - расстояния между поставщиками и потребителями,
    - информация о состоянии путей сообщения, включая препятствия, которые могут встретиться на пути следования,
    - объемы спроса,
    - информация о времени доставки грузов к каждому заказчику,
    - данные о средствах транспортировки,
    - принятые схемы перевозки (один ко многим, многие ко многим, сборные, сборно-развозочные и т.д.).

Полученные данные являются основой для решения проблем транспортного анализа.

2) Разбиение всего множества потребителей груза на совокупность подмножеств потребителей. Внутри каждого подмножества доставка грузов потребителям осуществляется посредством организации кольцевого маршрута, объезд которого совершается одним транспортным средством.
3) Составление оптимального маршрута объезда потребителей внутри каждой группы, полученной в (2). Данная задача относится к классу задач коммивояжера [3, 4].
4) Решение транспортной задачи закрепления поставщиков за потребителями [3, 4].
5) Составление оптимального расписания доставки грузов потребителям. Данная задача относится к задачам составления расписаний [4].

Среди перечня задач (1) – (5) решение задачи (2) должно быть получено в первую очередь. Задача разбиения множества потребителей на подмножества, или группы потребителей, в настоящее время решается с помощью методов Свира или Кларка-Райта [2]. В методе Свира луч, исходящий из пункта дислокации груза при своем вращении «заметает» некоторое множество пунктов доставки, суммарный спрос в которых не превышает грузоподъемности одного транспортного средства. Метод Кларка-Райта формирует подмножество пунктов доставки грузов путем последовательного присоединения пункта за пунктом до полной загрузки транспортного средства. Таким образом осуществляется разбиение всего множества потребителей на отдельные группы потребителей, в каждой из которых затем решается задача коммивояжера для организации оптимального кольцевого маршрута. Оба метода являются эвристическими и не гарантируют, что в результате их применения будет получено хорошее, в некотором смысле, разбиение всего множества потребителей на их подмножества.

В настоящей статье предлагается использовать методы кластерного анализа для решения задачи маршрутизации, т.е. разбиения множества потребителей на совокупность подмножеств потребителей, для каждого из которых затем строится маршрут объезда потребителей с помощью одного транспортного средства.

2. КЛАСТЕРНЫЙ АНАЛИЗ МНОЖЕСТВА ПОТРЕБИТЕЛЕЙ

Кластерный анализ [1] представляет собой совокупность вычислительных методов, используемых для классификации множества объектов по совокупности некоторых признаков. В результате кластерного анализа образуются группы объектов, или кластеров, которые объединены между собой по тому или иному принципу сходства. Другими словами, кластерный анализ представляет собой методологическую процедуру, с помощью которых множество объектов разбивается на подмножества, или кластеры, содержащие однородные в некотором смысле объекты. Результатом действия кластерного анализа является структурирование массива данных, которое, как правило, довольно сложно осуществить при визуальном обследовании или с помощью экспертов.

Понятие схожести, близости, также как и различия, объектов между собой является принципиальным при решении классификации множества объектов и их разбиения на кластеры. В качестве меры близости объектов (потребителей, пунктов доставки и т.д.) может использоваться та или иная метрика, ковариация, косинус, определяемый через скалярное произведение, коэффициенты ассоциативности, вероятностные коэффициенты сходства и т.д. [1].

Рассмотрим множество n объектов $O_1, O_2, \dots, O_n$. Каждый i-й объект O_i характеризуется множеством из m количественных и качественных признаков $x_{i1}, x_{i2}, \dots, x_{im}$, т.е. $O_i(x_{i1}, x_{i2}, \dots, x_{im})$, $i = 1, 2, \dots, n$. В качестве характерных признаков объекта могут выступать координаты места размещения объекта, объемом спроса, качество подъездных путей к объекту, цены транспортировки, вид транспортного средства и т.д. Каждый объект $O_i(x_{i1}, x_{i2}, \dots, x_{im})$ имеет простую геометрическую интерпретацию и может рассматриваться как точка в m-мерном пространстве характерных признаков с осями координат $X_1, X_2, \dots, X_m$ и координатами $(x_{i1}, x_{i2}, \dots, x_{im})$ вдоль осей координат. При такой интерпретации наиболее естественным является трактовать схожесть, или близость, любых двух объектов O_i и O_j, как расстояние между объектами O_i и O_j, т. е. как метрику, удовлетворяющую обычным аксиомам неотрицательности, симметричности, неравенству треугольника и равенству нулю расстояния любого объекта от самого себя.

Метрика между двумя объектами O_i и O_j может быть задана, например, расстоянием Минковского $d_{ij} = \left(\sum_{k=1}^{m} \left| x_{ik} - x_{jk} \right|^{p} \right)^{\frac{1}{p}}$, которое включает в себя, как частный случай, евклидово расстояние $d_{ij} = \sqrt{\sum_{k=1}^{m} (x_{ik} - x_{jk})^2}$ (при $p = 2$), и линейное, или манхэттенское, расстояние $d_{ij} = \sum_{k=1}^{m} \left| x_{ik} - x_{jk} \right|$, (при $p = 1$), используемое при перевозках во внутригородских кварталах, пункты отправления и доставки в которых расположены на улицах, образующих прямоугольную сетку, подобно стритам и авеню на Манхэттене в Нью-Йорке.

Как уже отмечалось выше характеристики x_{ik} объекта O_i ($i = 1, 2, \dots, n$, $k = 1, 2, \dots, m$) могут означать как геометрические координаты в многомерном (m-мерном) пространстве множества признаков, так и количественные и/или качественные признаки объекта O_i, такие, например, как спрос, финансовое состояние потребителя, качество подъездных путей и так далее. В случае, когда объекты характеризуются разнородными признаками, имеющими различную размерность, все «координаты» следует пронормировать, т. е. привести к безразмерному виду и однородной сопоставимой шкале.

Другой важной количественной мерой, используемой при разбиении множества потребителей на кластеры, является расстояние между любыми двумя кластерами. Расстояние между двумя кластерами может вводиться многими способами, например, как:

- среднее расстояние между всеми объектами, принадлежащими двум кластерам, с учетом расстояния между объектами внутри кластеров;

- расстояние между ближайшими объектами, принадлежащим различным кластерам;
- расстояние между центрами кластеров;
- среднее расстояние между кластерами.

Качество разбиения на кластеры оценивается по функционалу качества разбиения, который определяется на множестве всех возможных разбиений, причем наилучшим разбиением считается такое, при котором достигается экстремум функционала качества. Необходимо заметить, однако, что функционал качества кластеризации является формальной оценкой, тогда как подлинное качество должно оцениваться исходя из содержательного анализа соответствия решаемой задачи полученному разбиению на кластеры.

Наиболее распространенными методами кластерного анализа являются иерархические агломеративные и дивизимные методы. Если агломеративные методы последовательно, шаг за шагом, объединяют объекты в группы (кластеры), то дивизимные методы также последовательно разделяют группы на отдельные объекты [1].

3. РЕШЕНИЕ ЗАДАЧИ МАРШРУТИЗАЦИИ МЕТОДАМИ КЛАСТЕРНОГО АНАЛИЗА

Рассмотрим компанию, которая осуществляет локальные поставки клиентам, являясь дистрибьютором, приобретающим хлебобулочные изделия у производителей оптом и продающим их в розницу своим потребителям. Распределительный центр компании *C* и множество, состоящее из 21 потребителя, приведены на рис. 1, а спрос каждого потребителя указан в табл. 1. В распоряжении дистрибьютера имеется несколько 3-тонных грузовиков.

Задача маршрутизации заключается в том, чтобы разбить все множество потребителей, которым должен быть доставлен груз, на кластеры, объединяющие потребителей таким образом, чтобы суммарный спрос потребителей в каждом кластере не превышал грузоподъемности одного грузовика. При этом доставка груза каждому кластеру потребителей должна осуществляться только одним грузовиком.

После разбиения потребителей на кластеры необходимо выработать оптимальный маршрут развозки потребителей в каждом кластере, при котором 3-тонный грузовик выезжает из центра *C*, объезжает всех потребителей в одном кластере, побывав у каждого только один раз, и возвращается порожняком назад в центр.

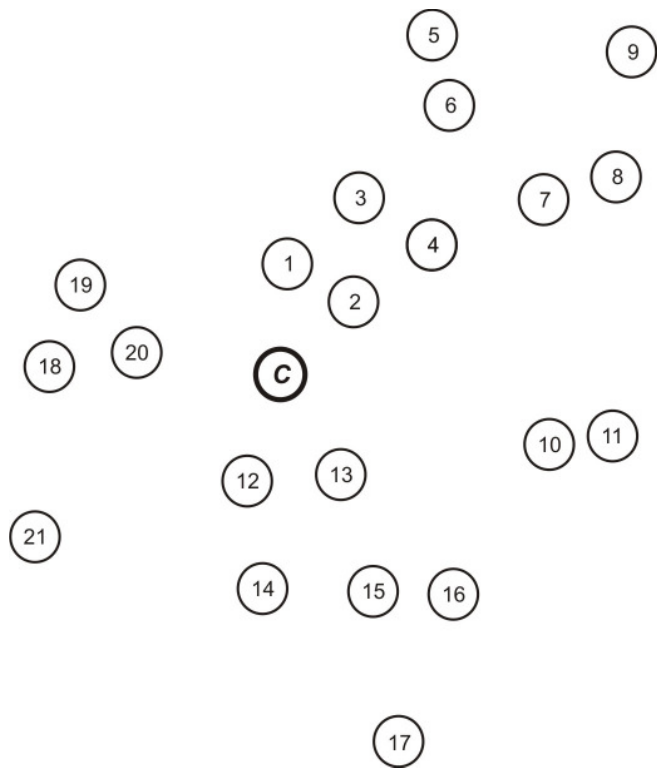

Рис. 1. Размещение потребителей (1 – 21) и распределительного центра *C* в задаче маршрутизации

Таблица 1

Спрос потребителей и их объединение в кластеры

Потребитель	Спрос, т	Кластер	Потребитель	Спрос, т	Кластер
1	0,35	I	12	0,15	III
2	0,78	S = 2,98	13	0,16	S = 2,96
3	1,25		14	0,23	
4	0,60		15	0,19	
5	0,15	II	16	0,13	
6	0,16	S = 2,96	17	2,10	
7	1,25		18	0,64	V
8	1,00		19	1,93	S = 2,99
9	0,40		20	0,18	
10	1,34	IV	21	0,24	
11	1,66	S = 3,00			

В рассматриваемой операции объединение потребителей в кластеры проводилось с помощью иерархического агломеративного метода по принципу ближайшего соседа. Результаты объединения в кластеры приведены в табл. 1, а дендрограмма, наглядно показывающая последовательные шаги кластеризации – на рис. 2. В табл. 1 приведены также объемы суммарного спроса (S) потребителей, объединенных в кластеры I – V.

Результаты проведенного кластерного анализа показывают, что множество из 21 потребителя, оказалось разбитым на пять кластеров, причем признаком остановки процедуры кластеризации служил суммарный объем спроса потребителей в каждом кластере, который не должен превышать грузоподъемности одного автомобиля (3 т).

Сравнение результатов, полученных с помощью кластерного анализа и методом Свира, показывает, что последний не позволяет достичь даже «хорошего» разбиения. Так, по методу Свира, следует объединить 2, 4, 7, 8 и 9 потребителей в один кластер, хотя суммарный спрос от такого объединения составит 4,03 т и превысит грузоподъемность 3-тонного автомобиля. Вследствие этого полученный методом Свира кластер необходимо снова подвергнуть разбиению на новые кластеры, причем суммарный спрос в каждом из новых кластеров будет уже существенно меньше грузоподъемности транспортного средства, и следовательно приведет к его недозагрузке. Отметим, что метод Свира также ничего не говорит о том, каким образом проводить деление кластера на несколько новых кластеров, если они лежат, или почти лежат, на одной прямой, исходящей из центра C, или в одном секторе.

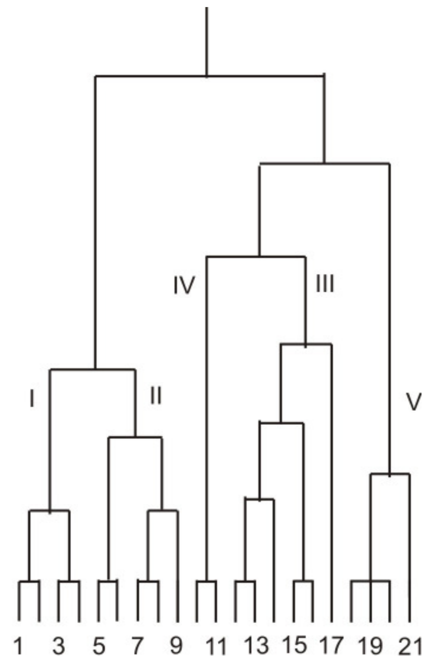

Рис. 2. Дендрограмма разбиения множества потребителей на кластеры

4. ВЫВОДЫ

Применение методов кластерного анализа для решения задачи маршрутизации, в процессе которой ищется оптимальное разбиение множества потребителей на кластеры потребителей, с суммарным спросом не превышающим грузоподъемности одного развозочного транспортного средства, показало их эффективность при поиске наилучшего разбиения.

После проведения кластерного анализа и разбиения потребителей на кластеры необходимо перейти к следующим этапам решения полной проблемы оптимальной маршрутизации в каждом кластере: составлению оптимального маршрута объезда потребителей (задача коммивояжера), решению транспортной задачи и составлению оптимального расписания развозки грузов по потребителям в каждом кластере.

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MODELING AND SIMULATION OF OPERATIONAL TRANSPORT COLLABORATION: A MULTIAGENT-BASED APPROACH

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Abstract: Operational transport collaboration is a recently observed trend in the transportation market. It refers to cooperation between freight forwarders in their operational planning using independent collaboration service providers. Due to the practical setting in which operational transport collaboration is established, the services have to be subject to significant testing beforehand. We suggest a representation as multi-agent system and a related multiagent-based simulation for testing and analysis of the collaborative systems for cooperations. Further, we introduce our implementation of the collaboration services and the agents representing the freight forwarders.

Recent trends observed in business logistics include decentralized decision-making, cooperation, increased software support with distributed computation systems, and going-green efforts. In addition, the classical objectives of business planning – namely high efficiency and cost minimization – remain within the focus of all companies involved in business logistics. A novel method of resolution that addresses these issues within the scope of transport planning, especially in vehicle routing and scheduling, is the so-called operational transport collaboration. This concept describes a specific form of horizontal cooperation between freight forwarders that is enabled by information technologies [2, 3, 6, 15]. Since operational transport collaboration is typically established between otherwise competing companies in a volatile market, the information systems that enable this form of cooperation require significant analysis and validation, especially with regards to potential manipulation and incentives for participation. Consequently, we argue the case for modeling operational transport collaboration as multi-agent system that can then be tested by means of multiagent-based simulation. We suggest one potential configuration of operational transport collaboration and describe its mapping to a multi-agent system.

1. INTRODUCTION

Operational transport collaborations are one possible means for fulfilling demands in transportation processes. The latter refer to all tasks dealing with the

physical movement of goods in a supply network. Those processes are usually outsourced, i.e., assigned to logistic service providers such as freight forwarders or third party logistic service providers. For simplicity, we will only refer to freight forwarders. As the transportation processes are outsourced, the supply chain owners can be seen as customers for the transportation processes. One segment of this market is less-than-truckload (LTL) freight that has to be picked-up at certain locations in order to be delivered to others. In our setting for operational transport collaboration we focus on this segment. Then, the members of the collaboration are independent freight forwarders who cooperate in their operational planning and execution processes. This cooperation creates improvement potentials as statistics, e.g., from the German market in 2007 illustrate: 20-30% of all trips driven in Germany were idle and the average utilization of the loaded trucks was only around 60% [12]. As previous work shows, reductions in idle trips and the number of trucks by increasing vehicle utilization are achievable objectives for operational transport collaborations [2, 7, 14].
We follow [5] in claiming that operational transport collaboration extends the execution modes for the individual freight forwarder. Classical execution modes include the self-fulfillment by own trucks and the subcontracting of transportation requests to carriers as described, for instance, by [11]. Subcontracting is thereby a form of vertical cooperation; subcontractors are carriers engaged by freight forwarders and as such the freight forwarders act as customers. Collaboration, in contrast, takes place between freight forwarders without a supplier-customer relationship. Therefore, it is possible that a request exchanged between two freight forwarders in the collaborative planning is eventually fulfilled by a subcontractor. However, it can be assumed that freight will in most cases be exchanged in collaborative planning only if it matches well with the existing plans of a freight forwarder's own fleet. This way, improvements of up to 30 % in reduced costs can be achieved [13]. Therefore, it is assumed that using collaborative planning is cheaper than subcontracting of requests [15].
In the following, we will first derive requirements to operational transport collaborations (Section 2). Those requirements summarize assumptions as well as necessities demanded in the literature for having this form of collaboration and operating it successfully. Afterwards, we will describe a setting of operational transport collaboration in more detail (Section 3) in order to discuss the simulation of this system. Simulation of this system is necessary since these collaborations are established only if the members are convinced that the system is beneficial for them, is fair, and cannot be manipulated [3]. In the discussion of simulation methods in Section 4, we introduce the benefits of agent-based simulation. This simulation requires the modeling as multi-agent-system first and we will introduce the multi-agent-system for our setting in Section 5. Section 6 eventually summarizes our conclusions and provides an outlook to future research.

2. PRACTICAL REQUIREMENTS

Resulting from our definition of operational transport collaboration, we refer to a network of independent partners cooperating in parts of their daily planning. Examples of such networks are introduced by [2, 6, 15]. All of these examples make the assumption that the partners retain their autonomy in all other parts of their businesses. Hence, we find a decentralized organizational structure with naturally distributed decision competencies. Additionally, the decision making is based on local and at least partly confidential information. Thus, the first requirement is to maintain this decentralized structure and the local decision-making competencies in operational transport collaborations.

Nowadays, concerns about the CO_2 emissions resulting from transportation processes increasingly influence the daily planning of freight forwarders. This is due to the higher significance of environmental consciousness of both the companies and their customers. The quantity of CO_2 emissions depends on the number of trucks used, their utilization and the distance driven. Thus, daily planning measures to lower emissions are the reduction of travel distances and a better utilization of trucks if it is combined with a reduction in the number of trucks. These going-green efforts go hand in hand with traditional objectives in vehicle routing and scheduling; namely finding distance-minimizing or utilization-maximizing routes and plans. This implies the requirement that operational transport collaborations need optimization techniques to address these issues.

The parties involved in transportation processes are today commonly supported by IT-systems. This includes parties within the operational as well as the administrative processes. Examples for operational processes are dispatchers using dedicated software for vehicle routing and scheduling and drivers using navigational and other electronic devices to receive information and updates on their jobs, routes and traffic. In administrative processes, the sales department, for instance, uses electronic marketplaces to find or sell transportation requests, and freight forwarders mostly process their invoicing and other request details electronically. As a consequence of the far-reaching permeation of business processes with IT-systems, a third requirement arises when designing technical solutions that enable operational transport collaborations. That is, the collaboration system must allow for the integration of a multitude of existing information systems. This point is of particular importance since operational transport collaborations do not constitute mergers. Therefore, the creation of a homogeneous IT landscape is not a feasible option. Instead, proposed solutions need to factor in given system heterogeneities. This situation thus calls for extensible and distributed system approaches [8].

As operational transport collaboration is enabled by new information systems, these systems have to be designed for the support of human decision makers. Consequently, we state as a fourth requirement that the systems provide a close link to the real planning situation. Especially when using agent-based systems, the agents should represent the roles of human decision makers. Their behaviors

should provide the devices and concepts for solving the problems encountered on a day-to-day basis by the respective decision makers[1]. Where necessary, bidirectional human-agent interfaces need to be established such that agents can inform their human counterparts on planned courses of actions. The humans, in turn, may specify revisions to the agents' suggestions.
The four requirements to operational transport collaboration are summarized in the four statements below. These statements support our reasoning for using a multiagent-based approach in order to analyze different system configurations experimentally with regards to emergent system behavior, fairness aspects and potential manipulation by its members.

1) The decentralized organizational structure and the distributed decision-making competencies, which are based on local information, have to be maintained. Thus, although central planning under perfect information will provide better solutions, this option is not feasible.
2) Environmental awareness and traditional business interests call for more effective planning and optimization techniques for the transportation processes. Consequently, further improvements for transport optimization are sought and have to be integrated later on.
3) New information support systems for operational transport collaboration have to incorporate the already existing variety of information systems at the freight forwarders.
4) The information system which enables operational transport collaboration should be a close representation of reality with regards to organizational roles and responsibilities. The system has to provide support for the human decision makers.

Fischer et al. [8] describe a transportation system with horizontal cooperation as a multi-agent system. Their approach is similar to ours; however the system differs in several ways and does not fulfill our requirements. In their scenario, the decision on request acceptance and the planning competencies for vehicle routing and scheduling are entirely passed on to truck agents. The requests are only for pickup or delivery, not both. Then, horizontal cooperation is the bilateral negotiation between the truck agents of two freight forwarders, whereas we use an auction involving all freight forwarders. Since significant decision competencies would have to be delegated to agents representing trucks we do not believe that the system of Fischer et.al. is a close representation of reality. Further, although their approach creates improvement potentials, these vary significantly from test instance to test instance, deviating between 3 and 73% from the optimal solution. We hope to reduce this width significantly by using auctions since Berger and Bierwirth [2] report lesser variation in the deviation from the optimal solution.

[1] This is generally demanded of agent-based systems [16].

3. OPERATIONAL TRANSPORT COLLABORATION SETTING

The scenario consists of a number of freight forwarders and a distributed software system for collaborative planning. Each freight forwarder acts independently with regards to the acquisition of customers and their requests, the fulfillment of customer requests, the negotiation of terms and conditions, the planning of the fulfillment, and all other business related tasks. We further assume that each freight forwarder operates its own fleet and has access to an unlimited number of carriers it can subcontract.

The freight forwarders receive pickup and delivery requests from their customers. Each request is specified by a pickup and a delivery location and the quantity of goods to be transported. The request specification may further comprise the earliest and latest pickup (delivery) time. Each request is to be completed within one day. Finally, the following restrictions and assumptions apply:

1) Each request is of truckload size maximally.
2) The considered trucks are technically equipped to execute each request.
3) The earliest pickup time is before the earliest drop-off time and the earliest pickup time plus the time for driving from pickup to delivery must be more or equal to the latest delivery time.
4) The usage of an own truck creates fixed starting costs and distance-dependent variable costs.

Whereas the capacity of own trucks is limited, we assume that enough subcontractors exist in the market to accept any number of requests. However, subcontractors may well have different tariffs for accepting requests [13]. In addition to those options, the freight forwarders now have the possibility to exchange requests via collaborative planning. The collaborative planning is in fact a combinatorial auction with the freight forwarders acting as sellers and bidders at the same time [2, 7, 15].

We follow a structure similar to the three phase structure which has been proposed by Krajewska and Kopfer [15]. Therefore, we distinguish a *pre-exchange phase*, the actual *exchange phase*, and finally a *post-exchange phase*.

In the *pre-exchange phase*, each freight forwarder submits requests that it does not want to fulfill on its own to a collaboration service provider. Said entity cumulates the requests within a pool which is eventually disclosed to the freight forwarders as initialization of the subsequent exchange phase. For each submitted request, the issuing freight forwarder needs to announce and make a payment, e.g. the expected cost in case of self-fulfillment [15].

In the *exchange phase*, the freight forwarders create and bid on request bundles which they want to acquire. In this particular case, bids are not payments made by the auction winner later on. Rather, the bids are tenders for fulfilling the request bundle at a certain price. The collaboration service provider solves the combinatorial auction and the requests are exchanged according to the winning bids. If the collaboration is beneficial, some money is left as collaboration profit. It is beneficial if the submitting freight forwarder has paid its self-fulfillment costs and it bid these costs on its own request in the auction.

In the *post-exchange phase*, any requests that have not been exchanged in the auction are consequently assigned to subcontractors that are contracted directly by the collaboration service provider. The costs of subcontracting are deducted from the remaining collaboration profit. The remaining profit is eventually divided amongst all collaboration participants in the auction according to a previously agreed payment scheme, such as *Collaboration Advantage Indices* [15].

4. ADEQUACY OF MULTIAGENT-BASED MODELING AND SIMULATION

The operational transport collaboration setting that has been introduced in Section 3 involves a number of independent and autonomously deciding participants. Due to its structure and setup, the operational transport collaboration can be conceived as a particular instance of autonomously cooperating logistics processes [5]. The aspired positive emergence is thereby created by the interaction between the participants. It expresses in an improvement of the situation compared to the sum of individual and independent planning and execution processes. Measuring this improvement by classical operations research methods can only specify a range within which the system performance of one planning period will reside. Difficulties arise when attempting to analyze the emergence created by the relationship between the various decisions made. Then, simulation systems that can show and analyze interdependencies between decisions can complement classical operations research methods.

One potential approach for the simulation of operational transport collaboration is *system dynamics*, which can be classified as belonging to *equation-based modeling techniques* [16]. However, with this technique difficulties arise due to the complexity of the individual decisions by actors in the system. As a central limitation, it holds that the actors in the collaboration cannot be modeled explicitly. Rather, the macro-behavior of the system is modeled globally in terms of *levels* and *flows.* The levels then represent transport request portfolios at certain stages. For instance, the level '*accepted requests*' may represent the accumulation of all requests of a particular freight forwarder [19]. For our analysis, the differentiation of *individual* requests in the level '*accepted requests*' is necessary since it is the set of respective characteristics which causes the later assignment of orders to one of the available execution modes. However, these individual characteristics cannot be easily modeled within the '*accepted requests*' level. According to Parunak et. al. [16] both, equation- and agent-based modeling, consider so-called observables, defined as "measurable characteristics of interest", that express the system behavior over time. The difference in the modeling approaches is that equation-based modeling expresses the relationship between observables explicitly. Agent-based modeling, in contrast, defines behaviors that create interaction between observables. Behaviors can then refer to several observables and observables can be used by several behaviors. Going back to our '*accepted requests'* example, equation-based modeling then means that for each type of request in the level a mathematical formulation is required. It describes how the request changes over time depending on the development of all related observables. Agent-based modeling, in contrast, monitors where the request goes from being accepted. Thereby, the requests' way is influenced by the behaviors that use it.

Agent-based modeling is capable of modeling the actors and the relationships connecting them explicitly [16]. Modeling actors as agents provides the benefit of a natural mapping from human decision maker to software agent. Each agent receives several behaviors. Behaviors can comprise decision-making problems and solution methods from operations research. Consequently, the agent can solve the decision-making problem based on the information it received. The interaction between agents in the system results as output of the modeling [16]: information on decisions made is passed on to other agents where necessary and new information is demanded when required. As such, our suggested modeling approach is not 'purely' agent-based since it has equation-based modeling parts within the behaviors of individual agents.

From a more practical point of view and referring again to the requirements we have presented in Section 2, agent-based modeling has further advantages compared to pure equation-based modeling. The most important aspect is the encapsulation of knowledge, information and behavior in the agents. Thus, private information and decision models, which constitute valuable company assets, need not be revealed to agents of different organizational affiliation: agents only communicate relevant outputs of their decisions, not details on how these have been made. Consider the example of an agent deciding between the execution modes of self-fulfillment, subcontracting and auctioning-off of transportation requests. For those requests it assigns to self-fulfillment, this agent provides the required request details only to an agent representing the own fleet of transport vehicles or even a single truck therein. Those requests to be subcontracted are forwarded to the selected subcontracting agent only. Finally, those requests to be auctioned-off are forwarded to an agent that represents the collaboration service provider. In sum, agent-based modeling encourages that each agent only receives the information that is relevant for fulfillment of its specific task. This is possibly the strongest argument for the usage of a multi-agent system to realize operational transport collaboration.

Standardization in the field of multi-agent systems has been brought forward over the last decade. The Foundation of Intelligent Physical Agents (FIPA) has played a major role in this process [17]. FIPA has developed standards to enable interoperability across different agent platforms by introducing the FIPA Abstract Architecture. FIPA has also set standards for message transfer between agent platforms, the build-up of messages in the Agent Communication Language (ACL), and extensible standard interaction protocols. As a consequence, heterogeneous mash-ups of FIPA-compliant multi-agent environments such as the JADE platform [1] emerged. In addition, technical solutions exist which allow for an embedding of agent systems in existing IT-environments. For instance, the so-called Web Service Integration Gateway (WSIG) [10] allows agents to interact with web services. Also, the agents can internally tie up existing software libraries developed in the Operations Research community, for instance for vehicle routing and scheduling. Thus, new algorithms for the vehicle routing and scheduling or for solving other decision-making problems can be included in the framework later on. Therefore, the design and modeling leaves room for the realization of further improvement potentials in routing and scheduling.

5. AGENT TYPES, RESPONSIBILITIES AND IMPLEMENTATION

The basic idea for the agents involved in operational transport collaboration extends our previous work [5]. Figure 1 depicts an exemplary set-up with only two freight forwarding companies. The actual implementation of the multi-agent system does scale towards a larger number of participating freight forwarders. As our simulation framework we have chosen the multiagent-based simulation environment PlaSMA[2] [9, 20].

The realization of executable simulation settings can be understood as being comprised of two complementary aspects: First, the implementation of the multi-agent system itself which is the subject of analysis in later simulation runs. Second, the modeling of the simulated environment in which the aforementioned multi-agent system will be deployed. As introduced in [20], the latter modeling is broken down in PlaSMA to a knowledge engineering task, as particular scenarios are specified as certain knowledge within an ontology. To that end, PlaSMA provides an extensible set of domain ontologies as modeling base. These ontologies encompass relevant aspects of the field of transport logistics required for our scenario, that is, logistic resources, commodities, traffic infrastructure and the like. PlaSMA also provides a basic scenario graph which covers the whole federal territory of Germany, including the fifty largest cities and large parts of the German highway network.

In our setting, we conceptually distinguish five different types of agents: Coordination Agents (CA), Transport Service Agents (TSA), Transport Resource Agents (TRA), Subcontracted Resource Agents (SRA) and a single Collaboration Agent (CLA).

[2] http://plasma.informatik.uni-bremen.de/

In the schema shown in Figure 1, the two large rectangles enclosing the TSA and the resource agents illustrate organizational boundaries between the freight forwarders. The rectangle surrounding the CLA stresses that the CLA has no direct affiliation to any of the freight forwarders. The CLA is the digital representative of a collaboration service provider.
Conceptually, each forwarding agency is modeled as a self-contained multiagent-system which features both a management tier and an operational tier. The management tier is thereby represented by a single CA per agency. This agent constitutes the interface between the freight forwarder and its customers. Its responsibility is the interaction with the market, making decisions such as whether to accept customer demands or to negotiate terms and conditions. The agent's decision problem regarding the acceptance of requests can be described as mixed-integer linear problem as in [18]. Once the requests have been negotiated, they are to be handed over to the operational tier of the freight forwarder's multi-agent system. Here, the further processing of customer requests, which comprises in particular the operational planning, is handled by the TSA. Finally, the transport vehicles are represented by TRA, which are responsible for the actual pickups and deliveries. The SRA are recruited by the freight forwarders, yet have their own organizational affiliation. The focus of attention in the agent-based implementation of the operational transport collaboration was initially on the realization of the transport service agents and their interaction counterpart, the collaboration agent. Therefore, the current implementation leaves the realization of the CA and thus the freight forwarders' management tier to future extensions. Instead, we have substituted an explicit model of customer demand and CLAs with a special, simulation-specific behavior which is configurable on a per agency basis and implements a transport order generator. For the time being, we also assume that the option of refusing customer requests is not exerted by the forwarding agencies.

The order generator behavior is the same for each freight forwarder. It is executed by the TSA with a parameterization which is specific for each forwarder. Over the course of simulation runs, requests for pickup and delivery of LTL freight are created according to a configurable underlying stochastic model. The parameterization allows for instance the specification of catchment areas, the frequency with which requests arrive and the distribution of request sizes.

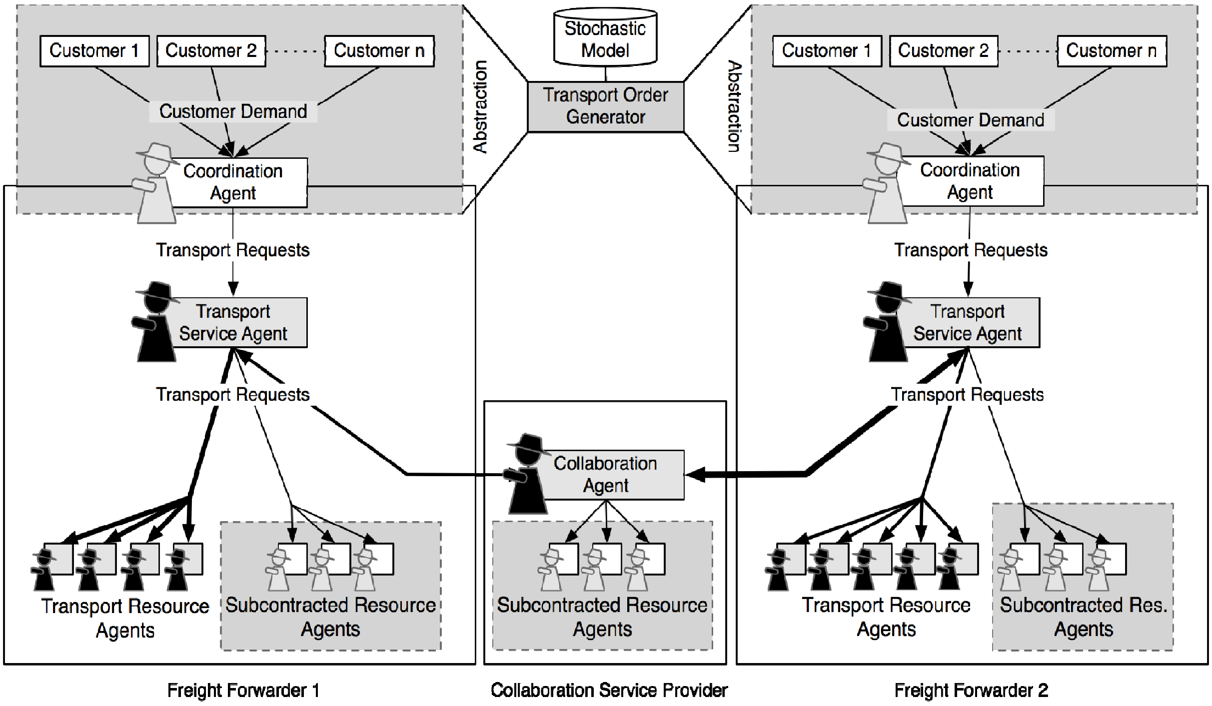

Figure 1: Operational Transport Collaboration as multi-agent system (based on [5])

In the real world, new inbound requests are consequently handled by dispatchers. The dispatchers and their tasks are represented by the TSA. They decide on the execution mode of the requests and exchange requests with other freight forwarders via the CLA. The TSA's decision problems and its interaction with the CLA are displayed in Figure 2.

In an initial step, the TSA receives and evaluates all incoming requests. Consequently, it decides on whether the requests are to be executed by the own fleet or constitute candidates for collaborative planning. In order to render such a decision, the TSA can solve a so-called integrated freight optimization problem [13]. Alternatively, the TSA uses heuristic methods to identify unsuitable requests [4]. Once this assignment problem has been solved, the TSA submits the candidate requests for collaborative planning to the CLA (cf. A in Figure 2). The CLA is responsible for the collection of placed requests from the TSA. Thus, the CLA fills an exchange pool. This operation is stopped after a previously defined time interval. Its contents now constitute the subject-matter of the next step in the collaboration process, namely the combinatorial auction. This auction is opened up by the CLA by sending a message to the TSA which provides full information about the contents of the pooled requests (cf. B). The TSA then create request bundles of the pooled requests and submit bids on those bundles to the CLA (cf. C). The CLA now plays the role of the auctioneer. Once again there is a deadline for placing bids, and only messages that arrive in time are considered for the auction. Afterwards, the CLA computes the winning bundles. The results are then transmitted back to the TSA (cf. D) and the allocation of request bundles is binding. This way, the TSA may receive further requests from the collaborative

planning to complement their original request portfolios. Each TSA then decides autonomously on the execution mode for each request: it is assigned either to a resource agent of the own fleet (TRA), or it is subcontracted to SRA. As should be pointed out here again, the CLA may also assign requests to SRA, as described in Section 3. Finally, the CLA distributes the remaining money (cf. E) amongst the participants according to a pre-specified profit sharing scheme such as the currently used Collaboration Advantage Indices [15].
By default, both, TRA and SRA, are currently simple service agents that execute the tasks of request fulfillment. This is due to the fact, that the computation of transport schedules for the trucks is performed by the TSA.

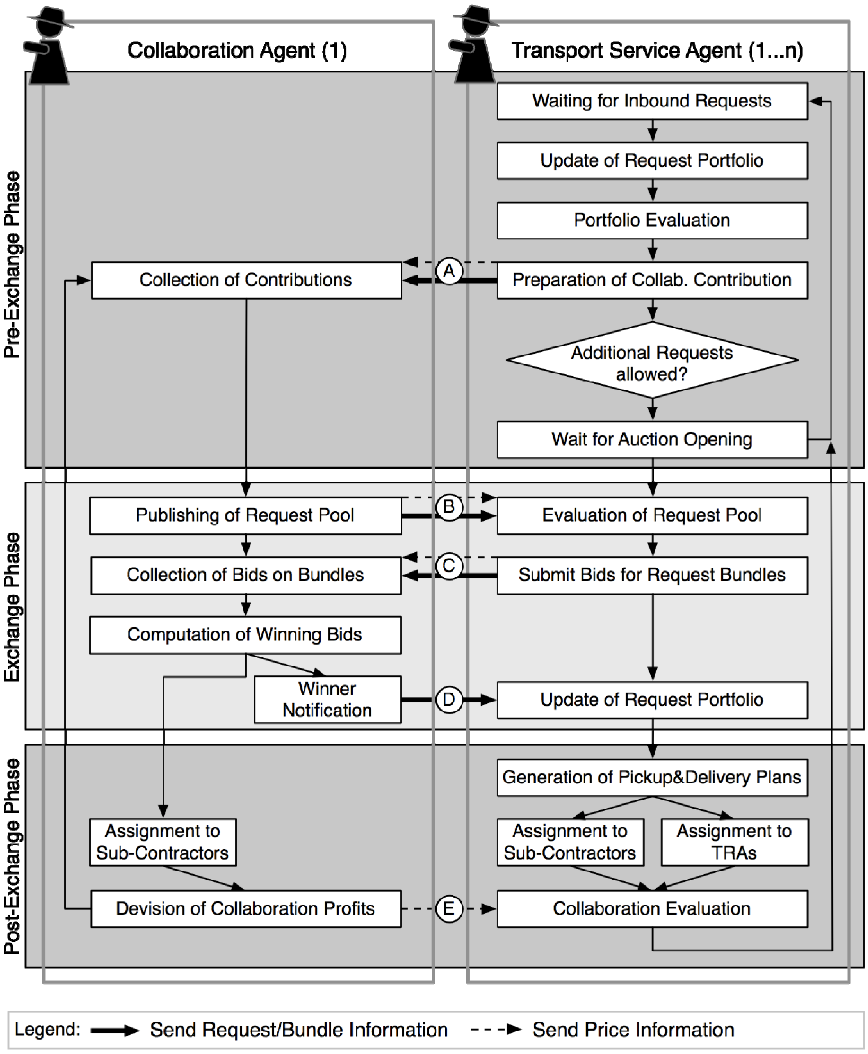

Figure 2: Interaction between TSA and CLA (adapted from [13])

6. CONCLUSIONS AND OUTLOOK

As for complex scenarios with various interacting agents, traditional optimization techniques come to their ends, we have discussed the potential of using simulation for a real scenario, operational transport collaboration. We provided a description of the setting and we derived four guidelines for modeling such a setting in order to be a close mapping to reality and to be transferable to the real world as software support system later on.

Based on a comparison of agent-based and equation-based modeling for the outlined set-up, we have arrived at the conclusion, that the former approach offers significant advantages. These reach from a natural mapping of actors and roles to their agent counterparts to scalability with regards to feasible simulation complexity to the potential of transferring a multi-agent system into operationalization. Resulting thereof, we have proposed a multi-agent system with constituent agents that create a flexible and extensible framework for research on coordination in and emergent properties of operational transport collaboration. The proposed multi-agent system has been implemented in the multiagent-based simulation environment PlaSMA.

As mentioned earlier, the current scenario has a strong focus on the request exchange between the partners in collaborative planning. As a consequence, some real world processes, such as request acceptance and the actual vehicle routing and scheduling exist only at an abstract level so far. Therefore, the additional modeling of these processes should be realized as a future extension of the multi-agent system as it will allow for more comprehensive simulation experiments. Furthermore, since the different decision problems which are tackled in the agent behaviors can be solved in many ways, it will be beneficial for comparative analyses to develop method portfolios.

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GAMES AND INVENTORY MANAGEMENT

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Abstract: In this paper game theory model of material stocks operating control are treated. We consider model of price competition. We assume that each firm has a warehouse. Demand for goods which are in stock is constant and uniformly distributed for the period of planning. Distributors are considered as players in a game with two-level decision making process. At the high level optimal solutions of distributors about selling prices forming Nash equilibrium are based on rational inventory solution (order quantity and maximal inventory level) as a reaction to chosen prices. We describe the price competition in context of modified model of Bertrand. Thus at the low level each player chooses internal strategy as an optimal reaction to competitive player's strategies which are called external. The iterative method is developed to solve this system. We also formulate a Separation theorem for the inventory game.

1. INTRODUCTION

Traditionally, inventory control systems are concerned with single decision makers, who makes decisions on ordered or produced quantity under some assumption about demand, planning horizon, some restrictions of the system. The first paper on mathematical modeling in inventory management was written by Harris [1] in 1915. We may also note books by Hadley and Whitin [2], Hax and Candea [3], Tersine [4]. Inventory control systems with single decision maker capture many important aspects of inventory management. On the other hand they usually don't take into account decisions of other competitors on the market.

Analysis of supply chain policy can benefit from applying game-theory concepts extensively. Game theory tries to enlighten the interactions between individuals or groups of people whose goals are opposed conflicting, or at least partially competing. A lot of researches are devoted to analytical design of contracting arrangements to eliminate inefficiency of decision making in supply chain with several players like Echelon Inventory game and Local Inventory game (see Cachon review, [5]).

Cachon and Zipkin also investigate a two-stage serial supply chain with stationary stochastic demand and fixed transportation times in [6]. We will discuss in the paper classic game theoretical approach to modeling in supply chain management with two-level strategies of players. Both non-cooperative and cooperative models may be discussed. We will only concern in the paper non-cooperative game models.

1.1 Basic Model for Inventory Policy with Backordering

A key problem in establishing inventory policy is to determine how many items has to be stocked periodicaly and when replanishment should occur. That is the main important control variable in the system is order quantity. In tipical inventory management situation, the various costs considered in evaluating inventory system are as follows:

1. ordering and procurement costs for items to be stocked
2. holding or carrying costs
3. shortage costs

Inventory ordering and procurement costs represent all expenses incured in ordering or manufacturing items, including not only acquisition costs assotiated with placing an order but also the costs of transporting, collecting and sorting, placing items in storage. Inventory holding or carring costs are the expenses during the storage of items. Inventory shortage costs are assosiated with demand for items which are not currently in stock and have to be backordered to meet the demand.

Let's consider a single-product inventory control system of stocks with a deficiency assumption. We will use relaxation method of regulation of stocks to minimize long-run inventory costs [7,8]. Assume the demand for items of product is known and uniformly distributed during period of planning. The following parameters are used to establish a mathematical model for this problem

K -- fixed cost per order
c -- unit cost of procurement an item of product
h -- cost per holding item in inventory during the period of planning
g -- cost of being short one item during the entire period of planning
a -- demand per inventory circle
y -- oder quantity
S -- maximal inventory level
D -- demand for the period of planning

Variables y и S are controlled variables in the problem and may be assumed as strategies.

The usual objective of an invtntory policy is to minimize cost of inventory system. To meet a given constant demand for the period of planning distributor has to make $m = D/y$ oders. The total cost of inventory system for the period of planning T_{plan} is the following

$$L(y,S) = mL_{cycle}(y,S) = \frac{D}{y}\left(K + cy + h\frac{S^2}{2a} + g\frac{(y-S)^2}{2a} \right) . \qquad (1)$$

2. DESCRIPTION OF NON-COOPERATIVE GAME

Following N.N.Vorobiev [9] system

$$\Gamma = \langle N, \{X_i\}_{i\in N}, \{\Pi_i\}_{i\in N} \rangle, \tag{2}$$

is called a non-cooperative game where

$N = \{1,2,...,n\}$ -- set of players

X_i -- set of trategies of player i

Π_i -- payoff function of player i, which is a mapping from the set of strategies of players $X = \prod_{i=1}^{n} X_i$ to R^1.

Players make an interactive decisions simultaneoasly choosing their strategies x_i from strategy sets X_i. Vector $x = (x_1, x_2, ..., x_n)$ is called situation in the game. As a result players are paid payoff $\Pi_i = \Pi_i(x)$. We call situation $x^* = (x_1^*, x_2^*, ..., x_n^*)$ a Nash equilibrium if for all admissible strategies $x_i \in X_i$, $i = 1,...,n$ the following inequalities hold

$$\Pi_i(x^*) \geq \Pi_i(x_1^*, x_2^*, ..., x_{i-1}^*, x_i, x_{i+1}^*, ..., x_n^*). \tag{3}$$

As shown in [10] in game (2) there exists Nash equilibrium in pure strategies if for each $i \in N$ strategy set x_i is compact and convex, and payoff function $\Pi_i(x)$ is concave with respect to x_i and continuous on X.

Assume for any $i \in N$ the function $\Pi_i(x)$ is twice continuously differentiable with respect to x_i. From [11] we can see that first-order necessary condition for Nash equilibrium is the following

$$\frac{\partial \Pi_i(x^*)}{\partial x_i} = 0, \quad i \in N \tag{4}$$

Suppose the payoff function $\Pi_i(x)$, $i = 1,...,n$ is concave for all $x_i \in X_i$, that is

$$\frac{\partial^2 \Pi_i(x^*)}{\partial x_i^2} \leq 0. \tag{5}$$

In this case solution of system (4) appears to be a Nash equilibrium in pure strategies in non-cooperative game $\Gamma = \langle N, \{X_i\}_{i\in N}, \{\Pi_i\}_{i\in N} \rangle$.

The most popular types of oligopoly are quantitave competiton (model of Kournot) and price competition (model of Bertrand) [11].

In the model of Kournot n players (distributors) make simultaneoasly interactive decisions about $Q_i \in \Omega_i$, quantities of product to be supplied (produced for) to the market. Their cost functions $L_i(Q_i)$, $i = 1,...,n$ are the same like in (1). Suppose $Q_{-i} = (Q_1, Q_2, ..., Q_{i-1}, Q_{i+1}, ..., Q_n)$ is a vector of expected value of quantities of product of other players. Demand is defined by decreasing inverse demand function $p(Q_i, Q_{-i})$. Modified model of Bertrand supposes that the demand function of player i $Q_i = D_i(p_i, p_{-i})$ depeneds on price $p_i \in \Omega_i$ assigned by player i and prices of competitors $p_{-i} = (p_1, p_2, ..., p_{i-1}, p_{i+1}, ..., p_n)$. In this case payoff function of player i will be of the form

$$\Pi_i(p_i, p_{-i}) = p_i D_i(p_i, p_{-i}) - L_i(D_i(p_i, p_{-i})). \tag{6}$$

We denote the game with payoff functions (8) by

$$\Gamma = \left\langle N, \{\Omega_i\}_{i=1}^n, \{\Pi_i\}_{i=1}^n \right\rangle. \tag{7}$$

3. GAME THEORY MODEL FOR IINVENTORY DECISION. PRICE COMPETITION

3.1 Statement of the problem

From (1) we get the following expression for the cost function

$$L_i(D_i(p_i, p_{-i})) = \overline{L}_i(p_i, p_{-i}, y_i, S_i) = \tag{8}$$

$$= \frac{D_i(p_i, p_{-i})}{y_i}\left(K_i + c_i y_i + h_i \frac{S_i^2}{2a_i} + g_i \frac{(y_i - S_i)^2}{2a_i} \right).$$

We consider demand function per inventory circle $a_i(\cdot)$ of the form $a_i = b_i(p_i, p_{-i})$, $i = 1, ..., n$. Thus function (6) can be rewritten as follows

$$L_i(D_i(p_i, p_{-i})) = \frac{D_i(p_i, p_{-i})}{y_i}\left(K_i + c_i y_i + h_i \frac{S_i^2}{2b_i(p_i, p_{-i})} + g_i \frac{(y_i - S_i)^2}{2b_i(p_i, p_{-i})} \right). \tag{9}$$

Substituting (9) in (8) we get profit function as follows

$$\Pi_i(p_i, p_{-i}) = \Pi_i(p_i, p_{-i}, y_i, S_i) = \tag{10}$$

$$= D_i(p_i, p_{-i}) p_i - \frac{D_i(p_i, p_{-i})}{y_i}\left(K_i + c_i y_i + h_i \frac{S_i^2}{2b_i(p_i, p_{-i})} + g_i \frac{(y_i - S_i)^2}{2b_i(p_i, p_{-i})} \right).$$

We call (y_i, S_i) internal strategy (low-level strategy), and p_i - external strategy (high-level strategy) of distributor i, $i = 1, ..., n$.

Strategy sets of player i, $i = 1, ..., n$ are as follows

$\Omega_i^{(1)} = \{p_i \mid p_i \in [a_i^{(1)}, b_i^{(1)}] \subset [0,\infty)\}$; $\Omega_i^{(2)} = \{y_i \mid y_i \in [a_i^{(2)}, b_i^{(2)}] \subset (0,\infty)\}$; $\Omega_i^{(3)} = \{S_i \mid S_i \in [a_i^{(3)}, b_i^{(3)}] \subset [0,\infty)\}$. Thus we have two level optimization problem for each distributor. It is also can be presented as combination of internal and external problems.

3.2 Internal optimization problem

In internal optimization problem player i chooses internal strategy $(y_i, S_i) \in \Omega_i^{(2)} \times \Omega_i^{(3)}$ with fixed given prices of all players $(p_i, p_{-i}) \in \Omega^{(1)} = \Omega_1^{(1)} \times \Omega_2^{(1)} \times ... \times \Omega_n^{(1)}$ to maximize profit function

$$\Pi_i(p_i, p_{-i}, y_i, S_i) \to_{(y_i, S_i)} max, \ y_i \in \Omega_i^{(2)}, \ S_i \in \Omega_i^{(3)}. \tag{11}$$

Suppose that for each i payoff function (10) is continuously differentiable with respect to y_i and S_i taken separately, and also is convex with respect to (y_i, S_i) on the set $[0,\infty) \times [0,\infty)$ (in particular on $\Omega_i^{(2)} \times \Omega_i^{(3)}$) when vector of prices (p_i, p_{-i}) is fixed.

Solving problem (13) we get the following internal strategies of players

$$y_i^* = y_i^*(p_i, p_{-i}) = \sqrt{\frac{2K_i(g_i + h_i)}{h_i g_i} b_i(p_i, p_{-i})}, \tag{12}$$

$$S_i^* = S_i^*(p_i, p_{-i}) = \sqrt{\frac{2K_i g_i}{h_i(g_i + h_i)} b_i(p_i, p_{-i})}. \quad i = 1, ..., n \tag{13}$$

3.3 Nahs equilibrium in external problem

Substituting internal strategies (12), (13) in (10) we can find payoff functions of players in external game

$$\Pi_i(p_i, p_{-i}, y_i^*(p_i, p_{-i}), S_i^*(p_i, p_{-i})) = \Phi_i(p_i, p_{-i}) = \tag{14}$$

$$= p_i D_i(p_i, p_{-i}) - \xi_i \frac{D_i(p_i, p_{-i})}{\sqrt{b_i(p_i, p_{-i})}} - D_i(p_i, p_{-i}) c_i,$$

where

$$\xi_i = \sqrt{\frac{2K_i g_i h_i}{h_i + g_i}}, i = 1, ..., n.$$

Notice that functions (14) depend only on external strategies of players $(p_i, p_{-i}) \in \Omega^{(1)} = \Omega_1^{(1)} \times \Omega_2^{(1)} \times ... \times \Omega_N^{(1)} \subset R_+^n$. Thus we are getting modified Bertrand model as high-level non-cooperative game

$$\Gamma = \left\langle N, \{\Omega_i^{(1)}\}_{i=1}^n, \{\Phi_i\}_{i=1}^n \right\rangle. \tag{15}$$

As can be strictly shown calculation of Nas equilibrium is based on the first-oder (4) and second-order (5) conditions. That is Nash equilibrium $(p_1^*, p_2^*, \dots, p_N^*)$ in high-level game can be found as a solution of the following system

$$\frac{\partial D_i(p_i, p_{-i})}{\partial p_i} b_i(p_i, p_{-i}) + D_i(p_i, p_{-i}) = \tag{16}$$

$$= \xi_i \frac{2\frac{\partial D_i(p_i, p_{-i})}{\partial p_i} b_i(p_i, p_{-i}) - D_i(p_i, p_{-i}) \frac{\partial b_i(p_i, p_{-i})}{\partial p_i}}{2b_i^{3/2}(p_i, p_{-i})} + \frac{\partial D_i(p_i, p_{-i})}{\partial p_i} c_i, \; i = 1, ..., n .$$

Finally we are finding Nash equilibrium strategies of players (p_i^*, y_i^*, S_i^*) $i = 1, ..., n$. One can notice that our method proposed to find internal and external strategies separetelly, but taking into account optimal reaction of inventory system to equilibrium prices.

SeparationTheorem. Optimal inventory decision and price in the case of price competition which form Nash equilibrium can be choosen separatelly.

4. EXAMPLE OF INVENTORY SYSTEM

Suppose that demand function $D_i(p_i, p_{-i})$ and demand per inventory circle function $b_i(p_i, p_{-i})$ for each distribotor i have the same properties of depending on external strategies. Analogously to [11] we introduce these functions as follows

$$D_i(p_i, p_{-i}) = d_i \frac{p_1^{\beta_{i1}} p_2^{\beta_{i2}} \dots p_{i-1}^{\beta_{i,i-1}} p_{i+1}^{\beta_{i,i+1}} \dots p_n^{\beta_{in}}}{p_i^{1+\alpha_i}}, \tag{17}$$

$$b_i(p_i, p_{-i}) = e_i \frac{p_1^{\beta_{i1}} p_2^{\beta_{i2}} \dots p_{i-1}^{\beta_{i,i-1}} p_{i+1}^{\beta_{i,i+1}} \dots p_n^{\beta n}}{p_i^{1+\alpha_i}}, \tag{18}$$

where d_i and e_i -- a positive constants , $\alpha_i > \beta_{ij} > 0 \;\; \forall \;\; j \neq i, \; i = 1, ..., n$.

Elasticity of distributor's demand function $D_i(p_i, p_{-i})$ with respect to his price is negative $\varepsilon_{ii} = -1-\alpha_i < 0$, $i = 1,...,n$, and with respect to competitors prices are positive and the following inequalities hold $\varepsilon_{ij} = \beta_{ij} > 0 . \forall \ j \neq i$, $i = 1,...,n$.
So that demand is uniform during the period of planning and circle as well, we notice that period of planning is equal to $D_i(p_i, p_{-i})/b_i(p_i, p_{-i}) = d_i/e_i$.
Let us consider internal and external problems in this case.
Internal problem. We can rewrite formulas for y_i and S_i in the form

$$y_i^*(p_i, p_{-i}) = \sqrt{\frac{2K_i(g_i + h_i)e_i p_1^{\beta_{i1}} p_2^{\beta_{i2}} \dots p_{i-1}^{\beta_{i,i-1}} p_{i+1}^{\beta_{i,i+1}} \dots p_n^{\beta_{in}}}{h_i g_i p_i^{1+\alpha_i}}},$$

$$S_i^*(p_i, p_{-i}) = \sqrt{\frac{2K_i g_i e_i p_1^{\beta_{i1}} p_2^{\beta_{i2}} \dots p_{i-1}^{\beta_{i,i-1}} p_{i+1}^{\beta_{i,i+1}} \dots p_n^{\beta_{in}}}{h_i(g_i + h_i) p_i^{1+\alpha_i}}}.$$

Denote $\gamma_i(p_{-i}) = p_1^{\beta_{i1}} p_2^{\beta_{i2}} \dots p_{i-1}^{\beta_{i,i-1}} p_{i+1}^{\beta_{i,i+1}} \dots p_n^{\beta_{in}}$. Than we get for $i = 1,...,n$

$$y_i^*(p_i, p_{-i}) = \sqrt{\frac{2K_i(g_i + h_i)e_i\gamma_i(p_{-i})}{h_i g_i p_i^{1+\alpha_i}}}, \tag{19}$$

$$S_i^*(p_i, p_{-i}) = \sqrt{\frac{2K_i g_i e_i \gamma_i(p_{-i})}{h_i(g_i + h_i) p_i^{1+\alpha_i}}}. \tag{20}$$

External problem. We substitute internal strategies (19), (20) in (8). Due to (17) and (18) we get

$$\Phi_i(p_i, p_{-i}) = \frac{d_i\gamma_i(p_{-i})}{p_i^{\alpha_i}} - \frac{d_i}{p_i^{(1+\alpha_i)/2}}\sqrt{\frac{2K_i g_i h_i \gamma_i(p_{-i})}{e_i(g_i + h_i)}} - \frac{d_i c_i \gamma_i(p_{-i})}{p_i^{1+\alpha_i}}. \tag{21}$$

Thus we state model of Bertrand for our case as non-cooperative game

$$\Gamma = \left\langle N, \{\Omega_i^{(1)}\}_{i=1}^n, \{\Phi_i\}_{i=1}^n \right\rangle,$$

where $\Omega_i^{(1)}$ -- the set of external strategies of player i, $\Omega_i^{(1)} = \{p_i \mid a_i^{(1)} \leq p_i \leq b_i^{(1)}\}$, $i = 1,...,n$.

Solving the problem . It is easy to see that second-order condition for function (21) is fulfilled $\frac{\partial^2\Phi_i(p_i, p_{-i})}{\partial p_i^2} \leq 0$ and from the first oder condition (4) we get the following system

$$\frac{\partial \Phi_i(p_i, p_{-i})}{\partial p_i} = -\frac{\alpha_i d_i \gamma_i(p_{-i})}{p_i^{1+\alpha_i}} + \frac{d_i(1+\alpha_i)}{2}\sqrt{\frac{2K_i g_i h_i \gamma_i(p_{-i})}{e_i(g_i+h_i)}}\frac{1}{p_i^{(3+\alpha_i)/2}} +$$

$$+\frac{(1+\alpha_i)d_i\gamma_i(p_{-i})c_i}{p_i^{2+\alpha_i}} = 0,\ i=1,...,n$$

It can also be written in the form

$$-\alpha_i p_i + \frac{1+\alpha_i}{2}\sqrt{\frac{2K_i g_i h_i}{e_i(g_i+h_i)\gamma_i(p_{-i})}}\, p_i^{(1+\alpha_i)/2} + (1+\alpha_i)c_i = 0,\ i=1,...,n.$$

Denoting

$$\xi_i = \frac{1+\alpha_i}{2}\sqrt{\frac{2K_i g_i h_i}{e_i(g_i+h_i)}},$$

we get system

$$\xi_i p_i^{\frac{1+\alpha_i}{2}} = \sqrt{p_1^{\beta_{i1}} p_2^{\beta_{i2}} \dots p_{i-1}^{\beta_{i-1,1}} p_{i+1}^{\beta_{i+1,1}} \dots p_n^{\beta_{in}}}\left(\alpha_i p_i - (1+\alpha_i)c_i\right),\ i=1,...,n.$$

This system can be only solved by numerical methods.

Let us consider game of two players i.e. $n=2$. For this case we will have the following system to find Nash equilibrium

$$\begin{aligned} &\xi_1 p_1^{\frac{\alpha_1+1}{2}} - \sqrt{p_2^{\beta_{12}}}\left(\alpha_1 p_1 - (\alpha_1+1)c_1\right) = 0, \\ &\xi_2 p_2^{\frac{\alpha_2+1}{2}} - \sqrt{p_1^{\beta_{21}}}\left(\alpha_2 p_2 - (\alpha_2+1)c_2\right) = 0. \end{aligned} \tag{22}$$

Let paremeters of the model are as follows

$K_1 = 400$, $c_1 = 10$, $h_1 = 10$, $d_1 = 100000$, $e_1 = 10000$, $g_1 = 5$, $\alpha_1 = 1/2$, $\beta_{12} = 1/4$, $K_2 = 400$, $c_2 = 8$, $h_2 = 8$, $d_2 = 100000$, $e_2 = 10000$, $g_2 = 6$, $\alpha_2 = 1/2$, $\beta_{21} = 1/4$.

System (22) will be of the form

$$\begin{aligned} &0{,}3872983344 p_1^{\frac{3}{4}} - p_2^{\frac{1}{8}}\left(\frac{1}{2}p_1 - 15\right) = 0, \\ &0{,}3927922024 p_2^{\frac{3}{4}} - p_1^{\frac{1}{8}}\left(\frac{1}{2}p_2 - 12\right) = 0. \end{aligned}$$

With the solution $p_1^* = 37{,}68643585$ USD and $p_2^* = 30{,}47300925$ USD. These prices are values of exsternal strategies in Nash equilibrium. Profit of distributors for this situation are $\Phi_1(p_1^*, p_2^*) = 26744{,}43112$ и $\Phi_2(p_1^*, p_2^*) = 22422{,}48488$.

Using (19) and (20) we also calculate internal strategies y_1^*, S_1^* и y_2^*, S_2^*: $y_1^* \approx 156,\ S_1^* \approx 52$ and $y_2^* \approx 185,\ S_2^* \approx 79$.

5. CONCLUDING REMARKS

In this paper, we are discussing model of inventory control system in the case of price competition. We propose and describe mathematical method for finding Nash equilibrium in pure strategies as analitically and numerecaly as well. Using these methods it is possible to get analytical expressions for internal and external strategies in deterministic models. When it is not the case we can find solutions numerically.

The contribution of this paper to logistics and game theory consists in developing new two-level models of operating inventory control and game theory application. New approach for finding optimal inventory policy is based on choosing Nash equilibrium as combination of external and internal strategies and separation calculation into two stages. With the developed model, important problems of supply chain analysis such as inventory decisions which provides maximal profit of firms can be solved. In addition, the results can be used for investigation of inventory policy in Echelon Inventory game and Local Inventory game with dynamic and stochastic demand.

The results of the research can be used for optimization of inventory system control and contribute to better understanding of supply chain optimization possibilities.

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SUPPLY CHAIN FLEXIBILITÄT UND MÖGLICHE QUANTITATIVE ANSÄTZE

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Zusammenfassung: In den Zeiten der Krise ist das Thema „Flexibilität" aktuell wie nie zuvor. Obwohl ein beachtlicher Fortschritt in der Untersuchung der Flexibilisierung von Supply Chains in den letzten Jahren erreicht wurde, bleiben noch einige Fragen offen. Erstens, die unterschiedlichen Sichten der Flexibilität werden meistens separat betrachtet. Zweitens, werden Supply Chains häufig aus Sicht der maximalen Flexibilität konfiguriert. Die dabei evtl. entstehende enorme Komplexität und fehlende Stabilität solcher Supply Chains wird selten in Betracht gezogen. Diese Arbeit widmet sich diesen zwei Problembereichen und erarbeitet ein mehrdimensionales Rahmenkonzept der Supply Chain Flexibilität sowie schlägt mögliche quantitative Ansätze vor.

1. EINFÜHRUNG

Heutzutage konkurrieren nicht mehr nur noch einzelne Unternehmen und ihre Endprodukte miteinander, sondern es stehen mittlerweile ganze Wertschöpfungsketten im nationalen und internationalen Wettbewerb gegenüber [1]. Dies macht eine gut strukturierte und flexible Wertschöpfungskette unerlässlich [2]. Während der Begriff zum einen sehr häufig verwendet wird, ist es zu beobachten, dass sich bis jetzt keine einheitliche und allgemeingültige Definition durchsetzen konnte, da sich die jeweiligen Definitionen auf bestimmte Untersuchungsperspektiven der Flexibilität beziehen. Obwohl ein beachtlicher Fortschritt in der Untersuchung der Flexibilisierung von Supply Chains in den letzten Jahren erreicht wurde, bleiben noch einige Fragen offen.

Erstens, wird der Begriff „Flexibilität" häufig auf die *Produktflexibilität*, d.h. Variantenvielfalt und Produktkomplexität, reduziert. Andere Flexibilitätsreserven, wie z.B. die neuen Koordinationskonzepte, Outsourcing, Contracting, neue Informationstechnologien, flexible Organisationsformen und Produktions- und Distributionsstrategien, d.h., die *Prozessflexibilität* und *Systemflexibilität*, werden nun unzureichend behandelt. Zweitens, werden die Supply Chains häufig aus Sicht der maximalen Flexibilität konfiguriert. Die dabei evtl. entstehende enorme Komplexität und fehlende Stabilität solcher Supply Chains, die s.g. „dark side" der Supply Chains wird aber nur selten in Betracht gezogen. Diese Arbeit widmet sich diesen zwei Problembereichen und erarbeitet ein mehrdimensionales Rahmenkonzept der Supply Chain Flexibilität sowie schlägt mögliche quantitative Ansätze vor.

2. RAHMENKONZEPT

Im vorgeschlagenen Rahmenkonzept zur Analyse der Supply Chain Flexibilität werden die folgenden Flexibilitätssichten betrachtet. Erstens, die *Produktflexibilität*, d.h. Variantenvielfalt und Produktkomplexität wird in Betracht gezogen. Zweitens, die Möglichkeit der Postponement-Entscheidungen wird hauptsächlich nur auf die Produkte in der Fertigung zurückgeführt. Die Produkte in der Distribution bzw. Auslieferung und damit verbundenen Postponement- und Order-Penetration-Point (OPP)-Entscheidungen in Bezug auf die Güterflüsse wurden bis jetzt nicht explizit behandelt. Und drittens, es werden sehr selten die neuen Organisationsformen der Koordination von Supply Chains für die kundenindividualisierten Produkte aus Sicht der Verzögerungsprinzipien und des Entkopplungspunktes untersucht. Abschließend sei erwähnt, dass sich alle Autoren, trotz ihrer unterschiedlichen Definitionen, über die Wichtigkeit und Notwendigkeit von Flexibilität in Unternehmen und Supply Chains einig sind.
Die Erhöhung der Supply Chain Flexibilität ist aus verschiedenen Gründen notwendig. Zum einen wachsen immer die Ansprüche der Kunden. Zum anderen besteht das Bedürfnis nach möglichst kurzen Lieferzeiten. Diese beiden Punkte sind vor allem auf bereits gesättigten Märkten sehr wichtig. Deshalb sind sie gezwungen, Kosten in der SC zu sparen und die Bedürfnisse der Kunden zu befriedigen, da ihr Erlösniveau sonst sinkt.

Tachizawa und *Thomsen* [3] betrachteten empirisch die Flexibilitätsaspekte, die zu den Aufwärtsflüssen gehören. *Coronado* und *Lyon* [4] untersuchten die Auswirkungen der Operations-Flexibilität in den industriellen Supply Chains und die damit verbundenen Einflüsse auf die Initiativelieferung für die make-to-order Manufacturing. *Wadhwa u.a.* [5] betrachteten die Rolle von verschiedener Flexibilitätsoptionen (fehlende Flexibilität, Teilflexibilität und volle Flexibilität) in einem dynamischen SC Model mit Hilfe einiger Schlüsselparameter und Leistungsindikatoren. *Swafford u.a.* [6] bewiesen, dass die Integration der IT dabei hilft, die Flexibilitätsprognosen des Unternehmens durchzuführen und trägt zur Steigerung der Businessleistungsindikatoren und der Flexibilität bei. *Ozbayrak u.a.* [7] sowie *Ivanov* und *Sokolov* [8] zeigten die Interrelation zwischen der Flexibilität und der Anpassungsfähigkeit. Nicht mehr die Technologie der Fertigung, sondern die Fähigkeit, Bedarfsschwankungen des Marktes auszugleichen, hilft im heutigen Wettbewerbskampf zu gewinnen [9].

Es gibt unterschiedliche Arten von Flexibilität. *Beamon* [10] nennt vier verschiedene Flexibilitätsarten: Mengenflexibilität, Lieferflexibilität, Produktflexibilität und Innovationsflexibilität. Flexibilität erlaubt der Supply Chain, schnell und effektiv auf die Veränderungen der Umwelt zu reagieren. Auch dringende Sonderaufträge von A-Kunden sollen einplanbar sein. Diese Fähigkeit nennt man Lieferflexibilität [11].

Die Mengenflexibilität wird mit Hilfe der Realisierungszeit für eine Erhöhung der Produktionsmenge um einen definierten Prozentsatz charakterisiert. Dazu definiert das SCOR-Modell die Aufwärtsflexibilität beispielsweise wie folgt: Anzahl an Tagen, die erforderlich ist, um einen ungeplanten, nachhaltigen Produktionszuwachs von 20 Prozent sicherzustellen [12].

Die Fähigkeit, neue Produkte bzw. Varianten in das Produktionsprogramm aufzunehmen, nennt man Produktflexibilität. Es wird immer mehr geforscht, wie sich die Flexibilität der Supply Chain erhöhen lässt, um auf individuelle Kundenanforderungen schnell und effizient reagieren zu können.

Eine der Möglichkeiten der Flexibilitätserhöhung liegt in der Erweiterung der Struktur der Supply Chain, indem man neue Unternehmensnetze „on demand" bilden kann. Diese Vorgehensweise ist dem Prinzip der Virtuellen Unternehmen nah. Sicherlich besteht auch die Option, auf diese Weise entstandene Flexibilität nicht nur für individuelle Kundenwünsche einzusetzen, sondern auch bei den laufenden Aufträgen im Falle einer Abweichung vom Plan anzuwenden, um die Abweichungen operativ zu verhindern.

Die bisherige Analyse lässt ein allgemeines Rahmenkonzept der Supply Chain Flexibilisierung ableiten, der in der Abbildung 1 dargestellt ist.

Abb. 1: Rahmenkonzept der Supply Chain Flexibilisierung aus der Sicht der Verzögerungsprinzipien und des Entkopplungspunktes

Zusätzlich zu den konventionellen Produktions- und Logistiksichten der flexiblen Gestaltung von Supply Chains für die kundenindividualisierten Produkte aus der Sicht der Verzögerungsprinzipien und des Entkopplungspunktes werden in dem o.a. Rahmenkonzept die innovativen Organisationsformen der Unternehmenskooperationen mit der flexiblen Lieferantenauswahl (z.B., virtuelle Unternehmen) und die modernen Konzepte der Informationskoordination in Betracht gezogen. Dies ermöglicht eine integrierte und umfangreichere Analyse der Supply Chain Flexibilität unter Einbeziehung von sowohl Material- als auch Informationsflüssen und modernen Managementkonzepten.

3. QUANTIFIZIERUNG DER FLEXIBILITÄT

Die Analyse der Flexibilisierung von Supply Chains für die kundenindividualisierten Produkte aus der Sicht der Verzögerungsprinzipien und des Entkopplungspunktes soll durch die begleitende Analyse der Strukturkomplexität und der Stabilität erweitert werden, damit die Effekte von der Flexibilisierung aufgrund der evtl. zu komplexen Supply Chains durch die Unsicherheit bzw. den Verlust der Steuerbarkeit nicht zunichte gemacht würden. Weiterhin soll die Möglichkeit der Postponement-Entscheidungen nicht nur für Produkte in der Fertigung, sondern auch für die Produkte in der Distribution bzw. Auslieferung betrachtet werden.

3.1 Analytisches Modell zur Bestimmung der Lage des Entkopplungspunktes

Mit Hilfe des nachstehenden Modells soll es möglich sein, die optimale Lage für den Entkopplungspunkt (Order Penetration Point – OPP) in einer gegebenen Supply Chain analytisch zu bestimmen [13]. Im Modell wird von einer konventionellen make-to-stock-Strategie ausgegangen. Dabei werden die erzielten finanziellen Ergebnisse, welche aufgrund dieser Strategie maximal erreicht werden können, betrachtet. Bei einer make-to-stock-Strategie wird ein Produkt direkt ab Lager verkauft. Es werden die Endprodukte auf Lager produziert und aufgrund von Hochrechnungen die Nachfrage prognostiziert [14].

Der Kunde wählt sich das gewünschte Produkt aus einer vorgegebenen Produktpalette aus. Typischerweise ist bei diesen Produkten die Variabilität deutlich eingeschränkt. Der Order-Penetration-Point liegt also sehr nahe beim Kunden, d.h. sehr weit downstream. Dies ermöglicht eine kostengünstige Produktion, da die Prozesse upstream vom OPP schlank (lean) modelliert sind. Deshalb zeichnen sich die Produkte in erster Linie durch einen günstigen Preis und sofortige Verfügbarkeit aus.

Desweiteren wird im Modell davon ausgegangen, dass die agilen Prozesse downstream des OPP eingeführt werden können, so dass sich zum Beispiel der Preis und die Verfügbarkeit eines Produktes zwar verschlechtern können, aber durch Vorteile, wie z.B. Verringerung der Lagerbestände, Erhöhung der Kundenzufriedenheit, individuellere Produktgestaltung usw., zu einer Verbesserung des gesamten finanziellen Ergebnisses führen. Entscheidend ist also nun, wie weit der Kunde in die Supply Chain eingreifen darf und wie viel ihm dieser Vorteil des Eingriffes auf die Individualisierung des Produktes wert ist.

Es gilt also festzuhalten, dass für eine Positionierung des OPP in Richtung upstream der Supply Chain kurze Lieferzeiten und eine Erhöhung der Effizienz in der Fertigung sprechen, was sich vor allem im Preis des Produktes und in der Lieferzuverlässigkeit widerspiegelt. Für die Positionierung des OPP in Richtung downstream der Supply Chain sprechen hingegen die erhöhten Möglichkeiten der Individualisierung der Produkte und der Abbau von Lagerbeständen. Dies zeigt sich dann zum Beispiel in einer breiteren Produktpalette und einer höheren Qualität. Innerhalb dieses Spannungsfeldes muss man nun versuchen, ein ausgewogenes Verhältnis zwischen Produktivität und Flexibilität zu erreichen

Die Lage des OPP soll nun durch die Kompensation der finanziellen Ergebnisse (das sog. „lost profit" Szenario) bestimmt werden. Dazu soll die nachstehende Formel (1) dienen:

$$D = \frac{R_a \times k_a - (C_u^a + C_d^a + P^a + L^a)}{R - (C + k \times P + k \times L)} \to \max[t_0; T], \qquad (1)$$

wobei

- D ist ein Index für die Effizienz des OPP
- R sind die Einnahmen im Falle von make-to-stock
- R_a sind die Einnahmen im Falle der Einführung des agilen Teils stromabwärts des OPPs
- C sind die Supply Chain Kosten im Falle von make-to-stock
- C_u^a sind die Supply Chain Kosten stromaufwärts des OPP im Falle der Einführung des agilen Teils
- C_d^a sind die Supply Chain Kosten stromabwärts des OPP im Falle der Einführung des agilen Teils
- P sind die Strafen für nicht erfüllte Verträge im Falle von make-to-stock
- P^a sind die Strafen für nicht erfüllte Verträge im Falle mit adaptivem Teil der Supply Chain
- L sind die Verluste durch zurückgewiesene Kundenanfragen im Falle von make-to-stock
- L^a sind die Verluste durch zurückgewiesene Kundenanfragen im Falle mit adaptivem Teil der Supply Chain
- k_a ist ein korrigierender Koeffizient in Abhängigkeit der Lage des OPP; da durch die steigende Reaktionsgeschwindigkeit ein zukünftiges Ansteigen der Verkäufe durch die Einführung des agilen Teils zu erwarten ist.
- k ist ein korrigierender Koeffizient in Abhängigkeit der Lage des OPP; da durch die fehlende Reaktionsfähigkeit eine zukünftige Senkung der Verkäufe zu erwarten ist.

Aufgrund dieser einfachen rechnerischen Formel soll nun derjenige OPP-Standort im Supply Chain Cycle (t_0; T] ausgewählt werden, der einen Wert für D > 0 ausweist und im Vergleich zu den alternativen Varianten der OPP Lage maximal ist. Sollte zu keinem der möglichen Zeitpunkte D > 0 gelten, soll die gesamte Supply Chain Konfiguration auf ihre Übereinstimmung mit den realen Marktbedingungen überprüft werden.

3.2. Entropie-basierte Analyse der Strukturkomplexität von Supply Chains

Bei der Flexibilisierung von Supply Chains besteht die Gefahr, so komplexe Strukturen aufzubauen, die nicht mehr steuerbar sind. Aus diesem Grund soll die Analyse der Flexibilisierung von Supply Chains für die kundenindividualisierten Produkte aus der Sicht der Verzögerungsprinzipien und des Entkopplungspunktes durch die begleitende Analyse der Strukturkomplexität erweitert werden, damit die Effekte der Flexibilisierung aufgrund von den evtl. zu komplexen Supply Chains durch die Unsicherheit bzw. den Verlust der Steuerbarkeit nicht zunichte gemacht würden.
Die Netzwerkstrukturkomplexität kann auf Grund der Entropie analysiert werden [15]. Entropie ist ein Maß für den mittleren Informationsgehalt oder auch Informationsdichte eines Zeichensystems. Die Entropie wird wie folgt berechnet:

$$H = -\sum_{i=1}^{N} p_i \ln p_i \qquad (2)$$

p_i ist die Wahrscheinlichkeit des Systemzustandes i, $i = 1,2,\ldots,N$.

In der Abbildung 2a ist ein Beispiel einer Supply Chain Struktur dargestellt. Für diese Supply Chain beträgt der Entropie-Index H = 1,74. Der maximale Wert wird erreicht, wenn alle Varianten der Übergänge zwischen den Supply Chain Elementen zulässig und gleich wahrscheinlich sind (siehe Abb. 2b). In diesem Fall erhalten wir H^{max} = 2,30.

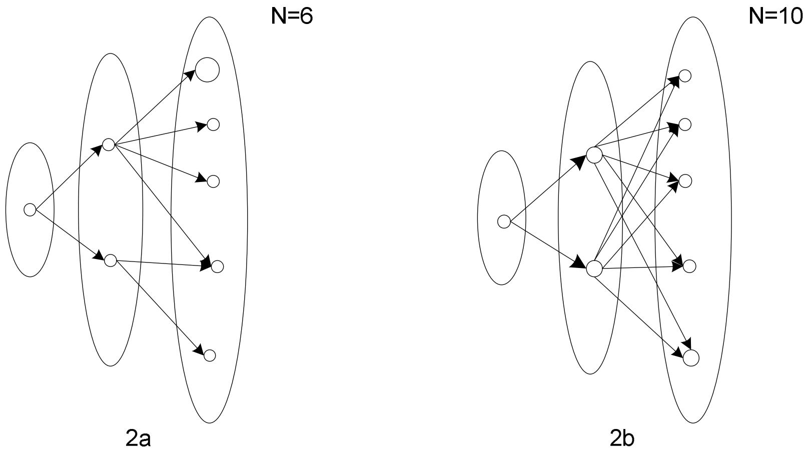

Abb. 2. Beispiele der Supply Chain Strukturen

Die Beziehung zwischen dem absoluten und dem maximalen Entropie-Wert $H^{(o)} = H/H^{max}$ ermöglicht es, einen relativen Entropie-Index zu berechnen, um die alternativen Supply Chain Strukturen hinsichtlich der Anzahl und der Vielfältigkeit von Elementen und deren Verbindungen vergleichen zu können. In dem Beispiel folgt $H^{(o)} = 1.74/2.30 = 0.76$. Dieser Wert des Entropie-Indexes kann als ein Entscheidungskriterium bei der Auswahl der Supply Chain Konfigurationen mit unterschiedlichen Flexibilitätsstrukturen angewendet werden.

Eine Erweiterung des Modells (2) ist die Berücksichtigung der Tatsache, dass sich die Bedeutung von Kanten im Supply Chain Graph unterscheiden kann. Die Kanten in unmittelbarer Nähe des Kunden weisen ein größeres Nutzen auf, denn dadurch erhöht sich die Flexibilität an der entscheidenden Stelle in der Supply Chain. Wir werden dieses Nutzen als w_t beschreiben so, dass $0 \leq w_t \leq 1$, $\sum w_t = 1$. Dementsprechend führen wir den sog. "gewichteten" Entropie-Wert H_w:

$$H_w = -\sum_{i=1}^{N}\sum_{t=0}^{T-1} w_t \left(\prod_{\substack{k=0 \\ k \neq t}}^{T-1} p_{ik}\right) x(p_{it} \ln p_{it}) \qquad (3)$$

Im Folgenden wird die Anwendung der Entropie-Werte bei der Analyse der Supply Chain Strukturen anhand eines numerischen Beispiels für die Strukturen aus der Abb. 2 und eine zusätzliche Struktur (siehe Abb. 3) verdeutlicht.

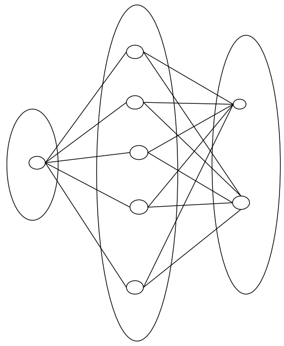

Abb. 3. Beispiel einer Supply Chain Struktur

Zwecks der Vereinfachung der Darsellung beschränken wir uns in den gegebenen Beispielen auf das Supply Chain Teil downstream des OPP. In der Abbildung 2 sind zwei im Hinblick auf die Anzahl der Elemente gleiche Supply Chain Strukturen mit einem zentralen Distributionslager, zwei regionalen Distributionszentren sowie fünf lokalen Lagern dargestellt. Obwohl die Strukturen in der Abbildung 2 gleich bzgl. der Anzahl an Elementen sind, sie unterscheiden sich hinsichtlich der Verbindungen (Kanten) und haben folglich unterschiedliche Flexibilität. In der Abbildung 3 ist eine andere Supply Chain Struktur dargstellt, die aus einem zentralen Distributionslager, fünf regionalen Distributionszenten und zwei nlokalen Lagern besteht. Das Problem besteht in der Analyse der Flexibilität der gegebenen Strukturen mit Hilfe des Entropywertes. Mit Hilfe des Modells (2)-(3) wurden die folgenden Werte berechnet (siehe Tabelle 1).

Aus der Tabelle 1 kann es abgeleitet werden, dass bei den Strukturen 2b und 3 die Entropie-Werte identisch sind und zugleich auch den maximalen Entropie-Werten entsprechen (d.h., sie weisen die maximale Komplexität auf). Die Kennzahl H_w weist auf die höhere Flexibilität der Struktur 2b (siehe Gleichung (3)) hin.

Tabelle 1. Beispiele der Supply Chain Strukturen

Struktur (Nummer der Abbildung)	H, (H^{max})	H_w
2a	1,74;(2,30)	0,94
2b	2,30;(2,30)	1,31
3	2,30;(2,30)	0,99

Der höhere Wert H_w widergibt, dass die Supply Chain Flexibilität in Richtung der Endkunden steigt; d.h., die Vielfalt der Prozesstrajektorien wird downstream der Supply Chain immer größer und die Supply Chain kann in unmittelbaren Nähe des Kunden angepasst werden.

Die endgültige Auswahl der Supply Chain Konfiguration basiert auf den Kennzahlen der ökonomischen Effizienz und den Entropie-Werten. Z.B., wenn eine bestimmte Supply Chain Struktur, wirtschaftlich gesehen, vorzuziehen ist, können zusätzlich Elemente der Flexibilität methodisch begründet eingeführt werden. Als Beispiel kann hier eine Vereinheitlichung des Produktsortiments an zwei oder drei Werken in der Supply Chain genannt werden, um eine Flexibilität bzgl. der Nachfrage- und Kapazitätsschwankungen zu implementieren.

4. ZUSAMMENFASSUNG

In diesem Beitrag erfolgte aufgrund des erarbeiteten Rahmenkonzeptes die qualitative und quantitative Analyse der Supply Chain Flexibilisierung aus der Sicht der Verzögerungsprinzipien und des Entkopplungspunktes. Zuerst erfolgte eine qualitative Analyse der die Flexibilisierung beeinflussenden Faktoren, die in vier Gruppen aufgegliedert wurden: die Variantenvielfalt in der Produktion, flexible Lieferantenauswahl, virtuelle Unternehmen und die Informationskoordination.

Basierend auf diesen Ergebnissen wurde dann ein quantitatives analytisches Modell zur Bestimmung der OPP Lage erarbeitet. Das Modell basiert auf dem Vergleich von zwei Situationen – Supply Chain Leistungen ohne den OPP und Supply Chain mit einem OPP an verschiedenen Positionen entlang der Supply Chain. Bei der Berechnung des rechten Teiles der Supply Chains (downstream des OPP) werden nun die früher definierten mehrdimensionalen Aspekte des Rahmenkonzeptes der Supply Chain Flexibilisierung berücksichtigt. Dieses Modell wird anschließend für die verschiedenen Branchen angewendet. Nachfolgend wurden die Strukturkomplexität mittels der Entropie analysiert. Abschließend wurde ein Modell der Abstimmung der Supply Chain Flexibilität und Stabilität erarbeitet und anhand eines numerischen Beispiels veranschaulicht.

Zusammenfasend ist festzustellen, dass die Analyse der Flexibilisierung von Supply Chains durch ein Mehrdimensionales Rahmenkonzept, ein quantitatives analytisches Modell sowie die begleitende Analyse der Strukturkomplexität erweitert worden ist. Dadurch kann methodisch begründet analysiert werden, inwieweit die Effekte von der Flexibilisierung und die evtl. zu komplexen Supply Chain Strukturen bzgl. der Unsicherheit miteinander abgestimmt sind.

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SIMULATION-BASED DESIGN OF MAKE-TO-ORDER PRODUCTION- AND DISTRIBUTION-NETWORKS

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Purpose of the paper
The purpose of this paper is to present a Simulation-Optimization method for the design of make-to-order production- and distribution-networks. The approach aims at capturing operational issues like stochastic arrivals of customer orders and the dynamics of production and distribution processes within the strategic decision making for facility location and capacity allocation. A rule based network reconfiguration approach is developed for iteratively adapting a given network design according to the bottlenecks that are identified by means of simulation. First computational results show that the approach effectively delivers designs of low cost that guarantee a preset service level of on-time deliveries.
Research/application methodology
We provide decision support to strategic Supply Chain Management by means of Operational Research methods. The problem considered belongs to the class of multi-stage multi-commodity facility location problems. The tools used within this study are mixed-integer programming modeling and event-driven simulation. Using both tools isolatedly provides a user with certain advantages and disadvantages that are outlined in this paper. Based on this, we justify the development of a combined Simulation-Optimization method [4,5] as a promising research approach for strategic network design.
Design of the paper
The paper is organized as follows. Section 1 motivates this study and explains the basic concept of Simulation-Optimization as well as the advantages gained over pure approaches for simulation or optimization. Afterwards, the considered problem is described in detail by characterizing the types of facilities, the product structure and the customers' demands for these products. A mathematical model is provided that links the strategic network design decisions with the operational performance measures that are determined within the simulation module. Section 3 outlines the proposed Simulation-Optimization approach. It provides details on the simulation model and on the network adaptation process that is used to modify a given network configuration according to the obtained simulation results. Section 4 provides first computational results for an exemplary problem instance with 15 facilities, 9 materials and products as well as 30 customers. The paper is concluded in Section 5 where we also sketch ideas for future research.
Main results
Conceptual results of this paper are found in the presented planning methodology, which illustrates how to combine strategic design decisions with operational performance measures. Computational results are preliminary so far, because the tests conducted for this paper consider merely a single example instance. However, it is found that the chosen approach is effective in determining feasible network designs and that the solution process improves an ini-

tial solution by decreasing the chosen cost measure. Future research will extend these computational results to get a deeper insight into the dynamics of production networks.

Academic contribution

While a large number of scientific publications addresses design problems for make-to-stock driven production- and distribution-networks, studies on optimization of make-to-order driven networks are comparably scarce. One explanation is the difficulty in capturing the non-linearities arising from stochastics and dynamics of order processing at the strategic network design level. The proposed Simulation-Optimization approach provides a powerful tool for representing these effects within the optimization process. The paper therefore provides researchers with an innovative tool for enriching network design problems into the mentioned direction.

Managerial insights

Applying the presented approach in a practical application allows for a deeper understanding of the interrelations of strategic network design and operational performance of facility networks. It furthermore provides a tool for evaluating alternative operation rules regarding supplier selection, assignment of production orders to plants and for scheduling these orders at the facilities. Preliminary results show the effectiveness of the approach and the simulation module can be easily extended towards a more detailed representation of production and distribution processes and to other performance measures than those considered in this study.

SIMULATIONSGESTÜTZTES DESIGN VON AUFTRAGSGETRIEBENEN PRODUKTIONS- UND DISTRIBUTIONSNETZWERKEN

Frank Meisel, Christian Bierwirth

Zusammenfassung: Dieses Papier stellt einen Ansatz zum Design von auftragsgetriebenen Produktions- und Distributionsnetzwerken vor. Wir verknüpfen Optimierungs- und Simulationstechniken, um kostenminimale Netzwerkkonfigurationen zu finden, die gleichzeitig ein vorgegebenes Serviceniveau für Lieferzeittreue bei der Erfüllung stochastisch eingehender Kundenaufträge gewährleisten. Der Optimierungskomponente kommt hierbei die Aufgabe zu, zulässige Konfigurationen für ein Netzwerk zu bestimmen. Die Simulationskomponente evaluiert diese Designs hinsichtlich ihrer operativen Leistungsfähigkeit, Produkte zeitgerecht zu fertigen und auszuliefern. In einem iterativen Prozess werden beide Komponenten verknüpft, um die Konfigurationsentscheidungen unter Einbezug der Simulationsergebnisse zielgerichtet zu revidieren. Wir erläutern in unserem Beitrag diese Vorgehensweise und zeigen, welche Vorteile sich aus dem kombinierten Einsatz der beiden Werkzeuge ergeben. An Hand einer exemplarischen Probleminstanz wird demonstriert, wie der gewählte Ansatz zur Lösung strategischer Netzwerkdesignprobleme genutzt werden kann.

1. EINFÜHRUNG

In diesem Papier untersuchen wir ein simulationsgestütztes Optimierungsverfahren für das Design auftragsgetriebener Produktionsnetzwerke. In solchen Netzwerken werden Produkte entsprechend eingehender Kundenaufträge gefertigt (Make-to-Order), wie es z. B. auf Grund kundenbezogener Spezifikationen von Komponenten und Fertigprodukten bei gleichzeitig prohibitiv hohen Lagerhaltungskosten erforderlich ist. Im Gegensatz zu einer Produktion auf Lager (Make-to-Stock), bei der sich die Leistungsfähigkeit eines Produktions- und Distributionssystems an der Verfügbarkeit (fill-rate) von Produkten misst, ist in auftragsgetriebenen Systemen insbesondere die Einhaltung vereinbarter Lieferzeiten von Bedeutung. Die vorliegende Arbeit bietet dahingehend einen Planungsansatz, in dem ein lieferzeittreues Netzwerkdesign mit geringen Gesamtkosten bestimmt wird.

Das Design von Produktions- und Distributionsnetzwerken stellt ein vielfach untersuchtes Optimierungsproblem des strategischen Supply Chain Management dar, vgl. Überblicksartikel [1,2,3]. Ein Großteil der Studien basiert auf Gemischt-Ganzzahligen Linearen Optimierungsmodellen, da diese die konkret untersuchte Problemstellung präzise abbilden können und damit einen Ausgangspunkt für exakte und heuristische Lösungsverfahren bieten. Allerdings stellen die Modelle meist sehr starke Abstraktionen realer Systeme dar, insbesondere im Bezug auf stochastische und dynamische Aspekte der operativen Abläufe in den geplanten Designs. Auf eine detaillierte Abbildung von Produktions- und Distributionsprozessen wird dabei meist zu Gunsten einer akzeptablen Problemkomplexität verzichtet. Das Nachvollziehen der Erfüllung konkreter Kundenaufträge ist hierbei im Allgemeinen nicht möglich.

Simulationsmodelle erlauben dahingegen eine deutlich präzisere Abbildung der in einem Netzwerk ablaufenden Prozesse. Ein Nachteil ist allerdings, dass reine Simulationsmodelle keine direkte Entscheidungsunterstützung liefern. Daher können zwar vorgegebene Netzwerkdesigns evaluiert werden, aber eine übergeordnete Planungsinstanz muss aus den gewonnenen Ergebnissen Verbesserungen an den untersuchten Designs ableiten. Hier setzt die Verknüpfung von Simulation und Optimierung (auch als Simulation-Optimization (SO) bezeichnet) an [4,5]. In einem iterativen Prozess werden dabei Lösungen für eine Planungsaufgabe durch Simulation evaluiert und durch eine Optimierungskomponente in potentiell bessere Lösungen überführt, vgl. Abb. 1.

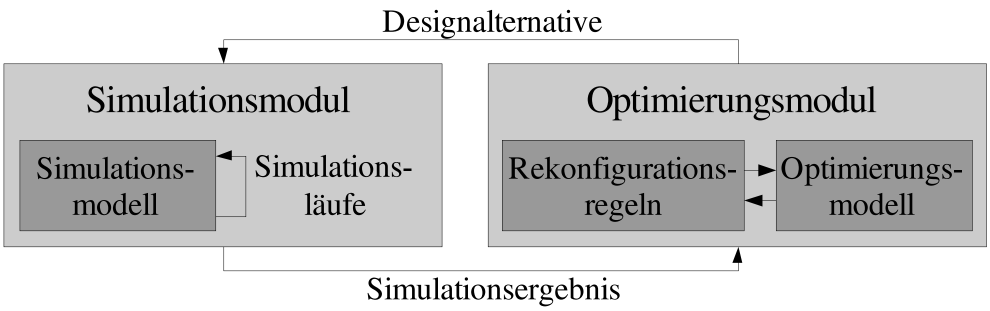

Abb. 1: Simulation-Optimization Framework, in Anlehnung an [6].

SO-Ansätze zeigten sich bereits erfolgreich für verschiedene logistische Planungsbereiche, wie der Auswahl und Parametrisierung von Bestellpolitiken sowie der Standortwahl in Make-to-Stock basierten Produktionsnetzwerken

[7,8,9,10]. Aus den genannten Gründen erscheint ein SO-basierter Planungsansatz ebenfalls geeignet für die Konfiguration von auftragsgetriebenen Netzwerken. Das vorliegende Papier liefert hierfür einen neuartigen Planungsansatz, bei dem die Lieferzeittreue und die Kosten der Leistungserstellung präzise durch eine Simulation bestimmt werden und durch einen regelbasierten Optimierungsansatz Engpässe im Design identifiziert sowie durch eine Rekonfiguration beseitigt werden. Dynamische Zuweisungsregeln von Aufträgen entsprechend der Auslastung einzelner Standorte, kapazitätsabhängige Warte- und Bearbeitungszeiten der Aufträge innerhalb der Produktionssysteme und eine auftragsindividuelle Bestimmung von Lieferzeiten bieten hierbei einen detaillierten Einblick in die Leistungsfähigkeit der untersuchten Designalternativen.

Wir erläutern im nachfolgenden Abschnitt die betrachtete Planungsaufgabe im Detail. Abschnitt 3 beschreibt den verfolgten SO-Ansatz. Abschnitt 4 bietet erste rechnerische Ergebnisse, gefolgt von einem Ausblick auf weitere Forschungsmöglichkeiten in Abschnitt 5.

2. PROBLEMBESCHREIBUNG UND MODELLIERUNG

Wir betrachten ein Netzwerk aus potentiellen Lieferanten S, Produktionsstandorten P und Distributionszentren W. An den Standorten werden Materialien R in Zwischenprodukte I und Endprodukte F transformiert und an Kunden aus der Menge C ausgeliefert. Wir bezeichnen mit $O = S \cup P \cup W$ die Gesamtheit aller Standorte, die als Ausgangspunkt für Güterströme im Netzwerk agieren können und mit $D = P \cup W \cup C$ diejenigen Standorte, die Empfänger von Güterströmen sein können. Die Gesamtheit aller betrachteten Güterarten wird mit $K = R \cup I \cup F$ beschrieben. Mengenmäßige Einsatzverhältnisse eines Gutes k für die Produktion einer Einheit k' sind in Form von Produktionskoeffizienten $a^{k,k'}$ gegeben. Für jeden Standort $o \in O$ ist darüber hinaus mit $K_o \subset K$ die Teilmenge derjenigen Güter gegeben, die an dem Standort potentiell produziert werden können. Weiterhin können in o bis zu $L_o^{\max}$ Fertigungslinien eingerichtet werden. Die Anzahl installierter Fertigungslinien repräsentiert die Produktionskapazität eines Standorts. Wir nehmen an, dass alle Fertigungslinien in o in der Lage sind, die Güter K_o herzustellen. Jede Fertigungslinie kann nur einen Fertigungsauftrag zurzeit bearbeiten, wobei Aufträge komplett durch die zugewiesene Fertigungslinie bearbeitet werden. Für jeden Kunden und jedes Produkt ist eine erwartete Kundennachfrage je Periode d_c^f bekannt. Es wird davon ausgegangen, dass die Kundennachfrage in Form einzelner Aufträge zu je einer Produkteinheit auftritt, die stochastisch im Zeitverlauf ausgelöst werden. Jeder Auftrag erfordert dabei kundenindividuelle Spezifikationen am Produkt, sodass eine auftragsgetriebene Produktion erfolgt. Zur Bestimmung der Lieferzeiten sind Produktionsprozesszeiten pt_o^k je Einheit von k an Standort o sowie Transportzeiten tt_{od} zwischen Standorten o und d bekannt. Die Auslieferung jedes Kundenauftrags soll innerhalb von τ Zeiteinheiten erfolgen, wobei die Lieferzeittreue ein vorgegebenes Mindestniveau $SL^{\min}$ erfüllen muss.

Die zu treffenden Designentscheidungen des Netzwerks sind $U_o = 1$, wenn Standort *o* geöffnet wird, andernfalls 0; $V_o^k = 1$ wenn *k* am Standort *o* produziert wird und $L_o \in [0,1,...L_o^{\max}]$ als Anzahl der in *o* eingerichteten Fertigungslinien. Die zu diesen Entscheidungen gehörigen Fixkosten sind mit $c_o^{\text{Ufix}}, c_{ok}^{\text{Vfix}}$ und c_o^{Lfix} gegeben. Während die Vektoren der Designvariablen *U*, *V* und *L* im Rahmen der Optimierung zu bestimmen sind, wird die Leistungsfähigkeit eines Netzwerkes durch seine operative Performance hinsichtlich der kostengünstigen und zeitgerechten Auftragserfüllung im Rahmen einer Simulation bestimmt. Die für eine gegebene Belegung von *U*, *V* und *L* durch Simulation ermittelte Produktionsmenge von *k* am Standort *o* wird mit $A_{ko}^{\text{SIM}}(U,V,L)$ bezeichnet und mit variablen Stückkosten c_{ko}^{var} bewertet. Transportierte Mengen von *k* zwischen Standorten *o* und *d* werden durch die Simulation als $X_{kod}^{\text{SIM}}(U,V,L)$ bestimmt. Die Kostenrate beträgt hier c_{kod}^{var}. $SL^{\text{SIM}}(U,V,L)$ bezeichnet die realisierte Lieferzeittreue, welche sich aus dem Verhältnis der innerhalb von τ Zeiteinheiten erfüllten Kundenaufträge gegenüber der Gesamtheit erfüllter Kundenaufträge ergibt. Eine mathematische Formulierung des Problems der Netzwerkkonfiguration stellt (1)-(10) dar.

$$\begin{aligned}\min Z = &\sum_{o \in O}\left(c_o^{\text{Ufix}} \cdot U_o + c_o^{\text{Lfix}} \cdot L_o + \sum_{k \in K_o}\left(c_{ok}^{\text{Vfix}} \cdot V_o^k + c_{ko}^{\text{var}} \cdot A_{ko}^{\text{SIM}}(U,V,L)\right)\right) \\ &+ \sum_{k \in K}\sum_{o \in O}\sum_{d \in D} c_{kod}^{\text{var}} \cdot X_{kod}^{\text{SIM}}(U,V,L)\end{aligned} \tag{1}$$

$$V_o^k \le U_o \qquad \forall o \in O; \forall k \in K_o \tag{2}$$

$$L_o \le L_o^{\max} \cdot U_o \qquad \forall o \in O \tag{3}$$

$$A_{ko}^{\text{SIM}}(U,V,L) \le M \cdot V_o^k \qquad \forall k \in K; \forall o \in O \tag{4}$$

$$\sum_{d \in D} X_{kod}^{\text{SIM}}(U,V,L) \le M \cdot V_o^k \qquad \forall k \in K; \forall o \in O \tag{5}$$

$$\sum_{k \in K}\sum_{o \in O} X_{kod}^{\text{SIM}}(U,V,L) \le M \cdot U_d \qquad \forall d \in D \tag{6}$$

$$SL^{\text{SIM}}(U,V,L) \ge SL^{\min} \tag{7}$$

$$U_o; V_o^k \in \{0;1\} \qquad \forall o \in O; \forall k \in K_o \tag{8}$$

$$L_o \in [0,1,...L_o^{\max}] \qquad \forall o \in O \tag{9}$$

$$A_{ko}^{\text{SIM}}(U,V,L); X_{kod}^{\text{SIM}}(U,V,L) \ge 0 \qquad \forall o \in O; \forall d \in D; \forall k \in K_o \tag{10}$$

Zielfunktion (1) strebt nach der Minimierung der Gesamtkosten, die für das realisierte Design entstehen. (2) und (3) stellen sicher, dass nur geöffnete Standorte die Produktion zugewiesener Güter übernehmen und dass höchstens $L_o^{\max}$ Fertigungslinien in o eingerichtet werden. Dementsprechend beschränken (4) bis (6) die Produktions- und Transportaktivitäten auf geöffnete Standorte mit der erforderlichen Güterzuweisung. (7) stellt sicher, dass die Lieferzeittreue mindestens der Vorgabe $SL^{\min}$ entspricht. (8) bis (10) beschränken die Wertebereiche der Entscheidungsvariablen.

Modell (1)-(10) ist nicht geschlossen, da realisierte Produktionsmengen A_{ko}^{SIM}, Transportmengen X_{kod}^{SIM} und Lieferzeittreue SL^{SIM} von U, V und L abhängen und nur im Rahmen einer Simulation bestimmt werden können. Das Simulationsmodul ist darüber hinaus für konsistente Gütertransformationen an den Standorten und für die realisierten Güterflüsse zwischen Standorten verantwortlich, sodass die Flussbedingungen zum Ausgleich ein- und ausgehender Güterströme an einem Standort nicht explizit im obigen Modell formuliert sind. Da das Simulationsmodell die stochastisch ausgelösten Kundenaufträge verarbeitet, findet sich im obigen Modell ebenfalls keine der üblichen Restriktionen bezüglich der Erfüllung der Kundenbedarfe d_c^f.

3. SIMULATION-OPTIMIZATION VERFAHREN

Allgemeiner Ablauf: Das SO-Verfahren erfordert eine Ausgangskonfiguration für das Netzwerk, welche z. B. in der Öffnung aller Standorte bei Zuweisung aller erlaubten Güter und Installation der maximalen Anzahl an Fertigungslinien bestehen kann. Durch Ausführung des nachfolgend beschriebenen Simulationsmoduls wird für dieses Design die Abarbeitung stochastisch eingehender Kundenaufträge simuliert. Die Simulationsergebnisse finden Verwendung im Optimierungsmodul, welches Kapazitätsengpässe und Überkapazitäten identifiziert und dahingehend das Ausgangsdesign modifiziert. Simulations- und Optimierungsmodul werden wiederholt ausgeführt, bis für eine vorgegebene Zahl von Iterationen keine Verbesserung der besten bekannten Lösung mehr erfolgt.

Simulationsmodul: Die Aufgabe des Simulationsmoduls ist es, für eine festgelegte Netzwerkkonfiguration, d. h. für eine Belegung der Variablen U, V und L, die erzielte Lieferzeittreue und die variablen Kosten der Auftragserfüllung zu bestimmen. Kundenaufträge werden hierbei zufallsverteilt ausgelöst. Die Zwischenankunftszeiten von Aufträgen eines Kunden c für ein Produkt f sind exponentialverteilt mit Mittelwert $1/d_c^f$, sodass die erwartete Kundennachfrage je Periode berücksichtigt wird. Wir verwenden eine ereignisgesteuerte Simulation, um die Erfüllung der stochastisch ausgelösten Kundenaufträge unter den beschränkten Fertigungskapazitäten und den erforderlichen Transportzeiten nachzuvollziehen. Die folgenden drei Hauptereignistypen werden hierfür genutzt.

Order-placed: Dieses Ereignis stellt das Auslösen eines Auftrags durch einen Kunden *c* für eine Produkt *f* dar. Zur Erfüllung dieses Kundenauftrags werden Produktionsaufträge für die erforderlichen Materialien und Vorprodukte sowie für die Fertigung des eigentlichen Produkts *f* bei Lieferanten und Produktionsstandorten ausgelöst. Diese Aufträge werden an den Einrichtungen in Warteschlangen eingereiht, wo sie auf den Eingang aller erforderlichen Vorprodukte warten. Nach deren Eingang wird ein Fertigungsauftrag für die Produktion freigegeben und einer frei werdenden Fertigungslinie zugeführt. Fertigungsaufträge werden an Standorte nach dem Kriterium frühester erwarteter Auftragserfüllung zugewiesen, wozu die Prozesszeiten aller einem Standort bereits zugewiesenen, aber unbegonnenen Aufträge, die Zahl installierter Fertigungslinien und die Transportzeit zur Empfängereinrichtung berücksichtigt werden. Nach diesem Kriterium wird ebenfalls ein für die Auslieferung zum Kunden zuständiges Distributionszentrum bestimmt.

Processing-finished: Dieses Ereignis wird ausgelöst, sobald ein Fertigungssauftrag an einem Standort beendet wird. Das gefertigte Gut wird an den zum Fertigungsauftrag gehörenden Zielort (z. B. im Fall eines Endproduktes an dasjenige Distributionszentrum, welches die Auslieferung an den Kunden übernimmt) versandt. Liegen weitere freigegebene Aufträge vor, so beginnt die frei gewordene Fertigungslinie mit der Bearbeitung desjenigen Auftrags, der am frühesten freigegeben wurde (First-come first-served Prinzip).

Receipt-of-goods: Dieses Ereignis wird ausgelöst, sobald ein Gütertransport an einem Standort eintrifft. Handelt es sich um die Auslieferung eines Produktes *f* an einen Kunden *c*, so wird das erzielte Serviceniveau des Netzwerks entsprechend der beobachteten (Nicht-)Einhaltung der vorgegebenen Lieferzeit τ aktualisiert. Trifft eine Sendung an einem Produktionsstandort ein, so wird sie im Rahmen eines angeschlossenen Fertigungssauftrags weiter verarbeitet. Stellt die betrachtete Sendung das letzte noch ausstehende Vorprodukt dieses Fertigungsauftrags dar, so wird der Auftrag nun für das Produktionssystem freigegeben und bei freier Produktionskapazität wird mit seiner Bearbeitung begonnen.

Optimierungsmodul: Das Optimierungsmodul modifiziert die aktuelle Netzwerkkonfiguration indem die Entscheidungen über die zu öffnenden Standorte (Entscheidungsvariablen U_o), die dort produzierbaren Güter (V_o^k) und die Zahl der Fertigungslinien (L_o) auf Grundlage der Ergebnisse des vorangegangenen Simulationslaufes revidiert werden. Prinzipiell können hierfür verschiedene Nachbarschaften einer Lösung definiert werden, die z. B. im Öffnen oder Schließen einzelner Standorte bestehen. Durch den iterativen Ablauf des SO-Verfahrens kann auf Grundlage solcher Nachbarschaften eine lokale Suche oder auch eine meta-heuristisch gesteuerte Suche nach besseren Designs durchgeführt werden. Ein solches Vorgehen erfordert allerdings einen hohen Rechenaufwand, da prinzipiell jede einzelne Nachbarschaftslösung durch einen Simulationslauf zu evaluieren ist. Die Implementierung des Optimierungsmoduls für das vorliegende SO-Verfahren verfolgt daher einen alternativen Ansatz. Wir verwenden ein regelbasiertes System, welches auf Grundlage des Simulationsergebnisses die Engpässe und Überkapazitäten im Netzwerk identifiziert und zu beseitigen sucht. Da in einem Netzwerk mehrere solcher kritischer Elemente parallel auftreten können, ermöglicht der regelbasierte Ansatz auch mehrere Modifikationen der Belegung von U, V und L innerhalb einer einzelnen SO-Iteration. Die gezielte Suche nach Schwachstellen in der aktuellen Lösung und die erweiterten Rekonfigurationsmöglichkeiten sollen bewirken, dass das SO-Verfahren zu hochwertigen Lösungen innerhalb einer geringen Anzahl von Iterationen führt. Die folgenden Regeln werden genutzt, um U, V und L an Hand der Ergebnisse eines vorangegangenen Simulationslaufes anzupassen. Sie werden in der Reihenfolge der nachfolgenden Erläuterungen auf eine Lösung angewendet.

Revision L_o: Ausgehend von den Simulationsergebnissen wird für jeden Standort o seine Auslastung $util_o$ bestimmt, indem die gesamte Produktionsprozesszeit aller dort bearbeiteten Aufträge durch die Zahl L_o installierter Fertigungslinien dividiert wird. Stellt $frac_o$ den Nachkommateil von $util_o$ dar, so wird die Zahl der Fertigungslinien am Standort o nach der folgenden Regel angepasst:

$$L_o^{neu} = \begin{cases} \lfloor util_o \rfloor & \text{, wenn } 0 \leq frac_o < frac^{min} \\ \lceil util_o \rceil & \text{, wenn } frac^{min} \leq frac_o < frac^{max} \\ \min\{\lceil util_o \rceil + 1; L_o^{max}\} & \text{, wenn } frac^{max} \leq frac_o < 1 \end{cases} \tag{11}$$

Im ersten Fall von (11) wird die Anzahl von Fertigungslinien verringert, wenn eine Minderauslastung durch eine Unterschreitung des vorzugebenden Schwellenwerts $frac^{min}$ identifiziert wird, wohingegen im zweiten Fall die Kapazität beibehalten wird und im dritten Fall eine Erhöhung der Kapazität bei Überschreiten des Schwellwertes $frac^{max}$ (Engpass) erfolgt. Als Beispiel seien die folgenden Parameterwerte $frac^{min}$=0.05 und $frac^{max}$=0.95 gegeben. Wir betrachten einen Standort mit $L_o^{max} = 6$ Fertigungslinien von denen derzeit L_o=4 eingerichtet sind. Beobachtet man nun im Rahmen der Simulation eine Auslastung von $util_o$=3.02 so wird die Kapazität des Standorts entsprechend Fall 1 in (11) auf $L_o^{neu} = 3$ gesenkt. Bei einer beobachteten Auslastung von z. B. $util_o$=3.67 wird die Kapazität mit $L_o^{neu} = 4$ beibehalten (Fall 2), wohingegen bei $util_o$=3.98 eine Erhöhung der Kapazität auf $L_o^{neu} = 5$ erfolgt (Fall 3).

Revision V_o^k: In diesem Schritt werden diejenigen Güter $k \in K$ bestimmt, deren Produktion bislang an Engpässen im Netzwerk erfolgte und die somit für die verspätete Auslieferung von Kundenaufträgen verantwortlich sind. Dazu wird für jeden Kundenauftrag mit einer realisierten Lieferzeit größer τ bestimmt, welcher zugehörige Fertigungsauftrag für Materialien, Zwischenprodukte oder das Endprodukt selbst die längste Wartezeit nach der Auftragsfreigabe zu verzeichnen hatte. Liegt die insgesamt realisierte Lieferzeittreue unter der Mindestforderung, d. h. $SL^{\text{SIM}}(U,V,L) \geq SL^{\min}$, wird dasjenige Gut *k* identifiziert, welches sich für die meisten Aufträge als Engpass darstellte. Sollten die derzeitigen Hersteller von *k* in der aktuellen Revision nicht bereits eine Kapazitätserhöhung erhalten haben, so erhält ein zusätzlicher Standort o' die Freigabe zur Produktion von *k,* d. h. wir setzen $V_{o'}^{k} = 1$. Dieser Standort wird zufällig unter allen bereits geöffneten Standorten gewählt, die *k* herstellen können, es bislang aber noch nicht durften, d. h. $o' \in \{o'' \in O \mid U_{o''} = 1, k \in K_{o''}, V_{o''}^{k} = 0\}$. Gibt es unter den geöffneten Standorten keinen, der diese Kriterien erfüllt, so wird ein zufällig gewählter neuer Standort eröffnet, der *k* produzieren kann.

Ein Gut *k* wird von einem Standort *o* wieder abgezogen $(V_o^k = 0)$, wenn die Gutbezogene Auslastung $util_o^k$ des Standortes unter dem Schwellwert $frac^{\min}$ liegt und es noch mindestens einen anderen Standort gibt, der dieses Gut produzieren kann.

Revision U_o: Für das Öffnen neuer Lieferanten- oder Produktionsstandorte gibt es keine explizite Regel, da diesbezügliche Anpassungen im Rahmen der vorher beschriebenen V_o^k-Revision erfolgen. Neu zu eröffnende Distributionszentren werden bestimmt, indem diejenigen Kunden identifiziert werden, die die höchste Zahl nicht termingerecht erfüllter Aufträge aufweisen. Falls für diese Kunden das naheste Distributionszentrum bislang geschlossen ist, so wird dieses geöffnet.

Standorte werden geschlossen (U_o=0), wenn ihnen im Rahmen der L_o-Revision alle Fertigungslinien oder im Rahmen der V_o^k-Revision alle Produkte entzogen wurden.

Diversifikation: Führen die genannten Schritte zu einer Konfiguration, die bereits in einer vorherigen Iteration untersucht wurde, so wird ein zufällig gewählter Standort geschlossen, um neue Bereiche des Lösungsraums zu durchsuchen.

4. EXEMPLARISCHE RECHENERGEBNISSE

Wir verwenden eine zufällig generierte Testinstanz, um erste Ergebnisse mit dem SO-Verfahren zu generieren. Die Instanz umfasst je 5 Materiallieferanten, Produktionseinrichtungen und Distributionszentren, die für die Herstellung von 3 Produkten unter Verwendung von 3 Materialien und 3 Zwischenprodukten zuständig sind. 30 Kunden sind zu bedienen, die einen zufällig gewählten jährlichen Bedarf für die Produkte aufweisen, der zwischen 50 und 500 platzierten Aufträgen je Produkt, Kunde und Jahr liegt. Die Erzeugnisstruktur der Endprodukte wurde durch zufälliges Ziehen der Produktionskoeffizienten $a^{k,k'}$ aus dem Intervall [1,2] bestimmt. Die Technologiemenge K_o von Standort *o* wurde so gewählt, dass jeder Lieferant zwei der drei Materialien bereitstellen kann und jeder Produktionsstandort zwei der drei Zwischenprodukte und zwei der drei Endprodukte herstellen kann. Für Lagerhäuser besteht keine Einschränkung hinsichtlich der Umschlagfähigkeit von Endprodukten. Wir verwenden $L_o^{\max} = 5$ für alle Einrichtungen. Standorte aller Einrichtungen und Kunden wurden zufällig in einer Ebene mit den Abmessungen 10×10 festgelegt. Die Transportdauer tt_{od} entspricht der euklidischen Distanz zwischen den Standorten *o* und *d*. Das Gleiche gilt für die variablen Transportkosten je transportierter Gütereinheit. Alle weiteren fixen und variablen Kostenraten wurden zufällig aus festgelegten Intervallen gezogen. Alle Produktionsprozesszeiten je Gütereinheit wurden auf $pt_o^k = 1$ Tag gesetzt. Für alle Kundenaufträge wird ein Lieferzeitziel von 30 Tagen vorgegeben. Ein Serviceniveau von 95% hinsichtlich dieses Kriteriums wird gefordert. Das Simulationsmodul simuliert einen Zeitraum von 5 Jahren.

Ergebnisse: Abbildung 2 zeigt die Entwicklung der Gesamtkosten und der erzielten Lieferzeittreue SL^{SIM} für die Designs, die innerhalb der ersten 70 Iterationen des SO-Verfahrens für die Beispielinstanz untersucht wurden. Eine erste zulässige Lösung mit Kosten von 1.445.687 wird in Iteration 1 generiert. Die beste zulässige Lösung wird in Iteration 51 gefunden. Sie weist Kosten von 1.331.023, was einer relativen Verbesserung von ca. 8% entspricht. Im Verlaufe des Lösungsprozesses werden schrittweise Senkungen der Kosten und kleine Änderungen bei dem Servicelevel beobachtet, die aus den Netzwerkrekonfigurationen folgen. Die großen Einbrüche bei den Kosten (z. B. Iterationen 8, 19, 30) resultieren aus Diversifikationsschritten, bei denen der geschlossene Standort ein kritisches Netzwerkelement darstellt und daher ebenfalls eine drastische Reduktion des erzielten Serviceniveaus erfolgt, s. Abb. 2 (rechts). Diese unzulässigen Lösungen werden in den nachfolgenden Iterationen stets wieder erfolgreich erweitert, sodass neue Designs gefunden werden, die die Servicezielsetzung erfüllen. Das SO-Verfahren zeigt sich somit effektiv in der Suche nach alternativen, zulässigen Netzwerkdesigns, was die Grundlage für das Finden von Lösungen mit geringen Kosten darstellt. Der gesamte Lösungsprozess erfordert für die verwendete Instanz ca. 4 Minuten Rechenzeit auf einem 2.8 GhZ P-IV Rechner, sodass hier Potential für die Untersuchung größerer Netzwerke gegeben ist.

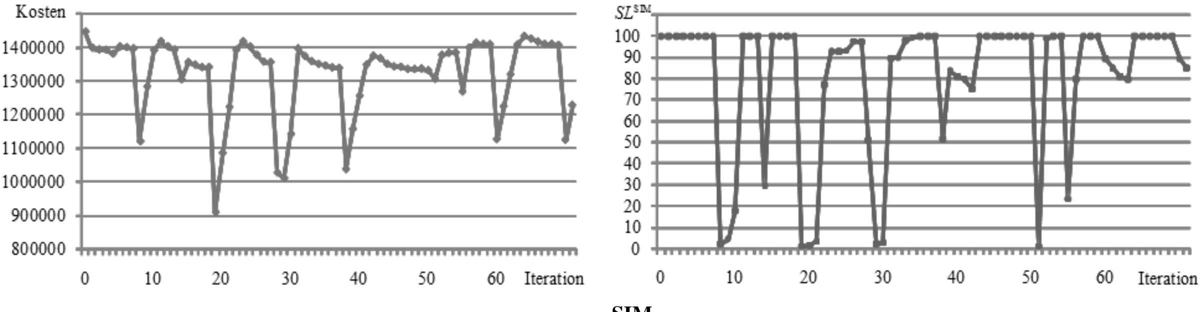

Abb. 2: Kosten (links) und Lieferzeittreue SL^{SIM} (rechts) im Verlauf des Lösungsprozesses.

5. ZUSAMMENFASSUNG UND AUSBLICK

Der vorliegende Beitrag beschreibt einen simulationsbasierten Optimierungsansatz für das Design von Produktions- und Distributionsnetzwerken. Erste Tests für eine Beispielinstanz zeigen, dass das vorgestellte Verfahren in der Lage ist, zulässige Netzwerkkonfigurationen hinsichtlich des vorgegebenen Serviceziels zu bestimmen. Weiterer Forschungsbedarf liegt in umfassenderen Tests hinsichtlich verschieden strukturierter Probleminstanzen, in der Evaluierung der Rekonfigurationsregeln hinsichtlich ihres individuellen Beitrags zur erzielbaren Lösungsqualität, sowie in Erweiterungen des Simulationsmodells um zusätzliche Problemaspekte, wie z. B. alternativer Ganz- order Teilladungsverkehre.

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EIN PLANSPIEL ZUR EVALUIERUNG DER AUSWIRKUNGEN VON INFORMATIONSASYMMETRIEN INNERHALB VON SUPPLY CHAINS

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The paper presents a case study, in which a simplified supply chain is simulated to illustrate the effects of asymmetric information between the involved enterprises. The supply chain consists of overall five enterprises (on three stages of production and a virtual market place) which produce parts, assemblies and finally whole cars. The case study takes up the basic concept of the well-known Beer Distribution Games and extends it by an enterprise-internal component. Thereby the case study handles the flow of material and information along the whole supply chain. It is designed as a dynamic model, in which all enterprises would drive through an internal cyclic planning process regarding the storage of finished products or material, the production program and the purchasing. Since the processes of the material and information flow are modeled close to reality, the presented case study is suitable particularly well in the academic training.

1. EINFÜHRUNG

Zur Verdeutlichung von Zusammenhängen und Wirkmechanismen innerhalb von Supply Chains (SC) werden in der Literatur eine Reihe von Planspielen vorgestellt. KOGAN und TAPIERO publizierten beispielsweise eine Reihe von mathematischen Planspielen zu verschiedenen detaillierten Problemstellungen im Kontext von Supply Chains [1]. Ein sehr komplexes Planspiel zur Veranschaulichung verschiedener Effekte, Zusammenhänge und Einflussmöglichkeiten stellt das vom Fraunhofer Institut entwickelte *SILKE-Planspiel* zur Steuerung integrierter Logistikketten dar [2]. Das wohl bekannteste Planspiel ist allerdings das sogenannte *Beer Distribution Game* [3], das sich im Wesentlichen auf den Materialfluss zwischen den SC-Teilnehmern und die Darstellung des Bullwhip-Effekts [4; 5] konzentriert. Das hier vorgestellte Planspiel greift, ähnlich dem SILKE-Planspiel, das Grundkonzept des Beer Distribution Games auf und erweitert es um die unternehmensinterne Komponente. Es werden sowohl Planungsprozesse als auch der Material- und Informationsfluss innerhalb des Unternehmens in das Planspiel integriert. Damit eröffnet sich die Möglichkeit, die teilweise verheerenden Auswirkungen lokaler Optimierungsprozesse auf die gesamte Supply Chain nachvollziehbar aufzuzeigen. Darüber

hinaus können die Auswirkungen des Supply Chain Managements (SCM) auf unternehmensinterne Prozesse sowie deren Stellgrößen veranschaulicht werden.
Das im Folgenden beschriebene Planspiel eignet sich damit besonders für den Einsatz in der Ausbildung, da die Prozesse des Material- und Informationsflusses realitätsnah abgebildet werden.

2. AUFBAU DES PLANSPIELS

Das Planspiel orientiert sich an der Automobilbranche und bildet den Material- und Informationsfluss einer mehrstufigen Herstellung von Fahrzeugen ab. Die Lieferkette setzt sich insgesamt aus fünf Unternehmen auf drei Fertigungsstufen sowie einem Markt zusammen. Letzterer ist für sämtliche Unternehmen der Lieferant aller Einzelteile und bezieht gleichzeitig als Kunde Ersatzteile. In Abbildung 1 werden die Unternehmen, deren Herstellungsstufen und der Materialfluss schematisch dargestellt.

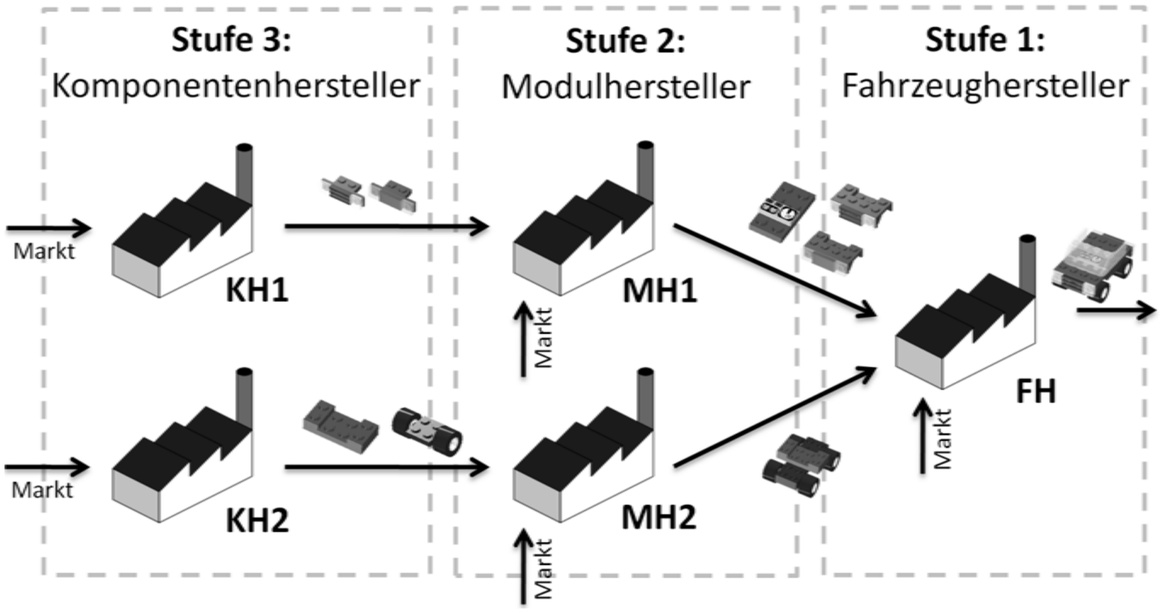

Abb. 1: Aufbau der Supply Chain im Planspiel

Die Unternehmen der Supply Chain bestehen jeweils aus den vier Funktionsbereichen Disposition, Fertigung, Distribution und Controlling sowie einem Fertigerzeugnis- und einem Materiallager.
Die Abteilung Distribution umfasst die Planung der Primärbedarfe und ist gleichzeitig für die Auslieferung der Kundenbedarfe zuständig. Ebenso trifft sie Rahmenvorgaben für die Fertigung, indem sie das Wunschproduktionsprogramm festlegt. Der Bereich Fertigung ist für die Umsetzung des Produktionsprogramms und die

Bereitstellung der Fertigerzeugnisse zuständig. Die Abteilung Disposition ist für die Beschaffung des Materials verantwortlich. Das Fertigteillager wird gemeinsam von den Abteilungen Distribution und Fertigung, das Materiallager gemeinsam von den Abteilungen Fertigung und Disposition geführt. Das Controlling übernimmt neben der gesamten Kostenrechnung des Unternehmens gleichzeitig eine Überwachungs- und Kontrollfunktion gegenüber den anderen Abteilungen, indem sie den Informations- und Materialfluss validiert. Abbildung 2 veranschaulicht die interne Aufbauorganisation der Unternehmen.
Der Materialfluss des Planspiels beinhaltet die Lagerung, die Herstellung und Lieferung von Gütern in und zwischen den Unternehmen der Lieferkette. Hierbei werden auf den drei Stufen der Lieferkette zunächst Komponenten, anschließend Module und final Fahrzeuge gefertigt (siehe Abbildung 1).

Material- und Informationsfluss
Zur besseren Veranschaulichung des Materialflusses wurde dieser auf ein Beispiel zur sukzessiven Fertigung von Fahrzeugen aus *LEGO*®-Bausteinen[1] abgestimmt. Der gesamte Materialfluss kann somit exemplarisch vollständig nachvollzogen werden, wenngleich für die Evaluierung des Planspiels kein gegenständlicher Materialfluss notwendig ist.
Die Abbildung des Informationsflusses sowie die unternehmensinterne Planung aller Funktionsbereiche erfolgt innerhalb eines ERP-Systems, das über funktionsspezifische Formulare bzw. Dokumente einer Tabellenkalkulation abgebildet wird. Die einzelnen Dokumente gliedern sich außerdem entsprechend ihrer Zuordnung zur strategischen oder operativen Planung im Unternehmen. Somit werden alle Stamm- und Bewegungsdaten im System erfasst.

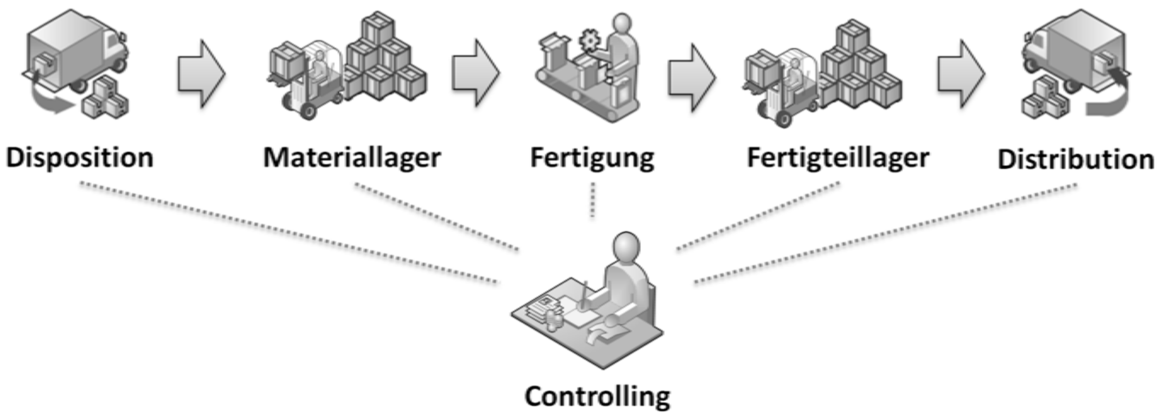

Abb. 2: Unternehmensinterne Aufbauorganisation

[1] LEGO® ist eine Marke der LEGO-Gruppe.

Konfiguration der Stammdaten
Zur Beschränkung der Komplexität auf ein notwendiges Maß sind die Preise für Materialien und Produkte der Unternehmen ebenso wie die variablen Fertigungskosten durch das Planspiel fix vorgegeben.
Die Kosten für die Lagerung werden als fixer Zinssatz bezogen auf den Einkaufspreis pro Stück von Materialien bzw. den Verkaufsstückpreis von Fertigprodukten veranschlagt. Außerdem entstehen Kosten für auftretende Fehlmengen je Teil und Monat Lieferverzögerung, die ebenfalls als Zinssatz bezogen auf den Stückpreis berechnet werden. Sie liegen allerdings wertmäßig über den Lagerkosten im Fertigteillager und sorgen somit für einen Abbau von Lieferrückständen. Die Berechnung der fixen Verkaufspreise ergibt sich aus den Material- und Fertigungskosten zuzüglich einer prozentualen Marge, aus der alle weiteren Kosten bedient werden und mögliche Gewinne entstehen.

3. ABLAUFORGANISATION

Der Ablauf der Planungs- und Steuerungsaufgaben sowie aller physischen Tätigkeiten innerhalb des Planspiels folgt einzelnen Geschäftsjahren, die wiederum in 12 Monatsperioden (t) als kleinste unterscheidbare Zeiteinheit untergliedert werden. Dem zugrundeliegend werden zwei Arten von Planungszyklen unterschieden. Der strategische Zyklus fasst sämtliche Aufgaben zusammen, die zu jedem Wechsel eines Geschäftsjahres stattfinden, währenddessen der operative Zyklus die Aufgaben und Tätigkeiten beinhaltet, die innerhalb der einzelnen Monatsperioden zu realisieren sind.

Strategischer Zyklus
Der strategische Zyklus umfasst ein Geschäftsjahr. Die dabei notwendigen Aufgaben müssen jeweils zum Jahreswechsel zwischen den Monaten Dezember und Januar durchgeführt werden. Demzufolge beinhaltet dieser Planungszyklus sowohl den Abschluss des vergangenen als auch den Beginn des neuen Geschäftsjahres. Am Ende jedes Geschäftsjahres wird das Jahresergebnis der Unternehmung ermittelt und die operativen Kennzahlen (z.B. Lagerendbestand, ausstehende Liefermengen) in das neue Geschäftsjahr übertragen.
Zum Geschäftsjahresbeginn muss zunächst eine Zeitreihenanalyse mit darauf aufbauender Bedarfsprognose für alle Fertigerzeugnisse des Unternehmens durchgeführt werden. Die Zeitreihenanalyse gründet auf Vergangenheitsdaten, die entweder (im ersten Jahr) bereitgestellt wurden oder aus den Werten des vergangenen Jahres zunächst ermittelt werden müssen. Die ermittelten Werte werden dann in der Distribution als prognostizierte Primärbedarfe für das kommende Geschäftsjahr übernommen. Diese Bruttobedarfe werden anschließend unter Einbeziehung der

Sicherheitsbestände (ebenfalls innerhalb des strategischen Zyklus zu bestimmen) mittels einer Brutto-Nettobedarfsrechnung in Nettobedarfe überführt. Darauf aufbauend muss anschließend das Produktionsprogramm bestimmt werden.
In der Disposition werden anhand der Bedarfsprognosen der Endprodukte die voraussichtlichen Jahressekundärbedarfe für alle Materialien ermittelt und anschließend einer ABC-Analyse unterzogen. Deren Ergebnisse legen die Dispositionsstrategien der Materialien fest. Hier wird zwischen der exakten Disposition von A-Teilen und der Disposition nach einem Bestellrhythmussystem für C-Teile unterschieden. Anschließend werden dazu notwendige Konfigurationsparameter ermittelt, sodass der operative Zyklus beginnen kann.

Operativer Zyklus
Der operative Zyklus dient der Realisierung und Erfassung aller Material- und Informationsflüsse innerhalb des Zeitraums von einem Monat. Für diesen Zweck werden in einem ERP-System spezifische Funktionalitäten bereitgestellt, die die jeweiligen Aufgaben informationstechnisch abbilden und damit unterstützen.
Die operative Planung erfolgt in allen Unternehmen der Supply Chain in insgesamt sechs Schritten mit einer festgelegten Reihenfolge. In Abbildung 3 wird der operative Zyklus grafisch im Kontext der Aufbauorganisation des Unternehmens dargestellt.

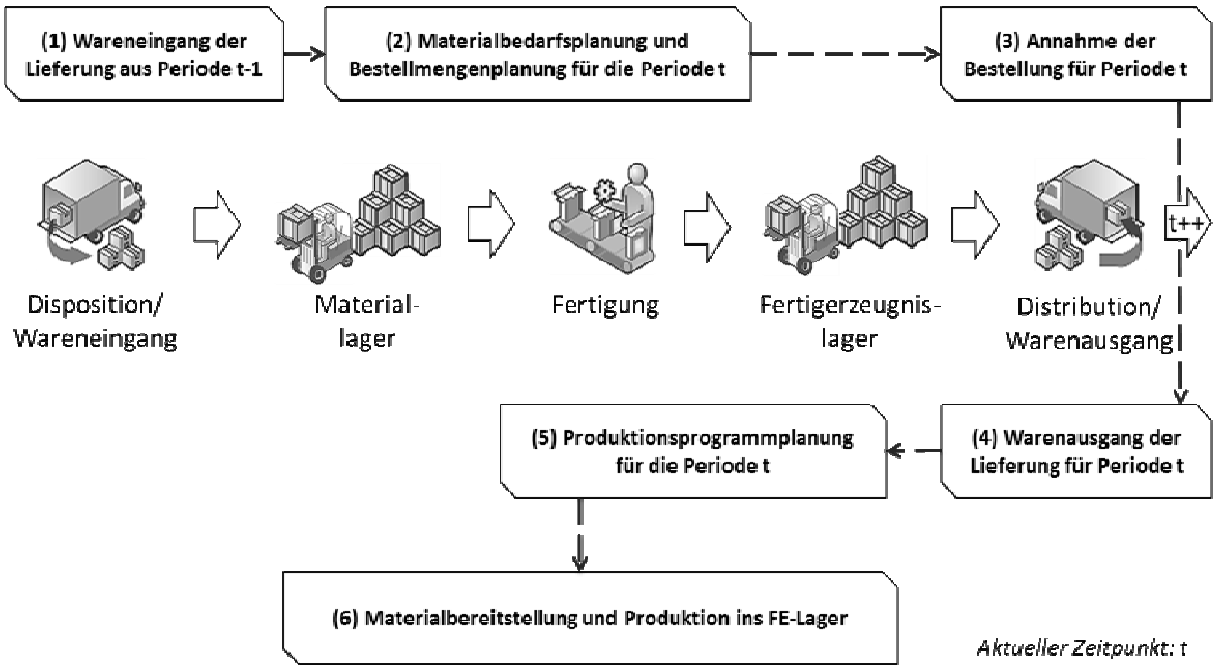

Abb. 3: Operativer Planungszyklus der Periode t

Der operative Zyklus der aktuellen Periode (t) beginnt im ersten Schritt mit dem Wareneingang des aus der vergangenen Periode (t-1) bestellten Materials und der zugehörigen Buchung im ERP-System. Anschließend werden die für die nächste Periode benötigten Netto-Sekundärbedarfe determiniert (Schritt 2), die zugehörige Bestellung ausgelöst und an den jeweiligen Lieferanten im Planspiel übermittelt (Schritt 3). Da die Materialbestellungen und die jeweilige Produktionsprogrammplanung der Unternehmen für die aktuelle Periode (t) vor dem Eintreffen der Kundenbestellungen erfolgen, ergibt sich eine Informationsasymmetrie, die zum Auftreten des Bullwhip-Effektes [4; 5] führen kann. Aufgrund dieser Entkopplung zwischen Kunde und Lieferant liegen in der ersten Phase des Planspiels lediglich prognostizierte Daten für die Kundenbestellungen vor, welche von den tatsächlichen Bestellungen teilweise stark abweichen können. Die Abweichungen lassen sich unter der Prämisse niedriger Kosten lediglich durch den Aufbau von Beständen ausgleichen.

Nach dem Eintreffen der Kundenbestellung werden die bestellten Produktmengen, soweit diese im Fertigerzeugnis-Lager (FE-Lager) vorhanden sind, kommissioniert und ausgeliefert. Sie treffen im ersten Schritt des operativen Zyklus der nächsten Periode (t+1) beim entsprechenden Kunden ein. In der aktuellen Periode werden anschließend an die Auslieferung in Schritt 5 die zu fertigenden Produktmengen ermittelt. In Schritt 6 werden die dazu benötigten Materialien bereitgestellt, die Produkte gefertigt und letztlich im FE-Lager eingelagert.

4. INFORMATIONSASYMMETRIE INNERHALB DES PLANSPIELS

Die bereits angesprochene Informationsasymmetrie (siehe Abschnitt 3) zwischen den Unternehmen basiert auf dem *Verweigerungsprinzip* [6]. Hierbei wird die Ansicht vertreten, dass sämtliche Informationen über Kundenbedarfe und Produktionsmengen wettbewerbsrelevante Daten darstellen und gegenüber allen Teilnehmern der Supply Chain soweit möglich geheim gehalten werden müssen.

Die Interaktion zwischen Lieferanten und Kunden der Supply Chain erfolgt ausschließlich über die Auslösung aktueller Bestellungen und deren Auslieferung. Da den Unternehmen keinerlei Informationen über künftige Bedarfe zur Verfügung stehen, sind sie auf die Prognose dieser Bedarfe auf der Basis von Vergangenheitsdaten angewiesen, um eine Planung von Beständen und Produktion durchführen zu können.

Die hier vorliegende Informationsasymmetrie entspricht im Kontext der *Principal-Agent-Theorie* einer sogenannten *hidden action*, da dem jeweiligen Lieferanten (Principal) ausschließlich die Ergebnisse der jeweiligen Handlungen des Kunden (Agenten), nicht jedoch darüber hinausgehende Informationen bekannt sind [7].

5. EVALUIERUNG

Zur Evaluierung des Planspiels werden die Bestellmengen sowie die aufgetretenen Bestände und Fehlmengen der einzelnen Unternehmen bzw. Stufen der SC gegenübergestellt und einer Analyse zugeführt.

Aufgrund der lokalen Optimierung der Bestellmengen durch beispielsweise Anwendung von Bestellpolitiken kommt es, ausgehend vom fokalen Unternehmen (Fahrzeughersteller) hin zu den Lieferanten (Komponentenhersteller), zu einer Verstärkung der Bedarfsschwankung. Der so entstehende Bullwhip-Effekt wurde für ein repräsentatives Material entlang der Wertschöpfung über alle Stufen nachvollzogen und ergab sich auch für alle weiteren Materialien erwartungsgemäß.

Abbildung 4 zeigt die Bestellmengen auf allen Stufen über einen Zeitraum von drei Jahren. Es ist zu erkennen, dass bereits die Bestellmengenoptimierung seitens des Fahrzeugherstellers zu einer starken Verzerrung der Bedarfszeitreihe des Modulherstellers führt, die sich dann über weitere Stufen sukzessive verstärkt.

Aufgrund der starken Bedarfsschwankungen und der damit einhergehenden mäßigen Prognostizierbarkeit der Bedarfe kommt es auf den vorgelagerten Stufen zu teilweise erheblichen Differenzen zwischen tatsächlichen Kundenbestellungen und den zugehörigen prognostizierten Bedarfswerten. In der Folge führt dies entweder zum Aufbau von Beständen oder zu einer Nichtlieferfähigkeit, d.h. zu Fehlmengen. Während die Auswirkungen von Fehlmengen sich unmittelbar im operativen Ablauf über die Unternehmensgrenzen hinwegsetzen, spiegeln sich hohe Bestände vielmehr nur in den Kosten der einzelnen Unternehmen wider und haben damit nur einen mittelbaren, aber konstitutiven Einfluss auf die Supply Chain.

Ohne den Einsatz geeigneter Maßnahmen des Supply Chain Managements und bei der Aufrechterhaltung des angesprochenen Verweigerungsprinzips ist der Aufbau überhöhter Bestände für den Erhalt eines reibungslosen operativen Ablaufs ohne das Entstehen von Fehlmengen unumgänglich.

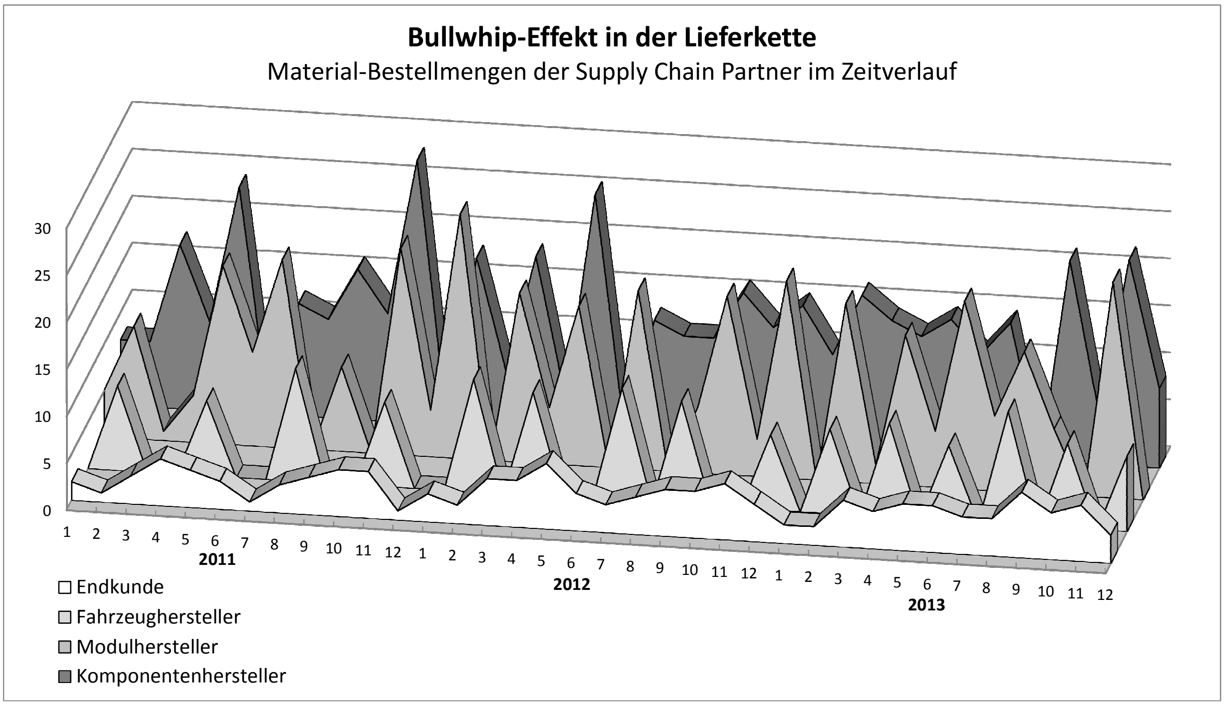

Abb. 4: Darstellung des Bullwhip-Effekts

Im hier vorgestellten Planspiel wurden die aufgetretenen Mittelwerte für die Bestände in den Material- und Fertigerzeugnislägern sowie für die Fehlmengen bei den Kundenauslieferungen aufgezeichnet. In Abbildung 5 wird das Ergebnis getrennt nach den beiden separaten Lieferketten *KH1-MH1-FH* (1) und *KH2-MH2-FH* (2) dargestellt. In der Grafik ist zunächst festzustellen, dass die mittleren Bestandsmengen ausgehend vom fokalen Unternehmen zum Lieferanten steigen. Dieser Umstand kann auf mehrere Gründe zurückgeführt werden. Neben der bereits angesprochenen Strategie zur Vermeidung von Fehlmengen spielt auch die Optimierung der Beschaffungslosgrößen unter Einfluss der Kapitalbindungskosten eine Rolle. Geringe Materialpreise führen zu vergleichsweise geringen Kapitalbindungskosten, die in einer Vergrößerung der Beschaffungslose resultieren.

Des Weiteren lässt sich anhand der Auswertungen feststellen, dass die Spannweite zwischen mittleren Bestand und Fehlmenge im Fertigerzeugnislager auf den vorgelagerten Stufen zunimmt. Dies ist wiederum auf das Auftreten des Bullwhip-Effekts zurückzuführen.

Im Ergebnis der Auswertungen lassen sich verschiedene Nachteile der Ausgangssituation erkennen, welche sich lediglich durch geeignete Maßnahmen aus dem Bereich des Supply Chain Managements beseitigen lassen. So stellt sich beispielsweise die Frage nach der Notwendigkeit der redundanten Lagerhaltung, da es neben einem Fertigerzeugnislager beim Lieferanten ebenso ein Materiallager beim dazugehörigen Kunden gibt, in dem die gleichen Erzeugnisse vorgehalten werden.

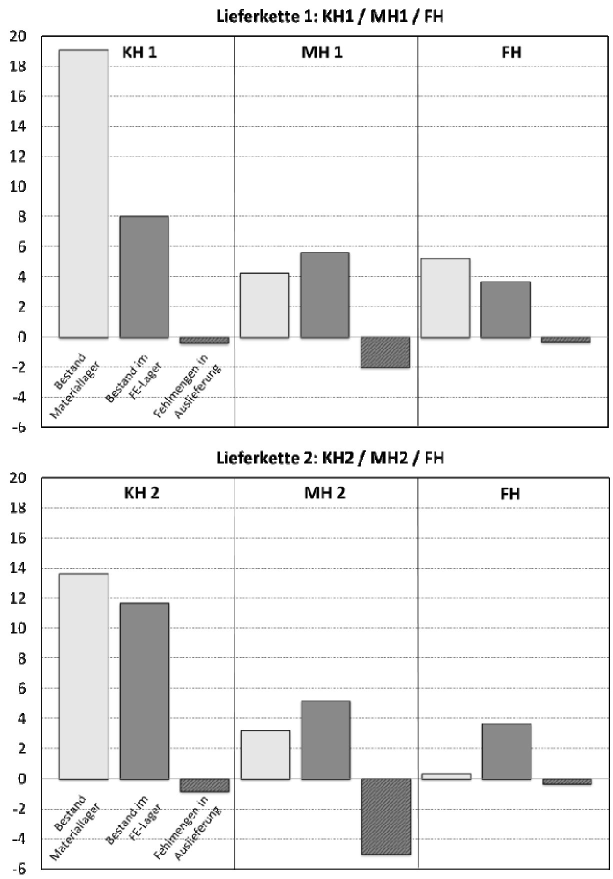

Abb. 5: Mittlere Bestände und Fehlmengen in den Unternehmen

Der entstehende Bullwhip-Effekt stellt die Unternehmen vor die Entscheidung, das angewendete Verweigerungsprinzip beizubehalten und die entsprechend aufgezeigten Konsequenzen in Form auftretender Bestände und Fehlmengen in Kauf zu nehmen, oder eine Informationsweitergabe, wie sie beispielsweise beim alternativen *Dyadischen Prinzip* [6] stattfindet, zuzulassen und dadurch die Planungssicherheit der Lieferanten zu verbessern. Letzteres würde die im Planspiel aufgetretenen Bestände und Fehlmengen, die sich letztendlich auf alle Unternehmen der Lieferkette auswirken, reduzieren und damit die Unternehmensergebnisse insgesamt verbessern.

6. ZUSAMMENFASSUNG

Das in diesem Beitrag vorgestellte Planspiel hat den Grundgedanken des bereits eingangs genannten Beer Distribution Games [3] aufgegriffen und konzeptionell um eine unternehmensinterne Komponente erweitert. Anhand der Evaluation konnte nicht nur der Bullwhip-Effekt, sondern auch dessen Ursachen aufgezeigt werden.

Aufgrund des Verweigerungsprinzips und der damit einhergehenden Informationsasymmetrie beschränkt sich der Handlungsspielraum der Unternehmen auf eine lokale Optimierung, die dann in einer Instabilität des Materialflusses innerhalb der Supply Chain resultiert. Im Kontext der Evaluation konnte der entstehende Bullwhip-Effekt sowie die damit verbundenen Probleme hinsichtlich der Lagerbestände und Nicht-Lieferfähigkeit dargelegt werden.
Das Planspiel bietet durch die Abbildung von Material- und Informationsfluss eine sehr gute Möglichkeit, die oben genannten Zusammenhänge zu demonstrieren. Es wird erfolgreich in der akademischen Ausbildung an der Technischen Universität Chemnitz als Fallstudien-Kurs eingesetzt, um Studenten für die Prozesse innerhalb von Supply Chains zu sensibilisieren.

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ДИВЕРСИФИКАЦИЯ ЭКСПОРТА ИНФРАСТРУКТУРНЫХ ЛОГИСТИЧЕСКИХ УСЛУГ МОРСКИХ ПОРТОВ НА ПРИМЕРЕ ПОСТАВОК СЖИЖЕННЫХ УГЛЕВОДОРОДНЫХ ГАЗОВ

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Аннотация: В соответствии с морской доктриной и федеральной программой в центре внимания остаются следующие проблемы: развитие результата морского порта, специализация комплекса терминала морского порта, введение новых технологий, развития инфраструктуры и сервисного усовершенствования транспортной логистики. Развитие инфраструктуры морского порта и новое технологическое применение требуют инвестиционного формирования, которое возможно в случае создания условий, которые благоприятны для инвесторов и создания необходимой нормативной базы.

DIVERSIFICATION OF INFRASTRUCTURE LOGISTICS SERVICES EXPORT OF SEAPORTS ON EXAMPLE OF LIQUEFIED HYDROCARBON GASES

Mirotin Leonid, Georgi Keridi

Purpose of the paper
Methodology generation of logistics infrastructure of transportation object on example of seaport for transfer of liquefied hydrocarbon gas. In compliance with sea doctrine and federal goal-oriented program in center of attention the next problems remain: development of seaport output, specialization of seaport terminal complex, introduction of new technologies, infrastructure development and transport-logistics services improvement. Solution of problems connected with interaction of all types of transport in seaport terminals is also important. Seaport infrastructure development and new technologies application require investment formation, which is possible in case of creation of conditions that are favorable for investors and creation of required normative base. Creation of preconditions for private investment formation in infrastructure development requires application of new models of interaction of all participants of foreign-economic activity, model of government-private partnership application, creation of special economic zones with preferential terms of taxation.
Research/application methodology
1) Analysis of similar transportation systems;

2) Process model of cargo transfer;
3) Development of real project of seaport for liquefied hydrocarbon gas transfer.

Creation of conditions for Russian and foreign investments formation for building and reconstruction of seaport infrastructure, development stimulation of seaport economy, and finally, seaport services development, that are competitive with foreign counterparts will let Russian seaport compete with seaports of neighbor countries.
This aim can be achieved through the solution of two major tasks:
1) Formation of investments in seaport through the creation of favorable conditions for investors (lowering losses).
2) Formation of considerable freight flow in seaport through the creation of favorable conditions (lowering losses) for carriers and cargo owners.

Design of the paper
Review of literature sources connected with modeling of logistics processes. Description of a concrete project.
Main results
The unique project of seaport on Sea of Azov has been created. The main direction of competitiveness growth of transport network must be the complex improvement of export transport infrastructure, which will allow to provide the export of strategic goods, uppermost, energy resources. It means about existing transport infrastructure that comes in international transport passages system, new sea terminals building. Shifting of export flows on Russian seaports will lower the risks connected with communication usage that Russia controls shortly.
Problems solution of building liquefied hydrocarbon gas (LHG) terminals and gas transport ships, in its turn, defines not only the development of oil & gas and transport sectors in a whole, but also strategically defines:
1) Lowering to the minimum pollution of environment (CO_2 emission during firing of passing oil gases on flares);
2) Perspective of processing of passing oil LHG gases;
3) Rational application of nonrenewable energy resources of country;
4) Development of internal LHG market and extension of external economic share of Russia on international market;
5) Lowering the export relation of Russian Federation from geopolitics problems (for example, Russia-Ukraine-Europe);
6) Ability of extension of export volumes, through the price lowering on cargo delivery to Russian seaport, and also lowering the price of processing (the price in Ukrainian seaports is considerably higher);
7) Ability to sell LHG produced in Russia on more interest conditions of freight (for example, using CIF).

Academic contribution
For the first time the methodology of joint between pipeline transport, automobile transport and ocean transport has been realized on logistics basis.
Managerial insights
Practical realization of developed project. Developed seaport economic, being an important infrastructure link in interregional and transnational economic connections of country (region), gives the last one additional advantages in competitive activity. In this respect existence of convenient and advanced technology seaports increases competitiveness of territory, reinforces its export-import abilities, assumes a higher level of integration in global economics system. Undeveloped seaport infrastructure slows the development of Russian economics. Annual losses of exporters because of seaport infrastructure imperfection in Russian Federation, by expert rates, foot up not less than $30m. per year.

1. ВВЕДЕНИЕ

Транспортная система Российской Федерации в условиях формирования новой модели развития мировой экономики, является важным инструментом реализации национальных интересов. Геополитическое положение России, использование ее транзитного потенциала может и должно быть приоритетом развития транспортной системы, а следовательно и роста экономики.

Развитию транспортной системы России, портовой инфраструктуры, совершенствованию транспортно-логистических услуг уделено серьезное внимание в «Морской доктрине Российской Федерации на период до 2020 года», утвержденной Президентом Российской Федерации в июле 2001 года. Морская доктрина является основополагающим документом, определяющим национальную политику страны в области морского транспорта. Практические задачи развития морского транспорта решаются в рамках подпрограммы «Морской транспорт» федеральной целевой программы «Модернизация транспортной системы России (2002-2010 годы)».

В соответствии с морской доктриной, федеральной целевой программой в центре внимания остаются проблемы развития портовых мощностей, специализация портовых терминальных комплексов и внедрение новых технологий, и развитие инфраструктуры, совершенствование транспортно-логистических услуг.

Развитие внешнеэкономических связей России, ее интеграция в мировую экономическую систему приводит к росту объема морских внешнеторговых перевозок, для реализации которых требуется дальнейшее наращивание производственной мощности российских морских портов.

Существенное увеличение объёмов внешней торговли привело в настоящее время к возникновению дефицита специализированных производственных мощностей морских портов и к нехватке пропускных возможностей железнодорожных и автомобильных подъездов к ним. Переориентация экономики с импорта на экспорт и выход Российской Федерации на новые международные рынки предполагают развитие инфраструктуры всех видов транспорта, обеспечивающих внешнеторговую деятельность.

2. СОСТОЯНИЕ ИССЛЕДУЕМОЙ ПРОБЛЕМЫ

Развитое портовое хозяйство, являясь важным инфраструктурным звеном в межрегиональных и межгосударственных хозяйственных связях страны (региона), дает последней дополнительные преимущества в конкурентной борьбе. В этом плане наличие удобных и высокотехнологичных портов повышает конкурентоспособность территории, усиливает ее экспортно-импортные возможности, предполагает более высокий уровень интеграции в глобальную экономическую систему. Неразвитая портовая инфраструктура тормозит развитие российской экономики. Ежегодные потери экспортеров от несовершенства портовой инфраструктуры Российской федерации, по экспертным оценкам, составляют не менее 30 млн. долларов США в год. Создание условий привлечения отечественных и иностранных инвестиций для строительства и реконструкции портовой инфраструктуры, стимулирование развития портового хозяйства, и, в конечном счете, развитие портовых услуг, конкурентоспособных с зарубежными аналогами позволит российским портам конкурировать с портами соседних стран. Данная цель может быть достигнута путем решения двух главных задач:

1) Привлечение в порт инвестиций через создание в нем благоприятных условий для инвесторов (снижение издержек).
2) Привлечение в порт значительного грузопотока, через создание в нем благоприятных условий (снижение издержек) для грузоперевозчиков и владельцев грузов.

Главным направлением повышения конкурентоспособности транспортной сети должна являться комплексная модернизация экспортной транспортной инфраструктуры, которая позволит обеспечить экспорт стратегических товаров, прежде всего энергоносителей. Речь идет о существующей транспортной инфраструктуре, входящей в систему международных транспортных коридоров, строительстве новых морских терминалов. Переключение экспортных потоков на российские порты снизит риски, связанные с использованием коммуникаций, которые Россия контролирует не полностью.

Наличие мирового флота для транспортировки сжиженного газа для транспортировки позволяет странам независимо от наличия природных ресурсов пользоваться преимуществами газообразного топлива, используя каналы международной торговли, которые открывают доступ к самым отдаленным источникам. Одним из перспективных направлений развития энергетической отрасли в соответствии с «Энергетической стратегией России» является производство и транспортировка сжиженного углеводородного газа. В России остро стоит проблема экспорта сжиженных газов из-за отсутствия, в первую очередь, портовых мощностей, что сдерживает развитие экспорта СУГ. Второй является проблема, связанная с первой, большой дефицит транспортных средств для организации морской транспортировки. Россия, три четверти границ которой являются морскими, осуществляющая значительную часть экспортно-импортного грузооборота морскими судами и активно развивающая добычу нефти и газа, так же, как и другие страны, должна обеспечивать поддержку своего национального судостроения. Созданные, осознанно или нет, неравные с зарубежными судостроителями экономические условия работы российских судостроителей вынудили отечественных судовладельцев-заказчиков судов уйти с российских верфей к зарубежным судостроителям. Объем гражданского судостроения сократился более чем в 5 раз. Уровень использования мощностей на судостроительных предприятиях снизился до 20-25%. Особенно остро ощущается недостаток портовых мощностей в сфере экспорта сжиженных газов. В настоящее время в южных портах России в Новороссийске и Туапсе нефтяные терминалы работают с предельной загрузкой, оставляя значительную долю экспорта для стран ближнего зарубежья и стран Балтии, вкладывая в эти страны огромные деньги за транспортировку газа и нефти. Решение проблем постройки терминалов СУГ и судов-газовозов, в свою очередь, определяет не только развитие нефтегазовой и транспортной отрасли в целом, а также стратегически определяет:

- снижение до минимума загрязнение окружающей среды (выбросы СОг при сжигании попутных нефтяных газов на факелах);
- перспективу переработки попутных нефтяных газов СУГ;
- рациональное использование не возобновляемых энергетических ресурсов страны;
- развитие внутреннего рынка СУГ, а также увеличение доли внешнеэкономического присутствия России на мировом рынке;
- уменьшение зависимости экспорта Российской Федерации от геополитических проблем (например, РФ-Украина-Европа);
- возможность наращивания экспортных объемов, за счет снижения цены доставки груза до порта РФ, а также стоимости обработки (цена в украинских портах гораздо выше);
- возможность продажи СУГ российского производства на более выгодном условии поставки (например, на CIF).

Ограниченные портовые мощности и возможности по перевалке на экспорт сжиженного газа повышают актуальность строительства новых речных и морских терминалов, что будет способствовать увеличению экспортного потенциала России, создаст более привлекательные условия для ряда российских трейдеров, обеспечивая сокращение транспортных издержек в 1,5-2 раза. Ближайшие годы актуальность проблемы может повыситься в связи с необходимостью перевалки дополнительных объемов экспорта сжиженных газов с новых месторождении и использования нефтяных попутных газов.

3. МЕТОДОЛОГИЯ ИССЛЕДОВАНИЯ И НОВЫЕ НАУЧНО-ПРАКТИЧЕСКИЕ РЕЗУЛЬТАТЫ

Строительство специализированного портового терминального комплекса должно быть ориентировано не только на решение экологических и экономических проблем, но и способствовать привлечению финансовых ресурсов в социальную сферу и развитие инфраструктуры региона. Наряду с этой основной целью деятельности портов существуют еще и другие цели: содействие лучшему использованию земли, стимулирование развития конкретных районов или определенных видов перевозки грузов, обеспечение занятости и получение иностранной валюты. Следует отметить, что строительство терминала СУГ также решает и вопросы безработица: например, проект экспортного терминала компании ЗАО «Азовтранзит» - помимо численности обслуживающего персонала комплекса, увеличится численность работающих в локомотивном депо, пожарной части, морской составляющей в строительных и дорожных организациях при сооружении объекта, а это порядка 300 человек.

Создание портовых мощностей по перевалке СУГ и развитие сопутствующих экспорту услуг увеличит и ускорит процесс увеличения доли присутствия Российской Федерации на мировом рынке СУГ, а также позволит перераспределить грузопотоки и денежные потоки в интересах России.

И самое важное, по нашему мнению, строительство специализированных терминальных комплексов будет способствовать привлечению транзитных грузов (например, азербайджанский и казахстанский СУГ), перевозка и перевалка которых принесет России солидный доход.

Несмотря на то, что задачи поддержки отечественного флота и портового хозяйства являются приоритетным для страны, кризис нехватки финансовых ресурсов и инвестиций в отрасль пока еще не преодолен.

Терминалы должны соответствовать самым последним достижениям и удовлетворять современным требованиям мирового рынка СУГ. Показатель качества предоставляемых услуг является важнейшим фактором обеспечения конкурентоспособности транспортной инфраструктуры и направлен на удовлетворение потребностей развивающейся экономики России в перевозках грузов. Строительство резервуаров хранения и площадок для хранения танк-контейнеров СУГ определяет организационные вопросы экспорта. В условиях дефицита портовых мощностей железнодорожный подвижной состав используется в режиме сверхнормативного использования подвижного состава, можно сказать транспортные средства используется в качестве «складов на колесах». В ожидании наивысшей конъюнктуры рынка должны использоваться резервуары хранения, а не транспортные средства и погрузочно-выгрузочные площадки, припортовые подъездные пути. В условиях дефицита портовых мощностей, организация взаимодействия железных дорог и морских портов является актуальным и важнейшим составным элементом транспортной стратегии России.

Важнейшим направлением оптимизации взаимодействия различных видов транспорта и повышения конкурентоспособности национальной транспортной системы является создание на территории России сети логистических центров, имеющих в своем составе грузовые терминалы с перегрузочной техникой, складские помещения с соответствующим техническим оснащением, информационно-аналитические, управляющие и расчетные системы, ориентированные на использование интегрированной базы данных и интегрированной системы электронного документооборота, а также другие обустройства.

Увеличение степени оборачиваемости подвижного состава, снижение непроизводственных простоев транспортных средств возможно при эффективной эксплуатации портовых терминалов организации успешного взаимодействия всех видов транспорта и транспортной инфраструктуры. Возможность хранить груз на территории терминала снижает затраты на транспортировку (например, при задержке судна в стоимость доставки вкладывается простой ж/д вагонов), бесплатное хранение СУГ на терминале в течение 10-15 дней (издержки включены в ставку перевалки) уменьшает срок аренды ж/д транспорта и как следствие стоимость ж/д транспортировки. Уменьшение времени хранения груза, стоянки транспортных средств в порту может быть достигнуто путем улучшения качества транспортно-логистического обслуживания, уменьшения времени на оформление портовых формальностей, пакета экспортных документов. Предоставление экспортеру СУГ возможности предварительного таможенного оформления вывозимого груза позволит отправлять загруженные суда сразу после подписания коносаментов, тем самым уменьшается время на таможенное оформление при подаче обычной ГТД.

Развитие портовых инфраструктурных и транспортно-экспедиционных услуг напрямую способствует привлечению грузопотока в порты, особенно транзитных. Основополагающим здесь является стоимость и качество услуг, предоставляемых грузоперевозчикам и грузовладельцам.

Как и владельцы терминала, так и структуры, участвующие в процессе транспортировки СУГ должны быть оснащены новым современным оборудованием; также компьютеризация, технологии, ускоряющие прохождение и оформление грузов и т.д. в порту существенно улучшат процесс обработки груза в порте. Наличия инфраструктуры должного уровня и предоставление удобств для перевозчиков и грузовладельцев на территории порта существенно увеличит грузооборот речных и морских портов, а также даст возможность конкурировать с иностранными портами.

Создание современной и эффективной транспортной инфраструктуры позволит обеспечить территориальную целостность государства, свяжет регионы России в единое экономическое и оборонное пространство. А также обеспечит выходы к труднодоступным сырьевым базам, снизит долю транспортных издержек в стоимости готовой продукции, что является определяющим показателем, предоставляющим возможность российским производителям выйти на международный рынок.

Отечественные морские торговые порты не должны уступать в конкурентной борьбе за грузопотоки зарубежным портам, обладающими и современной инфраструктурой и инновационными технологиями. Безусловно, помимо развития непосредственно портовой и припортовой инфраструктур, должна быть начата работа по обновлению судов обеспечивающего флота.

Удовлетворение потребностей роста экономики в перевалках грузов, обеспечение конкурентоспособности транспортной системы Российской Федерации, безусловное обеспечение роста товарооборота выдвигают на первый план решение таких задач, как совершенствование взаимодействия смежных видов транспорта при перевозках грузов в смешанном сообщении, комплексное развитие портовой инфраструктуры и железнодорожного транспорта. Инфраструктура морских торговых портов, необходимая для производства портовых услуг, занимает свою собственную нишу в сфере услуг, при этом оказывая непосредственное влияние на их количество, качество и ценовые характеристики.

В период пока ограничены (отсутствуют) возможности по перевалке СУГ через российские терминалы, предлагается уменьшить на краткосрочный и период, имеющихся недостатков традиционную транспортировку СУГ с применением 20- и 40-футовых контейнеров-цистерн. При транспортировке СУГ от производителя до конечного потребителя тип транспортных средств может меняться. При изменении вида транспорта (ж/д, водный, автомобильный) происходит стандартная в контейнерных перевозках перегрузка СУГ контейнера с платформы одного транспорта на платформу другого. При необходимости промежуточного хранения используются контейнерные терминалы, как существующие, так и построенные вновь. Это позволяет избежать потери времени на всем транспортном маршруте перелива СУГ из одной транспортной емкости в другую, стоимости транспортировки (простои вагонов) и соответственно затрат (перевалка контейнеров существенно дешевле перелива такого же количества СУГ). Немаловажно, применение новой транспортной схемы снижает себестоимость тонны газа в конце маршрута, делая его более конкурентоспособным.

4. ЗАКЛЮЧЕНИЕ

Российская Федерация, объективно заинтересованная в усилении своего присутствия в мировом рынке СУГ будет принимать все необходимые меры для усиления своих естественных конкурентных преимуществ, а именно: определит стратегические государственные приоритеты в переработке попутного нефтяного газа, и создаст условия, способствующие увеличения объемов их производства; будет способствовать диверсификации поставок энергоносителей на основные мировые рынки, в первую очередь используя морские коммуникации, обеспечивающие усиление положения отечественных производителей в условиях глобализации; о способствовать развитию перспективных портов по перевалке СУГ (в том числе с использованием международных портовых экономических зон) для обеспечения коридора Азия - Европа; о будет содействовать возрождению отечественного судостроения на инновационной основе с целью обеспечения перевозок углеводородного сырья (танкеры, газовозы); о будет способствовать повышению уровня и качества предоставляемых в порту услуг, увеличению грузооборота, путём применения современных технологий на специализированных терминальных комплексах. Развивая инфраструктуру, как транспортную, так и портовую, при внешнеэкономических операциях увеличивается экспорт услуг (транспортных), который может и должен быть столь же важной составляющей валового национального продукта, как и экспорт товаров.

Геополитическое и геоэкономическое положение страны самым непосредственным образом зависит от параметров функционирования и развития транспортной системы - схемы транспортных сетей, направлений и объемов основных грузопотоков, соотношения транзита и внутренних перевозок, структуры перевозимых грузов.

Данный доклад построен на авторской концепции методологии и развития портового хозяйства РФ, использованной в проекте «Развитие экспорта сжиженных углеводородных газов, оценке целесообразности и перспективы строительства Азовского портового терминального комплекса» по заказу ЗАО «Автотранзит». Концепция, построена на принципиально новой основе государственного и частного партнёрства, решает крупную задачу реструктуризации портов на базе логистических подходов формирования всей транспортной инфраструктуры.

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CONTAINER SHARING IN SEAPORT HINTERLAND TRANSPORTATION

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Abstract: In this contribution we optimize the transportation of containers in the hinterland of a local area with one terminal and one depot for empty containers and trucks. There are several customers who want to receive goods by inbound containers and several customers who want to ship goods by outbound containers. Additionally, there are empty inbound containers and empty outbound containers. We present two different models corresponding to different scenarios for the transportation processes performed by a homogeneous and limited set of available trucks. In the first scenario (distinct container problem) empty containers are exclusively used by their owners and therefore must be sent to their predefined destinations. In the second scenario (shared container problem) empty containers can be interchanged among several owners and therefore can be arbitrarily used. By comparing the model for the distinct container problem with the model representing the shared container problem the benefit of container sharing can be analyzed.

1. INTRODUCTION

We present a truck and container scheduling problem and we model this problem for a hinterland transportation scenario with full and empty containers which are transported in a local area. A trucking company with a set of homogeneous trucks and a pool of empty containers is considered. We assume that there is a depot in which empty containers can be stacked and where the trucks are stationed. Additionally, it is assumed that there is a sea port to which trucks transport full and empty containers from customers' places and vice versa. In general, it would be possible to model the above situation for several depots and several terminals in the local area. But in order to keep the problem formulation simple we only present models for the *Inland Container Transportation Problem* (ICT problem) with one depot and one terminal. For further simplification we restrict our considerations to 40-foot containers. The ICT problem has been presented in [1]. In contrast to [1] we consider in this paper two different versions of the ICT problem, one first version without allowing container sharing and a second version with the permission of container sharing. In the first version containers must be used for their predefined transportation task. In the second version containers can be arbitrarily interchanged in order to achieve improved solutions.

There are two types of containers, *inbound* and *outbound* containers. The containers located at the terminal that need to be moved to their destination (to the depots or their receivers) are called *inbound* containers. Reversely, the containers located at the depot or customers' places that need to be delivered to the terminal are called *outbound* containers. Moreover, each type of containers can be divided into full and empty containers. Thus, there are four types of containers demanding for transportation tasks that the company should carry out: inbound full, outbound full, inbound empty and outbound empty containers. First, an inbound full container has arrived from outside to the local area and is initially located at the terminal. It must be picked up by a truck at the terminal during a given terminal time window, must be delivered to its receiver (customer), and must be dropped off there. After being dropped off, the container is available at the customer location and is ready for being unpacked by the customer. When the inbound full container is completely handled at its destination, we obtain an empty container and a time window given for picking up the container at its current location. We have to move it to a depot or another alternative location by a truck. Secondly, an outbound full container is actually some freight that has to be transported in a container and is located at a customer's place. Thus, we should transport an empty container to the customer's location and deliver it during a given customer delivery time window which has been agreed on with the customer before. This empty container will be packed with freight by the customer. When the container is ready for shipment it can be picked up during a predefined customer pick up time window. It then has to be delivered to the specified terminal during a predefined terminal time window. Of course, the before mentioned customer pick up time window must be consistent with the terminal time window for this container. Thirdly, an inbound empty container is also initially located at a terminal and is available to be picked up during its specific terminal time window. We should pick it up at the terminal and transport it to a depot or another alternative location regarding the time window of the chosen location. Finally, an outbound empty container means that we should pick up an empty container at the depot and deliver it to the specified terminal during the specified terminal time window. The topic of this paper is the optimization of the container flows in the local area for a given time period as well as the resource planning and scheduling for a set of vehicles used for the needed container movements. To analyze the ICT we use an objective function which minimizes the total operating times of all trucks.

2. PROBLEM DESCRIPTION

For all full containers the origin (pickup location) and the destination (delivery location) is fixed by the problem data since these locations are defined by the required flows of goods carried in these containers. In the first scenario considered in this paper we assume that empty containers cannot be interchanged, maybe, since they have different owners and have to be used for their specific purpose or, maybe, since they have to reach their specific destination. This scenario is called *distinct container problem* during this paper. In the scenario of the distinct container problem the usage of empty containers being available at some location is determined in advance. That is why the origins and the destinations of all containers (empty containers as well as full containers) are fixed by the given data of a problem instance. In this case the optimization model related to the ICT problem comes up to a pickup-and-delivery problem with time windows (PDPTW) with each container movement representing a full truckload request for the PDPTW. The only difference to a usual PDPTW is that each customer has two time windows, one first time window for the delivery of a (full or empty) container in order to make the container available for the customer's loading or unloading operation and another second time window for picking up the container after the container has completely been handled by the customer.

But if it is allowed to interchange empty containers then we will have more flexibility. In this case, we can use any available empty container for any transportation. Throughout this paper this scenario will be called *shared container problem*. For the shared container problem, the decision which empty container will be assigned to the usage of which freight transportation task constitutes an optimization problem of its own. There are three types of empty containers which are available for the assignment to upcoming transportation tasks. The first type of available empty containers originates from the company's depot. The second type consists of all inbound empty containers located at the terminal. Finally, the third type of available empty containers is constituted by all containers that have been emptied at a customer location and that are currently disposable for a new task. Available empty containers can be used for three types of tasks. They can either be used as an outbound empty container (to be delivered to the terminal) or as a container which will be used to fulfill a customer's request for an empty container in the local area (i.e. the container will be packed with freight by this customer before it is transported to the terminal). Moreover, there is the opportunity for the trucking company to move the available empty containers to its depot. When empty containers can be interchanged, the origin of outbound empty containers and the destination of inbound empty containers are not defined by the problem data. The determination of these locations (i.e. a part of the input data of a PDPTW) is part of an optimization process itself. That is why the shared container problem cannot be modeled and solved as a usual PDPTW.

In this paper we discuss three approaches for modeling, describing and solving the ICT problem. The first approach refers to the distinct container problem, i.e. the model of the first approach describes the ICT problem without the possibility of container sharing. It turns out to be a PDPTW with a set of given container movements between customers, the terminal, and the depot. At the depot there are no time windows. For each container passing the terminal we have to respect its specific terminal time window. Each full container (inbound as well as outbound) has two time windows at its customer location (one for delivery and one for pickup).

The second and third approaches discussed in this paper refer to the shared container problem. The second approach is based on a sequential process for solving the two sub-problems of the ICT. The third approach pursues a simultaneous procedure for the solution of the ICT.

The second approach consists in the following two steps for solving the ICT. In the first step an optimal decision on the assignment of available empty containers to upcoming transportation tasks is aspired, i.e. in the first step it is tried to install minimum flows of empty containers in the local area in order to keep the total transportation demand of containers in the area as low as possible. The objective function used for the determination of the container flows is the minimization of the sum of the length of all distances that containers have to be transported. Of course, the determination of the container flows fixes an origin and a destination for each empty container which has to be transported. I.e., at the end of the first step, we have to solve the same type of problem as we have in the situation for the distinct container problem. That is why the model for the distinct container problem could also be used for the second step of the second approach. Since the flow of containers has to be performed by transportation processes fulfilled by the own fleet of the trucking company, the container flows have to be installed in that way that the given maximum number of coevally used trucks is not exceeded. The problem of minimum container flows with the important restriction of a limited resource capacity for transporting these containers is very interesting in general but it is not easy to solve. Since the problem in the first step of the second approach needs further investigation, this approach will not be pursued in the remainder of this paper.

Following the third approach we will solve the two sub-problems of the second approach in one single step, i.e. solving the assignment problem of empty containers simultaneously with the vehicle routing and scheduling problem induced by the originally given problem data and the compulsory assignment decisions. Using the model for solving the problem determines: a) where to deliver the empty containers released after inbound full/empty loads, b) where to pick up the empty containers for outbound full/empty loads, and c) in which order and by which truck the loads should be carried out.

3. EXAMPLE FOR CONTAINER INLAND TRANSPORTATION

Figures 1 and 2 show a very small example for the ICT problem. Customers are illustrated by circles; the depot is illustrated by a rectangle and the terminal by a triangle. According to the freight which has to be delivered from the terminal to a customer and the freight which has to be moved from a customer location to the terminal, we define two customer types represented by the nodes 1 and 2. These basic flows of goods from customer 1 to the terminal and from the terminal to customer 2 are illustrated by bold lines. The flow of goods is made possible by means of containers. The time window for the availability of a container at the customer's location i is given by $[s_i,e_i]$. Additionally, there are terminal delivery time windows for outbound containers and terminal pickup time windows for inbound containers. Customer 1 will have to pack the container provided to him during the time window $[s_1,e_1]$. The container of customer 1 has to reach the terminal respecting the terminal delivery time window for this container and will then leave the local area via the terminal. Customer 2 will receive a container carrying a flow of goods originating from the terminal. For this customer the time window for unloading the container is $[s_2,e_2]$.

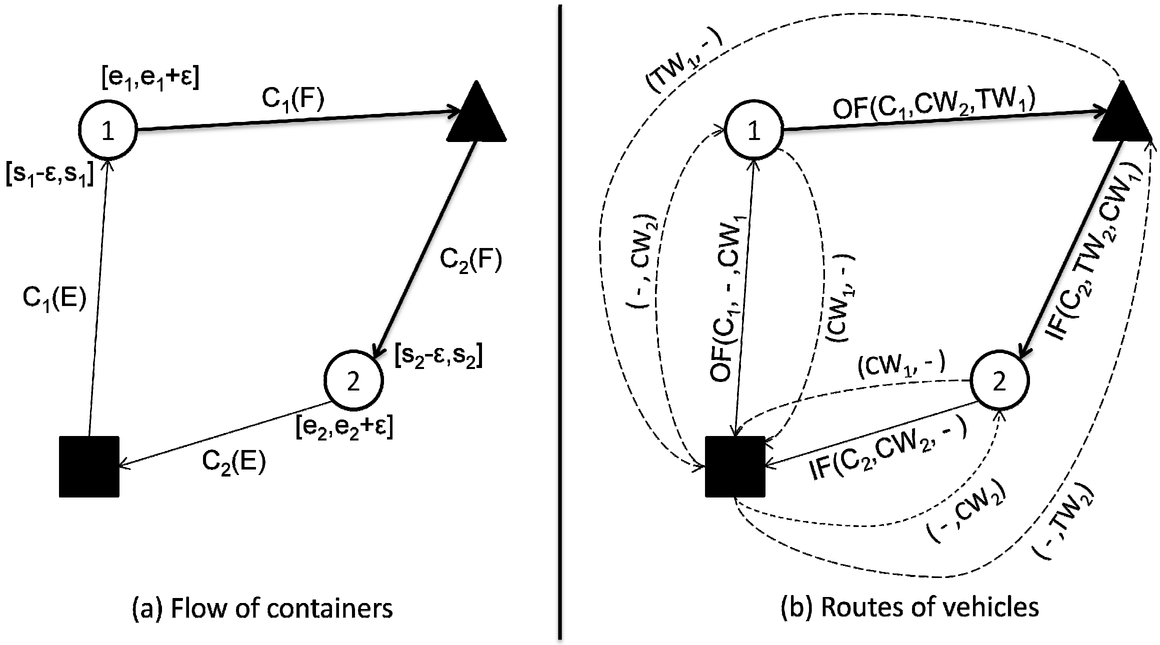

Figure 1: Distinct container problem

The flow of goods induces a flow of containers. Figure 1(a) shows the flow of containers for the case that the containers used for customer 1 and 2 cannot be interchanged (i.e. the situation of the distinct container problem). The container C_1 respectively C_2 will be used for the realization of the flow of goods $C_1(F)$ respectively $C_2(F)$. The flow of the empty container C_1 is denoted by $C_1(E)$ and afterwards when this container is loaded at customer site 1 its flow as a full container is denoted by $C_1(F)$. The flow of the full container C_2 from the terminal to the customer 2 is shown as arc $C_2(F)$ and after this container is unloaded by customer 2 its flow continues as an empty container to the depot on the arc denoted as $C_2(E)$. As mentioned above there is an availability time window for containers at each customer's site. We assume that the customer delivery time window for a container to be delivered to customer i will be $[s_i–\varepsilon,s_i]$ and the customer pickup time window will be $[e_i,e_i+\varepsilon]$, respectively, with ε denoting the amount of time that a container may arrive earlier at a customer's site than necessary or the amount of time that the container is allowed to remain at a customer's site after the availability time window is over.

The flow of container requires corresponding truck operations. Figure 1(b) shows the transportation processes needed to implement the intended container flows. The solid lines illustrate the transport of containers by a truck and the dotted lines illustrate truck movements without any container. The bold solid lines indicate the transportation of a full container while the semi-bold lines indicate the transportation of empty containers. The solid lines are marked by a denotation, for instance $OF(C_1,CW_2,TW_1)$. This denotation is used for describing the type of container, the identity of the container, and the relevant time windows. The first two characters denote the type of the container transported on that line: OE for Outbound Empty, OF for Outbound Full, IE for Inbound Empty, IF for Inbound Full. The first parameter within brackets identifies the container to be transported, e.g. C_1 for Container 1. The second parameter identifies the time window to be met when picking up the container. The values of that parameter might be CW_1 respectively CW_2 for the first respectively the second time window of the customer location where the container has to be picked up. Alternatively the value of the second parameter might be TW_j for the time window which is relevant for container j at the terminal. Finally, the value of the second parameter might be "-" indicating that no time window is relevant for the pickup operation. The third parameter identifies the time window to be met for the delivery of the container at its destination. The possible values of the third parameter are the same as the ones for the second parameter. The dotted lines used for the illustration of empty container movements are marked by a denotation which describes the time windows for the locations at the origin and destination of that movement, for instance $(-,CW_2)$ for a truck movement from the depot to a customer who has to be reached at his second time window. The first parameter identifies the time window at the starting point of that empty truck movement and the second parameter identifies the time window at the endpoint of that movement. The values for the time windows of empty movements can be the same as for the time windows for container movements on the solid lines. Figure 1(b) demonstrates the case that the time windows and the limitation of available trucks do not allow any bundling or concatenation of transport processes to common tours. For this case Figure 1(b) shows all transportation processes which are necessary in the local area to fulfill the container flows shown in Figure 1(a). There are 10 transportation processes needed for the transportation of the two containers. For each move of a container to or from the depot there will be needed a pendulum tour (i.e. 4 truck movements for the two containers). And for each move of a container between a customer location and the terminal there will be a tour with three transportation legs (i.e. 6 truck movements for 2 containers).

The optimization model for the distinct container problem will minimize the transportation effort (in driving distances or operating times of the available trucks) for a given set of container movements. The two approaches for the shared container problem try additionally to minimize the container flows. Provided that the availability time windows $[s_1,e_1]$ and $[s_2,e_2]$ of the customers 1 and 2 allow that the same container can be used for both customers, the container flow illustrated in Figure 1(a) can be reduced to the container flow presented in Figure 2(a). As a consequence the set of needed transportation processes shown in Figure 2(b) will also be reduced.

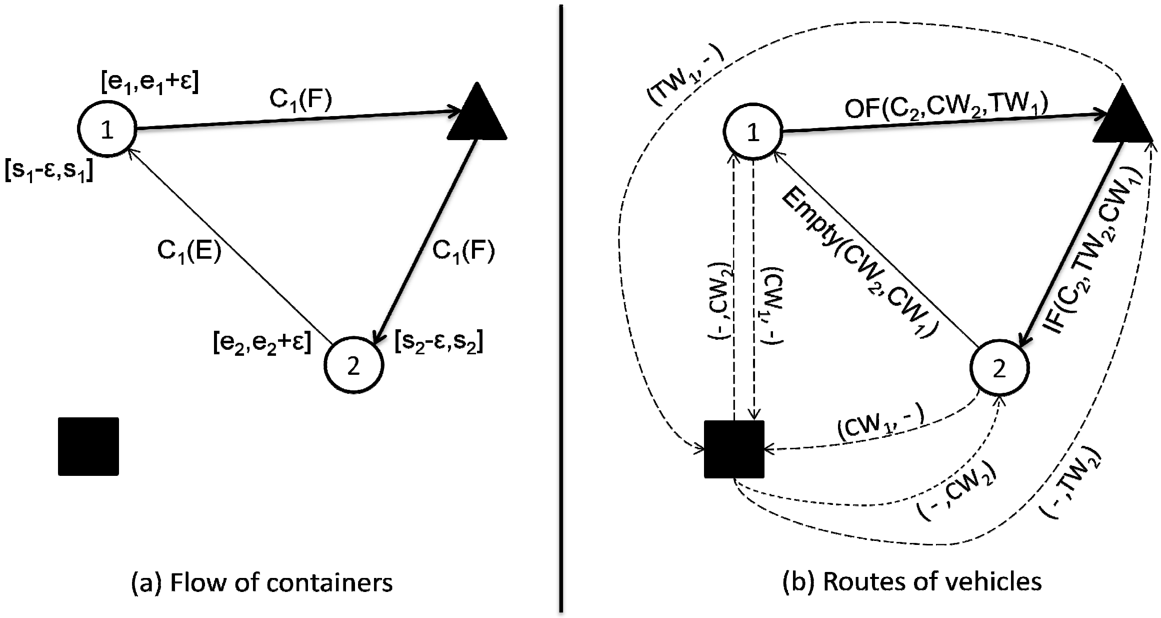

Figure 2: Shared container problem

4. MODELING THE CONTAINER INLAND TRANSPORTATION PROBLEM

The two models for the DCP and for the simultaneous approach of the SCP use the following variables, parameters and constants:

e	Number of IE containers
f	Number of OE containers
z	Number of additional empty containers (originating from the depot)
m	Number of trucks
M	Sufficiently big constant
t_{ij}	The travel time includes a service time at node i.
s_i/e_i	Time window of node i (i.e. TW_i for terminal time window of container i and CW_1 respectively CW_2 for the first respectively second customer time window)
$s(0) = \{0\}$	Start node (Depot)

$e(0) = \{3d + e + f + 1\}$	End node (Depot)
$S = S^i \cup S^o$	Shipper/OF customer nodes:
$S^i = (1, \dots, p)$	- First time window
$S^o = (d + 1, \dots, d + p)$	- Second time window
$R = R^i \cup R^o$	Receiver/IF customer nodes:
$R^i = (p + 1, \dots, d)$	- First time window
$R^o = (d + p + 1, \dots, 2d)$	- Second time window
$H^{OF} = 2\mathrm{d} + 1, \dots, 2\mathrm{d} + \mathrm{p}$	OF terminal nodes (belonging to the number of shippers)
$H^{IF} = 2d + p + 1, \dots, 3d$	IF terminal nodes (belonging to the number of receivers)
$H^{IE} = 3d + 1, \dots, 3d + e$	IE terminal nodes (belonging to the number of IE containers)
$H^{OE} = 3d + e + 1, \dots, 3d + e + f$	OE terminal nodes (belonging to the number of OE containers)
$H = H^{OF} \cup H^{OE} \cup H^{IF} \cup H^{IE}$	All terminal nodes
$V = s(0) \cup P \cup D \cup H \cup e(0)$	All nodes
$K = 1, \dots, m$	Vehicles
$C^{IF} = d - p$	IF containers
$C^{IE} = d - p + 1, \dots, d - p + e$	IE containers
$C^a = d - p + e + 1, \dots, d - p$ $+ e + 1 + z$	Additional empty containers (originating from the depot)
$C = C^{IF} \cup C^{IE} \cup C^a$	

Decision variables:

x_{ijk}	1, if truck k drives from node i to j; 0 otherwise
y_{ijc}	1, if container c is moved from node i to j; 0 otherwise
T_{ik}	Represents the starting time of truck k from node i
L_{ic}	Represents the starting time of container c from node i

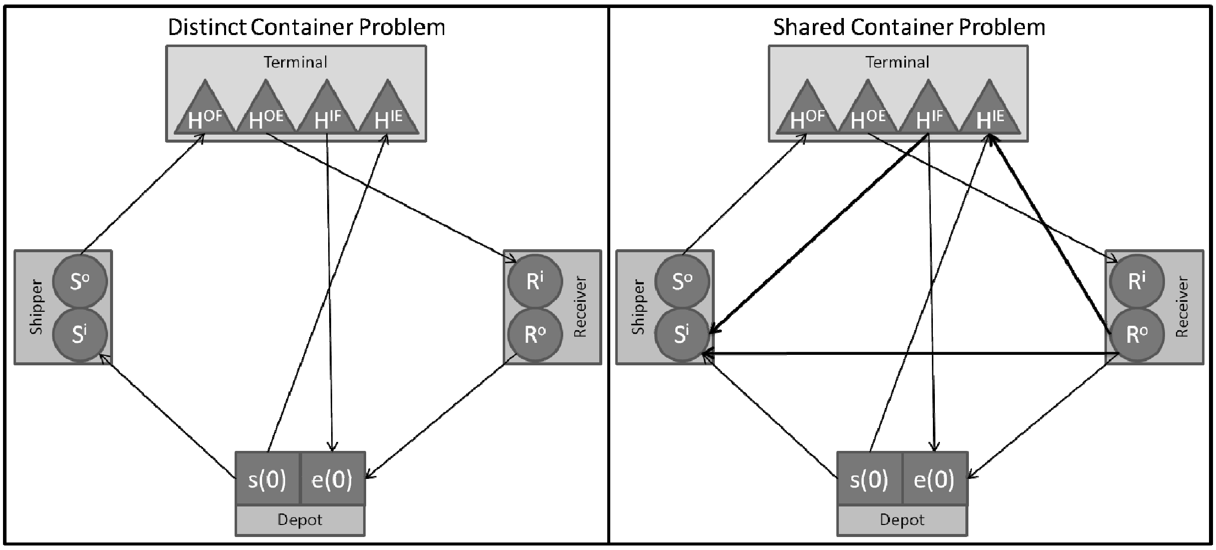

Figure 1: Possible arcs between the node sets

For a comprehensive survey of the different types of node sets Figure 3 illustrates their interrelations within the distinct and the shared container problem. Customers providing outbound full containers are defined as shippers. Additionally, customers who receive inbound full containers from the terminal are declared as receivers. To constitute the first and the second time window of the customer locations each customer is represented by two vertices (. The seaport has to handle all types of containers and thus is split into four node sets . The additional possibilities of the SCP to allocate the container between the node sets are illustrated through the bold arrows and lay the basis for the following mathematical models.

Objective function: (2)

Restrictions:

$$\sum_{j \in V} \sum_{k \in K} x_{ijk} = 1 \qquad i \in S \cup R \cup H; i \neq j \qquad (3)$$

$$\sum_{j \in V \setminus \{s(0)\}} x_{s(0)jk} = 1 \qquad k \in K \qquad (4)$$

$$\sum_{i \in V} x_{ie(0)k} = 1 \qquad k \in K \qquad (5)$$

$$\sum_{j \in V} x_{jik} - \sum_{j \in V} x_{ijk} = 0 \qquad i \in S \cup R \cup H; k \in K; i \neq j \qquad (6)$$

$$\sum_{k \in K} x_{i(d+i)k} = 1 \qquad i \in S^o \qquad (7)$$

$$\sum_{k \in K} x_{i(i-2d)k} = 1 \qquad i \in H^{IF} \qquad (8)$$

$$\sum_{k \in K} x_{s(0)jk} = 1 \qquad j \in S^i \cup H^{OE} \qquad (9)$$

$$\sum_{k \in K} x_{ie(0)k} = 1 \qquad i \in R^o \cup H^{IE} \qquad (10)$$

$$T_{jk} \geq T_{ik} + t_{ij} - M(1 - x_{ijk}) \qquad i,j \in V; k \in K \qquad (11)$$

$$s_i \leq T_{ik} \leq e_i \qquad i \in V; k \in K \qquad (12)$$

$$x_{ijk} \in \{0,1\} \qquad i,j \in V; k \in K \qquad (13)$$

The objective function (2) deals with the minimization of the total operating time of the trucks. Restriction (3) assures that every vertex is visited exactly once. While (6) guarantees the route continuity, restrictions (4) and (5) mean that a truck starts a tour from the depot and beyond ends the tour at this location. The following two restrictions ensure that a truck which picks up an outbound full container from a shipper during the second time window drives to the terminal. Furthermore, a truck driving to an inbound full terminal node has to move an inbound full container to the related receiver. Constraints (9) and (10) guarantee that every shipper and every outbound empty terminal node is supplied by empty containers from the depot. Furthermore empty containers from the terminal or a receiver node must be moved to the depot. While time continuity during a tour is assured by (11), (12) states that a truck reaches a location in its defined time window.

The simultaneous optimization problem for the SCP is represented by the objective function (13) and the restrictions (14) to (38).

Objective function: $$minimze \;\; z = \sum_{k \in K}(T_{e(0)k} - T_{s(0)k}) \qquad (13)$$

Restrictions:

$$\sum_{j \in V} \sum_{c \in C} y_{ijc} = 1 \qquad i \in S \cup R \cup H^{IF} \cup H^{IE}; i \neq j \qquad (14)$$

$$\sum_{i \in V} \sum_{c \in C} y_{ijc} = 1 \qquad j \in H^{OF} \cup H^{OE}; i \neq j \qquad (15)$$

$$\sum_{i \in H^{IF}} \sum_{j \in V} y_{i(i-2d)c} = 1 \qquad c \in C^{IF} \qquad (16)$$

$$\sum_{j \in e(0) \cup S^{i}} \sum_{c \in C^{IE}} y_{ijc} = 1 \qquad i \in H^{IE} \qquad (17)$$

$$\sum_{j \in V} y_{s(0)jc} = 1 \qquad c \in C^{a} \qquad (18)$$

$$\sum_{j \in V} y_{s(0)jc} = 0 \qquad c \in C^{IF} \cup C^{IE} \qquad (19)$$

$$\sum_{i \in V} y_{is(0)c} = 0 \qquad c \in C \qquad (20)$$

$$\sum_{j \in V} \sum_{c \in C} y_{ijc} = 0 \qquad i \in H^{OF} \cup H^{OE} \cup e(0); i \neq j \qquad (21)$$

$$\sum_{i \in V} \sum_{j \in H^{OF} \cup H^{OE} \cup e(0)} y_{ijc} = 1 \; c \in C; i \neq j \qquad (22)$$

$$\sum_{i \in s(0) \cup R^{o}} \sum_{c \in C} y_{ijc} = 1 \qquad j \in H^{OE}; i \neq j \qquad (23)$$

$$\sum_{c \in C} y_{i(d+i)c} = 1 \qquad i \in S \cup R^{i} \qquad (24)$$

$$\sum_{j \in V} y_{jic} - \sum_{j \in V} y_{ijc} = 0 \qquad i \in S \cup R; c \in C; i \neq j \qquad (25)$$

$$L_{jc} \geq L_{ic} + t_{ij} - M(1 - y_{ijc}) \;\; i,j \in V; c \in C; i \neq j \qquad (26)$$

$$s_i \leq L_{ic} \leq e_i \qquad i \in V; c \in C \qquad (27)$$

$$\sum_{j\in V}\sum_{k\in K} x_{ijk} = 1 \quad i \in S \cup R \cup H; i \neq j \quad (28)$$

$$\sum_{j\in V} x_{s(0)jk} = 1 \quad k \in K \quad (29)$$

$$\sum_{i\in V} x_{ie(0)k} = 1 \quad k \in K \quad (30)$$

$$\sum_{j\in V} x_{jik} - \sum_{j\in V} x_{ijk} = 0 \quad i \in S \cup R \cup H; k \in K; i \neq j \quad (31)$$

$$\sum_{k\in K} x_{ijk} \geq y_{ijc} \quad i \in S^o \cup R^o \cup H^{IE} \cup H^{IF}; j \in V; c \in C; i \neq j \quad (32)$$

$$\sum_{k\in K} x_{ijk} \geq y_{ijc} \quad i \in S \cup R \cup H; j \in S^i \cup R^i \cup H^{OF} \cup H^{OE} \cup e(0); c \in C; i \neq j \quad (33)$$

$$T_{jk} \geq T_{ik} + t_{ij} - M(1 - x_{ijk}) \quad i,j \in V; k \in K; i \neq j \quad (34)$$

$$T_{ik} = L_{ic} \quad i \in S \cup R \cup H; k \in K; c \in C \quad (35)$$

$$s_i \leq T_{ik} \leq e_i \quad i \in s(0) \cup e(0); k \in K \quad (36)$$

$$x_{ijk} \in \{0,1\} \quad i,j \in V; k \in K \quad (37)$$

$$y_{ijc} \in \{0,1\} \quad i,j \in V; c \in C \quad (38)$$

The objective function deals with the minimization of the total operating and waiting time of the trucks. As stated the simultaneous approach consists of two stages. While constraints (14) to (27) assure the containers' routes, (28) to (36) guarantee the routes of the trucks. Hence, (14) and (15) state that every customer and terminal node is visited once by a container. The start and end vertices of the different kinds of containers are guaranteed by restrictions (16) to (23). Thereby inbound full containers need to be moved from the terminal to the receivers. While inbound empty containers begin their route at the terminal and are transported to a shipper or the depot, (18) states that additional empty containers originate from the depot. These three types of containers are not allowed to begin their tour from a different start node stated by (19)-(21). Constraints (22) and (23) assure that the containers will end their tour either at the depot or the outbound empty terminal. While route continuity is stated by (25), restriction (24) ensures that a container visits the related node of a shipper/receiver to pass the filling and emptying process of the container. Finally, restriction (26) and (27) assure that a container holds the time continuity during a tour and reaches a location in its defined time window.

The truck constraints (28)-(36) are comparable to the restrictions for the DCP. Attention should be paid to restrictions (32), (33) and (35) which assure that the trucks are interlinked with the containers and pass every location at the same time. Hence, the trucks cover the containers' routes but can skip at a customer location the filling and emptying process of the container.

5. CONCLUDING REMARKS ON FUTURE RESEARCH

The models presented in Section 4 deliver a precise formulation of the ICT problem with and without container sharing. The problem is interesting from a theoretical point of view since there are two levels of transportation planning which are intervolved with each other and have to be matched together. On the lower level there is the resource planning for the containers which are to be used for transportation. On the upper level there is the resource planning for the trucks that are needed for the movement of these containers. CPLEX has been utilized for the solution of small instances of models presented in Section 4. By comparing the results of the solutions of instances of the distinct container problem with the results obtained by the solutions of instances of the shared container problem the benefit of container sharing can be estimated and analyzed in dependence of the characteristics of the given problem instances. This benefit is measured with respect to the reduction of the transportation costs for inland container transportation in a local area. Unfortunately, CPLEX is only able to solve small problem instances of the ICT problem. We assume that the benefit reached by container sharing is relatively small for undersized problem instances and will grow tremendously when the problem instances become bigger and bigger. In order to check this assumption in our future work we will develop heuristic approaches for the solution of the ICT problem for both scenarios, with and without container sharing.

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PATH DEPENDENCY IN THE PROCESS OF SUSTAINABLE REGIONAL DEVELOPMENT OF TRANSPORT AND LOGISTICS REGIONS: SOLUTIONS FOR SEA PORTS

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Abstract: The maritime port industry is capital-intensive, mature, dominated by a small number of big players and at the same time impacts the regional development of hinterland territories and coastal zones on the national and international level. As a rule, port authorities and governmental regulatory bodies have a stake in the port development and its influence on regional one. Value creation from logistics activities in sea ports is only one goal which has to be balanced by the public actors with other objectives like sustainable regional development of hinterland territories or neighbouring spatial zones. Successful regional development is, to a large degree, dependent on the capacity of local actors to take into account different interests, to consolidate regional resources and competences and to integrate the regional sea port based logistics cluster into global supply chains. Actors taking influence on the sustainable regional development in the context of sea ports build a very complex network with polycentric and heterarchical structure.

1. PURPOSE OF THE PAPER

Transport and logistics play a decisive role for the economic regional sustainable development. Moreover regional economic competition is addressing regional networks (local nodes) which consist of logistics clusters embedded by a holistic view in global supply chains [1]. In particular maritime logistics is crucial for the economy: sea ports link regional economy with the world one, are gateways of land and sea transport and important interfaces within local and global supply chains. International ports have certain distinctive features [2], are faced by similar challenges [3] and often show advocacy of generic solutions as typified by the World Bank Port Reform Toolkit [4].

Having passed the law about sea ports of Russian Federation at the end of the year 2007[1], a framework for the steps into market economy was created. Furthermore, the Russian Port Industry has experienced a remarkable upturn in recent years [5, 6]. Despite the implementing of new port governance and management structure in order to adapt positively to changing circumstances, Russian sea ports with belonging hinterland territories and coastal zones are as a rule under state control of direct public management. The key objectives of the national maritime strategy of the Russian Federation 2030[2] are efficiency, economic benefit through competition, enhancing management skills and minimizing of bureaucracy.

Sustainable regional development represents a permanent and sustainable use of a specific spatial space in accordance with the given endogenous and exogenous potentials and constraints [7]. This means that for the possibility to use all the potentials within transport and logistics regions by current and future generations a fair balance between different user interests and opportunities is needed, and natural potentials are to be used not irreversible. The concern over indicators of sustainable regional development in economic geography echoes older debates about spatial proximity or as an important determinant of regional growth [8], movements of tangible resources (such as people or capital) as a cause for convergence [9] or divergence [10,11]. Nowadays the role of learning, namely the acquisition and application of knowledge by regional actors is the almost central concern of sustainable regional development as an important source of regional growth in economic geography. Ability to know-how and know-who has a particular meaning in the port and sustainable regional development context: it enhances the capacity of regions (and actors in these regions) to improve their competitiveness within the global chains and secures decisive competitive advantages on the sustainable way, in part because sea ports border on ecologically sensitive territories. Innovation is also often used for reduction local negative externalities like traffic congestion or pollution, which take place in sea ports, hinterland territories or coastal zones.

Concerning the topic "Path Dependency in the Process of Sustainable Regional Development of Transport and Logistics Regions: solutions for sea ports" this paper follows the research question "in what way a sustainable competitiveness of the maritime logistics regions in an economic and natural environment in the era of global supply chains can be achieved?".

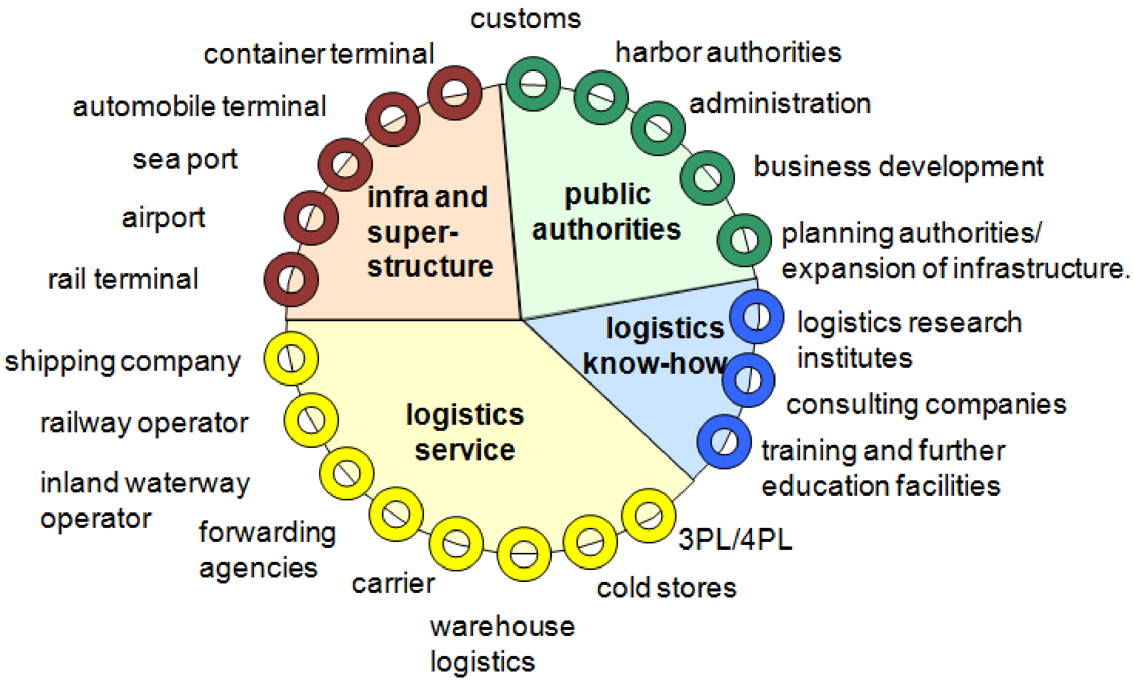
2. REASEARCH AND APPLICATION METHODOLOGY

Following neoinstitutional approach [12] that the way of relationships between actors depends on institutions of polity and economy, the paper shows that observed actor groups in context of sea ports are results of variations in institutional frameworks within which the sustainable regional development strategies have to be (new) nested. Existing institutions are "the formal rules, compliance producers, and standard operating practices that structure the relationships between actors in various units of polity and economy" [12] .The obtaining of sustainable acting in context of sea ports (with the aim of sustainable development of whole logistics regions connected with these sea ports) can be considered as a new condition, which causes structural contradictions within the establishes framework by means of path outcomes. Using the Porter's cluster theory [13,14,15] and the local-global perspective of Haasis method [16,17] of sustainable logistics cluster management the forthcoming analysis examines how different levels of port governance arrangements[3] interact to create unique, path dependent outcomes for the sustainable regional development.

3. DESIGN OF THE PAPER

In order to answer the research question one needs to be clear what are the main core groups of actors in the port sector and under which premises they interact with each other.

It can be assumed that all actors in the port context handle under two premises: homo oeconomicus and acting without aligning to business objectives. Picture 1 shows that actors in the port context include those who directly transport goods or arrange transport services (logistic service providers like forwarding agents, terminal operators or shipping companies), private infrastructure and superstructure providers as well as owners of the goods. These actors are considered to be homo oeconomicus, who act rationally with fixed preferences in order to maximize own benefits and have not fully information about all circumstances around [20]. A small number of actors (big players) are able to choose for example between ports as well, what can be also considered as a possibility of power exercising on other actors groups decisions. All rational acting actors aim in most senses to lower transaction costs. Transaction theory suggests that bounded rationality leads them to advocating some innovative practices to bound difficulties [21].



Picture 1. Actors in the port context[4]

Actors such as local political decision-makers (communities or local governments) or planning bodies operate rather under national-economic aspects, act by considerations of the common good of a site or a region and take part in port and regional development. The port authorities are regulators and also a part of a public sector. Public actors' task is to address collective problems like congestion in hinterland or pollution across its main transport roads to deal with.

Both, private and public actors are represented in the group infra- and superstructure: some infrastructure assets like transshipment or value-added processing facilities are private but most of them (e.g. rail transportation networks) are collective and under responsibility of a public regulators. Moreover, the public infrastructure is considered to be important for the port innovation [22].

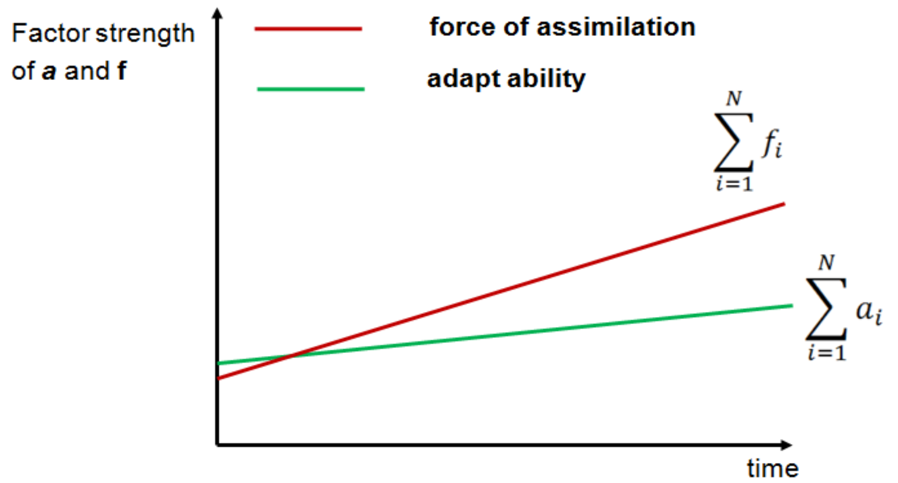
Training and other educating facilities as well as research institutes are localized sources of knowledge creation and learning. While certain forms of knowledge are easily codified and can be transmitted by writing, some specific skills and knowledge are person-bound, difficult to transfer to another person without extensive personal contact and trust [23]. Innovations or spill-over effects originate from the exchange and recombination of knowledge, which are usually "generated" in the course of recurrent, trust-based face-to-face contacts [24]. Hence the process of knowledge remains rooted in this kind of institutions. Knowledge carrier can make different actors in logistic clusters share the same level of logistics expertise.

Even though the concept of sustainable regional development is drawn up, a local government administration group is not enough for implementing the successful regional development strategy for local transport clusters. For the management of core competences of regional actors a special, neutral actor or institution for the role of "caretaker" is needed. That's why logistics clusters in Germany revive their sustainable regional development by founding of logistics associations or initiatives. Nowadays there are around 40 logistic "caretaker" for cluster management of regions cross over Germany.

Further, it has been recognized that clusters are successful because of how they can effectively govern their internal (e.g. within the Primorsk port logistic region) or external (within two neighbour logistics regions) relationships. Some economic geographers and logistics specialists speak about the local-global perspective of sustainable regional development of logistics regions [17, 25, 26]. The way, how sustainable cluster management theoretically can be realized and positive outcomes – generated can be shown as follows.

4. MAIN RESULTS

Before speaking about the way how positive outcomes in the existing port frameworks are generated it should be mentioned that every homo oeconomicus actor does business in the environment which is like puzzle of outcomes from acting of others in the region and rules of existing institutional frameworks. At the same time every actor's interaction takes influence on his and others environment. The whole regional network is very complex and dynamic. With other words interactions between regional partners are crucial for design of logistics location [27, 28] as well as (indirect) of great importance for each actor. The dependency in decisions is also called cluster effect, which shows an average regional relation between the force of assimilation of the environment to adapt ability of each player (see picture 2). The strength of the factors *a* (adapt ability) and *f* (force of assimilation) can be specified by a group of indicators according the Leavitt model for analysing management changes [29] or Pfohl model for analysing management changes by logistics providers [30]. Another kind of path-depended positive outcomes is cluster arbitrage. It measures the average difference between the force of assimilation and the adapt ability to the environmental assimilation. Both positive outcomes illustrates picture 2: by sustainable cluster management for N regional homo oeconomicus actors the developing of factor strengths “adapt ability” and “force of assimilation” changes positively after some time.



cluster effect = $\dfrac{\sum_{i=1}^{N} f_i}{\sum_{i=1}^{N} a_i * N}$ cluster arbitrage= $\dfrac{\sum_{i=1}^{N} (f_i - a_i)}{N}$

f_i force of assimilitaion of actor i in the logistics region

a_i adapt ability of actor i in the logistics region

Picture 2. Path-depended positive outcomes: cluster effect and cluster arbitrage

In the local-global perspective the sustainable regional development is driven by communication, cooperation, transfer of knowledge and innovation between actors at site. Especially in the context of ports the development of innovative technologies for handling cargoes or car flow management and the implementation of an effective knowledge management at site are decisive for the strategic design of logistics regions. Environmental innovation of sea ports is also a sustainable competitive advantage and a guarantee for sustainable design of maritime sites.

5. ACADEMIC CONTRIBUTION

This paper responds to calls from scientist of logistics regional development in the context of sea ports to bound transport and economic geography theoreti-

cally [27]. It shows that sustainable site development is impossible without innovative port planning, implementing, managing and operating. Innovation and knowledge transfer can be generated by a good coordinated cooperation of all actors in the region. The coordination of network cooperation should be a task of specific neutral institution at site.
Institutional frameworks of ports in advanced Western economies differ from the observed ones in developing countries. Sustainable development of logistics regions should be first of all a task of public actors and politic decision makers. Only after environmental innovation will be emerged as one important basis for competition between ports, logistics providers will be forced to adapt and hence generate positive outcomes for future sustainable regional development. Implementing of "Western best practices" without investigating fundamental regional differences is dangerous. This paper triggers the need for further analysing of diversity logistics regions in developing countries.

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NOTES

1. Full law name in Russian: Федеральный закон Российской Федерации от 8 ноября 2007 г. N 261-ФЗ "О морских портах в Российской Федерации и о внесении изменений в отдельные законодательные акты Российской Федерации"
2. Full law name in Russian: Стратегия развития морской деятельности Российской Федерации до 2030 года
3. Regional governance arrangements are new forms of actors networking (clusters) in cities and regions with a high level of self-control ability, in which public administration and policy decision makers do play a central role, but all interest groups (even citizens of logistics regions) - with growing importance – deliberately make a contribution to the regional development [18,19]
4. With minor individual adjustments adopted by Haasis/Landwehr 2009 [17]

СОЗДАНИЕ И УПРАВЛЕНИЕ ЛОГИСТИЧЕСКОЙ СИСТЕМОЙ СБЫТА НА МЕЖДУНАРОДНОМ РЫНКЕ

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ESTABLISHMENT AND MANAGEMENT OF LOGISTICS SYSTEM ON THE INTERNATIONAL MARKETS

Dmitry Zhuravlev

Аннотация / Annotation
The article aims to search for and apply practically methods of marketing activities within the international market. Practically every commercially-interested in selling goods company faces challenges with international market launch. No doubts, export of goods deters the business sector for its complexity and uncertainty. But at the same time this process could become helpful for business consolidation, Company’s image crafting.
At first the establishment of representative offices abroad can be a simple solution to work on the international market. However, external control of logistic systems including representational resources in accordance with current market needs is certainly a new challenge.
Research methodology
The main methods for scientific and practical problems’ solutions in logistics sales should include methods of system analysis, methods of operations research, cybernetic approach and prediction. The use of these methods let us create integrated management and monitoring system to check their movement, develop systems of logistic services, optimize resources and complete a number of other tasks including product distribution as well.
Various modeling techniques are widely used in logistics, i.e. the study of logistic systems and processes by constructing and studying their models.
Main results
The Company’s decision on the new market launch can be based on principally new logistic ways, where the allocation of the corporate distributional center will increment the Company’s marginal profit through customers’ consolidated costs and ensure accurate delivery in accordance with the market needs.
The increase of export deliveries depends on the growing medium-sized businesses which are able and ready to offer its product, its innovative solution for international consideration. The theoretical background for this task is almost non-existent, and the practical aspect has been formed only in recent years with due account for economic barrier to the internal market.
An international distribution formation would be possible on the following step basis:
1. Development of a price-formation Policy found on the new market research;
2. Logistic solutions as additional options for indirect distribution on the market (opening their own distributional channel in the new segment geographically and, therefore, legitimate

and legal steps to establish a distributional center of this relatively new resident of the country market).

Academic contribution

Material flows, as well as financial and information flows are the object of study for marketing activity. These flows on their way from the primary source of raw materials to the final consumer pass through different production, transport, storage units. Managing tasks for material flows are solved individually within each unit. Certain units represent so-called "closed systems" isolated from others technically, economically and methodologically.

Business management within the closed systems is carried out by well-known planning and management methods of economic and production systems and could easily be described in relevant sciences. These methods are still used within the logistic approach on the market level in material flow management. However, the transition from independent isolated systems to integrated logistic ones requires methodological management base expansion on the external level.

This base is relatively new according to the science. But at the same time this is valuable for the effective Company's operations aimed to increase a market share and sale volumes of certain goods.

Managerial insights

Export of goods without reasons deters the business sector while this process could become helpful for business consolidation, Company's image crafting and setting advantages for the next level of international politics through the trade similarity, where exports would not mean only export of raw materials but help companies' production to develop on the qualitative level.

1. ВВЕДЕНИЕ

Цель статьи предполагает поиск и применение методов развития сбытовой деятельности предприятия на международной арене. Практически любая компания, коммерчески заинтересованная в сбыте продукции, сталкивается с проблемой вывода своих товаров на рынки других стран. Экспорт товара, без сомнения, отпугивает предпринимательский сектор своей сложностью и неопределенностью, в то время как данный процесс мог бы стать хорошим подспорьем укрепления бизнеса, создания хорошего имиджа компании, роста «гуд-вилла» как статьи нематериальных активов и, главное, – расширения рынков сбыта на новых территориях с новым потенциалом роста объема продаж при понимании, что действующая внутренняя дистрибуция рано или поздно найдет свой предел. В этом случае предприятие стартует с кампанией по развитию международной дистрибьюции своих «новых» товаров, привлекая различные «новые» для себя маркетинговые инструменты, вкладывая инвестиции, создавая новые логистические системы.

В первом приближении *создание представительства* за рубежом может стать простым решением работы компании на международном рынке. Однако управление извне логистической системой, в том числе представительскими ресурсами, в соответствии с актуальными потребностями рынка является безусловно задачей новой, методика решения которой сложна, также, как сложно совершенствование самой сбытовой деятельности за рубежом. Таким образом, решение этой задачи представляет значительный научный интерес и будет охвачена в данной статье.

К первоначальным этапам поиска именно логистических решений в условиях экспансии продукта можно отнести:

- Постановка целей логистической системы;
- Разработка системы распределения на основе уже сложившейся;
- Качественный и количественный анализы действия логистической системы;
- Выбор и определение звеньев участка распределения продукта и поставок;
- Определение схемы функционирования склада и систем хранения продукта;
- Расчет показателей эффективности функционирования собственного корпоративного склада.

Отдельный интерес представляют маркетинговые инструменты, так или иначе влияющие на поиск, развитие и качество функционирования каналов сбыта. Вопросы следующего характера требуют решений:

- Как организовать обеспечение потребителя информацией о продукции?
- Как возможно стимулировать / создать спрос на данный товар за рубежом?

2. МЕТОДОЛОГИЧЕСКИЙ ПОДХОД

Материальные потоки, равно как и соответствующие им потоки финансовые и информационные, являются объектом изучения сбытовой деятельности предприятия. Эти потоки на своём пути от первичного источника сырья до конечного потребителя проходят различные производственные, транспортные, складские звенья. Задачи по управлению материальными потоками в каждом звене решаются обособленно. Отдельные звенья представляют при этом так называемые закрытые системы, изолированные от остальных систем технически, экономически и методологически [1].

Управление хозяйственными процессами в пределах закрытых систем осуществляется с помощью общеизвестных методов планирования и управления производственными и экономическими системами, и может быть явно описано в рамках соответствующих наук. Эти методы продолжают применяться и при логистическом подходе к управлению материальными потоками на уровне сбыта. Однако переход от изолированной разработки в значительной степени самостоятельных систем к интегрированным логистическим системам требует расширения методологической базы управления материальными потоками, в том числе и на внешнем уровне.

Данная база является сравнительно новой в научном понимании, при этом представляет особый интерес для полноценной работы компании, направленной на увеличение доли рынка и объема сбыта конкретной продукции.

К основным методам, применяемым для решения научных и практических задач в области логистики сбыта, следует отнести методы системного анализа, методы теории исследования операций, кибернетический подход и прогностику. Применение этих методов позволяет прогнозировать материальные потоки, создавать интегрированные системы управления и контроля за их движением, разрабатывать системы логистического обслуживания, оптимизировать запасы и решать ряд других задач в том числе по распределению продукции.

Стоит отметить, что принятие решений по управлению материальными потоками до начала широкого применения логистики в значительной степени основывалось на интуиции менеджмента компании. Как концепция сбыта, современная логистика, наряду с разработкой и использованием формализованных методов принятия решений, находит свое развитие в широком применении опыта профессионалов каждой из систем. Так начал свое развитие методологический аппарат. Как следствие были разработаны системы экспертной компьютерной поддержки (экспертные системы), позволяющие уже непосредственно персоналу компании принимать быстрые и достаточно эффективные решения. Широкое применение в логистике получили различные методы моделирования, то есть исследования логистических систем и процессов путём построения и изучения их моделей [2].

3. ФОРМИРОВАНИЕ ЛОГИСТИЧЕСКОЙ СИСТЕМЫ СБЫТА

Решение компании по выведению своего продукта на новый рынок может быть обеспечено принципиально новыми путями логистики, где выделение корпоративного центра дистрибьюции позволит прирастить маржинальную прибыль компании за счет консолидированного покрытия расходов клиентов и обеспечения точных поставок согласно потребностям рынка.

Выполнение задачи увеличения экспортных поставок продукции лежит на плечах растущего среднего бизнеса, который может и готов предложить свой продукт, свое инновационное решение на международное рассмотрение. Теоретического задела для данной задачи практически не существовало, а практический аспект стал формироваться лишь в последние годы с учетом экономического барьера внутреннего рынка.

Формирование международной дистрибьюции станет возможным основываясь на следующих этапах:

1) разработка ценовой политики компании на новом рынке, основываясь на соответствующих маркетинговых исследованиях;
2) логистические решения как варианты косвенной дистрибьюции на рынке:

открытие собственного канала распределения на территориально новом сегменте и, соответственно, легитимно-правовые меры по созданию данного распределительного центра относительно нерезидента страны нового рынка сбыта [3].

Определим базисную задачу освоения нового рынка сбыта как *ценообразование* (без определения маркетинговых инструментов), которое поэтапно заключается в следующем:

1) определение целей ценообразования;
2) сравнительный анализ существующих рекомендаций по разработке стратегии ценообразования;
3) определение этапов разработки стратегии ценообразования для компаний, выходящих на внешние рынки;
4) анализ внутренних факторов ценообразования (маркетинговая политика фирмы, оценка затрат, товарная политика);
5) анализ внешних факторов ценообразования (предпочтения покупателей, ценность товара для них, оценка спроса, конкуренция);
6) формулирование окончательной ценовой стратегии в условиях выхода компании на зарубежные рынки.

Далее требуется развитие *внешних каналов дистрибьюции*, изучение характера данных дилерских сетей, их плюсов и недостатков: первоначально использование чужих каналов других поставщиков является разумным решением дистрибьюции компании на новом рынке (см. рис.1).

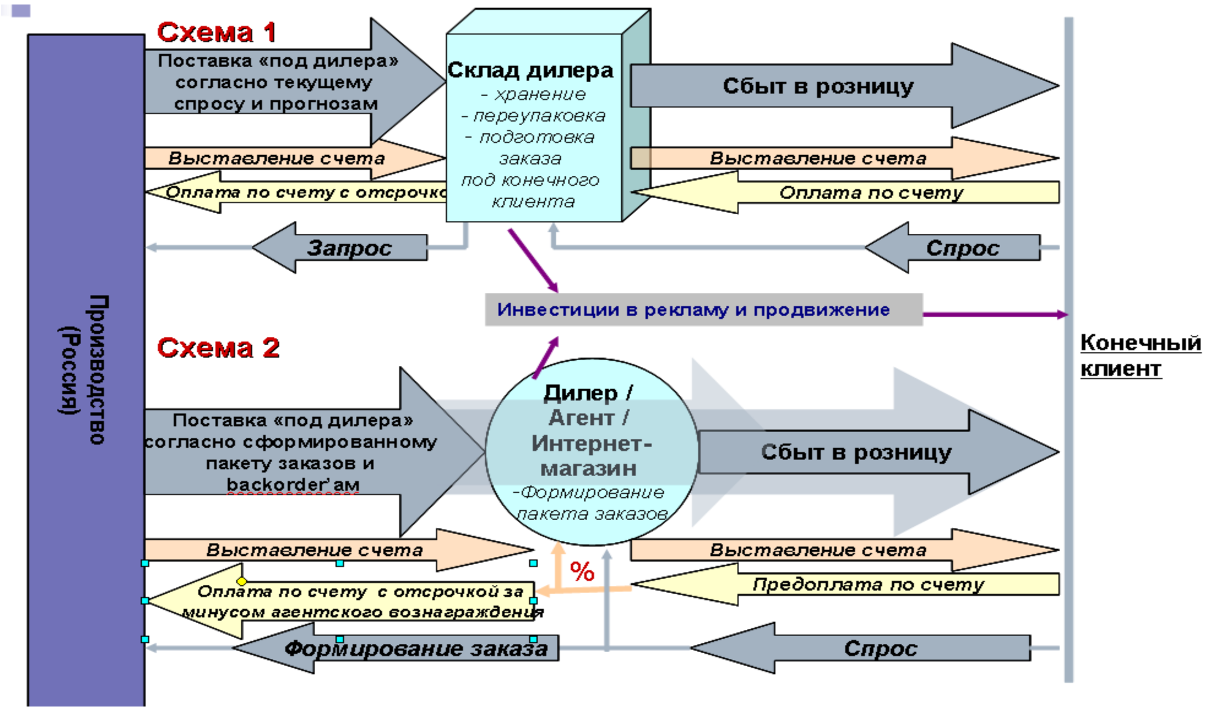

Рис. 1. Схема систем распределения на основе уже сложившихся на рынке (сторонние каналы)

Однако решение компании по выведению своего продукта на новый рынок может быть обеспечено принципиально новыми логистическими методами, в частности, созданием *корпоративного центра дистрибьюции,* что позволит прирастить маржинальную прибыль компании за счет консолидированного покрытия расходов клиентов, оставляя выходную цену прежней, и обеспечения точных поставок (JIT) согласно потребностям удаленного рынка.

Тогда поиск логистических решений в условиях экспансии продукта на новый рынок будет включать:

1) постановку стратегических целей логистической системы;
2) разработку оптимальной системы распределения на основе сложившейся (сторонние каналы) при выходе на новый рынок;
3) качественный и количественный анализ действия логистической системы;
4) определение места / роли / размера склада в распределительной системе;
5) прогноз величины потока товаров, проходящего через систему;
6) прогноз величины запасов в звеньях системы распределения и общего объема запасов;
7) проектирование этапов создания корпоративного склада;

8) выбор и определение звеньев участка распределения продукта;
9) определение наилучшего местоположения корпоративного центра;
10) определение схемы функционирования склада и систем хранения;
11) составление схемы движения товаров;
12) предварительный расчет цен за доставку единицы продукции;
13) расчет показателей эффективности функционирования корпоративного склада;
14) разработка системы управления всей логистической системой за рубежом.

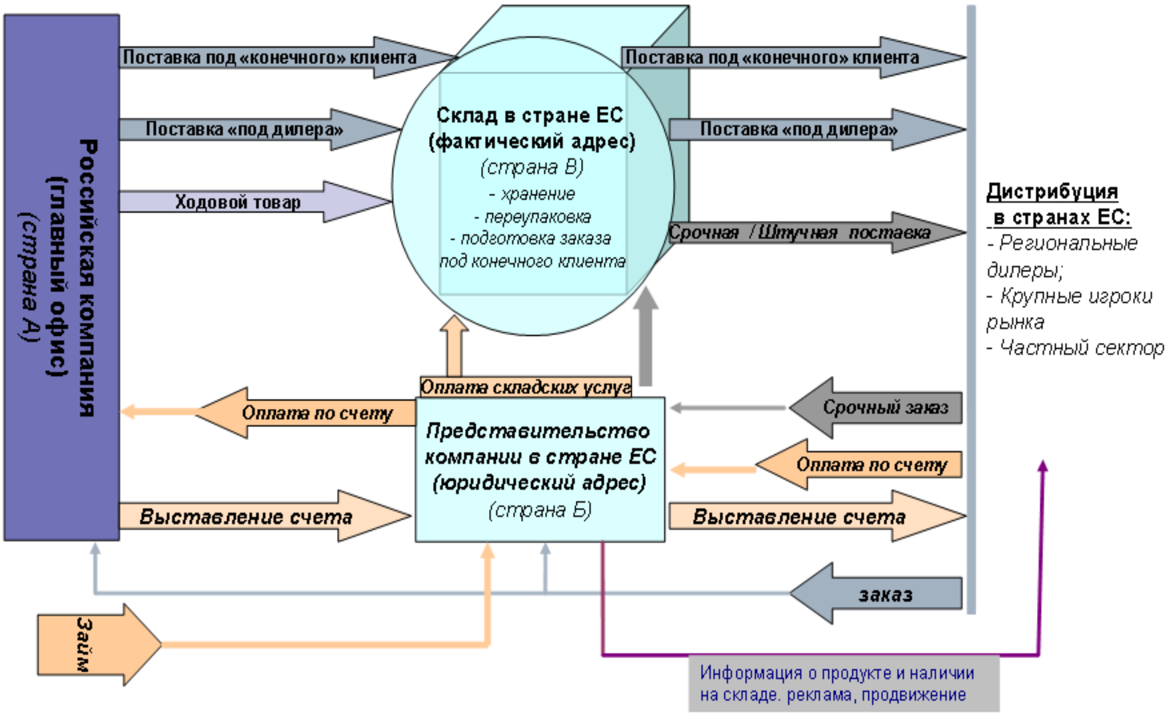

Рис.2. Схема функционирования *собственного* корпоративного центра дистрибуции

Таким образом, основным этапом является создание и развитие *собственного* корпоративного центра дистрибуции (см. рис.2), который сыграет роль клапана управления потоком продукта. С учетом маркетинговых исследований экспортного рынка при правильном ценообразовании можно четко определить наиболее перспективные регионы для запуска продукта и сделать упор именно на них, расставив приоритеты складской политики, которые в условиях ассиметричного спроса смогут обеспечить высокую оборачиваемость запасов товара.

Решение по внедрению продукта на новый рынок может быть целесообразно только при соблюдении всех факторов экономического, инвестиционного и логистического влияний. Бремя финансового кризиса толкает предприятия к поиску новых решений по продвижению своих продуктов, логистику которых важно учитывать помимо стратегического ценообразования и маркетинга, если продукт будет реализован на территориально новом международном рынке.

Так, центр дистрибуции сыграет роль рычага управления потоком продукта. В совокупности с маркетинговым исследованием регионов международного рынка, а также при правильном ценообразовании можно четко определить наиболее перспективные регионы для запуска продукта и сделать упор именно на них, расставив приоритеты складской политики. Таким образом, хранение и обработка продукта в условиях ассиметричного спроса окажется наиболее выгодной в тех регионах, которые смогут обеспечить его *высокую оборачиваемость.*

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INTEGRATIVE PLANUNG VON KOMMISSIONIERPROZESSEN DURCH DIE KOMBINATION VON MTM UND DER LEITMERKMALMETHODE

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Zusammenfassung: Untersuchungen von körperlichen Belastungen an ausgewählten Arbeitsplätzten in der Logistik haben nachgewiesen, dass fast durchweg eine hohe körperliche Belastung in Bezug auf das Handhaben von Lasten an diesen Arbeitsplätzen auftreten. Durch die Herausforderungen des demographischen Wandel muss ein Ziel sein, die Logistikarbeitsplätze so zu gestalten, dass die körperlichen Belastungen auf ein vertretbares Minimum reduziert werden und somit auch noch ältere Mitarbeiter in der Lage sind in der Logistik zu arbeiten. Grundlage dafür ist eine Arbeitsgestaltung die bereits bei der Planung ergonomische Aspekte berücksichtigt. Damit dies gelingt, muss der Planer in der Lage sein, bereits bei der Planung eine Belastungsanalyse für die geplanten Arbeitsplätzte durchzuführen. Der Beitrag stellt eine Methodik vor, die, basierend auf eigens entwickelten MTM-Prozessbausteinen für die Kommissionierung, eine einfache Lösung für die Belastungsermittlung nach der Leitmerkmalmethode bietet. Dabei wurde die Leitmerkmalmethode erweitert, um das heterogene Lastspektrum bzw. die Inhomogenität der Handhabungsprozesse des Kommissionierers bewerten zu können. Durch das entstandene excelbasierte Werkzeug erhält der MTM-Prozessplaner frühzeitig Aussagen über die bei der Tätigkeit des Kommissionierens auftretende Belastung.

1. NEUE HERAUSFORDERUNGEN DER LOGISTIKPLANUNG

Während in der Praxis häufig allein die ökonomische und ökologische Dimension der Nachhaltigkeit verstanden und bei der Gestaltung logistischer Systeme primär verfolgt wird, rückt vor dem Hintergrund des demographischen Wandels die soziale Nachhaltigkeit mehr und mehr in der Vordergrund. In den kommenden Jahren wird aufgrund der demographischen Entwicklung die Überalterung der Gesellschaft und somit auch der Erwerbstätigkeiten weiter voranschreiten.

Das Altern der Belegschaft stellt insofern eine Herausforderung dar, als dass sich mit zunehmendem Erwerbsalter die individuellen Fähigkeiten und Kompetenzen der Mitarbeiter verändern. Eine gesicherte Erkenntnis ist diesbezüglich, dass die Schwankungsbreite der Leistungsparameter mit dem Alter zunimmt [3,4]. Dabei darf nicht davon ausgegangen werden, dass alterstypische Veränderungen auf jeden älteren Beschäftigten zutreffen oder in gleichem Maße ausgeprägt sind. Dennoch lassen sich Veränderungen identifizieren, die typisch für ein zunehmendes Lebensalter sind [9]. Im von körperlicher Arbeit geprägten operativen Geschäft von Produktion und Logistik spielt insbesondere die tendenziell sinkende körperliche Belastbarkeit im Alter eine große Rolle. Diese kann zu Produktivitätseinbußen, höheren Ausfallzeiten der Mitarbeiter, größeren erforderlichen Erholzeiten sowie geringerer Einsatzflexibilität der Mitarbeiter aufgrund von altersbedingten Leistungswandlungen führen. Gerade der letztgenannten flexiblen Einsetzbarkeit der Mitarbeiter ist es zu verdanken, dass der Logistiker nach wie vor nicht aus den Logistikprozessen wegzudenken ist. Jedoch steigt gerade mit Zunahme des Erwerbsalters die Anzahl an körperlichen Einschränkungen der Mitarbeiter; insbesondere dann, wenn die Erwerbstätigkeit – wie oftmals in Produktion und Logistik – ein Leben lang durch körperliche Belastungen geprägt ist. In Zeiten der Wertschöpfungsorientierung kommt hinzu, dass die Anforderungen an die Mitarbeiter keinesfalls geringer werden. Die Logistik ist diesbezüglich in zweifacher Weise betroffen. Während in der Produktion Maßnahmen vorangetrieben werden, um dem demographischen Wandel entgegen zu treten, wird die Logistik als nicht wertschöpfende Tätigkeit eher stiefmütterlich behandelt. Zudem sortieren Unternehmen ihre Mitarbeiter oftmals aufgrund des in der Produktion herrschenden Leistungsdrucks der Takt- und Akkordvorgaben aus, um sie in den vermeintlich weniger belastenden Tätigkeiten der Logistik unterzubringen.

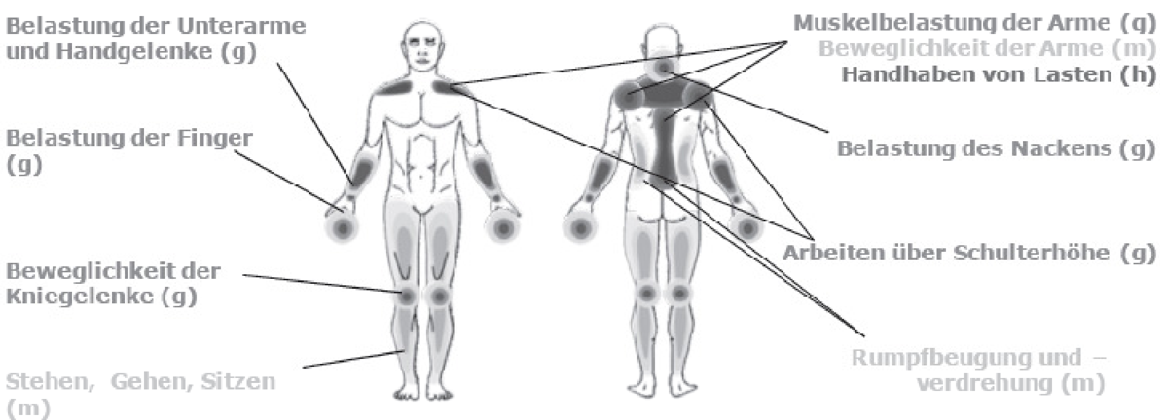

Abb. 1: Typische körperliche Belastung in der operativen Logistik inkl. Farbkodierung (g = geringe Belastung, m = mittlere Belastung, h = hohe Belastung)

Eine Untersuchung der Belastung an ausgewählten Arbeitsplätzen der operativen Logistik wurde vom Lehrstuhl fml der TU München im Rahmen des Teilprojekts „Logistiksysteme und Organisation" des von der Bayerischen Forschungsstiftung geförderten Forschungsverbundes „Zukunftsorientierte Produkte und Dienstleistungen für die demographischen Herausforderungen" (FitForAge) durchgeführt, um den aktuellen Stand der Belastungssituation in der Logistik abzubilden. Die Ergebnisse von aus mehr als 40 in der Praxis durchgeführten ingenieurs- und verhaltenswissenschaftlichen Arbeitsanalysen in der operativen Logistik zeigen ein deutliches Bild, was die körperliche Belastung der Mitarbeiter anbetrifft (Abbildung 1).

Die Anforderungs- und Belastbarkeits-Analysen (ABA) wurden hauptsächlich mit dem von der BMW Group zur Verfügung gestellten ABA-Tech [7] durchgeführt, wobei insbesondere die 11 Merkmale zur Beschreibung der auftretenden körperlichen Belastung von ABA-Tech im Vordergrund standen. Die untersuchten Tätigkeiten in der Logistik weisen fast durchweg eine hohe körperliche Belastung in Bezug auf das Handhaben von Lasten – als die typische Tätigkeit der operativen Logistik – nach. Damit einhergehend sind die Merkmale der Rumpfbeugung und -verdrehung sowie durch das häufige Überschreiten des Greifraums – die erforderliche „Beweglichkeit der Arme" – als belastend einzustufen. Dies ist insbesondere dann häufig der Fall, wenn das Handhaben der Waren in oder aus Großladungsträgern und Paletten erfolgt. Nicht zuletzt handelt es sich in der Logistik auf der einen Seite häufig um Steh-/Geharbeitsplätze, die nur selten durch Sitzmöglichkeiten Entlastung bringen; wie zum Beispiel beim Kommissionieren von Kleinteilen und Paketen. Andererseits sind umgekehrt Arbeitsplätze wie das Staplerfahren vorhanden, die als reine Sitzarbeitsplätze eingestuft werden können und umgekehrt wenig Belastungsausgleich in Form von Gehen und Stehen bieten. Der Schaden, den neben den Mitarbeitern auch die Unternehmen aufgrund von zu hoher körperlicher Belastung tragen müssen, ist nicht wegzudiskutieren. Nach wie vor nimmt der Anteil an Arbeitsunfähigkeitstagen (AU-Tage) aufgrund von Muskel-Skelett-Erkrankungen (MSE) den Hauptteil des Krankenstandes in den Industriebetrieben ein [1]. Etwa ein Viertel der AU-Tage fallen auf die MSE, wobei unbestritten ist, dass das Handhaben von Lasten erheblichen Anteil am Krankheitsgeschehen hat. In der operativen Logistik tritt dieses Phänomen häufig zu Tage, da die Kommissionierung und das Verpacken von Waren immer noch stark von körperlicher Arbeit in Form der Lastenhandhabung geprägt sind. Entsprechend wichtig ist es, bereits bei der Planung und Auslegung von Logistikarbeitsplätzen die körperliche Beanspruchung zu bewerten und als Gestaltungskriterium einzubeziehen. Ziel muss es sein, eine möglichst ergonomische und wertschöpfende Arbeitsgestaltung zu erzielen. Der Beitrag zeigt eine Methodik auf, welche die für die Prozessplanung und Ausführungsanalyse weit verbreiteten Methods Time Measurement (MTM) mit der Leitmerkmalmethode (LMM) [2] kombiniert. Für den Anwendungsfall der Kommissionierung wurde dabei die von der Bundesanstalt für Arbeitsschutz und Arbeitsmedizin für die praxisgerechte Ermittlung der objektiv vorhandenen Arbeitsbelastung empfohlene LMM adaptiert und mit eigens entwickelten MTM-Bausteinen für die Kommissionierung in einem excelbasierten Werkzeug verknüpft.

2. MTM-BAUSTEINE FÜR DIE KOMMISSIONIERUNG

Die Kommissionierung ist die zentrale Funktion der Lagerlogistik und hat wesentlichen Einfluss auf nachfolgende Bereiche wie Produktion und Distribution. Sie stellt trotz des Trends zur teilweisen Automatisierung einen kostenintensiven Bereich in modernen Logistiksystemen dar, was vor allem auf den hohen Personalanteil zurückzuführen ist. Bei der Kommissionierung werden Artikel aus einem Sortiment nach Kundenwunsch zusammengestellt und an den Kunden versendet. Dabei handelt es sich um die schwierigste Aufgabe der innerbetrieblichen Logistik [5]. Dies ist auf die Komplexität von Kommissioniersystemen zurückzuführen, da es eine Vielzahl von Verfahren gibt, wie die Kommissionieraufgabe durchgeführt werden kann.

Eng mit der Auswahl des Kommissionierverfahrens ist die Prozessgestaltung verknüpft. Für die spätere Bewertung der Arbeitsplätze muss der Prozess so beschrieben werden, dass Aussagen zur Belastung möglich sind. Hier eignen sich vor allem MTM-Analysen, da sie den Prozess transparent und nachvollziehbar darstellen und zusätzlich noch die Möglichkeit einer zeitlichen Bewertung bieten. Trotzdem, werden MTM-Planungsanalysen in der Logistikplanung bisher kaum eingesetzt. Dieser Sachverhalt ist zum einen durch die fehlende Ausbildung der Logistikplaner und zum anderen durch den hohen Zeitaufwand für die Analyse zu begründen. Die Erstellung von MTM-Analysen für die zahlreichen Varianten in der Planung erhöht den Aufwand merklich. Grundvoraussetzung für die Nutzung von MTM in der Systemfindung ist, dass der Planer auf hochaggregierte MTM-Prozessbausteine zurückgreifen kann. Dies erlaubt die schnelle Beschreibung von Prozessen im Kommissioniersystem.

Zahlreiche MTM-Ablaufanalysen von realen Kommissionierprozessen, die im Rahmen der Forschungsprojekte durchgeführt wurden, haben gezeigt, dass es kaum Prozesse gibt, die absolut identisch sind. Wird das Abstraktionsniveau erhöht, lässt sich ein Zusammenhang zwischen einem Kommissionierverfahren und einem Prozess erkennen. Wesentliche Einflussfaktoren, die den Ablauf eines Verfahrens beeinflussen, sind die Art der Informationsbereitstellung und die Transporthilfsmittel. Auf Grundlage der Erkenntnisse aus den MTM-Analysen wurde am Lehrstuhl fml eine Systematik entwickelt, die es jedem Logistikplaner erlaubt, in kurzer Zeit eine MTM-Prozessbeschreibung für einen Kommissionierprozess zu erstellen. Abbildung 2 stellt die Systematik am Beispiel des Kommissionierverfahrens „Person zur Ware in einer Fachbodenregalanlage“ dar.

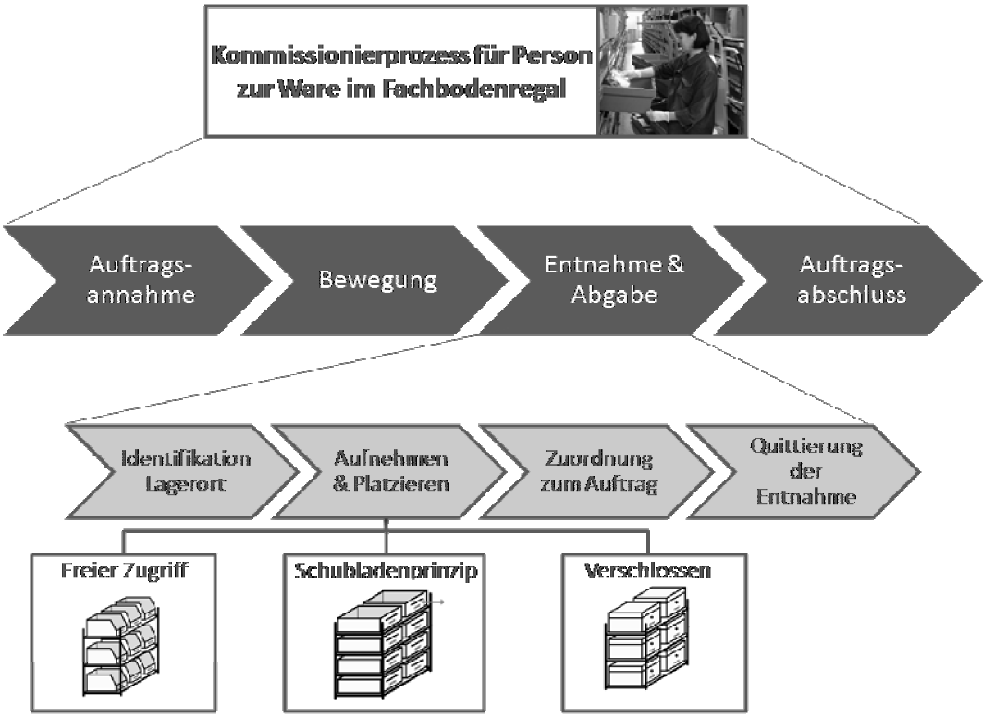

Abb. 2: Systematik für das Erstellen von MTM-Ablaufbeschreibungen auf Grundlage von vordefinierten Gestaltungsmöglichkeiten

Vom Kommissionierprinzip ausgehend muss der Planer für jeden Prozessschritt mögliche Gestaltungsmöglichkeiten auswählen. Dadurch wird der Prozess für dieses Kommissionierverfahren soweit spezifiziert, dass die Planungsanalyse aus hinterlegten MTM-Prozessbausteinen zusammengesetzt werden kann. Vorteil bei diesem Vorgehen ist, dass eine MTM-Ausbildung nicht zwingend notwendig ist. Die Prozessbeschreibung durch den Planer erfolgt nicht auf der Ebene von MTM-Prozessbausteinen, sondern auf der Ebene von Gestaltungsmerkmalen wie dem Regaltyp, dem Ladungsträger oder der Informationsbereitstellung. Durch eine Kontrolllogik wird nach jeder Auswahl geprüft, welche Optionen für noch nicht festgelegte Gestaltungsmöglichkeiten zulässig sind ohne dass ein Widerspruch in der Prozessbeschreibung entsteht.

Die entwickelten Bausteine basieren auf den Universelles Analysier-System (UAS). Der Einsatz der MTM-Bausteine in Projekten hat gezeigt, dass das höhere Abstraktionslevel die Planungsergebnisse nicht negativ beeinflusst. Vielmehr ließ sich durch den Einsatz der Bausteine die Genauigkeit der Planungsergebnisse mit Hilfe der genauen Prozessbeschreibung und der validen Prozesszeiten erhöhen. Abbildung 3 zeigt einen Vergleich von Prozesszeiten, die unter Verwendung der Bausteine bestimmt wurden, mit Zeitaufnahmen vor Ort. Eine Differenz von +/-10% ist für die Planung in einem akzeptablen Bereich.

Den Nachweis, dass ein Kommissionierprozess effizient ist, kann der Planer durch eine MTM-Analyse mit den erarbeiteten Bausteinen erbringen. Zum guten Ton gehört es heute zudem, frühzeitig die Belastungen, denen der Mitarbeiter bei der Kommissionierung ausgesetzt, wird zu bewerten.

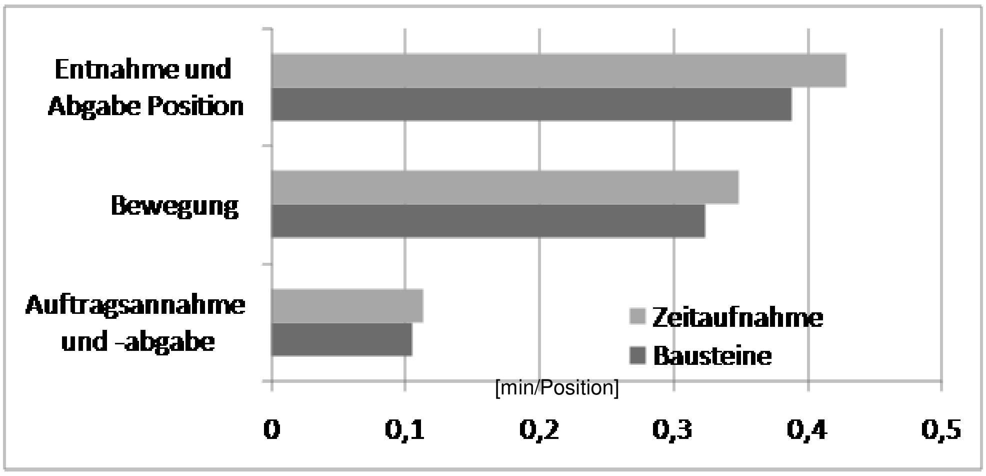

Abb. 3: Vergleich der durch die MTM-Bausteine ermittelten Zeiten mit im Betrieb gemessenen Zeiten.

3. BERECHNUNG DER BELASTUNG BEI MULTIPLER LASTHANDHABUNG MIT HETEROGENER LASTVERTEILUNG NACH DER LEITMERKMALMETHODE

Während für die Montage bereits zahlreiche Bewertungsmethoden zur Ermittlung der Belastung existieren, sind derzeit nur in Ansätzen Verfahren für die operative Logistik verfügbar; z.B. Bosch-Verfahren zur Bewertung von Milkruns [8], Wirbelsäulenbelastung in der Kommissionierung (Goldscheid 2008). Ursache hierfür ist die Inhomogenität in den Handhabungsprozessen aufgrund des großen Artikelspektrums, wie es sich vor allem in der Kommissionierung zeigt. Auch die LMM in ihrer Grundform wird den Anforderungen insofern nicht gerecht, als dass sie für eine zusammenfassende Bewertung von Teiltätigkeiten mit sich stark unterscheidenden Lastgewichten und Körperhaltungen nicht vorgesehen ist.

Eine Möglichkeit bietet sich jedoch durch die Berechnung eines Gesamtrisikowerts, der sich aus den Teiltätigkeiten unter Zuhilfenahme eines Normvorgangs (Abbildung 3) ergibt.
Im ersten Schritt werden hierzu aus der heterogenen Lastverteilung bei den Handhabungsvorgängen über die gesamte Arbeitszeit sinnvolle Lastklassen gebildet. Für jede Klasse wird aus den in ihr enthaltenen Einzelgewichten der Artikel der arithmetische Mittelwert berechnet. Im zweiten Schritt sind die Lastaufnahme- und abgabehöhen zu ermitteln und die bei der Abgabe und Aufnahme eingenommenen Körperhaltungen des Kommissionierers zuzuordnen. Diese definieren in Kombina-

tion mit den Hubhäufigkeiten je Lastklasse die Teiltätigkeiten, wobei die Hubhäufigkeiten durch die MTM-Prozessbeschreibung festgelegt wird.

Bezeichnung	Lastklasse [kg]	arithmetischer Mittelwert	Hübe je Lastklasse	Haltung	Hübe je Teiltätigkeit	Zeitw…	Lastwichtung Männer	Haltungswichtung	Ausführungswichtung	Einzelrisikowert	Normierte Zeitw…	Normierte Anzahl Hübe pro…
...	...	...	...	C	...	...	...	...	...	...	...	...
Lastklasse 2	3,0-7,9	5,7	303	A	75,8	3,26	1	1	0	6,53	1,63	13,94
				B	151,5	4,34	1	2	0	13,01	3,25	75,05
				C	75,8	3,26	1	4	0	16,32	4,08	130,62
Lastklasse 3	8,0-14,9	11,7	123	A	30,8	2,26	1,55	1	0	5,76	1,44	10,29
				B	61,5	3,00	1,55	2	0	7,89	1,97	22,15
				C	30,8	2,26	1,55	4	0	10,46	2,61	44,01
...	...	...	...	A	...	...	...	...	...	...	...	...
						Σ normierte Hübe pro Teiltätigkeit						438,53
						Zeitwichtung des gesamten Normvorgangs						6,70
						Gesamtrisikowert auf Basis des Normvorgangs						26,81

Abb. 3: Beispielrechnung zur Ermittlung des Gesamtrisikowerts nach der für die Anforderungen der operativen Logistik adaptierten Leitmerkmalmethode

Die Interpolation der Zahlenwerte für die Zeit- und Lastwichtung nach der LMM liefert für das Beispiel des Umsetzens von Lasten den formellen Zusammenhang:

$$y_1 = 4{,}2144x_1^{2{,}4416} \; mit \; y_1 = Zeitwichtung; \; x_1 = Anzahl\ Hübe\ pro\ Zeitintervall$$

$$y_2 = 13{,}02 \ln x_2 + 5{,}9561 \; mit \; y_2 = Lastwichtung \;\in R \geq 1; \; x_2 = wirksame\ Last\ für\ Männer$$

In Kombination mit der Haltungs- und Ausführungswichtung lassen sich die Einzelrisikowerte für jede Teiltätigkeit berechnen. Über einen zu definierenden Normvorgang (beliebig festzulegende Haltungs-, Last- und Ausführungswichtung) lässt sich für die Teiltätigkeiten die normierte Zeitwichtung und die äquivalenten Hubzahlen berechnen. Die Summe der normierten Hübe des fiktiven Normvorgangs spiegelt die äquivalente Belastung der realen Hubvorgänge mit ihrer heterogenen Lastverteilung wider. Zu guter Letzt lässt sich der Gesamtrisikowert auf Basis des Normvorgangs ermitteln.

Die meisten der Informationen, die für die Durchführung der beschriebenen LMM notwendig sind, sind bereits durch die MTM-Prozessbeschreibung festgelegt. Vielmehr ist eine fundierte LMM in der Planung nur dann durchführbar, wenn die Informationen aus einer detaillierten Prozessbeschreibung vorliegen. Nur so kann die Belastungsdauer möglichst objektiv und transparent ermittelt werden. Eine Belastungsermittlung durch Einschätzung von Experten (Mitarbeiter, Meister, Arbeitssicherheit, Betriebsrat etc.) zeigte eine große Abweichung zur errechneten Belastung, da häufig falsche Annahmen aufgrund fehlender Daten getroffen werden.

Der Schritt von einer MTM Prozessbeschreibung zur Durchführung der beschriebenen LMM ist demnach nicht sehr groß. Auf der anderen Seite lässt sich durch die Bewertung der Belastung sicherstellen, dass bei der Prozessplanung und Arbeitsplatzgestaltung ergonomische Gesichtspunkte berücksichtigt werden und der Planer für ergonomische Fragestellungen sensibilisiert wird.

Die beschriebenen MTM-Komissionierbausteine wurden gemeinsam mit der LMM-Methodik sowohl für das Heben als auch für das Ziehen und Schieben von Lasten [2] in der Kommissionierung in einem excelbasierten Werkzeug abgebildet. Als Ein-/Ausgaben sind im Wesentlichen die bestehende Lagergeometrie, der Kommissionierprozess an sich und die typische Last- und Haltungsverteilung einmalig zu hinterlegen. Weitere Einflussgrößen wie z.B. die Auftrags- und Sortimentsstruktur sowie Entnahme- und Abgabehöhen lassen sich oftmals aus dem Warehouse Management System beziehen.

4. FAZIT

Durch die vorgestellte Methode lässt sich bereits bei der Prozessplanung die auf den Kommissionierer wirkende Belastung berücksichtigen, was eine nachhaltige Planung von Logistiksystemen ermöglicht. Mit ihr ist zudem eine Form der Belastungsermittlung in der operativen Logistik möglich, die eine orientierende Aussage bei der Handhabung von unterschiedlichen Lastspektren sowie inhomogenen Prozessen liefert. Außerdem bieten die MTM-Kommissionierbausteine die Möglichkeit, Kommissionierprozesse schneller als bisher abzubilden.
Durch das am Lehrstuhl fml entstandene Werkzeug ist das Ziel, die Akzeptanz und den Einsatz der Arbeitsanalyse nach der Leitmerkmalmethode in der operativen Logistik zu steigern, ein Stück näher gerückt. So kann nun frühzeitig in der Prozessplanungsphase eine beanspruchungsgerechte Arbeitsplatzgestaltung berücksichtigt und so nachhaltig der Erhalt der Erwerbsfähigkeit der Mitarbeiter gesichert werden.

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ОЦЕНКА ПОТЕРЬ В ЛОГИСТИЧЕСКОЙ ПРОИЗВОДСТВЕННОЙ СИСТЕМЕ

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Аннотация: Систематизированы и проанализированы все возможные виды производственных потерь, проведена классификация потерь по результатам картирования, выявлены доминирующие потери, выявлен новый вид потерь из-за несоответствия квалификации персонала, апробированы методы устранения потерь, проведена оценка эффективности внедрения мероприятий по оптимизации и управлению потерями.

Сегодня конкурентоспособность промышленных предприятий объединяет в себе качество и экономичность товаров на всех стадиях их жизненного цикла, современные системы организации и управления бизнес-процессами [4]. Исключив хотя бы одну из перечисленных составляющих, невозможно создать конкурентоспособный товар и решить задачу повышения эффективности деятельности промышленного предприятия. Такой системный и комплексный подход возможно обеспечить в рамках реализации инновационных концепций организации производства, которые представляет собой набор конкретных методов организации бизнес-процессов в широком смысле этого слова, построенных на опыте передовых компаний мира, направленных на победу в конкурентной борьбе за счет минимизации различного рода потерь как в системе производства, так и в системе потребления.

Новые методы организации производства повсеместно признаются как наиболее эффективные, надежные и мало затратные пути компаний к выходу из кризиса и повышению конкурентоспособности в глобальном масштабе. К данным методам можно отнести: lean management, kaizen, kanban, just in time и другие [3]. Эти методы позволяют без существенных капитальных затрат значительно повысить производительность, улучшить качество продукции и услуг, сократить издержки, время производственного цикла и дефектность, устранить потери.

Применительно к новым методам организации производства термин «бережливое производство», предполагающий принципиально новую систему взглядов на управление потерями, был введен Дж.Кравчиком. Позднее развитием указанной системы методов занимались О.С.Виханский, Дж.Вумек, Д.Джонс и другие авторы. Lean – это концепция менеджмента, созданная в компании Toyota и основанная на неуклонном стремлении к устранению семи видов потер:1.пепепроизводства; 2.излишних запасов; 3.транспортировки; 4.времени ожидания; 5.излишней обработки; 6.перемещения; дефектов и переделок.

Новые методы организации производства, зародившиеся из практики передовых японских компаний, быстро находят широкое применение по всему миру [6]. Указанные проблемы уже особенно актуальны и будут приобретать все большее значение в будущем, по мере роста населения планеты и исчерпаемости ограниченных ресурсов. Исследования в этой области, проведенные до настоящего времени такими экономистами, как Т.Оно, Д.Лайкер, Д.Майер, Д.Вумек и др., говорят о значительном научном и практическом потенциале новых концепций организации производства в решении проблемы обеспечения конкурентоспособности предприятий. Однако они в основном касались международных компаний.

Так, например, зарубежные предприятия (Daimler AG, Toyota и другие), идущие по пути внедрения новых принципов и инструментов организации производства, при минимальных вложениях добиваются следующих результатов: увеличение производительности труда на 35-70 процентов; сокращение времени производственного цикла на 25-90 процентов; рост качества на 40 процентов.

Теоретические разработки и практика промышленных предприятий показали, что для большинства машиностроительных предприятий имеются значительные резервы повышения эффективности процессов снижения образования потерь. По результатам многочисленных исследований, значение количественных показателей производственных потерь в машиностроительной отрасли превышает аналогичные параметры в любых других сферах применения на 30%[1], разработка эффективной системы мониторинга и управления производственными потерями на предприятиях машиностроения позволяют сократить данные показатели на 34-37%. Причем последние достижения экономической и организационной науки позволяют пересмотреть бытовавшие ранее взгляды на потери как на чисто материальные потери, для чего вводятся новые категории потерь, имеющие место на машиностроительных производствах.

За время использования на предприятиях Российской Федерации (РФ) методик устранения потерь появилась положительная динамика развития предприятий. Эффективность внедрения доказана на таких предприятиях, как «Камский Автомобильный Завод» (КамАЗ), «Казанькомпрессормаш», «Елабужзский Автомобильный Завод» (ЕЛАЗ), «Новосибирское авиационное производственное объединение им. В. П. Чкалова» (НАПО), «Горьковский автомобильный завод» (ГАЗ) и др.

[1] По данным рейтингового агентства «Эксперт РА»

Так, например, на ОАО «КамАЗ» по итогам 2009 года экономический эффект от применения lean-методов и созданной производственной системы «КамАЗ» (PSK) составил 1,6 миллиарда рублей, на 2010 год - 1,8 миллиарда. Достигнуты главные цели по качеству: число рекламаций на продукцию собственного производства уменьшилось в два раза, по компонентам, закупаемым у сторонних поставщиков, – на 45 процентов, За период с 2006 по 2011 годы с производственных площадей убрано 10 тысяч штук крупногабаритной тары, что позволило снизить запасы комплектующих на сборочных линиях в 3 раза. Лишь за счет улучшений, которые инициированы работниками цехов, а также конструкторами и технологами, на ОАО «КамАЗ» получен экономический эффект от внедренных предложений в размере 7 млн. 600 тысяч рублей. В 2011 году от использования методов и инструментов PSK экономический эффект предположительно составит более 4,5 миллиарда рублей.

Однозначно позитивным образом сказались такие преобразования, как изменение логистической системы, структуры управления логистикой, решения по календарному планированию, а также проводившаяся в течение года централизация складов, передача этого хозяйства в ведение логистического центра.

Активно занимаясь снижением затрат с помощью инструментов Бережливого производства, на КамАЗе накопили значительный опыт по выявлению потерь. В рамках сотрудничества со своим стратегическим партнером – компанией Daimler AG, ОАО «КамАЗ» сегодня работает над интеграцией PSK с ее немецким аналогом Truck Operating System. Все улучшения проверяются на соответствие 14 стандартным принципам логистики Daimler. Текущее состояние соответствует 14 стандартным принципам логистики TOS на 18 %. Их совместный проект «Маяк» помимо известных семи видов потерь выделяет еще два источника потерь – мури (перезагрузка) и мура (неравномерность).

Устранять эти два вида потерь, планируется путем внедрения стандартов сборки стратегического партнера КамАЗ компании Daimler AG, балансировки сборочных линий и выравнивания трудоемкости операций внутри сборочных процессов с помощью построения диаграмм Ямадзуми (рис.1). Суть этих диаграмм заключается в том, что время, необходимое на каждую операцию, анализируется на соответствие целевому такту процесса, а внутри самой операции выделяют этапы создания ценности, вынужденные и явные потери, за счет устранения которых общее время на операцию приводят в соответствие с целевым тактом.

В условиях современного этапа технико-экономического развития, большинство внедрений происходило по разработкам зарубежных авторов, в то время как работ по адаптации новых методов к российским реалиям практически нет, а жизнь предъявляет повышенный спрос на подобные работы.

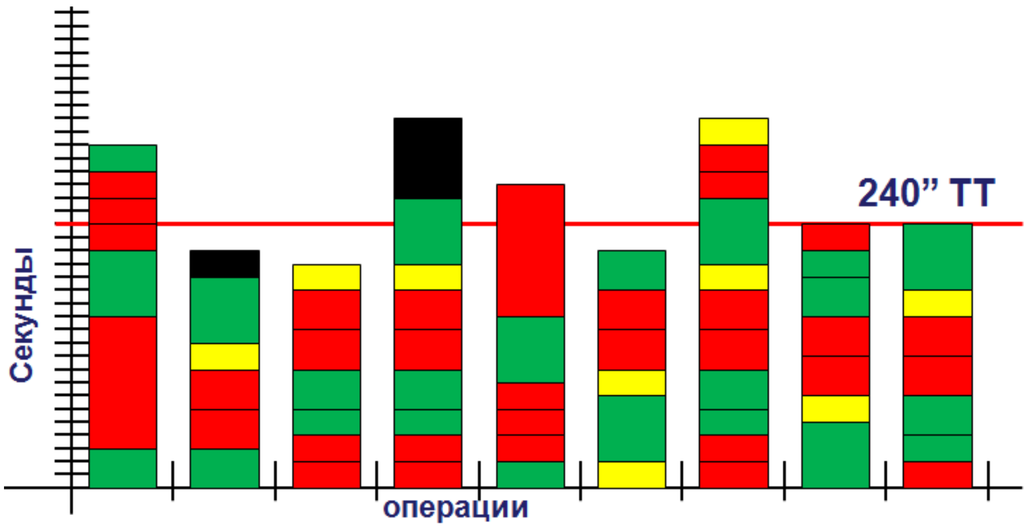

Рис.1 Диаграмма Ямадзуми

В этой связи, нами разработана концептуальная структура системы снижения производственных потерь на машиностроительных предприятиях, включающая характеристику субъектов системы, объектов системы и механизмов взаимодействия между объектами и субъектами, и авторская матрица соотносимости потерь и инструментов их устранения по видам ресурсов, позволяющая формировать набор мероприятий, в наибольшей степени соответствующий текущему состоянию объекта системы.

Понятно, что эффективной является производственная система, которая при заданном уровне качества позволяет максимально быстро управлять, проектировать, осваивать, изготавливать и предоставлять заказчику требуемые изделия с минимальным вовлечением оборотных средств и минимально возможными операционными расходами (быстро и без потерь). Обычно выделяют следующие направления развития производственных систем: внедрение бережливого производства, техническое перевооружение производства, внедрение системы бережливой разработки продукции, внедрение информационных технологий.

Управление производством в целом и отдельными составными элементами возможно только системно. Базовыми характеристиками системы считаются объект, субъект, механизм их взаимодействия и цель функционирования. Концептуально, наша система на микроуровне выглядит следующим образом (рис. 2).

Эта система снижения производственных потерь на машиностроительных предприятиях будет являться подсистемой относительно всей системы управления предприятием. Субъекты системы оказывают то или иное управляющее воздействие в соответствии с выполняемыми ими функциями. Причем субъектами системы будут считаться все службы и работники, от действий которых зависит снижение производственных потерь: от органов государственной власти, устанавливающих нормы потерь и требования к производственному процессу, до работников, непосредственно воздействующих на сырье и полуфабрикаты.

Рис. 2. Концептуальная структура системы снижения производственных потерь на машиностроительных предприятиях на микроуровне [2]

Объектом системы являются бизнес-процессы, в ходе выполнения которых могут возникать различные производственные потери. С точки зрения управления важно не только выделить такие бизнес-процессы, но и определить, на каком процессе возможно возникновение тех или иных типов потерь. Механизмы управляющего воздействия субъектов на объекты зависят от характера бизнес-процессов, от типа наиболее значимых потерь в данном бизнес-процессе, от специфики субъекта, оказывающего управляющее воздействие. Очень большое значение приобретает обратная связь от объекта к субъекту. Благодаря этому можно оценить качество воздействия и скорректировать последующие воздействия.

Предлагаемая нами концептуальная структура благодаря своей внутренней гибкости позволяет учесть все многообразие машиностроительных производств и, одновременно, создает предпосылки для существенного повышения эффективности процессов снижения производственных потерь на машиностроительных предприятиях.

Для любого развивающегося предприятия, приблизившегося к пределам линейного роста, оптимизация затрат становится одним из приоритетных инструментов повышения прибыльности. В ситуации же финансового кризиса сокращение затрат для многих организаций становится основным условием выживания. Таким образом, анализ и прогнозирование возможных потерь ресурсов занимает центральное место в рыночных отношениях, причем не объективно необходимого расхода ресурсов, обусловленного характером и масштабом производственно-сбытовой деятельности предприятия (фирмы), а случайных, непредвиденных, но потенциально возможных потерь, возникающих вследствие отклонения от запланированного хода производства и реализации продукции. Это могут быть материальные, трудовые и финансовые потери, потери времени.

Иная точка зрения представлена в концепции бережливого производства: всю деятельность предприятия можно классифицировать так: операции и процессы, добавляющие ценность для потребителя, и операции и процессы, не добавляющие ценности для потребителя. Следовательно, всё, что не добавляет ценности для потребителя, с точки зрения бережливого производства, классифицируется как потери, и должно быть устранено.

Суммарные потери по структурному подразделению P^{Σ} определяют по формуле:

$$P^{\Sigma} = \sum_{j=1}^{7} P_j \,. \qquad (1)\ [2]$$

Оценка потерь проводилась на промышленном предприятии ОАО «Казанькомпрессормаш». При выборе наиболее эффективных инструментов был применен метод Парето.

Выбор необходимых инструментов свелся к следующим шагам:

1) Классификация потерь по результатам картирования (потери, выявленные при картировании идентифицированы и отнесены к соответствующей группе потерь).
2) Выявление доминирующих потерь (просуммировано время потерь по видам и определено процентное соотношение потерь в исследуемом процессе).
3) Определение необходимых первоочередных инструментов (для этого внесены потери и их процентный «вес» в аттестационную карту и для 2-3 видов доминирующих потерь определены соответствующие инструменты).

Данная работа должна проводиться во всех последующих аттестационных картах, так как доминирующие потери могут изменяться по мере использования инструментов бережливого производства и для их устранения необходимы другие инструменты.

Если взять для примера оценку эффективности внедрения мероприятий бережливого производства результаты картирования типовой детали, то доминирующей потерей будет являться – ожидание. Доля этого вида потерь составляет 91% от всей совокупности потерь (рис. 3).

Потери	Ток	БТК	Сверл	БТК	Итого, мин	Итого, % (без ожид.)	Итого, % (с ожид)
Перепроизводство	81,9	18,75	80,1	45	225,75	39,5	7,6
Дефекты							
Передвижения	15		10		25	4,4	0,8
Транспортировка	5	5	5	5	20	3,5	0,7
Запасы							
Излишняя обработка		6,25		15	21,25	3,7	0,7
Ожидание	170 (2400)		110		280 (2680)	49	91
					572 / 2972		

Рис. 3 Выявление доминирующих потерь типовой детали [5]

Соответственно, аттестационная карта (рис. 4) показывает, что наиболее эффективным инструментами сокращения потерь на данном этапе будут являться система точно вовремя, составление карты потока и быстрая переналадка.

Аттестационная карта

Наименование Фланец | Обозначение 4.524.816

Инструменты для устранения потерь / Обнаруженные потери	Перепроизводство	Дефекты	Передвижения	Транспортировка	Запасы	Излишняя обработка	Ожидание
Организация рабочих мест (система 5S)	1	1	2	1	2		2
Система всеобщего ухода за оборудованием (TPM)	2	3	1		1		3
Визуальный контроль	2	2	2	2	2	1	2
Стандартные операционные процедуры		3	2			2	
Точно вовремя	3	1			3	2	1
Канбан	3				3		3
Компоновка ячеек	3	2	3	3	3		1
Составление карты потока	3	3	3	3	3	3	3
Управление очередностью операций			1	2	3		3
Поток единичных изделий	3	1	1	2	3	1	3
Защита от ошибок	2	3	1	1	2	2	1
Быстрая переналадка	3	2	2		3		3
Балансировка производственных линий	3	1	2		3	2	1
	7,6		0,8	0,7		0,7	90,2

Рис. 4 Аттестационная карта типовой детали [5]

Теория организации производства в части снижения производственных потерь выработала определенный инструментарий, направленный на нейтрализацию определенных видов потерь [2]: 1) система TPM (Total Productive Maintenance); 2) система 5S4; 3) система SMED; 4) система JIT; 5) дзидока; 6) вытягивающее поточное производство; 7) картрирование потока создания ценности; 8) визуализация; 9) U-образные ячейки; 10) канбан; 11) ABC-анализ; 12) управления цепями поставок; 13) MRPII.

Нами предлагается матрица соотносимости разработанного инструментария с видами потерь, которые могут быть устранены (табл. 1).

Табл.1 Матрица соотносимости потерь, ресурсов и инструментов устранения потерь

Виды потерь	Инструменты устранения потерь ресурсов												
	ТРМ	5S	SMED	Точно в срок	Дзидока	Вытягиваю-щее поточное производство	VSM	Визуализация	U-образные ячейки	Канбан	АВС анализ	Цепи поставок	MRP II
Потери из-за перепроизводства				М		М, К					М		М
Потери из-за лишних этапов обработки		К				М, К	М					К	М
Потери из-за ненужных перемещений		К, Ф		М	М, Ф	К		К	К	М, К		К	
Потери из-за лишних запасов				Ф		Ф	Ф		К, Ф		М, Ф		Ф
Потери из-за ненужных проверок (контроля)					К								
Потери времени из-за ожидания	Ф	К	К	Ф	К	К	Ф	К		К		Ф	
Потери из-за выпуска дефектной продукции	К	К, Ф	К, Ф		М								
Потери из-за несоответствия квалификации персонала		К			М	Ф							К

Примечание. Потери ресурсов обозначены следующим образом: М – материальные, Ф – финансовые, К – кадровые.

Применительно к инновационным производствам на наш взгляд целесообразно выделять еще один вид потерь - потери из-за несоответствия уровня квалификации персонала. Данный вид потерь может формироваться, во-первых, из-за опоздания роста имеющегося уровня квалификации персонала по сравнению с ростом уровня требования к персоналу со стороны производства. Такая ситуация весьма возможна на инновационных предприятиях, когда переход на следующий уровень развития производства может скачкообразно повысить требования к квалификации персонала, а персонал как более инертная подсистема не сможет также оперативно изменить свои квалификационные характеристики [1]. Во-вторых, хотя это более редкая ситуация, потери из-за несоответствия уровня квалификации персонала могут принять и такую форму: имеющийся персонал имеет более высокую квалификацию, чем предъявляет производство. Например, такая ситуация может возникнуть, если на производстве в рамках подготовки к внедрению инновационного продукта был привлечен персонал с более высокой квалификацией, но инновационный скачок по каким-либо причинам откладывается (либо отменяется). В этом случае персонал требует повышенных расходов, но эти расходы не дают соответствующей отдачи, что приводит к потерям.

Качественно новым является «трехмерность» предлагаемой нами матрицы: наряду с используемыми ранее двумя размерностями – типы потерь и инструментарий – нами добавлено третье измерение – типы ресурсов, подверженных потерям. Третье измерение реализовано путем кодировки типов ресурсов и размещением кодов в ячейки матрицы. Такой подход позволяет более комплексно анализировать производственные потери и, соответственно, более эффективно управлять их снижением.

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GROUP SCHEDULING IN FLOW-LINE MANUFACTURING CELLS WITH VARIABLE NEIGHBORHOOD SEARCH

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Abstract: Group technology and cellular manufacturing, which lead to a reduction of setup times as well as a simplification of production control and logistics, have been a great benefit for the producing industry. But the implementation of manufacturing cells and part families result in a special scheduling problem with a high complexity referred to as group scheduling. On the one hand a sequence of jobs within every part family has to be determined, on the other hand the order of processing the part families is to be found. For this problem a heuristic variable neighborhood search algorithm is developed to minimize makespan. While traditional group scheduling algorithms consider an exhaustive processing of all jobs of a part family without interruption only, an extension is proposed that allows the splitting of part families. For several test problems both variable neighborhood search algorithms prove to be suitable for group scheduling problems. The average improvement compared to a well-known deterministic algorithm show that the results are similar to best known algorithms so far. While in general the average improvement ratios of non-exhaustive schedules are rather low, the non-exhaustive algorithm is able to gain significant improvements compared to the exhaustive solutions for some test instances. Therefore, the proposed approach gives direction for further research.

1. INTRODUCTION

Various challenges have been brought to the manufacturing industry during the last decades caused by, amongst others, a growing price competition, shorter product life cycles and customized products with a higher complexity and diversification [1]. As a result of these developments the flow-type mass production, which had been prevalent since the early twentieth century, was increasingly replaced by small lot size batch production. But this production type often causes diverse material flows and therewith very complex production control and logistics. To face these challenges, the concepts of “group technology” and “cellular manufacturing” were developed. Group technology is defined as “a manufacturing philosophy that identifies and exploits the underlying sameness of parts and manufacturing processes” [2], while cellular manufacturing (CM) is referred to as implementation of group technology in a manufacturing environment. For this purpose the manufacturing resources are divided into smaller organizational units called manufacturing cells, each of which produces a certain set of products referred to as part families. These part families are usually formed according to the required operations, machines and tooling. Beside a minimization of setup costs, the main advantage of CM is a simplification of material flows and consequently production logistics. Through the responsibility of a team for a limited set of parts production control can be handled within each cell autonomously while an improved operator expertise is achieved, which also leads to a more reliable production with improved quality and lower rework costs. Furthermore, shorter throughput times, lower stocks and therefore decreasing material handling and production costs are gained [3]. Thus, CM is especially advantageous in complex material flow systems with a high level of automation like “flexible manufacturing systems”.

But to obtain these impacts three major planning activities are necessary [4]: the grouping of machines, referred to as cell formation, the cell loading problem, which implies the assignment of part families and jobs to manufacturing cells, and the scheduling problem, that will be discussed in this paper. Of course, the scheduling task within each manufacturing cell is much less complex compared to the whole manufacturing system, since the number of jobs as well as the number of machines is limited. While traditional production systems often constitute job shop environments (i.e. the operations of a job have to be executed in a given sequence of machines that can vary for each job) the resolution of a flow shop is sufficient for scheduling in CM systems, that means the order of machines on which a job has to be processed is equal for all jobs. Nevertheless, either the assignment of more than just one part family to a cell or the splitting of part families to subfamilies (also “tooling families”), in which jobs require a similar tooling, still result in a complex sequencing task at two levels: At the first level a sequence of jobs or parts within each part family has to be determined, which is called a job sequence. At the second level the family sequence must be identified, a preferably optimal sequence of part families or subfamilies respectively [5]. Together, the family sequence and the job sequences form a group schedule. This problem is referred to as group scheduling problem in a (pure) flow line manufacturing cell and will be considered in this paper for a static and deterministic case.

Usually, sequence-independent or negligible setup times occur when changing from one job to another within a part family, so they can be included in processing times. However, sequence-dependent major setup times, which arise from a change of part families and the involved change of tooling, have a significant impact. Therefore, the “group technology assumption” is established, stating that all jobs of a part family have to be processed consecutively without interruption by jobs of a different part family.

Since the two-machine group scheduling problem with sequence-dependent setup times can easily be reduced to the NP-complete traveling salesman problem it is possible to solve it optimally for small problem instances only [7]. Thus, a number of algorithms and solution methods for the group scheduling problem with sequence-dependent as well as sequence-independent setup times have been developed since the early 1980’s [10]. While a modification of Johnson’s algorithm solves two-machine group scheduling problems optimally [2], various heuristic approaches were developed to find near-optimal solutions for larger instances within reasonable time. Among these were extensions of the CDS and NEH heuristic [9], heuristic branch-and-bound algorithms [10], as well as meta-heuristic approaches like simulated annealing [11], taboo search [8] and genetic algorithms [12]. Among the best-performing heuristics are a memetic algorithm [4] and a taboo search [13] which generated for several test problems group schedules whose makespans are only about 0.8% higher than a lower bound. Since a further improvement of a solution is harder to find the better a solution already is, gaining lower makespans is only possible with substantial additional effort. However, a simulated annealing algorithm [14] which creates non-permutation schedules recently generated significantly better solutions within reasonable time compared to permutation schedules and proved that new algorithms that are not limited to conventional restrictions are worth further research. The considered problem is described as follows: There are N jobs which have to be processed on M machines in the same given technological order without any priorities between individual jobs or part families. Every job belongs to one of N_F part families, while N_f jobs represents the number of jobs belonging to a family f. An anticipatory sequence-dependent family setup time s_{mgf} has to be taken into account for every changeover from part family g to family f on machine m. All setup and processing times are static, known in advance and executed without preemption. The family sequence as well as the job sequences are identical on every machine, i.e. only permutation schedules are considered. The objective is to minimize makespan of the group schedule. Using the classical notation by Graham et al. [15]. the problem can be described as $Fm| s_{fg,fam} |C_{max}$.

In this paper a new heuristic approach for the group scheduling problem with sequence-dependent setup times, which is based on the meta-heuristic of variable neighborhood search, is developed in chapter 2. Furthermore an extension that allows families to be processed in two batches separately is presented. In chapter 3 the computational results of the proposed algorithms for several test problems are discussed, followed by a summary and suggestions for further research.

2. GROUP SCHEDULING WITH VNS

Variable neighborhood search (VNS) has recently shown good performance for various problems [16], among these were also several scheduling problems [17,18]. VNS is characterized by simplicity as well as a high flexibility and adaptability to different types of problems. The basic idea of VNS is to systematically explore several types of neighborhood structures and so avoid being trapped in a local optimum, whereas a neighborhood structure is defined as a set of solutions that can be obtained through a specific modification of the incumbent solution [19]. The basic steps of VNS algorithms are shown in figure 1.

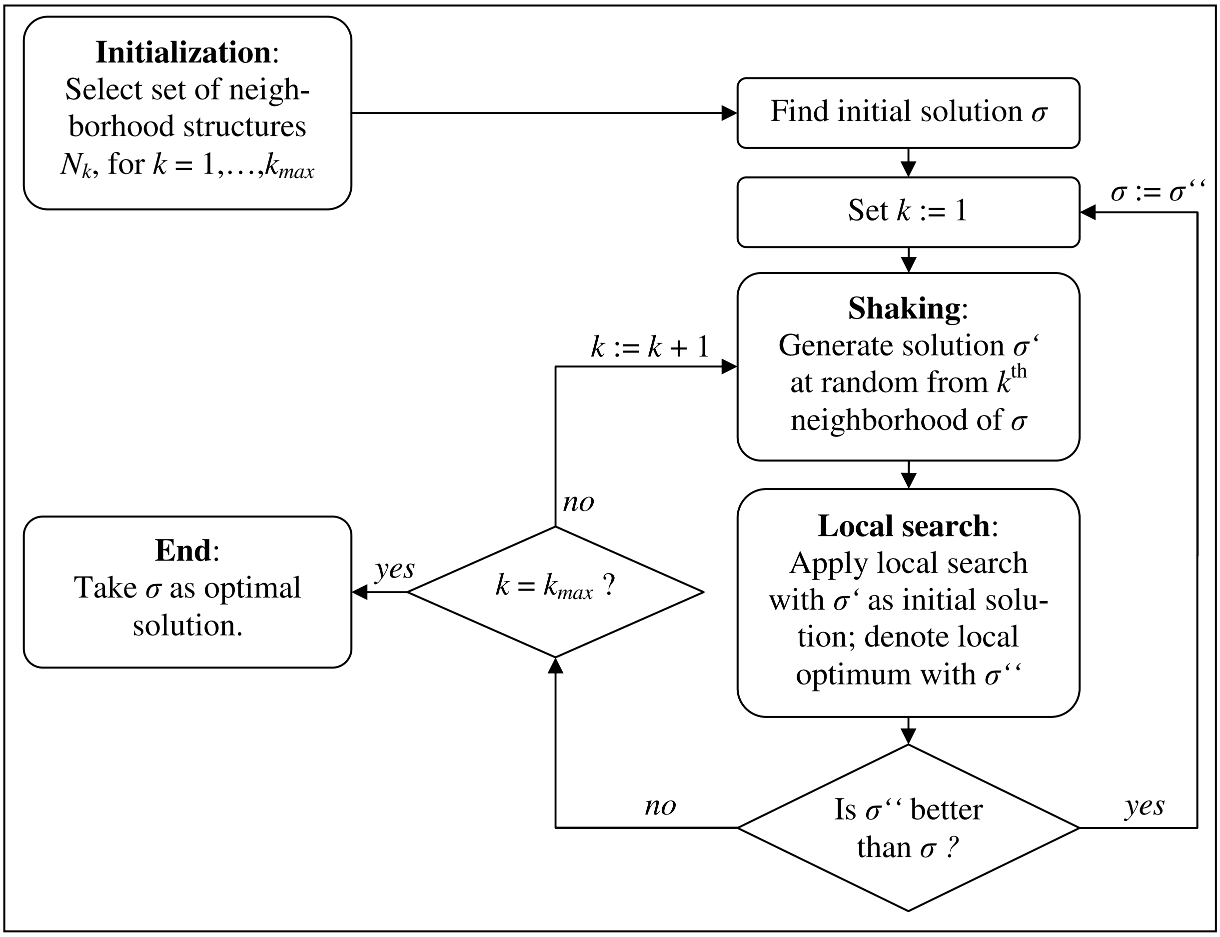

Figure 1: Basic steps of variable neighborhood search

Through the general formulation of VNS the definition and order of the neighborhood structures N_k, for $k = 1, \ldots, k_{max}$, is significant for the performance and has great impact on the character of the application of VNS. Usually, but not necessarily, the neighborhoods N_k are nested successively, i.e. the solution space of a neighborhood structure increases with growing k.

For the considered group scheduling problem a new VNS improvement algorithm is proposed which uses three different neighborhood definitions. In order to meet the interdependency of the two scheduling levels, the family and the job sequences are partly changed simultaneously. In the following the algorithm is described in more detail.

Solution representation

The solution representation for this problem is taken from [4]. N_F describing the number of part families, a solution σ (group schedule) is divided into $N_F + 1$ sections, each of which represents a family or job sequence. The first section stands for the family sequence σ_F and contains all part families. The second section represents the first job sequence σ_{J1}, the third one represents the second job sequence σ_{J2} and so on. Every job of a family is denoted by an individual number

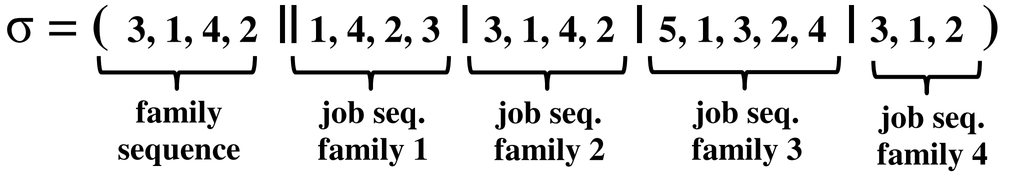

Figure 2: Solution representation for an example with four part families

between 1 and N_f, while N_f is the number of jobs in family f (see example in figure 2). This solution representation has the advantage that changes in the family and job sequences do not affect the representation of each other.

Initial Solution

In order to find a good initial solution a simple algorithm which is based on the basic steps of the NEH heuristic is applied [20]. Firstly, for every part family a job sequence is determined independently by successively adding every job to an in the beginning empty job sequence at the position with the lowest makespan. Thereby the schedules for every possible position of the inserted job are compared. Secondly, all part families with the determined job sequences are added to the family sequence analogously.

Due to the specific character of the group scheduling problem another solution is generated similarly, with the only difference that the job sequences are not determined by minimizing makespan but according to the lowest sum of inserted idle times. Of these two solutions the schedule with the lower makespan is taken as initial solution for the VNS algorithm. Compared to other simple algorithms this procedure showed very good results. In about 30% of all cases the minimization of the sum of inserted idle times for the generated test problems resulted in group schedules with a lower makespan than by minimizing makespan. For 26,2% of the cases both schedules showed an equal makespan.

Neighborhood definitions

Starting from this initial solution three different neighborhood structures are applied successively. These differ from each other in the number of insertion moves that are applied to the family and/or job sequences. With an insertion move a job (or family) in the position a is inserted to the position b. All jobs (families) between a and b are moved one position forward, for a > b, or backward, for b > a. Hence, the neighborhoods are defined as follows:

N_1: The first neighborhood contains all solutions that can be achieved with a single insertion move in one job sequence. All other job sequences and the family sequence σ_F remain unchanged.

N_2: In the second neighborhood all job sequences are kept constant, while a single insertion is applied to a family in the family sequence.

N_3: In order to attain all schedules of the third neighborhood structure, to every job and family sequence two insertion moves are applied. Hence, a simultaneous change of job and family sequences is realized.

According to the procedure of the VNS, finding a better solution always leads to a restart with the first neighborhood definition N_1. Thus, an alternating adjustment of the two levels is ensured whenever a new family sequence is found.

Local search
A simple descent local search is applied, which explores the respective neighborhood by performing random insertion moves until either a better solution is found or a maximum number of iterations without improvement is reached. Since this local search is similar to the shaking step of the general VNS procedure, the shaking step is disregarded. In neighborhood structure N_1 that only changes a single job sequence at a time the insertion moves are applied to every job sequence consecutively, even if a better solution is found meanwhile.

Restart
The stopping condition of the algorithm is met if the maximum number of iterations in the last neighborhood structure N_3 is reached, i.e. all neighborhood structures have been applied without finding a better solution.
Since the proposed VNS algorithm provides primarily a strong intensification ability it is necessary to ensure an effective diversification of solutions. Therefore, if the stopping condition of the algorithm is met, the currently best solution is saved and a new solution is generated randomly. Afterwards the algorithm is restarted. This enables the heuristic to reach different regions of the solution space and leads to a higher diversification. If any restart leads to a lower makespan, the currently best solution is also saved. In order to limit the required computation time, the number of restarts is restricted to 4.

Non-exhaustive extension
Most research so far has focused on exhaustive heuristics, since an exhaustive processing of all jobs of a part family leads to a minimum of setup times. Furthermore, the complexity of the group scheduling problem is reduced, as the family sequence and the job sequences can be solved independently. However, processing all jobs of a family together might cause some jobs to be early and at the same time others to be tardy. Additionally, exhaustive scheduling might lead to extensive idle times dependent on the structure of processing times. As for some problem instances it can easily be shown that a significant improvement of makespan is gained through non-exhaustive scheduling, it remains an open question whether non-exhaustive algorithms should be preferred generally. Thus, an extension of the proposed VNS heuristic was developed which allows

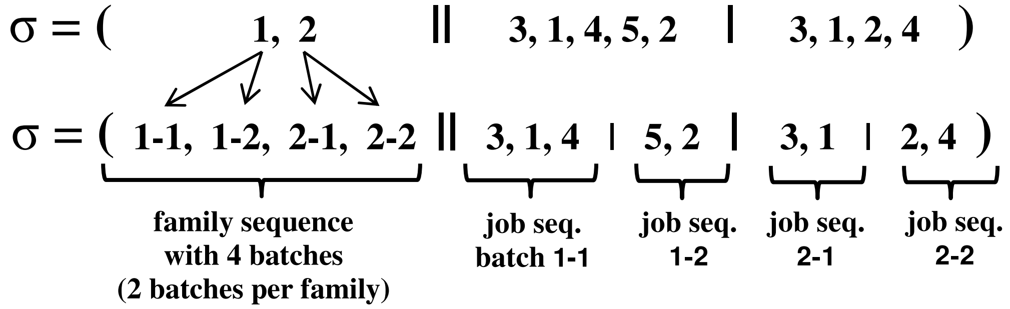

Figure 3: Solution representation of a non-exhaustive solution

the splitting of each part family into two batches. While the general procedure is not changed this variation requires changes of the solution representation and neighborhood definitions.

Figure 3 shows an exhaustive group schedule σ with 2 part families. For the non-exhaustive solution representation the family sequence σ_F is expanded and consists of two batches per family, while every job sequence is split into two parts. The first section of the job sequence now represents the job sequence of the first batch of the respective family, the second section represents the one of the second batch.

In figure 4 an exhaustive group schedule with 3 part families and 3 jobs per family is displayed (C_{max}=94). Two insertion moves are applied to the family sequence in the example. Thereby, the first family is split and processed in two batches, which leads to a reduction of makespan in the example (C_{max}=90).

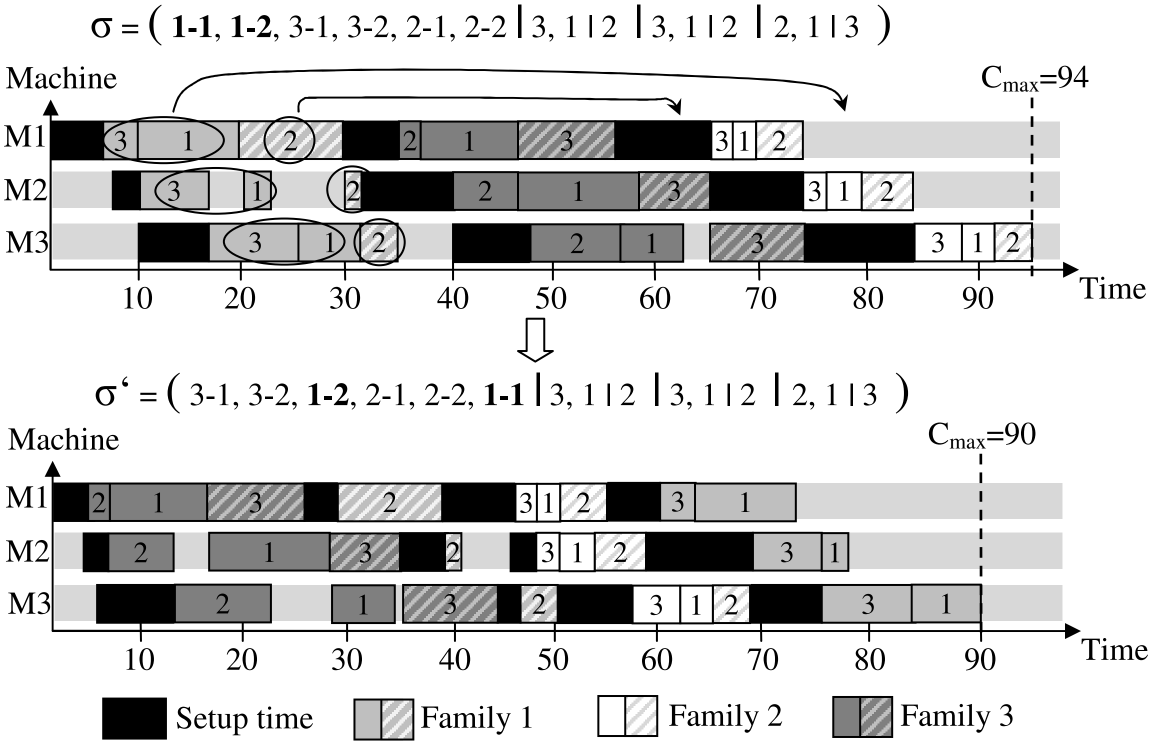

Figure 4: Improvement of a group schedule with two family insertion moves

Neighborhood definitions

Now the neighborhood structures are defined as follows:

> **N_{1x}:** The first neighborhood contains all solutions that can be reached by a single insertion move applied to a job sequence of a batch. This implies that the assignment of jobs to batches is not changed. All other job sequences as well as the family sequence remain constant.
>
> **N_{2x}:** A single insertion move within a job sequence is applied to gain the solutions of the second neighborhood, too, but this move is not applied to the job sequence of a certain batch, but to the job sequence of a part family of the original problem. This can lead to a change of jobs between the batches of a part family.
>
> **N_{3x}:** The third neighborhood structure consists of all solutions that can be achieved by applying a single insertion move to a batch within the family sequence σ_F. All job sequences remain constant.
>
> **N_{4x}:** Within the fourth neighborhood structure to the family sequence as well as to every job sequence of a batch a single insertion move is applied. As in N_{1x} the job sequence is only changed within a batch, hence the assignment of jobs to a batch is not changed.
>
> **N_{5x}:** The fifth neighborhood contains solutions that are gained by two insertion moves to a batch within the family sequence and two insertion moves to every job sequence. In contrast to N_{4x} the job sequence insertions can result in a different assignment of jobs to batches.

Again, the simple descent local search that has been used for the exhaustive VNS heuristic is applied. New schedules are randomly generated according to the currently effective neighborhood structure. As soon as an improvement is achieved, the algorithm is restarted with the first neighborhood structure. If no improvement is gained after a certain number of iterations, the next neighborhood is attained.

A schedule generated by the exhaustive VNS algorithm is used as initial solution. Again the algorithm is restarted with different starting solutions. For the first restart the family sequence of the currently best solution is selected, while all job sequences are generated randomly. Thereby, all jobs are assigned randomly to the batches of a part family. For the second restart, the job sequences as well as the assignment of jobs to batches of the currently best solution are retained. The order of batches within the family sequence is generated randomly. As starting solution for the third restart of the VNS procedure a totally new solution is generated: the family sequences as well as all the job sequences and the assignment of jobs to batches are chosen randomly.

3. RESULTS

The proposed VNS algorithm as well as the non-exhaustive extension were tested using several test instances of different size (see table 1). All processing times were randomly chosen from a uniform distribution in the range of [1, 10] considering integers only. Four different classes of sequence-dependent setup times were taken into account: Very small setups with a ratio of mean family set-up time to mean job processing time S/R of 1:1, small setups (with S/R = 2:1), medium setups (S/R = 5:1) and large setups (S/R = 10:1). Therewith, the test instances are similar to those used by [6,13] with the exception of the first class of setup times. For each problem size 40 test instances were generated, 10 for each class of setup times. Hence, in total 320 different instances were tested, each of them 10 times by the proposed algorithms. In order to obtain comparable information about the solution quality all problem instances were also solved by the CMD heuristic [13], which is known as an easy and efficient deterministic group scheduling algorithm. The makespan of the initial solution, determined by the steps of the NEH heuristic, was taken as an upper bound. All algorithms were implemented using Delphi 2005 and run on a PC with an AMD Athlon XP 2600+ CPU (2.08GHz) and 1.5 GB memory.

Problem Size	**CMD**		**VNS**		**Non-exhaustive VNS**	
$M \times N_{fam} \times N_{job}$	**Ave.**	**Max.**	**Ave.**	**Max.**	**Ave.**	**Max.**
3 x 3 x 3	1,87%	12,53%	2,09%	12,53%	2,09%	12,53%
5 x 5 x 5	0,99%	5,66%	3,04%	6,36%	3,37%	6,36%
8 x 8 x 8	1,47%	4,16%	3,18%	6,41%	4,10%	6,59%
10 x 10 x 10	1,28%	4,59%	2,54%	5,64%	3,38%	5,71%
3 x 8 x 25	0,04%	1,68%	1,19%	3,15%	1,54%	3,24%
8 x 8 x 25	0,44%	2,47%	1,68%	3,74%	2,20%	4,10%
3 x 8 x 3	1,75%	7,14%	4,40%	10,78%	5,24%	10,78%
8 x 8 x 3	0,24%	5,68%	3,24%	8,01%	4,14%	8,01%
Ave. Total	**1,01%**	**5,49%**	**2,67%**	**7,08%**	**3,26%**	**7,16%**

Table 1: Makespan: Average and maximum improvement of the proposed algorithms

The results displayed in table 1 show that the VNS algorithm outperforms the CMD heuristic for all problem sizes. The average improvement compared to the initial solution is 2.67%, while the CMD heuristic only gains 1.01% lower makespans. Especially for small sized problems the average and maximum improvement rates are high, but even for big instances significantly lower makespans are gained. Of the in total 3,200 calculated test instances 322 could be further improved by the non-exhaustive algorithm with an additional average improvement between none (3x3x3) and 0.84% (8x8x8 and 3x8x3). Obviously, the additional improvement is relatively small, which can be explained with the good quality of the initial exhaustive solutions. Nevertheless, a significant improvement can be gained for individual test problems.

However, the good results obtained by the new algorithms are gained at the expense of higher computation times. The VNS algorithm requires on average more than 10 times higher CPU times (0.712 s) compared to CMD (0.066 s), while the non-exhaustive algorithm on average additionally takes 9.986 s computation time. Nevertheless, all required CPU times for the proposed test instances remain affordable.

4. CONCLUSIONS

This study discussed the group scheduling problem with makespan objective in flow shop environments as it is commonly found in manufacturing cells. In order to solve the problem heuristically a variable neighborhood search algorithm has been developed and tested, which proved the applicability of variable neighborhood search for group scheduling. Furthermore, a non-exhaustive improvement algorithm was introduced and applied to the solutions of the exhaustive algorithm. Thereby, a significant improvement of makespan could be achieved for some test instances only, while the average improvement was rather low. Nevertheless, a comparison of the proposed algorithms to the currently best performing heuristics is still necessary to obtain a complete evaluation of the actual effectiveness of the VNS algorithms. Especially, since improvement rates of the VNS algorithms compared to the CMD heuristic are equal to those in previous studies and suggest a roughly similar performance.

The results indicate that there is only a very low potential for lower makespans even by scheduling without the consideration of the group technology assumption, which does not justify the additional effort so far. However, the problem of non-exhaustive flow shop group scheduling has not been examined thoroughly, yet, and further theoretical and experimental research is needed.

New non-exhaustive algorithms, for example with different neighborhood definition or local search methods, might solve group scheduling problems more effectively, while the development of lower bounds could provide definite conclusions for the general potential of non-exhaustive group scheduling. In addition, the removal of the group technology assumption might be reasonable combined with the acceptance of non-permutation schedules as shown in [14].

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A ONE-DIMENSIONAL CUTTING STOCK PROBLEM WITH ALTERNATIVE CUTTING LENGHTS IN THE STEEL INDUSTRY

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Abstract: The input material of the tubes production process consists of steel bars that have to be cut into pieces before they are heated and rolled. In order to avoid waste of input material the cuts of the input material have to be optimised which is a classical one-dimensional cutting problem. A special characteristic of the tubes production is that the same output can be reached with different cutting lengths. Thus, the minimisation of input material gets more difficult and the known algorithms have to be adapted.

1. OVERVIEW

Cutting stock problems are integer linear programming problems and a well known class of optimisation problems [3] since its first mention in 1939. [12] They deal with the problem how to cut a given input material in order to fulfil purchase orders so that the wasted input material will be minimised. Even one-dimensional cutting stock problems are already NP-hard [15] and the optimal solution cannot be found in acceptable computational time. [13] The general one-dimensional problem can be characterised as follows: [4][5][6][8][11] Given an input material with a fixed length L and a set of M orders. Each order is a tuple (d_m, l_m), m=1,…, M, where l_m is the desired length of order m and d_m is the number to be produced for order m. The input material can be cut into the order lengths l_m by using J different patterns. Let a_{mj} be the number of times order m appears in cutting pattern j. Then, each cutting pattern must be shorter than the length L of input material. Let c_j be the costs – in most cases the waste – of pattern j and x_j the number cutting pattern j hast o be cut. Then, the summation $c_j \cdot x_j$ of all cutting patterns has to be minimised.

2. THE TUBES ROLLING PROCESS PROBLEM

In the steel industry a typical production process consists in rolling tubes out of solid steel bars. Customers order a number of tubes with a desired profile, size,

length and diameter. These tubes are made out of solid steel bars of a single length and diameter, the so-called raws. With the length and the diameter of the ordered tubes as input parameters the needed lengths of input material can be calculated. Due to several degrees of freedom within the rolling process there is not a fixed relation between the output and the input of the production process. Instead, it is possible to produce the same output with different cutting lengths that can be used alternatively. Thus, we get alternative cutting lengths that can be used to fulfil a customer order. For example, it can be possible to fulfil a customer order with 10 pieces of input length 12 or with 14 pieces of input length 10.
These rolling process input lengths have to be cut out of the raws. Unfortunately, the exact relation between input alternatives and output is unknown to the department that plans the cutting. The input parameters for the cutting planning are the numbers of different alternatives that can be used for a customer order. Instead of a customer order we speak of a rolling lot that consists of several alternative cutting lengths.
Then, the input material is heated in a furnace. In the furnace, there is a fixed number of places to heat the steel bars. Each place can be filled with one bar irrespective of its length. The furnace is rotating permanently. A steel bar is heated within one rotation. After the heating, a mandrel is put through the steel bars which are rolled out to tubes in several rolling steps. Then, the tubes are cooled and the final cutting is done where the tubes are cut into the desired customer lengths. Additionally, the end sections of the tubes cannot be used due to the heating and rolling. Therefore, they are cut off. See figure 1 for the production process.

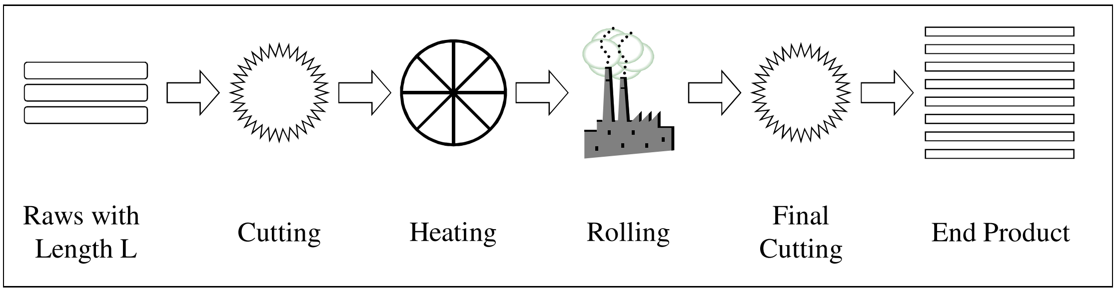

Figure 1: Tubes Rolling Production Process.

Due to practical relevance, the number of different alternatives is limited to one main variant and up to five side variants. The main variant is always the longest variant and optimal for the rolling process. That is because of the heating. The heating process is independent of the length of a steel bar because each place in the furnace can only be used to heat one bar at the same time irrespective of its length. Thus, the longer a steel bar is the more efficiently the heating process works. Furthermore, there is a production waste in the tubes rolling process that mainly de-

pends on the number of bars to be rolled. This waste consists in the end sections of the rolled tubes that cannot be used and have to be cut off.
Because of the side variants and the additional waste in the production process we cannot use the commonly known algorithms because they always are limited to one length per customer order.
In the following, we will firstly describe the optimisation model for this specialised problem. Because that model is already NP-hard with many variables that cannot be reduced we cannot optimise a given instance of the problem in acceptable time. Therefore, we will use the well known Delayed Column Generation approach of Gilmore and Gomory that has to be adapted to the new requirements. As the DCG does not handle integrality a post optimisation will be introduced that will lead to satisfying results. This algorithm leads to good results in an acceptable computational time.

3. OPTIMISATION MODEL

The general one-dimensional cutting stock problem minimises the costs for the raws. Additionally, we have to minimise the costs for the production waste and the production inefficiency we get when we use alternative cutting lengths. Let J be the number of possible cutting patterns and C_j the costs of cutting pattern j. C_j consists of the costs CWC_j for the waste of pattern j, of the production waste PW_j and of the penalty costs PC_j of pattern j that arise because of production inefficiencies when cutting pattern j is not the main variant. Then, we have to minimise the total production costs C that is the sum of all single cutting pattern costs $CWC_j+PW_j+PC_j$ multiplied with x_j.
In the general problem, a customer order consists of the length and the number of times that the length has to be produced. Now, there exist several variants that can be used to produce a rolling lot. We have to consider W different rolling lots each one having up to I_w alternative lengths. Thus, rolling lot w, w=1,…, W, consists of an ordered set of tuples (d_{iw}, l_{iw}), i=,1…, I_w, where l_{iw} is the length of alternative i of rolling lot w and d_{iw} is the number of times length l_{iw} has to be produced if no other alternative length of rolling lot w is used. The first cutting length is the longest one and is called main variant. The others are called side variants. The main variant is the optimal one concerning the latter production process but is not necessarily optimal concerning the cutting waste. Let a_{iwj} be the number of times that alternative length i of rolling lot w appears in cutting pattern j. Again, like in the general problem the length of each possible cutting pattern must be shorter than the raws‘ length.
The cutting waste of a cutting pattern j determines its costs CWC_j. These costs are proportional to the length of waste. Let c be the costs of waste proportional to its

length. Then, the cutting waste costs CWC_j of cutting pattern j is the difference between the raws‘ length L and the used length of the cutting pattern.
All orders have to be fulfilled. In contrast to the general problem, we can use the different alternative lengths simultaneously. Unfortunately, the relation between the input and the output of the tubes rolling process is not known when planning the cutting. Thus, we only know the number of input material to fulfil a rolling lot but we do not know the number of output material we get with a certain cutting length. The correct substitution slope between the different alternative lengths is unknown. Therefore, we work with the percentage with which a cutting pattern j fulfils a rolling lot w.
Due to the alternative cutting lengths, we have to consider not only the waste that results from cutting the input material but also the waste PW_j of the production process. The main length is optimal concerning the production process. We cannot reach a better waste. Therefore, we need at least $l_{1w} \cdot d_{1w}$ of input material for the optimal production process. Each alternative length needs $l_{iw} \cdot d_{iw} \geq l_{1w} \cdot d_{1w}$ of input material. Thus, the production waste of alternative i is $l_{iw} \cdot d_{iw} - l_{1w} \cdot d_{1w}$. This waste can now percentally be distributed among the cutting patterns.
Additionally, when using alternative lengths instead of the first alternative there is not only waste of material but also a waste of time: The alternative lengths are shorter than the first length so that we need more pieces of length 2 to I_w than of length 1. Therefore, more steel bars have to be heated and rolled so that more time will be consumed. This additional time consumption has to be considered within the optimisation model.
Due to the production process the time T that is needed to roll one length is fixed and independent of the length. In order to consider the time waste in the model we can calculate a penalty for each alternative cutting length. [2] This penalty is based on the main length and the number of times d_{1w} it has to be cut within lot w. The alternative lengths in general have more cuts d_{iw}. Therefore, the penalty costs pc_{iw} of alternative i of lot w can be computed with the help of the difference between the main variant and the alternative variant. Then, the penalty costs for each alternative can be easily summed up.
In the general problem, a cutting pattern a_j is represented by a tuple with the number of times the cutting lengths l_m appear in the pattern. $a_j = (a_{1j}, \ldots, a_{Mj})$. The transposed representation is used together with the vector $d=(d_1,\ldots,d_m)^T$ within the DCG of Gilmore and Gomory which is based on a revised simplex. Because of the alternative lengths, this representation of cutting patterns cannot be used anymore. The alternative lengths cannot be handled independently from each other. Therefore, we have to adapt the representation of a cutting pattern. Again, the representation is a tuple of W values. Instead of using the number of times a cutting length

appears in a pattern we use the percental share of cutting pattern to fulfil rolling lot w. Now, each value represents the degree cutting pattern j fulfils rolling lot w.
For example given length L=10 of input material and two orders O_1 and O_2. Order O_1 requires 5 pieces of length 5 O_{11}=(5,5) or 8 pieces of length 4 O_{12}=(8,4) and O_2 requires 7 pieces of length 3 O_2=(7,3). With three different lengths l_1=5, l_2=4 and l_3=3 we get 6 cutting patterns that are not dominated by another one (see figure 2).

$$\begin{pmatrix}2\\0\\0\end{pmatrix},\begin{pmatrix}1\\1\\0\end{pmatrix},\begin{pmatrix}1\\0\\1\end{pmatrix},\begin{pmatrix}0\\2\\0\end{pmatrix},\begin{pmatrix}0\\1\\2\end{pmatrix},\begin{pmatrix}0\\0\\3\end{pmatrix}$$

Figure 2: Not dominated cutting patterns – classical representation

In the classical representation of figure 2 the first two rows affect order 1 and the third row affects order 2. In order to get only one row per customer order we now use the adapted cutting pattern representation with its percental notation. Then, the rows of a cutting pattern do not represent the cutting lengths anymore. Instead, they represent the degree the cutting pattern fulfils an order O_w.

$$\begin{pmatrix}2/5\\0\end{pmatrix},\begin{pmatrix}13/40\\0\end{pmatrix},\begin{pmatrix}1/5\\1/7\end{pmatrix},\begin{pmatrix}1/4\\0\end{pmatrix},\begin{pmatrix}1/8\\2/7\end{pmatrix},\begin{pmatrix}0\\3/7\end{pmatrix}$$

Figure 3: Not dominated cutting patterns – percental representation

4. PROBLEM SOLVING METHOD

The optimisation model we described above is NP-hard and cannot be solved exactly in acceptable computational time. [13] That is because the number of cutting patterns is growing exponentially with the number of cutting lengths. [17] There are several approaches that solve the standard problem. [10] Many of them are linear programming solution procedures [19] e.g. based on the Delayed Column Generation approach (DCG) of Gilmore and Gomory. [4][5] Others are so-called sequential heuristic procedures, hybrid solution procedures [10] or artificial intelligence solutions e.g. [14]. For one-dimensional cutting stock problems new approaches often do not operate better [1] or faster [18] than the DCG. Besides, sequential heuristic procedures for example may lead to a solution with much higher waste. [10] Therefore, we have chosen the DCG as solution procedure. Future work can be done by analysing if other solution procedures would operate better than the standard DCG.

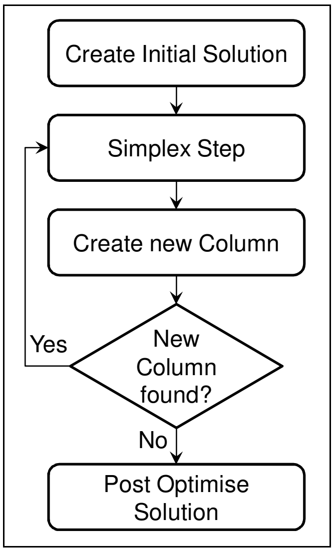

Figure 4: Delayed Column Generation approach

The standard DCG approach can be characterised as follows (see figure 4): Firstly, the integer constraint is relaxed so that the relaxed problem could be solved with a revised simplex [2] where the columns of the simplex are cutting patterns of the problem. For this, we need an initial (non-optimal) solution of cutting patterns. This initial solution can be generated with a good and quick heuristic. Because the number of cutting patterns is growing exponentially with the number of cutting lengths [7] the DCG does not operate on all possible cutting patterns but only on a small number, the so-called basic columns. Other cutting patterns are not considered when solving the simplex. After solving the simplex of the basic columns the optimal solution concerning the basic columns and the relaxed problem is found. This solution is not necessarily the optimum concerning all cutting patterns. Therefore, the DCG approach generates a cutting pattern that improves the actual solution. This pattern is put into the basic columns and replaces an old pattern. These steps are repeated until no new pattern can be found that is able to improve the solution. In this case, the optimal solution for the relaxed problem is found. This solution in most cases violates the integrality constraint of the non-relaxed problem and therefore has to be post-optimised.

This algorithm has to be adapted concerning the specialised problem. Instead of using the classical pattern representation we work with the percental form. Like in the standard approach the first step is to relax the integer constraint of the specialised problem and to insert slack variables $\tilde{x}_{J+W}$ into the model that can now be solved with a revised simplex. Therefore, we need an initial solution $A_B^{initial}$. A simple initial solution is that each cutting pattern satisfies exactly one rolling lot. [4] Such a solution in general is quite far away from the optimal solution. In order to get the optimal solution more quickly it is better to start with an already good solu-

tion. Such a good solution can be generated with several algorithms, [5][6] for example the heuristic algorithm First-Fit-Decreasing FFD [2] or the Repeated Pattern Exhaustion RPE [9]. Both heuristics lead to satisfying results and the computational time in combination with the DCG is nearly the same. [5] Because FFD is more similar to the former planning it is used to create the initial solution. FFD works as follows: Because main variants are preferred we are only operating with main variants. FFD generates W cutting patterns by satisfying rolling lots with the longest length firstly. The lots are sorted descending by length. Then the first lot is taken and its main variant is "put into" the actual cutting pattern j as often as possible. If the remaining waste of pattern j allows to cut another length l_w this length is considered in the generated pattern. This is done until no rolling lot fits into the waste of the pattern. Then, k rolling lots can theoretically be satisfied by cutting pattern j. The cutting pattern j is then used to satisfy that rolling lot w that needs the minimal number of pattern j to be satisfied. We eliminate lot w in the set of lots and adjust the demands of those lots that are affected by pattern j. After that, a new cutting pattern j+1 is generated by the use of the adjusted values. Thus, in each iteration at least one rolling lot is satisfied so that FFD stops after W iterations. Except the percental representation no other adaption has to be made concerning the specialised problem.
Starting with the initial solution the optimal solution concerning the basic columns is found. Then after computing the simplex, we have to find a cutting pattern outside the basic columns that improves the found solution. For this, we can use the dual prices $\tilde{y}_w$ of the rolling lots w. If there is a cutting pattern outside the basic columns which has costs $C_j=CWC_j+PW_j+PC_j$ that are lower than the dual prices weighted with the cutting pattern representation then this cutting pattern improves the solution. Because there are very many possible cutting patterns the cutting pattern that improves the found solution best has to be generated.
This pattern generation is a problem similar to the classical knapsack problem.[6][7] L is the capacity of the knapsack, the lengths are the elements to be put into the knapsack, the dual prices $\tilde{y}_w$ are benefit of the elements and l_{iw} is the space consumption of an element. A Knapsack problem can be solved via branch-and-bound in acceptable time. [4][16]
The result of the branch-and-bound algorithm is an optimal solution for the relaxed non integer problem. This solution has to be adapted to solve the integer problem with the help of known decomposition algorithms. [7] A suitable decomposition works as follows: [5] First of all, the solution is rounded down to integer values. Then, the rest problem is solved by examining the found cutting patterns. In each iteration, the algorithm takes the cutting pattern that satisfies the remaining demand of the rest problem most. Due to the percental representation of cutting patterns the determination of that cutting pattern can easily be done. The number to be pro-

duced of this cutting pattern is then heightened by one piece. If no cutting pattern is found that can be taken without producing more pieces of a rolling lot than ordered new cutting patterns have to be generated with which the remaining rest problem can be fulfilled.

This generation again can be done with FFD or RPE. This time, the usage of RPE is more promising because now the use of side variants can be more efficient than of main variants. The RPE heuristic generates the new cutting patterns by solving a knapsack problem. [9] The dual prices (of the last DCG step) are again used as benefits, the only modification is that when solving the knapsack problem the demands of the rolling lots now are the remaining demands that are not satisfied by the solution found via DCG.

5. RESULTS

The specialised optimisation method was implemented at a supplier of VALLOUREC & MANNESMANN TUBES, a manufacturer with long experience in rolling tubes. This supplier cuts steel bars for V&M Tubes and then deliveres them to the factory. Before the implementation the supplier did not have an optimisation algotithm in use and did the planning manually. This manual planning was very time consuming and comprised at an average five rolling lots.

Because of missing values of the manual planning we cannot compare the manual planning to the optimisation program. Instead, we analysed the algorithm and its benefit when varying the problem instances. For this, we defined the following problem classes: We varied the number of rolling lots $W \in (5,10,20,30)$ and the average number of ordered cutting lengths $\overline{d} \in (50,100,150)$ concerning the main length. We started with the average number (5) of lots that were considered within the manual plannung. The other numbers of rolling lots and the number of ordered cutting lengths $\overline{d}$ are typical for the production process and the customer orders. Then we computed the percental divergence of the solution to the lower bound of the theoretically possible optimal solution. This lower bound is calculated when solving the knapsack problem within the relaxed non integer problem. The results are not surprising (see table 1): The more lots we are taking into account and the bigger the rolling lots are at an average the better the results are. The difference between the lower bound of the optimal solution and the computed solution decreases from over 8% to less than 1%. If we assume, that the manual planning has round about the same solution quality as the first problem instance of W=5 and $\overline{d}$ =50 (the most typically instance) then we are facing an enormous decrease of waste of up to 8%. In fact, an analogue decrease could be observed. Much more lots could be taken into account so that the planning period for the cutting could be widened. As a side effect the factory in deed could operate at full capacity.

W	$\bar{d}$	$\bar{d}$ A(%)
5	50	8.36
	100	4.20
	150	2.62
10	50	5.08
	100	3.07
	150	1.62
20	50	1.81
	100	1.07
	150	0.83
30	50	0.78
	100	0.24
	150	0.05

Table 1: Averaged percental divergence to the lower bound

If the use of multiple alternatives improves the results only little. The reason is the penalty for the use of side variants that leads to the fact that they are used more seldom than the main length.
For ten examples not only the lower bound but also the optimal solution was computed. The algorithm found five of ten optimal solutions. Three times the divergence was less than 2% and only two times more than 2% (maximum was 4.2%). Thus, we can say that the algorithm really improves the situation of the manufacturer. It is less time consuming and in most cases it reduces the waste at a very high level. A typical customer order ranges between 5t and 3000t of steel. At a normal price level for steel of about 300US$, a saving of only 1% of input material leads to savings of approximately 5000 US$. Overall savings then can be greater than 1 M US$. Concerning the high steel prices of 2008 and saving of more than 4% averaged the manufacturer's benefit is much greater.

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SMART-M3 JUST-IN-TIME LOGISTICS: THE TECHNOLOGICAL FRAMEWORK

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Abstract: The paper describes a solution for just-in-time logistics, which is done on top of Smart-M3 platform as a further development of the basic ridesharing principles. The ridesharing idea assumes shared use of a car by a driver and one or more passengers and/or cargo items for commuting. Our approach is based on the idea of smart spaces, where various electronic devices can seamlessly access all required information distributed in the multi-device system. Implementation of the proposed solution was done on top of Smart-M3 open source platform.

1. INTRODUCTION

Today's highly dynamic markets demand use of new approaches to organization of the supply chain systems. One of the perspective approaches is "Just-in-Time Logistics" – the process of minimizing the times required to source, handle, produce, transport, and deliver products in order to meet customer requirements [0-2]. The same principles and approach can be used to implement individual passengers transport logistics system. The main focus of this paper is on definition of approach and description of implementation of the dynamic ridesharing system for passenger and cargo transportation.

Ridesharing (also known as carpooling, lift-sharing and covoiturage) is the shared use of a car by a driver and one or more passengers, usually for on-the-way commuting. Dynamic ridesharing (also known as instant ridesharing, ad-hoc ridesharing, real-time ridesharing or dynamic carpooling), denotes a special implementation of a ridesharing service that enables formation of carpools on relatively short notice. Typical requirements for this type scenario of carpooling are:

- organization of single-time trips instead of recurrent appointments for commuters;
- use of mobile phones for placing carpooling requests and offers through a data service, automatic and instant matching of rides through a network service.

On the wave of increasing attention to sustainable production and logistics systems the idea of ridesharing has got a good development potential (e.g. Figure 1 represents activity of major vehicle manufacturers in the car-sharing market).

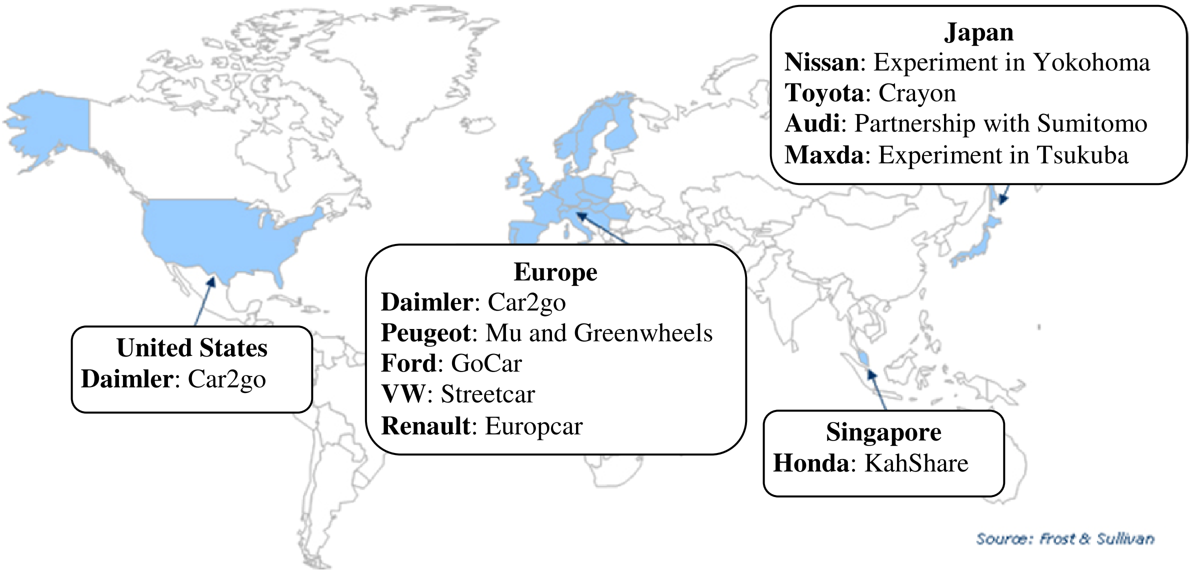

Figure 1: Major vehicle manufacturers in the car-sharing market (World), 2009

The main idea of the proposed approach is to develop models and methods that would enable configuration of resources for decision support in ad-hoc sustainable logistics. The decision support is planned to be based on optimization of the route and transportation means (thus providing for the multimodal logistics) as well as to take into account user preferences.

This paper proposes a technological framework for implementation of dynamic ridesharing. Modern ICTs make it possible to combine several ideas, which would result in a more flexible and efficient transportation system. The proposed solution provides both “static” and dynamic ridesharing for passengers as well as for cargo.

2. RELATED WORK

Nowadays one can find a number of studies that present different ridesharing solutions [3-6]. They cover a wide variety of such systems is ranging from simple free regional or university ridesharing system to complex commercial proprietary solution The first instances of ride sharing in its modern form can be traced back to 1914 [7]. The ridesharing services become popular in 1970s, when people could make this kind of appointments via human operator.

The main advantages of ride sharing solutions are:

- Supposedly the same number of people travels in fewer cars, therefore noise, green house gas emissions and air pollution affecting the local environment all decrease.

- In the territories with little or inefficient public transportation, the ridesharing service can increase the speed of traveling and partly or even completely solve the problem.
- Roadblocks and congestions would be less frequent and therefore the macroeconomical costs of congestion would be reduced.
- Traveling together will lead to increase of social capital and gives a possibility to learn to know people whom they would never have met otherwise.
- As less cars are on the road probability of an accident with, e.g., pedestrians or cyclists, is lower. For instant pedestrians of cyclists, in an accident goes down.
- The ameliorated connectivity, especially in rural areas, leads to economical growth as the markets become bigger.
- Because of ridesharing less people will buy new cars, the used cars will drive more kilometers per year and thus lead to a higher replacement rate resulting in more fuel-efficient and safer cars as well as improved material efficiency.

The main disadvantages of ridesharing:

- When carpooling, additional arrangements and more effort are required to run errands on the way to and from the common locations.
- All time availability and reliability of such service are difficult to organize and maintain due to changing travel patterns and needs.
- Sign mark locations outside of their metro stops and large bus stations are required where drivers can share rides with other passengers in an orderly fashion.

To increase the efficiency of ridesharing the following recommendations can be formulated:

- Proper and reliable functioning of a ridesharing solution requires a “critical mass” of drivers and passengers. In order to guaranty wide acceptance of this service, the corresponding solution should be easy to use and from the beginning provide reliable high enough quality of service. The following recommendations related to this issue can be formulated:
  - A ride query shouldn’t take more than some seconds to enter.
  - Well defined user profiles have to be automatically collected and maintained by the system to keep rider’s preferences.
  - Current user context has to be taken into account at the matching process.
- To increase the probability of ride-matching the passengers can use more than one car consequently during one trip, but this option should be carefully considered, as it might lead to degradation of the quality of experience.

The approach proposed in the paper is aimed in solving the above mentioned problems by use of the Smart-M3 platform and underlying technologies such as profiling and ontology management.

3. TECHNOLOGICAL FRAMEWORK

Figure 2 shows generic architecture of the proposed solution that we have built on top of the discussed approach. The main idea of the selected approach is to represent components of the logistics system by the sets of services provided by them. As a result it allows replacing configuration of the logistics system with that of distributed services. For the purpose of interoperability the services are represented by services using the common notation described by the ontology.

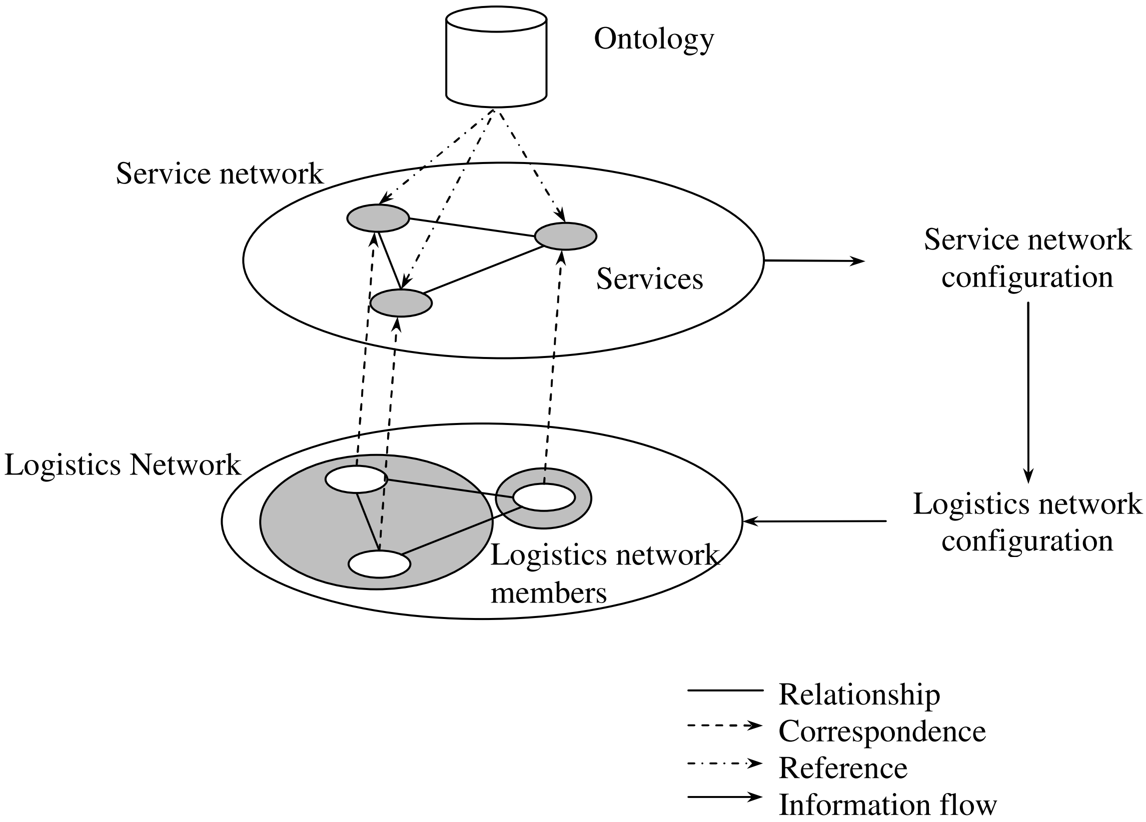

Figure 2: Definition of an approach to definition of the system architecture

The first version of the proposed solution was implemented on top of Smart-M3 platform developed by Nokia Research Center (Helsinki) and partners [8]. The key idea in Smart-M3 is that devices and software entities can publish their embedded information for other devices and software entities through simple, shared information brokers – a "push"-based information sharing model rather than specific publish-subscribe. The understandability of information is based on usage of the common ontology models and common data formats. Another key idea is that Smart-M3 is device, domain, and vendor independent. It is free to use, open source solution available under BSD license. In a nutshell, the Smart-M3 refers to a piece of software technology, a number of software products encoding this software technology, a computing platform that the software products make available and any computing system that has been developed and deployed by using this computing platform [9].

The developed prototype knowledge processors (KPs) represent participants of the system and usually they are running on mobile devices of the users integrated into an ad-hoc network via communication technologies such as GSM or WiFi. Places are defined via coordinates or address/intersection. "Car" actually stands for any means of transportation, including family car, small car, or even bicycle. The broker produces possible matches between transportation service requesters and providers. These matches are used then for direct negotiation between KPs concerning the transportation service.

The UML sequence diagram for KP interaction in the use case scenario is presented in Figure 3. In this scenario the User KPs prepare requests and offers for the Broker KP. Besides, the KP of the Private Car shares additional information such as current location, car's specific characteristics, etc. (more to be defined in the future research). The Broker KP also receives additional information, such as traffic information, map of the region, weather, etc. (more to be defined in the future research) and searches for matching requests and offers. The resulting matched pairs are shared with User KPs to engage negotiation between them. The final meeting deals are made as results of such negotiation process.

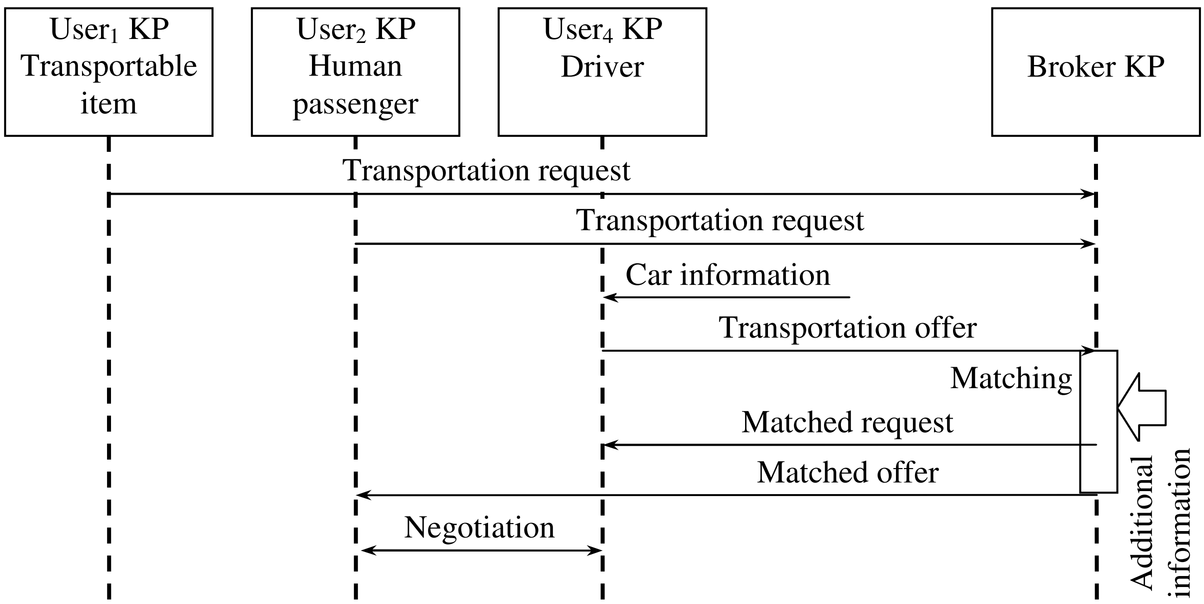

Figure 3: Sequence diagram of the use case scenario (example)

4. BROKER

As it can be seen from the sequence diagram above, Broker is the most critical part of the system. It processes transport requests and offers to find matching ones. For each request in the smart space it checks all available offers. However, in reality the amount of calculations can be significantly reduced since the complete search through all the offers and requests is needed only when the broker makes the very first cycle of operations. After that it only needs to go through offers upon appearance of a new request and go through requests upon appearance of a new offer.

First, the broker finds the minimal distance from passenger's trip start point to the closest point on driver's route as well as the minimal distance from passenger's end point and driver's route. Based on this distance it estimates whether the driver under study is suitable and the best candidate to give a ride to pick up a given passenger (whether their travel paths are not too far from one another): the sum of these distances should be smaller than the maximum allowed detours for both passenger and driver.

Then, it is checked if the trip *timewindows* of a passenger [*p.start_time*, *p.end_time* + *p.delay*] and a driver [*d.start_time*, *d.end_time* + *d.delay*] are overlapping. If not then the joint trip is not possible.

These two operations allow significantly decreasing the search space. After that the more precise estimation of the possibility of the joint travel and the joint travel's path and schedule is done. The following mathematical model describes the "Adjustment of the driver's and passenger's paths".

Input data:

- passenger's max detour (*p.det*);
- passenger's max delay (*p.del*);
- passenger's estimated speed (*p.speed*)
- driver's max detour (*d.det*);
- driver's max delay (*d.del*);
- driver's estimated speed (*d.speed*)
- passenger start and end locations: *p.points* = [$p.point_1$, $p.point_2$];
- driver's path, ordered array of points: *d.point* = [$d.point_1$, $d.point_2$, …, $d.point_n$];
- minimal distances (d_1, d_2) between the nearest points of driver and passenger calculated at the previous step ($p.point_1$ and $d.point_i$, $p.point_2$ and $d.point_j$);

Each point includes the following values: [*x*, *y*, *time*, *vacant_seats*];

ms.point = *find_start_meeting_point*(*p.det*, *p.del*, *p.speed*, *d.det*, *d.del*, *d.speed*, *p.points*, *d.points*)

me.point = *find_end_meeting_point*(*p.det*, *p.del*, *p.speed*, *d.det*, *d.del*, *d.speed*, *p.points*, *d.points*)

These functions search for the start and end meeting points (*ms.point* = [*x*, *y*, *time*]) of the passenger and driver, taking into account the following constraints:

$$distance(p.point, m.point) \leq p.det$$

$$distance(d.point, m.point) \leq p.det$$

$$\frac{distance(p.point, m.point)}{p.speed} \leq p.del$$

$$\frac{distance(d.point, m.point)}{d.speed} \leq d.del$$

These functions also check for availability of vacant seats:

foreach *d.point* between (*ms.point* and *me.point*)

    if *d.point->vacant_seats* < 1 then

        return "The driver *d* can't take the passenger *p*"

If an acceptable joint path is found the information about it is saved.

Let us consider the following case: passenger 1 can travel with drivers 1 and 2, passenger 2 can travel only with driver 1. In this case it would be better for the system for passenger 1 to travel with driver 2. For this purpose a procedure improving the set of matching requests and offers is proposed.

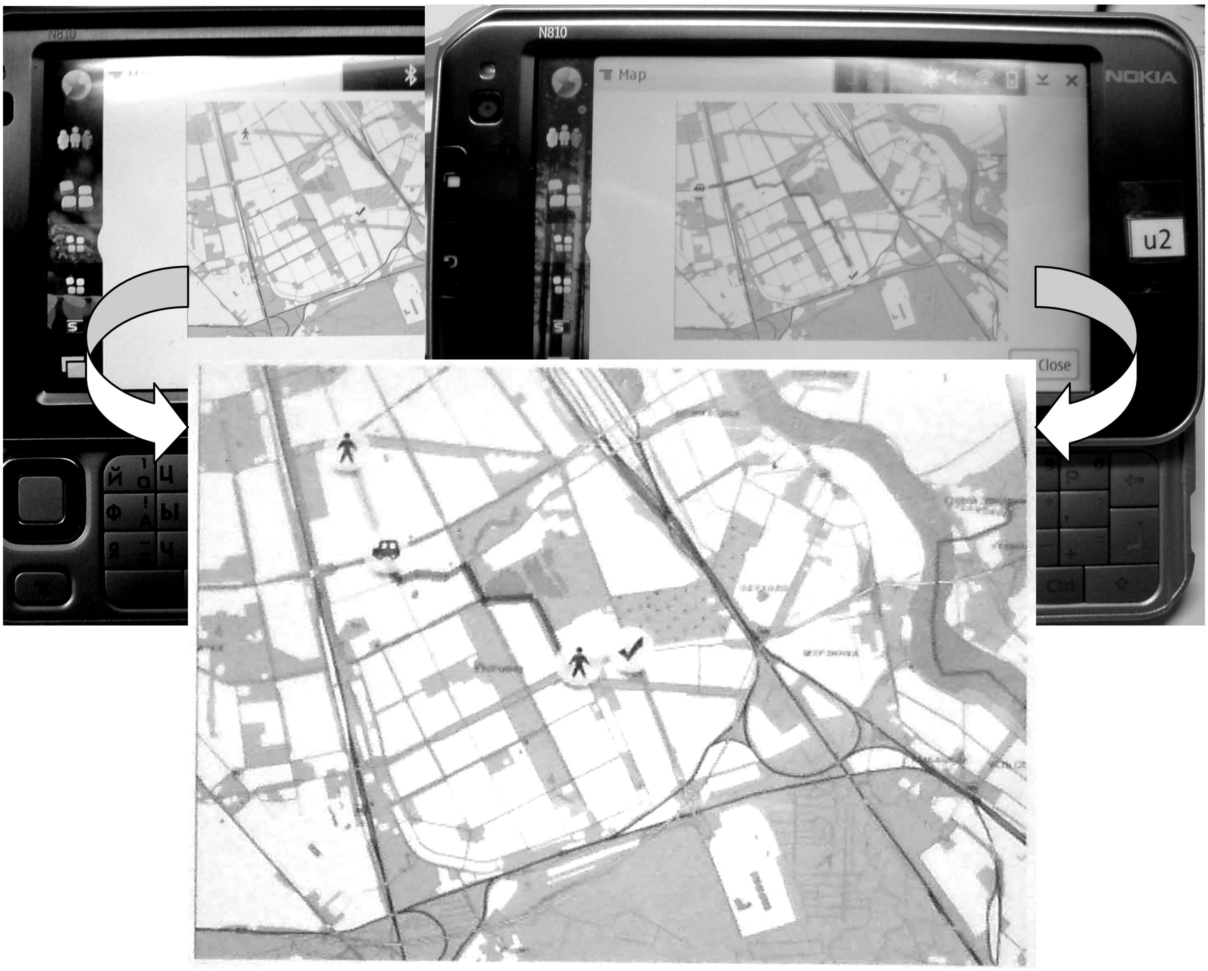

Figure 4: Prototype screenshots

The solutions are presented to the clients (passengers, drivers, item senders) into a certain sequence in accordance with delays and detours. Besides, it is proposed to take into account the above mentioned factor. The procedure assigns weights to the solutions in accordance with the following logic. For passengers and luggage items the drivers who can transport more passengers (have more matching requests) have a lower weight. For drivers the passengers/items which have more travel options have a lower weight. Since the clients will tend to select the topmost solutions the solutions with a higher weight will be presented followed by the solutions with a lower weight.

The screens represented in Figure 4 demonstrate the routes for the passenger as a pedestrian (left), for the driver (right), and the joint route when the driver gives a ride to the passenger (bottom).

5. EXPERIMENTAL RESULTS

The experiments were performed when the Broker KP placed at the regular PC with Pentium M 1.86 GHz processor and 1024 Mb of RAM.

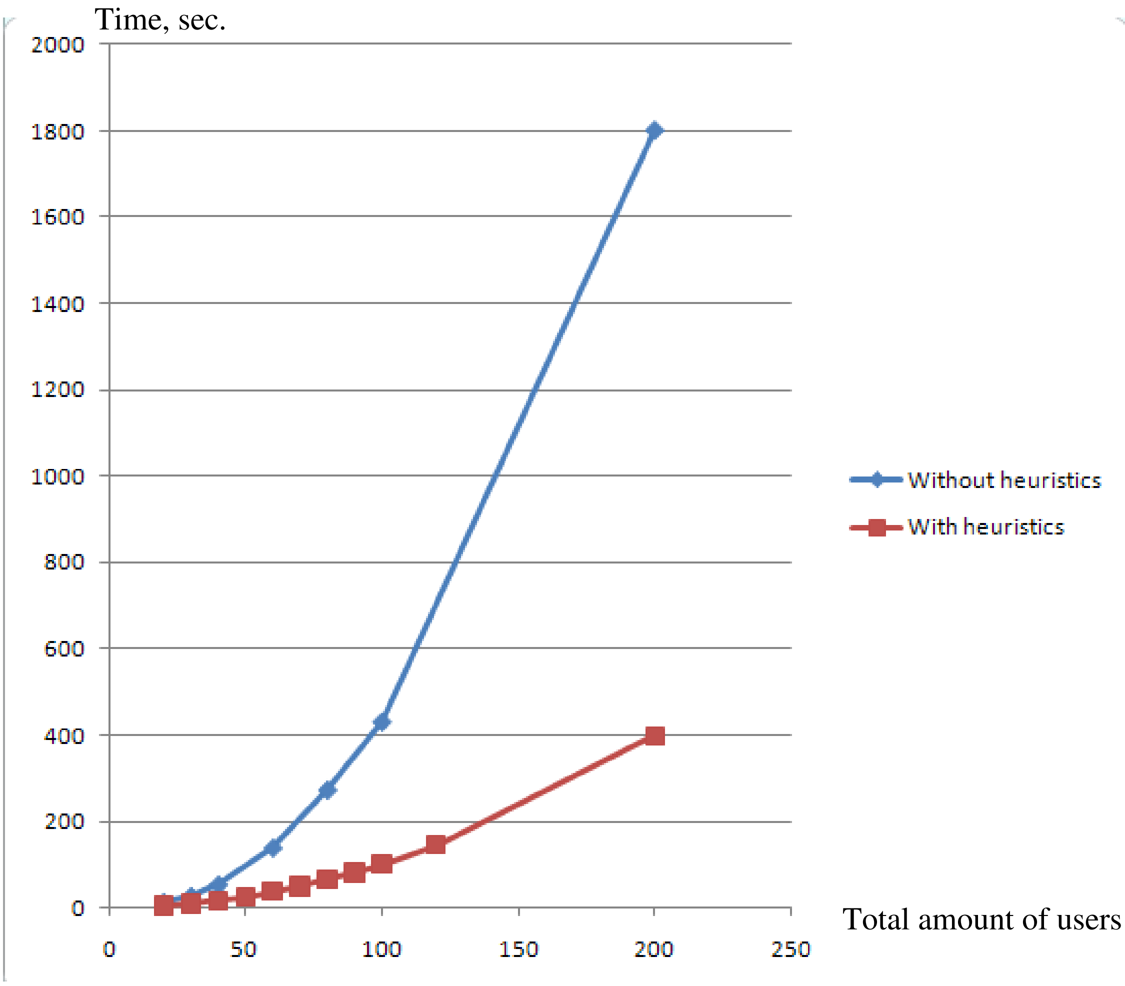

Figure 5: The experiments comparison graph

The first set of experiments was performed without using heuristics aimed at the reduction of the computational complexity. Instead an exhaustive search for matching requests and offers. The approximating equation is quadratic for the total amount of users. The second set of experiments was performed using heuristics aimed at the reduction of the computational complexity. The approximating equation is also quadratic for the total amount of users. However, it can be seen that usage of heuristics significantly reduces the calculation time (about 4 times). The comparison graph is shown in Figure 5.

6. CONCLUSIONS

The paper proposes a new approach to organize ridesharing systems as a development of just-in-time logistics principles applied in production networks. The idea of ride sharing or lift sharing, carpooling and hitchhiking is not new and as it can be seen from the state-of-the-art study it is possible to find plenty of commercial and non-commercial services that deliver such solutions. The approach proposed in the paper is aimed at solving a number of problems via usage of the Smart-M3 platform and underlying technologies. Usage of Smart-M3 platform enables us to easily utilise advanced capabilities of cross-device communication on mobile devices. At the same time it enables information sharing between users and computational servers (such as broker) while this information remains stored on users' devices.

Presented ontologies and scenarios are designed to be processed by handheld devices. The broker is aimed to be run on a server, but be responsive enough to handle millions of queries per day. For this purpose the matching and other broker procedures have been segmented into several steps, where each step significantly reduces further search space. The presented approach also has several heuristics which allow significant reduction of the overall complexity of the selected approach. These heuristics restrict the search space in computationally intensive parts of the algorithm.

7. ACKNOWLEDGEMENTS

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INTEGRATED SCHEDULING AND CONTROL WITH RFID-DRIVEN FEEDBACKS FOR COMPLEX INTERNATIONAL SUPPLY CHAINS

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Abstract: Recent studies indicated that the scheduling needs to be considered with regard to a real supply chain (SC) execution environment. Modern developments in information technologies such as RFID (Radio Frequency Identification) provide a constructive basis to incorporate the stages of SC scheduling and execution under the attracting adaptation methods. In this study, we investigate the issues of establishing feedbacks between supply chain scheduling and execution from the perspectives of modern control theory. In using optimal control in combination with mathematical programming for the scheduling stage and feedback adaptive control for the execution stage, we provide a mathematically integrated framework for SC scheduling and execution control. Both at the scheduling and execution stages, SC processes are interpreted as a dynamic complex of operations execution. The proposed framework supports goal-oriented SC adaptation for the achievement of the desired performance.

1. INTRODUCTION

Logistics landscapes in multi-continental dimensions, such as in Eurasia, are *a priori* shaped by complex supply chains. For example, intermodal transport corridors China-Kazakhstan-Russia-Belarus-Lithuania with different market players, different tariffs and customs systems, transportation, border-crossing procedures and formalities to cargo transportation procedures at border-crossings evidence enough of Eurasia supply chain complexity and uncertainty. For managing such complex systems, the issues of schedule and execution control become even more important. Scheduling is one of the most popular and well-grounded research area in operations research and supply chain management (SCM) [1], [2], [3]. Supply chains (SC) are subject to the dynamics and uncertainty of an actual execution environment. An SC schedule may be subject to numerous unplanned changes/disruptions and, therefore, need continuous adaptation. The study by Mulani and Lee [4] showed that SC managers spend about 40-60% of their working time handling disruptions. Recent studies indicated that the scheduling needs to be considered with regard to a real SC performance and perturbed execution environment [2], [3]. The

challenge is no more to schedule "ideal" optimal SCs that fail in a real execution environment, but adaptable and robust SCs [3], [4], [5].
Modern developments in information technologies (IT) such as RFID (Radio Frequency Identification), SCEM (SC Event Management) and mobile business provide a constructive basis to incorporate the stages of SC planning and execution. However, the IT serve in SCs as organizational systems the decision-support role (and not automatic decision execution role). RFID does neither explain nor solve the fluctuations of customer demand, the delays in transportation, the level of inventory, etc. [6], [7], [8], [9], [10]. It identifies and processes the data in the volume according to the tags, readers and middleware functionalities and at the places where they are installed.
RFID also does not propose any control actions that should be taken to adapt a SC in the case of changes or disruptions at the execution stage. Hence, the analysis frameworks for the decision support regarding the designing and applying IT, incl. RFID, infrastructures in SCs are practically needed.
Quality of adjustment adaptive actions' efficiency at the execution stage depends on two factors: (1) control actions that are taken in operations' execution dynamics and (2) control actions that have been taken at the planning stage. Hence, the planning and execution models are to be inter-reflected, which means, in both of the models, that the decision-making principles of the other model are to be reflected. The preferable way to ensure such integration is to apply the same modeling methods [11]. In these settings, the extensive development of approaches and models to dynamic SC scheduling under the attracting adaptation methods is becoming a timely and crucial topic in SCM.
It is quite natural that the designing RFID infrastructures should be interconnected with the analysis of management issues in SCs to achieve the consistency among the RFID costs, RFID impacts on the SC performance and real requirements for control actions that are taken by SC managers on the basis of data from RFID. Surprisingly, there is a gap in this research direction. The application of RFID for SCM is frequently not supported by the analysis of the correspondence of RFID functionalities and costs to the actual needs of execution control and SC adaptation for the achievement of the desired performance. This frequently results in redundant or not justified investments in RFID or negative assessment of RFID project results [8], [12], [13].
In this study, we investigate the issues of establishing adaptive feedbacks between SC scheduling and execution control from the perspectives of modern control theory and operations research. The aim of this study is neither to provide a rigor mathematical formulation nor a novel RFID data management infrastructure, but to deliberate conceptually and to approach the existing gap between the management and IT levels from constructive engineering positions and formal methods. This

study is to contribute to the methodological basis of intellectual technology, principles of SC control, intellectual interactive monitoring and decision making in complex SC control systems.

The rest of this paper is organized as follows. We start with a state-of-the-art analysis. Section 3 describes the research approach, which is theoretically based on the combined application of modern control theory and operations research. In Section 4, we describe the developed framework of interlinking SC scheduling and execution control. We conclude the paper in Section 5 by the description of the experimental environmental and summarizing the most important features of the proposed framework.

2. LITERATURE REVIEW

The achievement of the planned SC performance in a real execution environment depends both at the decisions of the scheduling stage and the decisions of the execution stage. The SC performance at the scheduling stage depends on two factors: (1) control actions that are planned and (2) future control actions to compensate for a possible deviation from the plan. On the other hand, adjustment actions' efficiency at the execution stage also depends on two factors: (1) control actions that are taken in operations' execution dynamics and (2) control actions that have been taken at the planning stage.

For the last decade, considerable advancements have been achieved in the area of SC scheduling area [1]. After long-lasting research on SC optimality from the service level's and costs' points of view, the research community has begun to shift to a paradigm that the performance of SCs is to consider regarding adaptable, stable, and crisis-resistant processes to compete in a real perturbed execution environment [3], [11], [14].

While a SC is running, it can be affected by different disturbances. Hence, deviations in SC execution in relation to planned states cannot be eliminated. In these settings, it becomes very important to reveal these deviations in a timely manner and to generate efficient adjustment actions.

One of the basic technologies to facilitate the feedbacks between the SC execution and scheduling is RFID. RFID is an automatic identification technology for wireless identifying items (objects) and gathering data on items [10]. The common target of RFID is to reduce costs created by manual operating, to accelerate data receipt and transmission, and to increase the preciseness and quality of data [12].

RFID systems include tags, readers and software to process, the data (middleware). The reader sends a radio signal that is received by all tags present in the RF field tuned to that frequency. Tags receive the signal via their antennas and respond by transmitting their stored data. The tag can hold many types of data, including a serial number, configuration instructions, activity history (e.g., date of last maintenance, when the tag passed a specific location, etc.), or even temperature and other data provided by sensors. The read/write device receives the tag signal via its antenna, de-codes it and transfers the data to the computer system through a cable or wireless connection.

Application of RFID in logistics and SC management (SCM) has been widely discussed in recent literature [7], [8], [9], [12], [13]. RFID is believed to provide crucial benefits in inventory reduction, increased product availability and customer service, production, storing and transportation tracking, mitigating the bullwhip-effect, integrating SC, improved returns and asset management, and supply stability/continuity by means of reduced shrinkage, improved data accuracy, increase in material handling efficiency, improved information sharing, and SC monitoring support through a faster exception management [7], [8[, [15], [16]. SCs can potentially become more flexible, responsive, agile and secure by applying RFID. In addition, RFID in SCM can potentially contribute to SC competitiveness [13].

However, the introduction of RFID brings not only benefits but also the risks. On one hand, significant business performance improvements are expected (e.g., 9% to 14% stock reduction by Metro AG) [8]. On the other hand, Wal-Mart suppliers are to spend more than $25 M to integrate RFID into their software applications [8]. The actual influence of RFID on the business performance improvement still remains vaguely estimated. Besides, some technical problems of RFID utilization, especially security and a lack of standardization can be named.

3. RESEARCH METHODOLOGY

3.1. Modern control theory for SC scheduling

As stated above, we consider SC scheduling subject to SC execution. SC execution is accomplished by permanent changes in the internal network properties and the environment. It requires establishing feedbacks and SC adaptation to the current execution environment. The real dynamics, feedbacks and not determined considerations of future make SC process non-stationary and non-linear [11], [17], [18]. These particular features of SC execution control lead us to the selection of the modern control theory as the research methodology.

Control theory (CT) can efficiently explore adaptability, controllability and dynamics in the real-time mode taking into account non-linearity, non-stationarity and uncertainty. In contrast to classical automatic control of technical devices and technological processes, modern control theory (MCT) provides methods and tools for synthesis and analysis of complex operations control systems to a variety of new application areas [17]-[20]; one of them is SCM [11], [21]. With the help of MCT, control of tasks and resources distribution and scheduling problems can be approached in dynamic and feedback-driven manner [21]-[24].

The first strong contribution of MCT to operations and SCM regarding the dynamics is the interpretation of planning and execution processes not as isolated domains but as a continuous adaptive process. With the help of MCT, both SC scheduling and execution can be interpreted as a dynamic execution process of a complex of operations. Hence, the problems and models of planning, scheduling, and adaptation can be integrated on unified methodical principles. The coordination and coherency of planning and execution models do not require special efforts and occur in a natural way within the unified mathematical axiomatic of MCT. In contrast, if applying different techniques for the scheduling and execution stages, the coordination and coherency of schedule optimization and execution simulation models require special efforts and would not necessarily be successful because of human subjectivism.

3.2. Designing RFID infrastructure

After the schedules are set up, the stage of SC operations execution follows. At the physical level, cargo movement control takes place. The data from primary control devices (e.g. RFID) are transmitted, accumulated and evaluated within the information systems level. At the interface between the information systems level and the event management level, based on SCEM tools, SC monitoring and reinstating (adaptation) take place. This results in decisions on SC processes, plans or goal correcting, amending or replacing on the basis of the disturbances that occurred and the control actions that existed.

In designing the RFID infrastructure, we follow the IEEE 802.15.4 standard for wireless autonomous control. In a simple case, there is enough to establish links between RFID readers and a superordinated IT, e.g., an SCEM system. In more complex cases, the networking of different RFID readers via special protocols (e.g., low-level reader protocol (LLRP) is mandatory. In this setting, the RFID infrastructure should be built up of two levels: networking RFID readers with each other and networking RFID readers with an SCEM system.

4. THE COMPLEX OF INTEGRATED MODELS

4.1. Multi-structural modeling supply chains

SCs consist of different structures: business processes and technological, organizational, technical, topological, informational, and financial structures. All of these structures are interrelated and change in their dynamics. The study by Ivanov et al.

[18] elaborated a framework for multi-structural SC design and dynamics control with the help of the theory of structure dynamics control [19], [25].
The developed models use the fundamental scientific results obtained within the modern optimal control theory operating with complex dynamic objects with re-configurable structures in combination with operations research techniques. Regarding the issues of this study, the developed multi-structural framework provides the possibility of relating SC functional, organizational, and information structures for the simultaneous consideration and optimization of business-process goals and processes with executive data-handling procedures, information processing, and information communication.

4.2. Optimal control-based supply chain scheduling

In real life situations it is often necessary to take into account continuously changing SC execution environment (e.g., to take into account demand changes, delivery delays, etc.) what makes the scheduling problem more complex and requires its solving in real-time [3], [5], [14].
In developing a mathematical model for SC scheduling in terms of dynamic analysis of SC execution, it is important to ensure mathematical consistency of dynamics to be considered both from a narrow perspective (operations dynamics within a schedule in accordance to a given plan) and a wide perspective (execution dynamics and adaptation of both schedules and plans). Hence, the problems and models of planning, scheduling, and adaptation should be integrated on unified mathematical principles. This can be achieved in applying MCT models which consider dynamics both at the planning and execution stages.
In doing so, it is possible to describe both the planning and execution stages in terms of control [11]. However, despite optimal control models make it possible to reflect the optimization of a performance indicator the value of which is accumulated over time, the consideration of sequencing and resource allocation in these models is significantly complicated by specific mathematical features. Hence, scheduling could not be performed.
To overcome this shortcoming, the study by Ivanov and Sokolov [11] developed a SC dynamic scheduling model that is based on a combined application of optimal control and mathematical programming approaches. The model is based on a dynamic interpretation of SC execution as a dynamic complex of operations. This dynamic interpretation is used both at the scheduling and execution control stages. At each instant of time while calculating solutions in the optimal control dynamic model with the help of the Pontryagin's maximum principle, the linear programming (LP) problems to allocate jobs to resources and integer programming (IP)

problems for (re)distributing material and time resources are solved with conventional capacitated LP/IP algorithms.

The modelling procedure is based on an essential reduction of problem dimensionality that is under solution at each instant of time due to connectivity decreases. At each point of time, only variables and constraints that are relevant at this time section are considered for scheduling and transmitted as input data to an LP/IP algorithm. The whole dimensionality and dynamics is kept within the optimal control model. With the special mathematical techniques and due to the integration with MP, it becomes possible to represent input and output data in discrete form while the solution procedure itself extensively applies the advantages of the continuous optimization.

Within the scheduling model, we can explicitly change resource consumption for the protection of SC against uncertainty and analyze the impact of these changes at SC output service level and costs.

4.3. Supply chain execution control

At the scheduling stage, different levers (material inventory, financial reserves, and IT, incl. RFID) to mitigate uncertainty and to ensure SC execution under the presence of disturbances are built. As the SC execution is inevitably followed by changes of both environment and SC itself, the adjustment of SC behavior to these changes is needed. A convenient way to approach this issue is the concept of adaptation.

The adaptation is the property of a SC consisting of the continuous changes of its functioning and the abilities to function in unpredicted conditions by a goal-oriented adjustment of the process parameters and/or structures. The SCs are adapted by decisions of human beings, the SC managers.

The main purpose of the adaptation framework is to ensure a dynamic integrated SC scheduling and execution control model with a parameter tuning with regard to changes in the execution environment and planned values of performance indicators.

The following parameters belong to the first group and can be evaluated through the external adapter:

- the values of SC performance indicators (e.g., minimal admissible service level of 95% can be amended to 93%);
- execution indicators of SC processes (e.g., cycle time); and
- probabilistic characteristics and values of real and ob-served random processes.

The second group of parameters being evaluated through the internal adapter includes such characteristics as:

- a redundancy rate for functional, informational, and temporal reserving;

- priority of SC performance indicators; and
- parameters that define the variants of adaptation in the simulation models.

A hierarchy of adjustment actions is brought into correspondence with different deviations in the SC execution. A state correction takes place with a time horizon of hours, days, weeks or months. To match the SC execution analysis and recovering the SC operability, we elaborated a concept of the complex SC adaptation, which is built as a five-level structure. Each adaptation level characterizes a certain control loop in accordance with oscillations and deviations and corresponds to certain management actions

We distinguish parametric adaptation (i.e. rush orders), structural-functional adaptation (i.e. supplier structure changing), project goals' adaptation (i.e. delivery delay), and SC goals' adaptation (i.e. network profit changing), as well as SC strategy and models' adaptation. This makes it possible to match the results of the stability analysis and the actual execution analysis. It also provides a decision maker with a tool to make decisions about the SC adjustment in a real-time mode.

Let's observe an example. As a result of the perturbation influence "Delay in delivery from the supplier", the SC can appear inefficient or in a disabled state (it is defined on the basis of the stability analysis). In the case of a disabled condition, it is a question of disturbance in the performance of the SC function "Start manufacturing a product lot" owing to the absence of the necessary material (a deviation in the parameter "Start term of manufacturing a product lot"). Further, this disturbance can be classified as a disruption or deviation. In the case that the broken function nevertheless can be executed (i.e. the parameter "End term of manufacturing a product lot" does not deviate from the planned value) without correcting managing influences, for example, on the basis of the safety stock use, it is a question of deviation. If the function can be executed only with the application of control influences, it is a question of disruption, which should be eliminated on the basis of managerial decisions on the restoration of an efficient SC state (for example, process corrections on the basis of the urgent material acquisition from other suppliers; see parametrical adaptation). In the case of the impossibility of performance of all the planned orders according to the goals (delivery time, costs, quality), plan correction, for example, the redistribution of the resources between various orders, the attraction of additional suppliers etc., is necessary. If there is a situation of plan disruption, goal adaptation is necessary, i.e., replanning (for example, changes in delivery times). An extreme case of failure is a catastrophic situation, when the restoration of the SC plans (at all three levels of management) is impossible and a new strategy and control system for the SC is necessary. In this case, it is possible to talk about the loss of a SC's resilience and stability.

5. EXPERIMENTAL ENVIRONMENT

For the investigating of the RFID-based feedbacks within the developed modeling framework, an experimental stand with a transport network and some production and warehouse facilities is currently under development (the transportation network with an RFID infrastructure is already elaborated).

We note that the RFID experimental environment is not in-tended (at least, in its current version) to the full implementation of the developed models. It is much simpler as the modeling framework and serves to gather experimental data for the modeling complex. The modeling complex itself is implemented in a special software environment, which contains a simulation and optimization “engine” of SC planning and execution control, a Web platform, an ERP system, and APS system, and a SCEM system. The kernel of the computational framework is the decision modeling component, that is, the simulation and optimization “engine”.

The schedules can be analyzed with regard to performance indicators and different execution scenarios with different perturbations. Subsequently, parameters of the SC structures and the environment can be tuned if the decision-maker is not satisfied with the values of performance indicators. In analyzing the impact of the scale and location of the adaptation steps on the SC performance, it becomes possible to justify methodically the requirements for the RFID functionalities, the stages of an SC for the RFID elements locations, and the processing information from RFID.

In particular, possible discrepancies between actual needs for wireless solution of SC control problems and the total costs of ownership regarding RFID can be analyzed. In addition, processing information from RFID can be subordinated to different management and operation decision-making levels (according to the developed multi-loop adaptation framework). Pilot RFID devices with reconfigurable functional structure are developed.

Let us discuss some observations and results. At the first stage of the establishing the experimental stand, we came to the conclusion that traditional networking technologies tend to be expensive for integration of many readers. In this work some efforts have been made to analyze and optimize RFID network structure to be more suitable for SC control tasks.

The most valuable property of RFID technology is wireless data interchange with objects (tags) without power source (passive RFID). Main advantages of passive tags such as low cost, size, weight, make them ideal candidates to be agents for data accumulation and transmission along with physical objects [27]. Most of tag access protocols are international standards. This improves interoperability of readers and tags of different manufacturers. Cost of a tag is continuously decreasing that enables their applications in real life.

Although main function of readers is reading data from tags, readers can also perform many additional functions such as writing data, setting password, locking data and killing tag. However, readers do not have well defined protocols to be controlled with. Each manufacturer offers its own solution for data interchange between a reader and computer. In fact, there is no interoperability between readers of different manufacturers.

One of the most important issues from the system integration point of view is a ratio of readers being used to the computers which control them. Today, only a few readers can be directly connected to a single PC. However, future RFID systems will need to be distributed RFID networks.

For many RFID systems with a single reader the wider reading range is the preferable way. However, the wide detection range decreases the resolution for locating objects. For pure storage operations, the wide range has two drawbacks. First, increased number of tags located in the field of the reader decreases the reading performance and enlarges the storage cycle. This has negative effects on the systems designed to monitor especially valuable objects. Second, the wide range is equivalent of poor resolution in case of localizing objects. So, for the tasks where object location is important (e.g. tasks of object storage and logistics) many readers are required to arrange a wide zone totally covered with RFID field. Distributed reader networks tend to be expensive if based on readers optimized for the wide range operation.

Several changes in system architecture can be proposed to achieve desired properties of the system. First, readers should be integrated in a special bus that will provide both power and data path to readers using the single coaxial cable to be easily mounted and minimize connections. Second, software can be split according to client server model based on TCP/IP sockets using well-defined portable interface. Thus, application programmers can use the same command set to access any reader in a bus behind the server. Since the TCP/IP is an Internet protocol user applications can be spread over the network and talk to both local and remote servers [53].

The Sim-Sim architecture can be treated as a basement of distributed RFID networks which will be the future of RFID technology. Once the readers get inexpensive, other factors start to determine overall system cost. Sim-Sim architecture potentially offers both hardware and software solutions to reduce these costs. Existing readers can be easily integrated into Sim-Sim Server using back-end drivers. Thus, Sim-Sim architecture provides both reader manufacturers and application programmers with cost-effective, stable, scalable and portable RFID solution.

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TOWARDS INTELLIGENT INFORMATION LOGISTICS SERVICES: CASE STUDY FROM TRANSPORTATION

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Abstract: Logistics is a high-technology industry, making intensive use of modern information technology and logistics is widely considered an application field for new types of intelligent information logistics services. Such services are often based on integration and orchestrated interpretation of different information sources, like on-board vehicle information systems, traffic control systems and fleet management systems. The paper focuses on selected aspects of the knowledge architecture for intelligent information logistics services. Based on an industrial case and on experiences from enterprise knowledge modeling and information logistics, the work investigates the knowledge architecture for capturing and evaluating observations from a wireless sensor network built into a semi-trailer for a truck. Domain model and event correlation are introduced and discussed. The paper also reflects on use of ontology design patterns to speed up domain model development.

1. INTRODUCTION

Over recent years, the logistics industry has changed under the impact of the internal European market and of an increasing globalization. Logistics is a high-technology industry, making intensive use of modern information technology. The technology platform for road transport ERTRAC – to take one example - has elaborated a long-term vision and strategic research agenda [1]. ERTRAC expects that improvement information technology systems will be one element contributing to further reductions in fuel consumption by 10-20%. In order to reach this objective, integrative and interoperable information infrastructures encompassing all relevant types of logistics and supporting the specific needs of the dynamic logistics environment are required.

However, reality in the logistics domain is characterized by a multitude of information systems supporting different logistic functions, like load planning, fulfillment planning, fleet management, tracking, dock-door schedule, or returns management, which use different IT-platforms, protocols and architectures. This results in a lack of interoperability, the repeated recording of the same data and time-consuming maintenance. The further development of systems due to changing demands and cross-sectional tasks such as reporting and controlling are made more difficult to carry out. Interoperability, reusability and low-cost adaptability to quickly changing requirements require more flexible, service-oriented IT infrastructures. At the same time, the industrial demand for more

dynamic logistics solutions with adequate IT support is increasing. Many industries experienced during the last 10 years a shift in sourcing and logistics strategies from long-term customer-supplier relationships to more networked strategies adapted for global markets, like value networks, flexible supply networks and cluster-based approaches [2].
In the context of the above demand, the logistics and transportation area is widely considered as promising application field for new types of intelligent information logistics services, since

- Advances in wireless sensor networks and senor/actuator technologies in general allow for new ways of tagging and tracking goods and vehicles,
- Many different actors with heterogeneous information systems tailored to different purposes offer possibilities for automating or transforming processes by means of system integration and interoperability,
- Due to growing requirements from environmental or security rules and regulations, and due to an increasing awareness of sustainability issues on the customer side, the market for applications creating more ecological and economic services is developing fast.

The paper focuses on one of the essential elements of such intelligent information logistics services: the knowledge architecture forming the basis for service implementation. Based on an industrial case and on experiences from enterprise knowledge modeling and information logistics, the paper investigates the essential elements of the knowledge architecture for the case under consideration. The focus in the case is on the knowledge architecture part for capturing and evaluating observations from a wireless sensor network built into a semi-trailer for a truck.
The paper is structured as follows: Section 2 gives a brief introduction to background work from information logistics and enterprise knowledge modeling. Section 3 presents the industrial case. The knowledge architecture with its different elements is introduced and discussed in Section 4. Experiences from the industrial case are presented in Section 5. Summary and future work are discussed in the last section.

2. BACKGROUND

Work from information logistics and enterprise modeling forms the conceptual background for this paper. Both areas are briefly introduced in this section.

2.1 Information Logistics

Accurate and readily available information is essential in decision-making situations, problem solving and knowledge-intensive work. Recent studies show that information overload is perceived as a problem in industrial enterprises [8]. An example of a problem in relation to information overload is, in relation to different roles, to find the right information needed for a work task [8]. It is expected that an improved information supply would contribute significantly to saving time and most likely to improving productivity.

The research field information logistics addresses the above mentioned challenge in information supply by using principles from material logistics, like just-in-time delivery, in the area of information supply. The main objective of information logistics is improved information provision and information flow. This is based on demands with respect to the content, the time of delivery, the location, the presentation and the quality of information. The scope can be a single person, a target group, a machine/facility or any kind of networked organisation. The research field information logistics explores, develops, and implements concepts, methods, technologies, and solutions for the above mentioned purpose.

Contemporary research work in information logistics includes

- method for information demand analysis in an enterprise context [7],
- patterns of information demand for efficiently constructing information supply solutions [6],
- technologies for matching information demand and content [5],
- applications of solutions in an SME context, e.g. for networks of automotive suppliers [4] or media industries [3].

2.2 Enterprise Knowledge Modelling

In general terms, enterprise modelling is addressing the systematic analysis and modelling of processes, organization structures, products structures, IT-systems or any other perspective relevant for the modelling purpose [9]. Established approaches for enterprise modelling can be divided into at least two major communities: the enterprise engineering community and the artificial intelligence inspired community. Lillehagen and Krogstie [10] provide a detailed account of enterprise modelling and integration approaches from an enterprise engineering perspective. Fox and Gruninger [11] are prominent representatives of the AI-related approaches. Enterprise models can be applied for various purposes, such as visualization of current processes and structures in an enterprise, process improvement and optimization, introduction of new IT solutions or analysis purposes.

Enterprise knowledge modelling combines and extends approaches and techniques from enterprise modelling. The knowledge needed for performing a certain task in an enterprise or for acting in a certain role has to include the context of the individual, which requires including all relevant perspectives in the same model. Thus, an essential characteristic of knowledge models are "mutually reflective views of the different perspectives included in the model" [10]. Enterprise knowledge modelling aims at capturing reusable knowledge of processes and products in knowledge architectures supporting work execution [12]. These architectures form the basis for model-based solutions, which often are represented as active knowledge models. [13] identify characteristics of active models vs. passive models and emphasize that "the model must be dynamic, users must be supported in changing the model to fit their local reality, enabling tailoring of the system's behavior".

3. Industrial Case

Work presented in this paper is based on an industrial research and development project from transport and logistics industries. One of the world's largest truck manufacturers is developing new transport related services based on an integration and orchestrated interpretation of different information sources, like onboard vehicle information systems, traffic control systems and fleet management systems. Our case aims at using wireless sensor networks in trailers for innovative applications. In comparison to the well-equipped trucks, most of today's trailers are poorly equipped with electronic systems, although they "carry" the actual goods, are during a transportation assignment often switched between trucks and logistics operators, and outnumber the number of trucks by far.

The wireless sensor network is installed in the position lights of a trailer. Each position light carries a sensor node able to communicate by ZigBee[1] with neighboring nodes and equipped with a radar sensor. The radar sensor could be used for protecting the goods loaded on the trailer against theft, offering additional assistance to the driver of the truck (e.g. lane control, blind spot support) or for surveillance of the goods (e.g. sealing different compartments of the trailer). The wireless sensor network in the position lights is controlled by a gateway in the trailer, which communicates with the back-office of the owner of the trailer or the owner of the goods, and – for some application cases – with the onboard computer of the truck.

In order to prepare a variety of different usage scenarios, the objective of the research and development project was to develop the architecture of an IT-infrastructure which at the same time was efficient enough for managing thousands of trailers and flexible enough to be configured for different services without changing the software installations on the wireless sensor nodes or the gateways in the trailers. Efficiency in this context included minimizing the costly communication between trailer-gateway and back-office, i.e. it is required to pre-process the information from the trailer in the gateway in order to minimize information flow. Flexibility in this case included the possibility to dynamically integrate new sensor nodes in the trailer's wireless sensor network, if the service required doing so. An example would be future temperature surveillance sensors nodes built into load units with temperature-sensitive goods.

Initially, the development work in the case was organized like a systems development following the Unified Process. A number of potential business models

[1] For more information, see http://www.zigbee.org

was discussed and documented, and the most promising ones were selected as scope of the project. Within this scope, use case models were developed as part of requirements specification; important concepts were identified and documented in order to begin a domain analysis; potential system components were identified and documented; and the architecture of a prototype was drafted.

However, after the first iteration of the requirement elicitation and system architecture work, the development team decided to focus on commonalities and dependencies between the planned services, the domain model underlying these services, and requirements for configuring services and components from the operational context of the trailer. This decision was based on experiences from information logistics that it is essential to understand (1) information demand of different roles and (2) the context of information usage for information logistics solutions. The development project was split into three sub-projects: the development of the wireless sensor network infrastructure on a trailer; the development of a prototype back-office – trailer communication; and the development of the knowledge architecture and detailed system architecture. The following parts of the paper will primarily focus on the knowledge architecture sub-project.

4. KNOWLEDGE ARCHITECTURE

In this paper, the term enterprise knowledge architecture will be used as follows: *The enterprise knowledge architecture identifies elements of enterprise knowledge including their structural relationships and their context of use.* The main difference in comparison to an information architecture is that the context of knowledge use is modeled explicitly, since the context of use is essential for tailoring the knowledge to the demand at hand. In our case, "context" includes both all characteristics needed to determine the situation of a trailer and the characteristics of the actual information logistics service to be supported (cf. section 4.1).

Several use cases were defined within the project which aim at showing the adaptability of the platform to different types of environments and events. Within this paper, we use one of these use cases to illustrate our proposition, which at the same time is part of a future service. The example is a service protecting the trailer as such when parked against theft, i.e. that it is towed away by an unauthorized truck. Authorizing the transport of a trailer in this use case would show the following characteristics:

- The protection service is booked by the trailer owner.
- The trailer is parked, i.e. not moving.
- The protection mode is activated for the trailer.
- A truck driver sends the "unlock" request.
- The authorization process of the truck driver is successful (i.e. identity is proven and trailer owner has authorized the driver).

- The driver is in the close vicinity of the trailer.

Our aim, within the knowledge architecture, is to combine observations acquired through the different sensors (and potentially already processed at a low level), with information coming from other sources, like an authentication service for the driver's identity. We then have to detect potential critical events, according to what is specified by the end users of the system. From a system architecture perspective, this requires a knowledge base on the trailers gateway and in the back office. The (minimal) knowledge base in the gateway is populated by observations from the sensors; the knowledge base in the back-office by the information provided from the gateways.

4.1 Domain Model

Modeling the application domain allows sharing both a common vision of the aim of the application and the specificities of the domain among the different software components of the planned system, as well as among the different end-users of the system. Domain modeling also provides the knowledge necessary in order to process the incoming information, understand it and make useful decisions regarding the ongoing situation. Within our case study, the domain modeling and knowledge representation relies on the use of ontologies. They are used as the core representation paradigm and formalism. We take benefit of the progress that has been achieved regarding standardization with respect to semantic technologies. The domain model contains the basic domain knowledge of the transportation sector, the sensors and their control hierarchy, the situations of the services, and the participants in the situations.

The knowledge representation structure used for the domain model is a 5-tuple $O := \{C, R, H^C, rel, A^O\}$, consisting of

- two disjoint sets C and R whose elements are called concepts and relations respectively.
- a directed relation $H^C \subseteq C \times C$ which is called concept hierarchy or taxonomy. $H(C_1,C_2)$ means that C_1 is a sub-concept of C_2.
- a function $rel : R \rightarrow C \times C$, that relates concepts non-hierarchically (note that this also includes attributes). For $rel(R)=(C_1,C_2)$ one may also write $R(C_1,C_2)$.
- a set of ontology axioms A^O, expressed in an appropriate logical language.

The basic transportation domain knowledge in the ontology should be based on proven and industrially accepted developments. After an evaluation of SCOR based information models and TAPA TSR requirements[2], the decision was made to use the MSI group[3] information model as basis and specialize it for the case under consideration. Figure 1 shows an excerpt of the specialization of the

[2] For more information, see: http://tapaemea.com/public/trucking_security_requirements.php

[3] For more information, see: http://www.msigroup.se/index.php/en

MSI model, where the “Assignment” type is specified as aggregation of a specific “Logging” type and the generic MSI types VehicleInfoType, AssignmentIdType, LoadUnitDataType, and AffiliationInfoType. This assignment type is used for representing assignments to drivers (DriverAssignment), which also include the assigned vehicle and a trajectory of the planned route for purposes of geo-fencing.

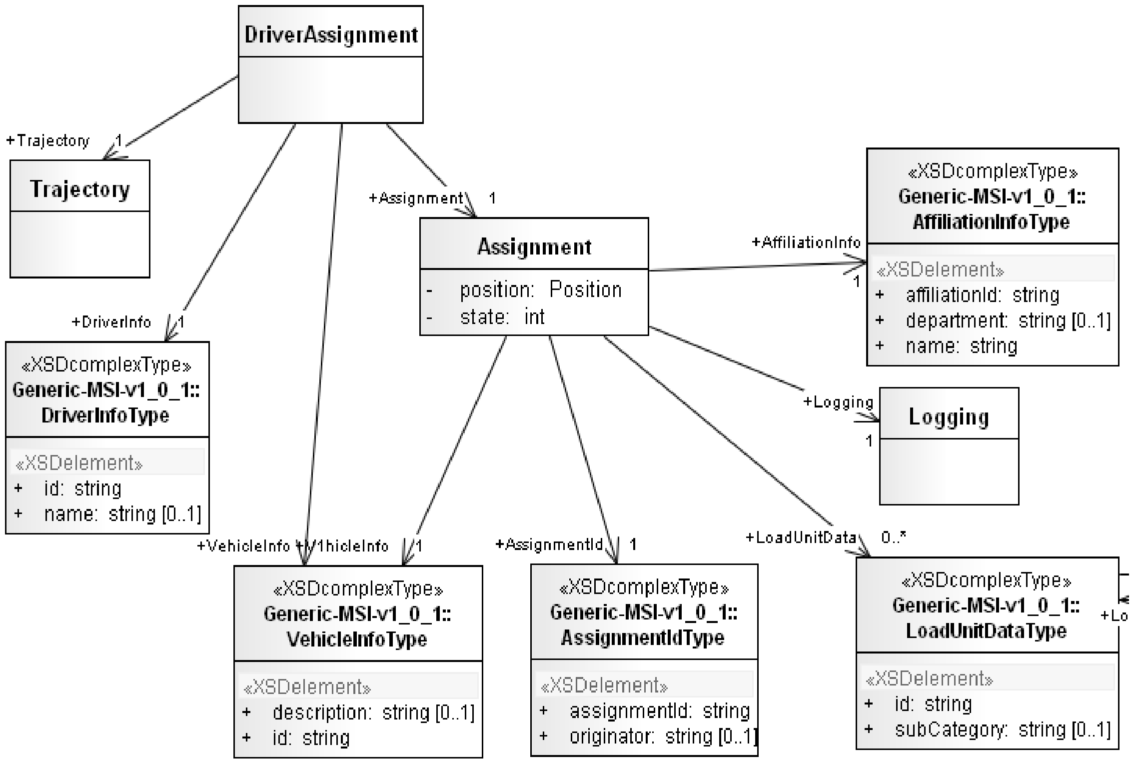

Figure 1: Excerpt from transportation domain knowledge part of the domain model

Another part of the domain model covers the sensors in the trailers and the control hierarchy, which at least consists of the sensor nodes, the trailer gateways, the trailer fleet of a customer of a service type, and the set of all customers of a service type. For the trailer-WSN related part of the domain model, the OGC sensor web enablement, in particular the sensor observation service (SOS) [14], was taken as starting point. Hence, like in SOS, an observation is modeled as an event which produces a result whose value is an estimate of a property of the feature of interest. Based on the generic types in SOS, specific property types were derived for the service under consideration, like geographic position of the trailer or violation of the inner borders. An observation instance is classified by its eventTime, featureOfInterest, observedProperty, and the sensor within the WSN used.

The next part of the domain model had to cover the situations of a trailer. Situation in this context means the set of all events, which need to be detected by the sensors and stored in the knowledge base on the controlling gateway due to the current configuration. An example is given in the introduction to this section.

For this part of the domain model, the TSO model[4] developed for civil security applications and the situation pattern from the ontology design pattern portal[5] (ODP) served as starting point. The TSO model introduces missions and different event types connected to missions. For our modeling purposes, the TSO event category "TRP" (transport) was found relevant. The situation pattern from ODP was used to introduce the recommended properties and relations between sensors and situations.

4.2 Event Correlation

Detecting relevant situations at the trailer does not only require a domain model providing the basis for the knowledge base, but a mechanism for event correlation, i.e. what observations – in the context of the trailer – have to be registered as events and what events are correlated and form a relevant situation?

The Event Correlation component was designed to recognize two types of correlations of events and/or facts registered in the knowledge base of the system:

- Anomalies requiring the attention of the back-office, i.e. the conditions characterizing an "abnormal" correlation of events are explicitly stated,
- Unacceptable or unexpected event correlations requiring the intervention from the back-office, i.e. the conditions for "normal" correlation of events are specified and all deviations are considered suspicious.

Unexpected event correlations and anomalies can be defined based on the domain model. An *unexpected event* is defined as follows: Let $SE := \{C^{SE}, rel^{SE}, A^{SE}\}$ be the rule set describing an unexpected event correlation, consisting of

- a set of concepts C^{SE} being a subset of the concepts in the domain model
- a set of relations rel^{SE} being a subset of the relations in the domain model
- a set of axioms A^{SE} over the concept set C^{SE} and the relation set.

A set of facts created in input data interpretation based on observation shall be declared an unexpected event correlation if all axioms in A^{SE} evaluate true.

Furthermore, an *anomaly* is defined as follows: Let A^{A} be a subset of the axioms of the domain model and each axiom $a_i \in A^{A}$ describe an anomaly to be detected. A fact created in input data interpretation based on observation shall be declared an anomaly if there exists an axiom a_i which evaluates false.

Both types of correlations have to be defined and configured before applying them in an operative trailer. A rule set specifying a specific event correlation will in the following be called correlation model. For instance, concerning the example from the introduction of section 4, failed authorization attempts and change in the trailer's geographic position (trailer moving), have to be considered as correlated. A rule set describing this event correlation will be defined as a correlation model, expressed in a declarative language and allowing reasoning in an appropriate logic language, e.g. as (subject, predicate, object) triples.

[4] http://www.tacticalsituationobject.org/

[5] http://ontologydesignpatterns.org

All correlation models have to be compliant with the domain model. The subjects and objects used in the rule sets of a correlation model are concepts from the domain model and the predicates of the rule sets are relations or properties in the domain model. The event correlation component exploits events registered by the WSN and leads to notifications, which are sent to the back-office together with information that supports decision making.

5. EXPERIENCES

This section presents experiences from developing the knowledge architecture with respect to the use of ontology design patterns and the IRTV approach.

5.1 Ontology Design Pattern Use

Due to the increasing use of ontologies in industrial applications, ontology design, ontology engineering and ontology evaluation have become a major concern. The aim is to efficiently produce high quality ontologies as a basis for semantic web applications or enterprise knowledge management. Despite quite a few well-defined ontology construction methods and a number of reusable ontologies offered on the Internet, efficient ontology development continues to be a challenge, since this still requires a lot of experience and knowledge of the underlying logical theory.

We experimented with the use of predefined patterns in order to speed up the development and configuration process of both the domain model and the knowledge base of the trailer gateway. In 2005, the term ontology design pattern in its current interpretation was mentioned by Gangemi [15] and introduced by Blomqvist & Sandkuhl [16]. Ontology design patterns provide a way of representing reusable knowledge of the transportation domain. An ontology pattern is a set of ontological elements, structures or construction principles that intend to solve a specific engineering problem and that recur, either exactly replicated or in an adapted form, within some set of ontologies or is envisioned to recur within some future set of ontologies. Two types of patterns are of particular interest: *structural-* and *content* patterns. *Structural patterns* deal only with the logical structure of the ontological elements but not with the actual ontology represented by these. A structural pattern is only a logical vocabulary with an empty signature, so no actual concepts and relations or other axioms are actually present. *Content patterns* are a specialization of structural patterns, since they both constrain the logical structure of how the solution to the problem should be modeled and set requirements on the ontological content. Content patterns are instantiations, and possibly combinations, of structural patterns where the signature is no longer empty.

Platforms offering ODP currently include the ODP wiki portal[6] initiated by the NeOn-project[7] and the logical ODPs maintained by the University of Manchester[8] .

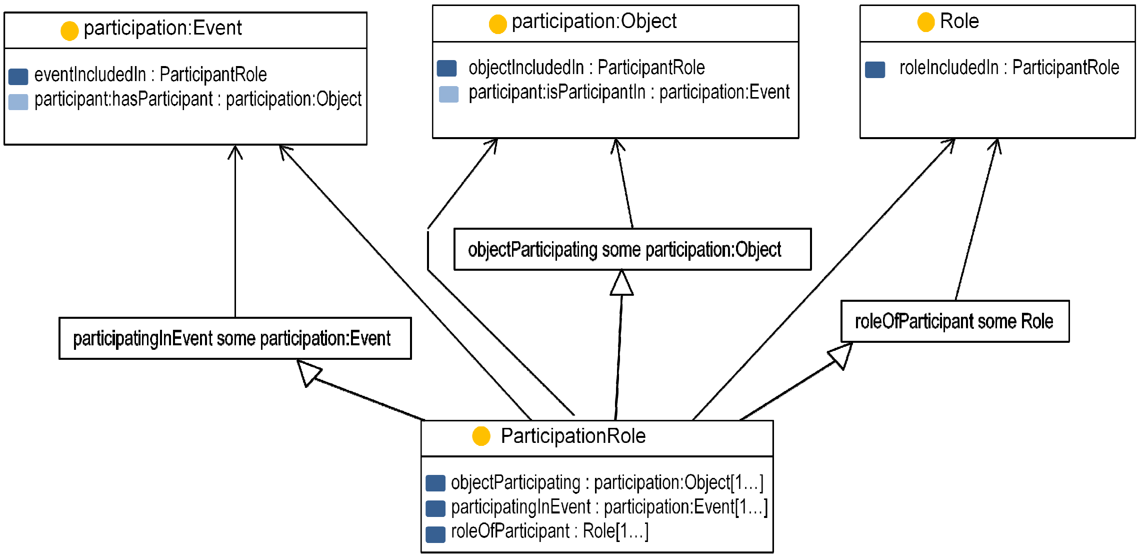

Figure 2: The ParticipantRole content ODP's, illustrated using UML.

An example of a content ODP is the "ParticipantRole" pattern, which initially was proposed in [17] and now also is available in the ODP portal catalogue[9]. The pattern specifies how to represent participants in events holding specific roles in that particular event. Figure 2 illustrates the OWL building block of the pattern. The pattern catalogue provides additional information according to a pattern template, including name, intent, domain addressed, author, competency questions (showing the requirements covered), scenarios, consequences, and a link to a reusable OWL model representing the solution proposed by the pattern.

5.2 IRTV Concept

During identification of context relevant knowledge and characteristics in the back-office, the use of the IRTV approach [18] proved beneficial. This approach recommends considering four different dimensions when analyzing enterprise knowledge:

- Information (I): which information is needed to offer the planned services, which information is produced.
- Roles (R): what actors are involved in the work, what is their responsibilities, which tasks do they perform, which information do they use, which views should their work environment encompass.

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[6] http://ontologydesignpatterns.org

[7] EU-FP7 funded IP that ended in February 2010 - http://www.neon-project.org

[8] http://www.gong.manchester.ac.uk/odp/html/index.html

[9] http://ontologydesignpatterns.org/wiki/Submissions:ParticipantRole

- Tasks (T): which tasks are performed, which services are used to achieve the results.
- Views (V): which views should be available to the actors, which information and services should they give access to, what should it look like.

The above dimensions are mutually dependent. Tasks require and produce information, tasks are performed by roles, roles are defined by the tasks the role is responsible for, roles need access to information, information is owned by roles, views are applied by roles performing tasks on some information, etc. Understanding and managing these dependencies are crucial for designing the right information, role, task and view models.

Applying the IRTV approach helped to identify relationships between the elements in each dimension, and as well between the dimensions. Tasks are often organized into process hierarchies, information by service structures, roles into organizational structures and views.

6. SUMMARY AND FUTURE WORK

Based on an industrial case study, the paper presented selected aspects of an intelligent information logistics service for transportation industry. The focus of the paper is on the knowledge architecture in the case under consideration in order to emphasize its importance for knowledge-based applications. The case is considered an example for future logistics services integrating and fusing knowledge from various sources. Furthermore, the paper reflected on use of ontology design patterns to speed up domain model development and the IRTV concept to identify context information.

Future work will be of experimental and conceptual nature. From an experimental perspective, the proposed approach has to be implemented and evaluated in controlled environments or real-world cases. This will most likely lead to changes, refinements and improvements of the proposed approach. The conceptual work includes to further elaborate the aspects of ontology design patterns, identifying reusable elements of transportation domain models, and adequate software infrastructure for implementation.

ACKNOWLEDGEMENTS

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NAVIGATION SYSTEMS AND ITS APPLICATION IN LOGISTICS IN RUSSIA AND GERMANY

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Abstract: The existing level of theory and technology provides plenty of opportunities for information logistics. In recent years there has been observed a progressive augmentation of various logistics innovative solutions based on global navigation systems. Particular characteristics of these innovative technical solutions are determined by both local requirements of necessary logistics service and technical capabilities of navigation systems, as well as the basic characteristics of the satellite information. Additional conditions on such technologies have place in consequence of using the sustainable management principles. Increasing transport and shipping traffic in the environments of existing transport infrastructure, which is typical for Russia and Germany, on the one hand, the necessity of timely and precise information about moving object positioning data from remote regions with undeveloped infrastructure, such as arctic areas in Russia, on the other hand, require a careful approach to the efficiency evaluating of the system application for different purposes and regions, searching for additional solutions and cooperation in global navigation. The article provides an overview of global navigation satellite systems (GNSS) and its applications in Russia and Germany, main characteristics of navigation platforms, functioning and development prospects of the navigation technology in logistics.

1. INTRODUCTION

In many respects enhancement of logistic system working efficiency and quality is determined by the scientific and technological progress implementation in logistics. Both for Russia and for Germany as a catalyst for these processes can be considered the growing impact of globalization. Scientific and technological progress in the field of logistics is achieved through the improvement of scientific approaches, logistic operation process organization and, of course, modern technique and innovative technology deployment. It can be said with confidence that at the present stage and in the foreseeable future the performance of logistics systems will be directly related to the implementation of advanced technological achievements, in particular satellite technologies.

It is obvious that space technology can bring and has already brought a number of advantages for large corporations and also for small companies. Therefore space satellite industry is currently in the centre of attention of both governmental institutions and commercial organizations in Russia and Germany. Even during the economic crisis it is confirmed by the impressive figures of space agencies budgets, presented in Table 1 [1], and percentage of gross domestic product, that was spent on civil space, presented in Table 2 [2].

Agency	2009, billion US Dollars
European Space Agency(ESA)	5.16
Germany	0.77
Russia	2.90

Table 1. Global Space Budgets, 2009

Country	2008 GDP (Constant Prices)	2009 Civil Space Spending	% GDP Spent on Civil Space
Germany	2.270 trillion euro	1.2 billion euro	0.05%
Russia	34.965 trillion ruble	87.9 billion ruble	0.25%

Table 2. Civil Space Spending as a percentage of Gross Domestic Product (GDP)

The World revenue in 2009 for commercial space infrastructure, including launch vehicles, satellites, in-space platforms, ground equipment, and infrastructure support industries came to 83.63 billion US Dollars [1].

One of the most popular satellite technology application fields in logistics is using of global navigation satellite systems for various freight and transportation types. At present time different type of navigation platforms, as information technologies, are part of the developing world logistics infrastructure. Over the past 10-15 years, global navigation has made a significant contribution to the global economy evolution. At the moment, global navigation satellite systems have hundreds of application areas, including embedded systems. By 2025, as estimated, the volume of the global market for equipment and services of satellite navigation will reach 400 billion euros [3].

2. SYSTEM TECHNICAL OVERVIEW

Global navigation satellite systems are designed to determine the location, speed, and the precise time of sea, air, land and other types of moving objects. Navigation systems are independent (completely autonomous) and no requestable (user equipment receives the signal only and doesn't transmit a request to the satellite). They use signals on the basis of pseudo noise sequences, and it gives them a high noise immunity and reliability in spite of low emission power transmitters.

Let's give a brief description of such systems. The satellite system consists of three major subsystems:

- Space segment;
- Control and measuring ground segment;
- User segment.

The main difference between the space segment of global navigation systems and other satellite systems is that the navigation satellites rotate in multiple orbital planes in the same medium earth orbit at a constant distance from the Earth's surface. To receive the signal at any time, anywhere in the world, maximum at 100 kilometers from the earth's surface it is required 24 satellites. If we divide it between two hemispheres, then it comes to 12 satellites in each of them. The orbits of these satellites organize a kind of network over the Earth surface. Consequently it is always guaranteed to be at least four satellites above the horizon. A constellation is constructed so, that, as a rule, there is a possibility to obtain no less than six spacecrafts. Fully operational satellite system also has reserve satellites, one in each plane for the urgent emergency swap (in case of the main satellite breakdowns they can be quickly put into operation instead of broken one). Backup satellites are not inactive, and they also operate in the system improving the positioning accuracy and providing sufficient redundancy. They can also be used to increase the coverage of a particular region. In a limited frame satellites can be rearranged by a team from the ground control station, but due to the limited fuel supply on satellite board it can be done only in exceptional cases. If it’s necessary, during the spacecraft lifetime it is possible to do only a small correction movement. There are several standards of time and frequency (precision atomic clock) on satellite board. It can be supplied with three or four such devices. And one of the etalons always works.

3. SYSTEM FUNCTIONAL FIELDS

On the base of defined above systems the following main navigation system application areas in logistics can be distinguished on land and at sea:

1. Classification of highways and land roads for the goals of surface transportation management.
2. Improvement and alignment of roads.
3. Positioning of mobile objects and monitoring of their movement.
4. Transport safety and security of cargo.
5. Optimal routing, including finding alternate routes.
6. Fixing of speed limits, taking into account daytime.
7. Counting the estimated delivery time of goods, passengers and vehicles. Possibility of determining the maximum and minimum.
8. Study of moving time, traffic analysis, effectiveness determination and route planning.
9. Global transport telematics, which is defined as the integration navigation satellite system, mobile and satellite communication and Internet:

GNSS + MOBCOM + SATCOM + INTERNET = GTTS

Transport telematics is one of the most important items for logistics, because it means a large-scale integration and implementation of telecommunications and information technologies in the transport industry in such a way that they penetrate into all areas: transportation modes, vehicles, infrastructure, organization and transport management. GTSS joins together all of these elements, both with each other and a society as a whole. Transport telematics combines human, vehicles and roads to improve transportation security, better environments, more efficient and reliable transport system, and a better exploitation of existing infrastructure.

4. NAVIGATION PLATFORMS

At the moment development of the own global navigation systems GLONASS and GALILEO is put on the agenda of government policy both in Russia and Europe. Nevertheless due to the objective reasons the most widely used system in Germany and Russia is an American Global Positioning System (GPS), because this is still the only one system that provides full coverage of the earth's surface. The constellation working group consists of 24 satellites in six orbital planes at an angle of 55 ° at an altitude of 20,180 km. Apart from the fact of complete dependence on the signal receiving conditions from the U.S. Defense Department a significant disadvantage of using this system in Russia, also for logistics purposes, is the fact that low-inclination of GPS spacecraft orbits seriously degrades the accuracy of positioning data in the north polar regions of the Earth, as the GPS satellites are situated too low above the horizon. In environment of increasing attention to the Arctic region development, it is important to have suitable technical systems, which can provide precise positioning of these areas. According to Information-Analytical Center of the Russian Federal Space Agency at the beginning of 2011 Russian GLObal NAvigation Satellite System (GLONASS) guaranteed the hundred percent of integral navigation availability in Russia, and 99.5% integral navigation availability globally. GLONASS has the same long history as GPS and relates to the crucial national infrastructure, providing national security and economic development. It realizes according to the Federal Program "Global Navigation System", approved by Government Decree dated 20 August 2001 № 587 in the wording of Government Decree dated 12 September 2008 № 680. Complete system deployment consists of 24 satellites in three orbital planes at an angle of 64,8 ° on medium earth orbit at 19,130 km. According to the system state in January 2011 twenty two satellites are used for the intended purposes, another four satellites temporarily removed for maintenance. Incomplete deployment of the system, that is large error in the coordinate data output in big cities, was one of the reasons for the GLONASS unpopularity for Russian users and giving the preference to GPS. One more system disadvantage was following: compatible with GLONASS user segment equipment was non-competitive. But the system could overcome some of shortcomings. Despite an unsuccessful last launch of satellites in December 2010 and that the system is not fully deployed, according to the control tests of monitoring the GLONASS infrastructure, which were made by group of companies “Echelon Geolife" in October 2010 in Moscow, the positioning accuracy in environment of city compact planning and high level of electromagnetic radiation, both systems are comparable. Next launch of three GLONASS satellites is planned in May-June 2011. At present time a satellite Glonass-K is ready for launch and in February will go under launch procedure. The satellite will be the twenty third spacecraft in the Russian group of navigation satellites.

Unfortunately, in consequence of most navigation receivers have orientation toward a GPS signal; the GLONASS doesn't have widespread use in Germany yet. This situation will be changed with the spreading of technical devices with multiple GNSS signal compatibility.

Before proceeding to describing of the European system GALILEO, it is necessary to add a few words about the project EGNOS, which is important for navigation in Germany. EGNOS is the abbreviation for European Geostationary Navigation Overlay Service. The system, which began to design in 1993, is the first European company that is related to the satellite navigation development. The main purpose of the system was to increase the navigation data accuracy of the two GNSS (GPS and GLONASS) for solving different problems, also in logistics field, requiring high accuracy and reliability (for instance, aircraft control or marine navigation in narrow channels) in Europe. With getting more information about the reliability and accuracy of the GPS signals, users located in Europe can determine their location positioning with greater accuracy. Since the beginning of the operational functioning of GALILEO project the EGNOS system will be used to increase the accuracy and integrity of its signals.

EGNOS is a joint project of the European Space Agency, European Commission and Eurocontrol. Space segment consists of 3 geostationary satellites. In contrast to GPS or GLONASS, the three spacecrafts do not have on-board signal source. Retransmitter only repeats the signals received from ground stations. The ground segment consists of a base monitoring station (Ranging and Integrity Monitoring Stations, RIMS), control and transmission station. The base stations control the position of each EGNOS satellite and compare the exact calculation of position data for each GPS and GLONASS satellite coordinates, which were made on the basis of satellite signals. Then the information is transmitted with ground-based networks to the control station system, which determine the accuracy of satellite signals and the positioning errors. By transmitting stations these data are sent to the geostationary satellites, next radio signals are received by users.

Unfortunately, the possibilities of using this system in Russia are limited. Although the signals of geostationary satellites can be received in the European part of Russia, there are no base stations of monitoring on Russian territory. Therefore, in most cases, using EGNOS signals is not recommended because it can not improve the navigation and even worsen it.

European satellite system GALILEO is undoubtedly important for the advancement of logistics services, regardless of the technical facility state in other countries. The complete space segment consists of 27 satellites in three orbital planes at an angle of 56 ° (9 basic satellites and one spare in each plane) located at an

altitude of 23,222 km. GALILEO project was developed as a joint initiative of the European Union and ESA after the establishment of EGNOS. Being an element of strategic infrastructure GALILEO system will have all necessary tools to guarantee national safety.
Governance structures will need to adapt for ensuring the most effective capital productivity for deployment and operation of GALILEO and also for the most effective capital formation from both public and private partners.
Since the end of December 2005 two experimental system apparatus GIOVE A and GIOVE B were orbited. System GALILEO is planned to put into operation in 2013. Now the first satellite of the GALILEO system is being tested in the technical center of the European Space Agency (ESTEC) in Holland. It is verified for the purpose of its readiness evaluation for launch into orbit. The first part of the European satellite navigation system, namely four orbital test satellite (IOV), will be running in two years. Over the next four years it is planned to have the first good configuration of 18 satellites in medium earth orbit.

5. CONCLUSION

Satellite Navigation can be considered as a vital area for many logistic fields such as, surface transport management, intelligent highway system, container traffic, maritime transport, rail, oil and gas production and others.
Certainly step by step processes of internationalization and globalization of world economy lead to a convergence of all global navigation satellite systems, such as GPS, GLONASS, GALILEO and others, which were not mentioned in this article. Gradually, there is an increasing shift of global navigation military orientation in direction of logistics technology support. Regional technical advantages of the various GNSS require the ability to support the satellite data from different navigation systems, since the positioning in the northern polar regions will be more accurate and reliable with using GLONASS, in Europe greater accuracy will be given by deployed GALILEO system, GPS will provide more accurate positioning data of moving objects in equatorial latitudes. In any case, free access to more than one system will provide reliable and timely logistics information regardless of user and object location.
Hereby the prospects for positioning accuracy enhancement and accordingly the improving of logistics services quality consist in using of adjusting receiver hardware (user segment) designed to support signals from different satellite constellations. To give location coordinates navigation receiver have to see at least four satellites. Orbital satellite constellation, such as GALILEO, GLONASS, and GPS are constructed so that receiver device can have 6 - 7 spacecrafts of each system in the field of view at the same time. The device selects four of them with the most powerful and stable signals, and according to them it gives the coordinates of the location. Therefore if we are talking about using GALILEO-GLONASS-GPS compatible hardware, then we will automatically

increase up to three times the density of the orbital grouping (space segment). In this case, the user device will be able to choose four beacon not only from 6-7 units, but from 18-27. This will allow to operate without fail in all conditions, for example, in the city areas or in the mountains, where relief may overshadow satellites, which are situated low to the horizon. The universal devices designed to receive signals from all the accessible systems have an advantage over one aligned receiver. So the problem of the preferable navigation system choice is solved by combined using of few GNSS. Due to a larger number of satellites and better signal reception logistics information systems will provide users with more accurate information and not only in Germany or Russia.

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SECURITY AND INTEGRATED RISK MANAGEMENT IN THE SUPPLY CHAIN

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Goal of the article
Goal of the article is research of new approaches in the field of interaction between security management system and risk management for effectiveness increase and supply chain stability on basis of risk integration in the adaptive monitoring system.
Research/application methodology
Different methodological applied methods are used in the work for realization. Methodology complex supply chain security (CSCS), worked out by professor Nekrasov A.G., was taken as a principle. Acceptable risk criteria ALARA (As Low As Reasonably Achievable) and a number of new international standards (ISO 28000, ISO 31000, ISO/ IEC 15288) were used with regard to sphere of SCM.
Management risk complex systems methods of testing, methodological and methodical approaches for neuronets building and teaching in respect to supply chain were developed by another author, post-graduate student Nekrasova M.A. Modelling of incidents and potential consequences is used for analysis operation of neurologistic module in the monitoring system.
Structure
Structure of the article corresponds to the assigned goal and contains the description of suggested new methodological methods in the field integrated risk security and management in supply chain.
Prerequisites in formation of new object – integrated risk- are considered in the first section of the article "Integrated approach to risk management". Analysis of main foreign sources regarding to problem of different approaches to risk and structures vulnerability assessment in supply chain is given.
Integrated approach is used in the transport security processes, as well as thought estimation of their reliability. Security management SCM is considered as global security aspect. So an approach which allows to consolidate different risks and to use risk management as universal tool for supply chain management is required.
Issues of the methodology regarding to formation special and general requirements to security management system on basis of risk management are considered in the second section "Structure and processes of risk integration in supply chain". Difference between risk management and managing risk is identified in terms of system analyses of international standard ISO 31000 "Risk management". Three-dimensional matrix model of integrated risk management in supply chain is shown.
The adaptive integrated risk monitoring system model is adduced in the final section "Perspectives of using integrated risk monitoring in supply chain". Such system involves all life cycle of processes in supply chain and is implemented on the software level. Integrated incident image is identified in chain "consequences - forecast" and provides reaction to discovered incidents (failures) in functional logistic cycle.

Academic contribution
Methodological approach is defined from traditional management individual risks methods in supply chain to integration metrics data on basis of risk monitoring neurologistic module. Effective method of consolidation risk monitoring system opportunities and automatic identification technologies in supply chain is suggested.
Practical value
Practical value of the research is in requirements definition to model and integrated risk management processes in supply chain which enables to enterprise:
- to provide more effective operation at the expense of loss prevention and consumer service quality improvement;
- to counteract low-quality goods (spares) and counterfeits in proactive risk management conditions;
- to juxtapose indices of supply chain operating activities with risk management indices;
- to reduce decision time in risk conditions.

БЕЗОПАСНОСТЬ И УПРАВЛЕНИЕ ИНТЕГРИРОВАННЫМ РИСКОМ В ЦЕПЯХ ПОСТАВОК

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Аннотация: Рассмотрены научно-практические материалы исследований, связанные с формированием интегрированной модели управления риском в цепи поставок. Формирование требований к структуре и процессам управления интегрированными рисками позволяет объединить методологию комплексной безопасности цепей поставок (CSCS) с модулями процессов менеджмента качества и менеджмента надежности, ориентированные на требования международных стандартов. Излагается новый подход для построения адаптивной системы мониторинга рисков, построенной на инцидентах.

1. ИНТЕГРИРОВАННЫЙ ПОДХОД К РИСК-МЕНЕДЖМЕНТУ

За последнее десятилетие совершенствование технологий менеджмента и обеспечения безопасности цепей поставок создали объективные условия для системной интеграции ранее разделенных самостоятельных экономических систем и соответствующих угроз.
Приобретая интегрированный характер, экономика и ее инфраструктура становиться все более уязвимой к инцидентам в системе безопасности цепей поставок. При этом, надо учитывать результаты глобального

экономического кризиса, который оказал негативное влияние на динамику внутреннего валового продукта всех стран. Учет эффекта влияния неопределенностей на цели цепи поставок в современной прикладной науке и практике связывают с риском и системой управления им – риск-менеджментом, который является ядром системы менеджмента безопасности цепей поставок [8][9][11]. Организации управляют риском через его идентификацию, анализ и затем оценку, может ли риск быть изменен с помощью обработки риска, чтобы он удовлетворял установленному критерию приемлемого риска ALARA. Все это предполагает рассматривать вопросы систем менеджмента безопасности, риска и структурной надежности процессов цепи поставок в рамках интегрированного подхода.

Анализ современных зарубежных источников также показывает тенденции в данном направлении. В статье [2] развивается индексная система оценки рисков, которая может быть использована для оценки уязвимости различных структур в цепи поставок. Исследование рассматривает тестирование уязвимости трех стандартных видов структур:

- с единичным источником;
- с составным (сложным) источником;
- с комбинированным (состоящим из единичных) источником.

Структурная надежность называется одним из используемых параметров. Именно через нее производится оценка вероятностей реализации риска для того или иного компонента цепи поставок.

В другой статье[6] менеджмент цепи поставок рассматривается с позиций управления выбором поставщиков/производителей, обеспечивающий надежность.

В книге [1] представлен также интегрированный подход к процессам транспортной безопасности с позиций процессов и операций. Исследование затрагивает вопросы модальных аспектов транспортной безопасности и технологических приложений, применяемых для реализации поставленных задач.

В [3] представлен подход, определяющий взаимоотношения ключевых элементов, которые непосредственно влияют на производительность цепи поставок (например, инфраструктуру). Надежность рассматривается авторами как одна из статей затрат, образующую конечную стоимость для потребителей, и оказывающая непосредственное влияние на конкурентоспособность предприятия.

В [4],[5],[7] рассматриваются категории рисков цепей поставок, факторы уязвимости и методы ее снижения, преимущества, которые дает механизм уменьшения рисков.

Рассматриваемые проблемы надежности и уязвимости в цепях поставок все чаще рассматриваются авторами как аспекты глобальной безопасности. Менеджмент безопасности цепей поставок приобретает все большее значение в условиях посткризисного развития экономики в целом и отдельных ее отраслей. В прошлом, компании рассматривали только потенциальную угрозу по отношению к их собственной деятельности. Риски, реализовавшись на уровне отдельного предприятия, могут вызвать кумулятивный эффект, накапливающийся при переходе от звена к звену, от уровня к уровню, приводя к неустойчивости.

Практически все организации управляют различными аспектами риска, но необходимо сделать менеджмент риска более эффективным, используя его как универсальный управленческий инструмент в цепи поставок. Стратегической целью его применения является интеграция процессов для управления риском в руководстве, стратегии и планировании, процессах отчетности, ценностях и культуре организации.

2. СТРУКТУРА И ПРОЦЕССЫ ИНТЕГРАЦИИ РИСКОВ В ЦЕПИ ПОСТАВОК

В настоящее время организации должны проактивно повышать устойчивость и надежность цепей поставок к по отношению к различным угрозам. Вместе с тем, вопросы операционных и технологических угроз и сопровождающих их отказов (сбоев) в производственных и транспортно-логистических процессах практически не рассматриваются. Эволюция количественных методов и риск-менеджмента затрагивает в первую очередь финансовые учреждения, а в реальном секторе экономики, где по объективным причинам преобладают как раз операционные риски производственных и других процессов, риск-менеджмент пока еще используется слабо. Управление рисками в реальном секторе отчасти развивается в самостоятельно существующих направлениях: промышленной и экологической безопасности, теории надежности и других инженерных дисциплинах.

В[9]и[12] в качестве универсальной модели предложено использование интегрированной системы менеджмента безопасности (ИСМБ), объединяющей модуль менеджмента безопасности, риск-менеджмента и менеджмента надежности в единую среду. Характерные черты данной модели используются для формирования исходных требований для управления интегрированными рисками (рис.1).

В целях конкретизации требований предлагается использовать процессы международного стандарта ИСО 31000, которые через «установления контекста» обеспечивают общее управление[14].

Современные практики менеджмента и процессов цепей поставок (ЦП) включают в себя компоненты менеджмента риска, и многие организации уже адаптировали формальный процесс риск-менеджмента для частных видов рисков или отказов. В таких случаях организация может принять решение в критическом пересмотре существующей методологии и практики в свете новых требований, содержащихся в международном стандарте ИСО 31000.

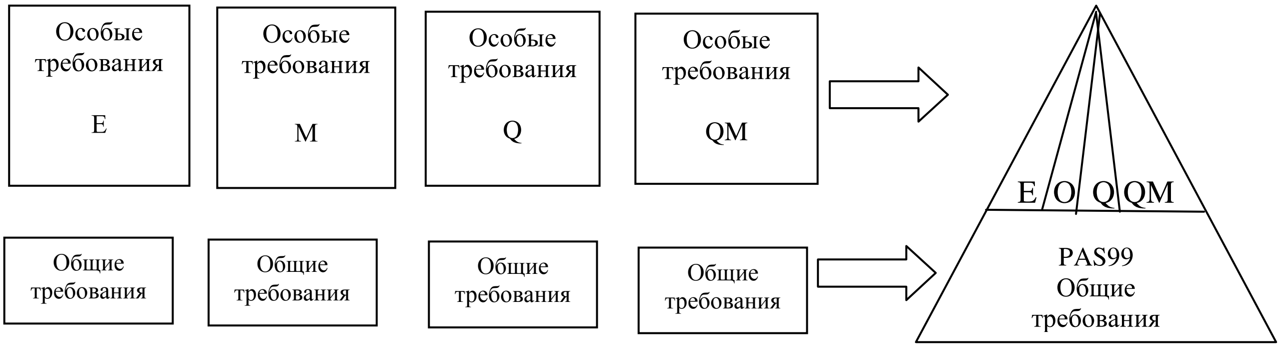

Рис.1. Структурная модель для интеграции рисков в цепи поставок (E – окружающая среда; M – менеджмент безопасности; Q – качество; QM – другие системы менеджмента)

Одновременно следует поводить различия между выражениями «risk management» и «managing risk». В общих выражениях «risk management» (менеджмент риска) относится к архитектуре (принципы, структура и процессы) для эффективного управления риском, в то время как «managing risk» (управление риском) относится к применению этой архитектуры к конкретным рискам.

Следи основных элементов процесса интегрированного риска следует выделить:

- установление контекста;
- идентификация риска;
- анализ риска;
- оценка риска;
- обработка риска;
- мониторинг и обзор;
- коммуникации.

С помощью установления контекста организация формулирует цели, определяет внешние и внутренние параметры принимаемые в расчет при управлении риском, устанавливает область и критерии риска для остаточного процесса.

Анализ риска включает в себя развитие понимания риска. Анализ риска включает в себя рассмотрение причины и источники риска, их положительные и негативные последствия и вероятность, с которой эти последствия могут произойти.

Целью оценки риска является оказание помощи при принятии решения, основанного на выходной информации анализа риска, какие риски необходимо обработать и каков приоритет выполнения обработки. Оценка риска включает в себя сравнение уровня иска, обнаруженного в процессе анализа процесса, с критерием риска, установленного при рассмотрении контекста.

Обработка риска предполагает рассмотрение отчета с более широким контекстом риска, включая рассмотрение устойчивости. Обработка риска включает в себя циклический процесс по: оценке обработки риска; принятию решения, приемлемы ли остаточные уровни риска; оценку эффективности этой обработки.

Результаты обработки рисков могут быть встроены во всеобщее управление производительностью организации, метрики, во внешние и внутренние отчеты по видам деятельности. Соответственно, такие элементы, как мониторинг и коммуникации, обеспечивают непрерывность измерения, постоянных улучшений, корректирующих и предупреждающих действий.

На основе изложенных требований к структуре и процессам модель управления риском в цепи поставок будет представлять собой интеграцию трех процессных модулей (рис.2):

1) процессов, отраженных в требованиях ИСО 9000, включая сферу логистики (управление функциональным логистическим циклом);
2) процессов системы менеджмента надежности, включая процессы интегрированной логистической поддержки продукции (ИЛП);
3) процессов управления риском, отраженных в требованиях ИСО 31000.

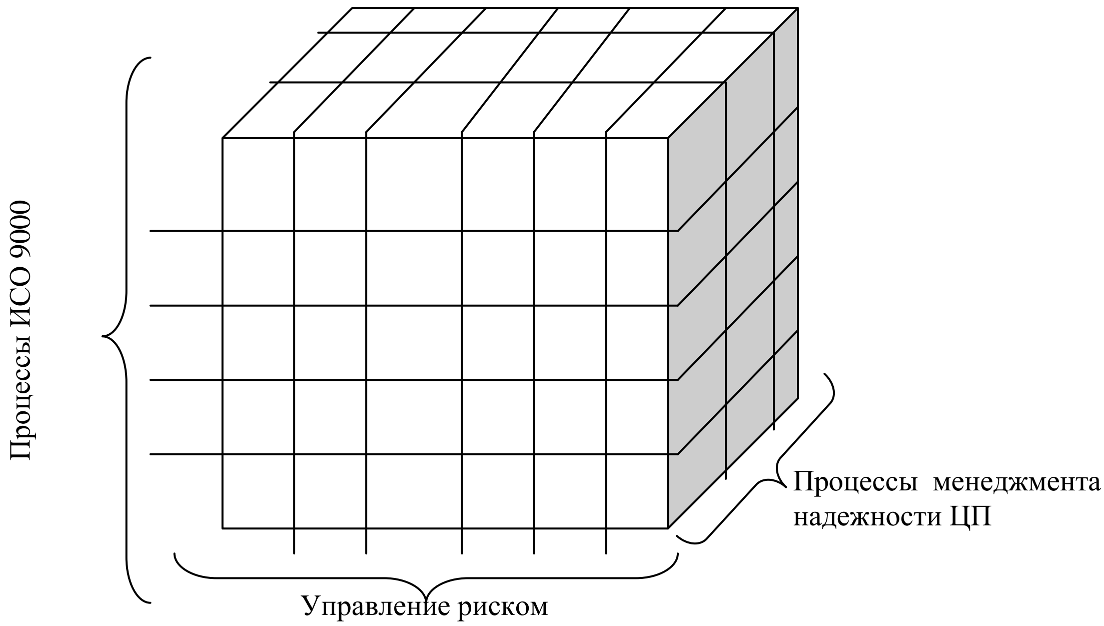

Рис. 2. Матричная модель взаимодействия процессов управления интегрированным риском в ЦП

3. НАУЧНЫЕ РЕЗУЛЬТАТЫ И ПРАКТИЧЕСКАЯ ЗНАЧИМОСТЬ

Результатом статьи является определение научно-методического подхода от традиционных методов управления отдельными рисками в цепи поставок - к интеграции данных метрик на основе нейрологистического модуля мониторинга рисков. Предложен эффективный метод по объединению возможности системы мониторинга риска и технологий автоматической идентификации в ЦП.

Нейрологистический модуль на уровне программы формирует интегрированный образ инцидента для определения цепочки «последствия – прогноз» и обеспечивает реагирование на выявленные инциденты в цепи поставок (рис.3).

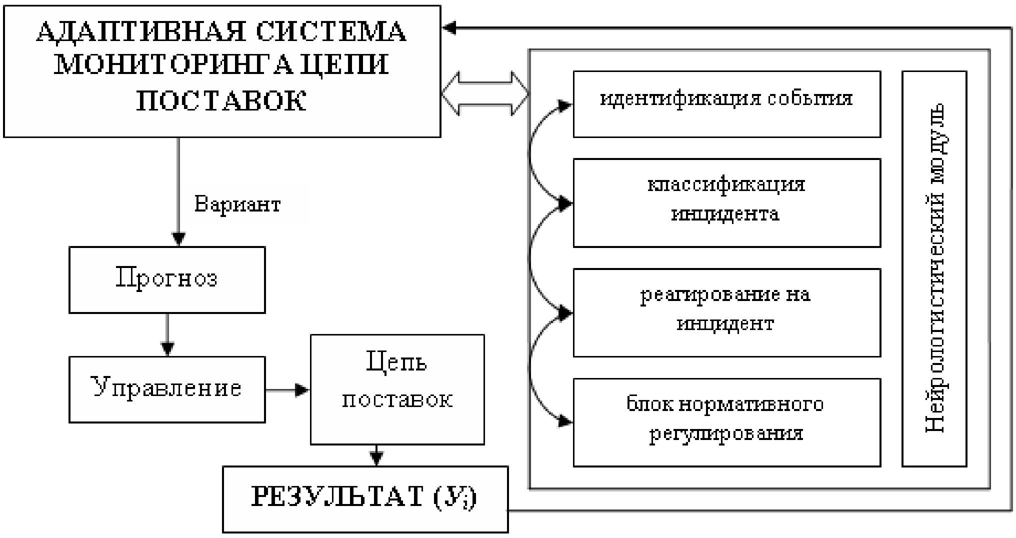

Рис.3. Элементы модели адаптивной системы мониторинга

Результат работы нейрологистического модуля можно представить в виде «светофора» на основе заполнения метрик кодами «1» и «0», вычисляемых из данных внутрифирменных отчетов. Внедрение новой системы интегрированного риск-менеджмента в практику SCM позволяет снизить потери, интегрировать средства автоматической идентификации (штрихкодов или RFID) с адаптивной системой мониторинга. Некоторые результаты были использованы в отчете ГосНИИ АС по сопровождению координационного проекта «ЕС-Россия и гражданская авиация»(1-й этап)», а также в практике работы ряда компаний РФ (ОАО «В/О «Авиаэкспорт», ООО «Силтэк», ООО «ИнтегПрог»).

Практическая значимость заключается в выработке требований к модели и процессам управления интегрированным риском в ЦП, которые позволят предприятию:

- обеспечить более эффективную работу за счет снижения потерь и повышения качества обслуживания потребителей;

- противодействовать в режиме проактивного управления риском случаям поставки контрафактных и некачественных изделий (запчастей);
- сблизить показатели операционной деятельности ЦП с показателями риск-менеджмента;
- сократить время принятия решений в условиях риска.

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SECURITY ASPECTS IN CONTAINER LOGISTICS: RFID E-SEALS

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Abstract: Many alternatives based on smart container security devices and RFID electronic seals have been examined and extensively tested since 9/11. Nevertheless, undefined electronic seal's status on the world market and manipulations with international standards for such devices involve many discussions about when, how and what type of seal will be most effective and secure for container logistics purposes. This research covers some aspects of security in international container logistics. The paper has a purpose to investigate current issues and possibilities for international operation of RFID e-seals in the container supply chain networks to enhance the security and efficiency of container transport systems.
Keywords: RFID e-seals, security, efficiency, container logistics

1. INTRODUCTION

The interactions of complex logistic transport systems have strategic impact on systems' security and efficiency. The supply chain and logistics industry considered cargo theft as the main challenge to supply chain security, while safeguarding against a terrorist attack is slightly less important. RFID e-seals are one of the aspects in complete solution for security and visibility improvement of container shipments. RFID e-seals allow importers, shipping companies, port officials and customs inspectors to identify, without a physical inspection, whether the container has been tampered with and whether the security of the container compromised. Active RFID electronic seal technology is still the most popular technology for e-seals between there several other advanced possibilities to secure the containers.

The existing standards for electronic seals are developing by the International Organization for Standardization (ISO). Regarding ISO/IEC 19762, Parts 1 and 3, ISO 17712 electronic seal is "read-only, non-reusable freight container seal conforming to the high security seal defined in ISO 17712 and conforming to ISO 18185 or revision thereof that electronically evidences tampering or intrusion through the container doors" [1]. The ISO 18185 e-seal standard is close to complete and in a little while being available as a useful tool for solution developers and end users. Some basic principles of e-seals have been agreed on meanwhile: the standard electronic seal will be an attachment device fixed to (or integrated into) the mechanical seal that secures the door of the container and programmed with a standardized set of data. These coded information [2] includes seal ID number, manufacturer ID number for a seal, an indication of the time when the seal had been closed and when it had been opened and a bit that indicates an eventual tampering of the seal. The main feature of the system is their dual frequency operations. The strength of a seal is measured with tests based on impact, shear, bend and tensile strength. The values, the measures of strength, reflected numbers in use by major customs authorities. For example, in the research project INTEGRITY (Intermodal Global Door-to Door Container Supply Chain Visibility) aims to support logistics operators in Business-to-Customs cooperation processes and investigate how to integrate container security devices technologies consider new EU security regulations [3]. Another the EU-China Customs project (SSTL – Smart and Secure Trade Lanes) has already started to test security procedures for intermodal transport in door-to-door supply chains [4].

2. RFID E-SEALS APPLICATIONS IN CONTAINER LOGISTICS

There are some constructive commercial and scientific trials to implement e-seals for the real tradelines in the international practice. The most of tested electronic seals' systems are based on RFID technology supported additionally by GPS/GPRS technology. For instance, SaviTrak(TM) customers in Asia and South America are discovered that a real-time data, a system captures from shipments tagged with active RFID e-Seals, enhances security visibility, speeds clearance by their countries' Customs authorities, and reduces in-transit inventory costs [5]. Another logistics and security firm identifies that the Savi Networks system has cut security costs in Colombia by $300 per container trip for its customers, which include Johnson & Johnson, Pfizer and Cadbury Adams. Western Digital, a leader in information storage products, says that per-trip costs have been reduced by $40 for point-to-point shipments from its manufacturing facilities to Royal Thai Customs authorities in Bangkok because the automated security devices speed collaboration and government clearances [5]. Several biggest container ports in the world have already adopted RFID projects, in particular, testing e-seals abilities for cargo tracking [6, 7].

The projects are focused on various advantages from RFID system implementation in port environment, like greater efficiency by shortening the time for container checking and management through the port by using active RFID e-seals [8], the issues of congestion and security in the ports [9] or improving the security of containers destined for the USA, with more stringent security requirements [10]. Their results show that smart RFID e-seal with its multifunctional ability can be effective for logistics purposes and applications in container supply chains/container ports. Nevertheless, even the anticipated solutions for integration of e-seals in container logistics are proposed only for the particular trade lines and based on the single container tracking devices. Consequently, the question about international utilization of RFID e-seals is still open.

3. MAIN CHALLENGES FOR RFID E-SEALS IN CONTAINER LOGISTICS

Many solutions based on smart seals have been examined and extensively tested since 9/11. Most of the proposed solutions focus on the electronic seal, and sensor on the container door. They do not address the problem of intrusion through other surfaces of the containers not touching the lock and seal or gasket or the contents stuffed inside the containers. The basic challenges for standardized e-seals [11] involve problems with inspection of all containers or even 10% oft them; difficulties to obtain an information whether a container is tampered with during the transit and uncertainty whether contents of any container contain weapons of mass destruction.

3.1 Standardization

A lack of standards seems to be a major issue hindering their applicability to international trade flows. A further barrier is the acceptability and cost of e-seals to the container industry. Regular use of seals requires new software connections and container sealing procedures, which could slow acceptance [12].

Regarding [13] it is still remains technical challenges despite the increasing attention to RFID applications. The use of radio waves obviates the needs for a clear line-of-sight placement of a container door with RFID seal, because metal sides of the container reflect electromagnetic energy. This often results in decreased identification rates of seals. Electromagnetic interference from other nearby transmissions in a port area can also affect the tag performance and tag to reader communications. Physical effects such as reflection and diffraction may also affect tag performance. Inconsistent interoperability across various RFID systems, companies, and countries also presents a challenge to the wide-scale development and deployment of RFID technologies.

Technical standards, frequency, and power levels are critical issues for successful global interoperability of RFID systems. There are several efforts underway to develop and refine technical standards for tags and readers, and common standards remain a goal. Likewise, differences in operational frequency ranges, allowable transmission standards, and allowable power limits in countries continue to serve as operational constraints [14].

The current research and development of future RFID capabilities moves towards the processors fabricated with new conductive materials or use of organic microprocessors for RFID tags and other applications. For example, the National Institute of Standards and Technology is looking at the technical feasibility of replacing silicon or inorganic materials in RFID devices with mostly or wholly organic materials such as plastics. This and other ongoing research in materials and tag and chip design, fabrication, and production will result in more robust and functional tags over time [13].

Container transport is an open system with a broad variety of often unknown actors who contribute to the services in the transport chain. The owners' code register of Bureau International des Containers in Paris notes more than 1600 owners and operators of containers using their world-wide unique code to establish identity for their containers. Standardization is a vital condition of the current efficiency of the container transport system. Standardization is needed for security actions as well. The Customs Convention on Containers (Geneva 1972) defines that a seal for container transport under customs seal must be approved by the national Customs Administration concerned. This regulation has, in the end, produced several thousand of different seal designs. Under such condition, it would be most difficult to ascertain whether a seal has been attached by an authorized party or been replaced somewhere under way [2].

Another RFID technology critical issue is a powering the container for batteries tags. Not every port of call offers charging facilities. Some have proposed solar-panel or self-charging devices, but these may be damaged during rough handling of a container, not to mention the logistics of strategic panel placement required to capture sunlight. No one has satisfactorily solved this problem [15]. To date, the common interoperability among e-seals and readers manufactured by different vendors is additional restrictive factor for national and international adoption of e-seals. For RFID e-seals compatibility and exchangeability of RFID components can bring the costs also down [16].

3.2 Political impact

Another milestone in global e-seals implementation process is political issue. There are two kinds of political issues. The first is international and national spectrum regulation, which includes spectrum allocation and power and duty cycle regulation; this is an issue in part because there is no global frequency set aside for RFID logistics applications. The second political issue is about commercial interests, as different companies aim for market advantage [17].

Therefore, undefined electronic seal's status on the world market and manipulations with international standards for such devices involve many discussions about when, how and what type of seal will be most effective and secure for container logistics purposes. The debates took a long time and there still no solution or trade-off between customs authorities and business sector, between manufactures of e-seals and standardization institutions regarding technical capabilities of security devices and logistics applications of it.

3.3 Costs

Increased container and port security will not come without additional costs, and it does not refer only to the money that the government must invest to increase security. It is essential to balance port and container security with economic efficiency of cargo flows. While port security is the crucial part of the competitive maritime transportation system, too much security can damper trade and leads to a loss of a sense of freedom and to feelings of insecurity [18].

Maritime transportation and logistics activities traditionally have been among the largest costs in international trade. But in contrast to that, the most significant advances in modern logistics have not been in cost reduction, but in improved processes to move goods and materials between nations in a timely and seamless manner [19]. The implementation of CSI and other security initiatives have also placed an increased trouble in terms of processes and costs for all the players in global supply chains. This means that for CSI to be fully sustainable as a process in global supply chains, the financing of CSI must also be equitable or fair. There are two possible sources for financing CSI [19] payment by users and public sources.

3.3.1 Payment by users

A tax or a fee can be charged by the relevant authorities. This specific fee can be collected to finance the extra process, equipments and technology used for CSI. The use of appropriate INCOTERMS will become critical in deciding whether the exporter or the importer should pay this specific fee.

3.3.2 Public sources

Financing can be national and international where each government is responsible for all security initiatives within its borders. In this case the most developed countries would already have security equipment. In place while the developing countries would have to invest a significant amount in order to achieve acceptable levels of security. The international financing could take place if the countries, such as the US, provide a grant to the implementation of CSI around the world [19]. On the level of the public financing there is always the risk of not achieving the desired level of security in global supply chains. Regarding the third option, the bilateral financing it is necessary to mention that important to achieve also the financial sustainability after implementation of security measures in global transport network. However, to finance the security measures such as e-seals from whatever sources is not guarantee global supply chain security.

Understanding the finances of current intermodal container tracking first requires an understanding of incentives, investment values, and returns. In practical terms, this means the cost of the equipment and the detention charges applied to keeping equipment longer than the specified free period [20]. Once these elements of the system are well understood, the value of better tracking systems can be evaluated.

Nevertheless, any technological advancement to enhance security must also stimulate trade by reducing the cost or increasing the efficiency of operations. Therefore, integrating a modular tracking, seal, and sensor system utilizing RFID and GPS into the container structure will both increase container security and optimize trade [21]. Its success depends on business/government partnerships and international implementation. It must be partnered with stringent initiatives

that enhance information exchange and security of the physical and personal components of the supply chain.
DNV Consulting international company has done the study for European Commission regarding estimating the general economic impact of international and European programs towards improving and especially investing in transport security in EU [22]. The DNV have analysed the effect from implementing high security seals, compliant to ISO/PAS 17712, for containers export to outside the EU if seal has a cost of below 0.75 Euro a piece. It is assumed that 80% of intra cargo (2 billion tons per year) is subject to the seal programme and an average cargo unit weighs 20 tons the number of seals needed to implement an EU seal program will be 80 million investment. It is assumen that it takes 2 minutes to mount and dismount such a high security bolt the additional expenses for industry would be in the order of 150 million Euros [22].
The equipment costs can be broken down into the cost of the container, the seal, the RFID tag, and the smart box. The investment for new shipping containers is between $7,000 and $40,000, depending on the size and its function (dry goods or refrigerated goods) [21]. High-security mechanical seals cost between $0.50 and $2 per seal depending on the material employed [23]. Electronic seals developed by Savi Technology, used by the Department of Defense and tested in a pilot program with the Asia Pacific Economic Cooperation (APEC) Secure Trade in the APEC Region (STAR), have a value between $300 and $400 [21].
The designs of reading infrastructure of e-seals have as well a principal impact on the range that the system can be effective and on the ability of the devices to communicate in complex environments such as container yard / terminal gate area. The differences in effective reader range have a key impact on the infrastructure required to cover a large reading area [24, 25]. This is an important trade-off that will determine the total infrastructure cost of an installation. Less complex systems will have a lower potential cost per reader; however multiple readers will likely be required. More sophisticated devices could have greater potential investment per reader but only a single reader might be required [26].

3.4 Mandating issue

United States Customs Border Protection (CBP) became effective requiring all US inbound maritime containers to be secured with an International Organization for Standardization ISO/PAS 17712 bolt seal [27]. However, many shippers and container carriers have been using these bolts for years with no appreciable effect [28]. These seals are easily counterfeited, and their main advantage seems to be that they are inexpensive. The technology is available now to develop a single-use, disposable, inexpensive, versatile and reliable e-seal. Part of the argument put forward by the DHS for not using e-seals is the concern by both government and industry about the costs of the e-seals, costs of an extensive and expensive RFID infrastructure, the logistics of returning reusable e-seals and responding to ‘false positive’ alarms caused by defective and unreliable e-seals.

4. CONCLUSION

The public sector needs to adapt to new business practices and introduce appropriate technologies for securing of transportation process. However, this process will be beneficial only if existing administrative and commercial practices are overhauled prior to the computerization of procedures [29]. Smart e-seals can present a wide range of attractive and useful functions such as business intelligence in transport logistics [30, 31]. Nevertheless, there are still some challenges in worldwide usage of smart RFID security and identification systems.

This paper highlighted the main issues of security aspect regarding RFID e-seals application in container logistics. The first discussion point is what kind of technology should be used as a worldwide standard of e-seals. This discussion has a substantial importance for the next issues: what kind of infrastructure need to be established and what kind of functionality one could obtain from the device [32]. The infrastructure for RFID e-seals does not presently exist, and need to be installed on thousands of different properties. Another actual issue for e-seals global implementation is international ISO standards for the devices. It is still an open question what the product needs to do; what specific events must be captured and recorded; is capturing entry through the doors enough or must it detect entry into the container through the walls, ceiling or floor; does the device have to detect conditions other than entry intrusion? No doubt, that better security and greater visibility will bring a lot of value to the global trade growth. But first of all, the governments and industry have to archive the equilibrium from security requirements and achievement of benefits for logistics system stakeholders, before to set specifications for container security devices and begin the process of global RFID e-seals implementation.

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RISK MANAGEMENT IN THE TRANSNATIONAL ROAD FREIGHT TRANSPORT IN THE BALTIC SEA REGION

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Abstract: The Baltic Sea Region (BSR) is one of the most dynamic regions in the European Union (EU) and is characterized by a high transport volume. The transnational road freight transport comes along with different kinds of transport risks. Until recently a detailed classification and analysis of risks within the road freight transport in the BSR and deduction of strategies of how to implement a comprehensive supply chain risk management in this context have not been made.
This paper presents the results of an empirical risk management study and of an international workshop on the analysis of transport risks which were conducted within the EU project C.A.S.H. (Connecting Authorities for Safer Heavy Goods Traffic in the Baltic Sea Region).

1. INTRODUCTION

Since the expansion of the European Union (EU) in 2004, the Baltic Sea Region (BSR) has become one of the most dynamic regions in the EU. This development has led to a continuously increasing amount of transnational transport of both freight and goods. The trend will most probably even accelerate in the future. But transnational road freight transport is aligned with dangers and therefore risks in road traffic, which can lead to numerous accidents [1-2]. To identify these risks and to develop adequate counteractive measures, the EU co-finances the project C.A.S.H. (Connecting Authorities for Safer Heavy Goods Traffic in the Baltic Sea Region) from September 2009 until August 2012. This paper provides insight into the BSR, highlighting the importance of logistics for the region, providing first results of an empirical study on risk management as well as of a conducted workshop on transport risks. Furthermore, the paper introduces the planned activities of the C.A.S.H. project, which focus on the development of measures for a holistic risk management in the transnational road freight transport.

2. LOGISTICS IN THE BALTIC SEA REGION

The BSR is situated in the North-East of the European mainland and consists of Denmark, Estonia, Finland, Northern Germany, Iceland, Latvia, Lithuania, Norway, Northern Poland, Northwest Russia and Sweden. The region has 60 million inhabitants, approximately 500,000 less in comparison to the highest value in the year 1997. The Nordic countries (Denmark, Finland, Norway, Sweden) account for roughly 45% of the population [3].

According to the "Global Competitiveness Report 2009-2010" published by the World Economic Forum, the countries Sweden, Denmark, Finland and Germany belong to the world's most competitive countries. The companies in the BSR not only have access to the consumers of their area, but also to the markets of the other EU member states as well as Russia, comprising 640 million inhabitants in total [4].
The cross domestic product (GDP) shows that the BSR has evolved into an important European growth region over the last ten years. With growth rates between seven and nine percent in 2007, the Eastern European EU member states Estonia, Latvia and Lithuania as well as Russia were above the average growth of the EU. However, in the Nordic countries and Germany there was only an increase between one and five percent (cf. figure 1). Strong growth rates are recorded in the BSR prior entering the world economic crisis. Nevertheless, the economic differences between regions are still visible [5]. The crisis shows its effect in the BSR. It is reflected particularly in the Baltic States (Estonia, Latvia, Lithuania) and even leads to an increase of the economic differences between developed and transitional countries in the BSR. Only Poland had a low positive growth rate during the crisis. The downturn in Russia was not as high as in the Baltic States. The predicted values for 2010 reflect an economic recovery in the whole BSR [3].

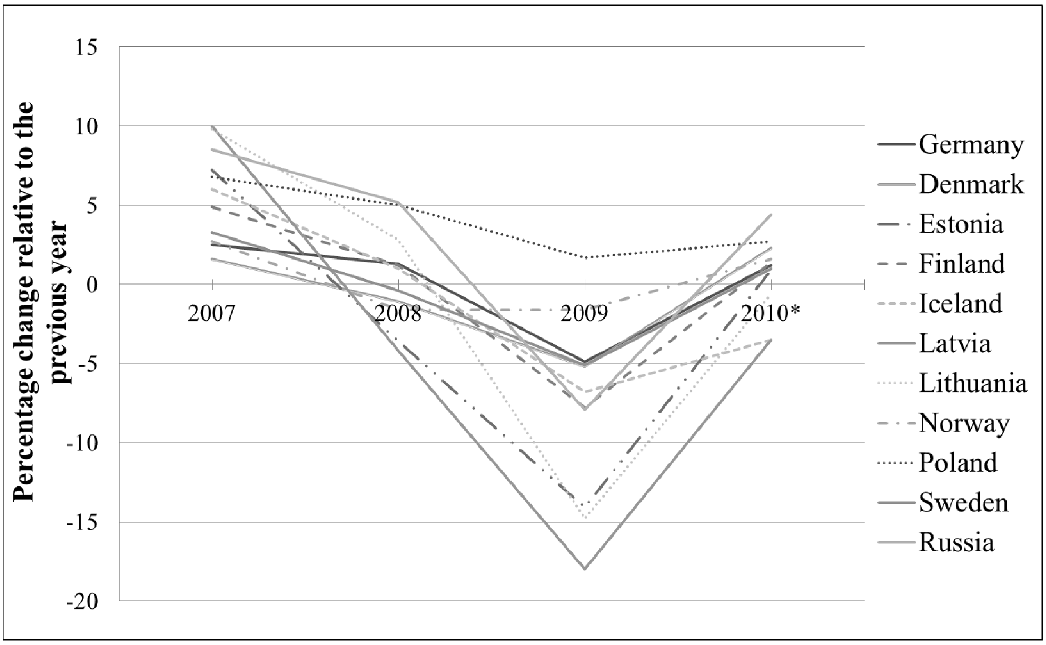

Figure 1. GDP growth rates (relative to the previous year) in the BSR [6]. Values for Russia are estimated for 2009 and projected for 2010 [7].

Due to the geographic location and the dynamic economic development, logistics has a central role in the BSR. Many goods are transported from Russia as a resource-rich country via the BSR to Central and Western Europe. The Baltic Sea forms a major axis for freight transport in Europe. Freight traffic is split up into road and rail traffic, pipelines, air freight, inland water transport and shipping in this region [8].

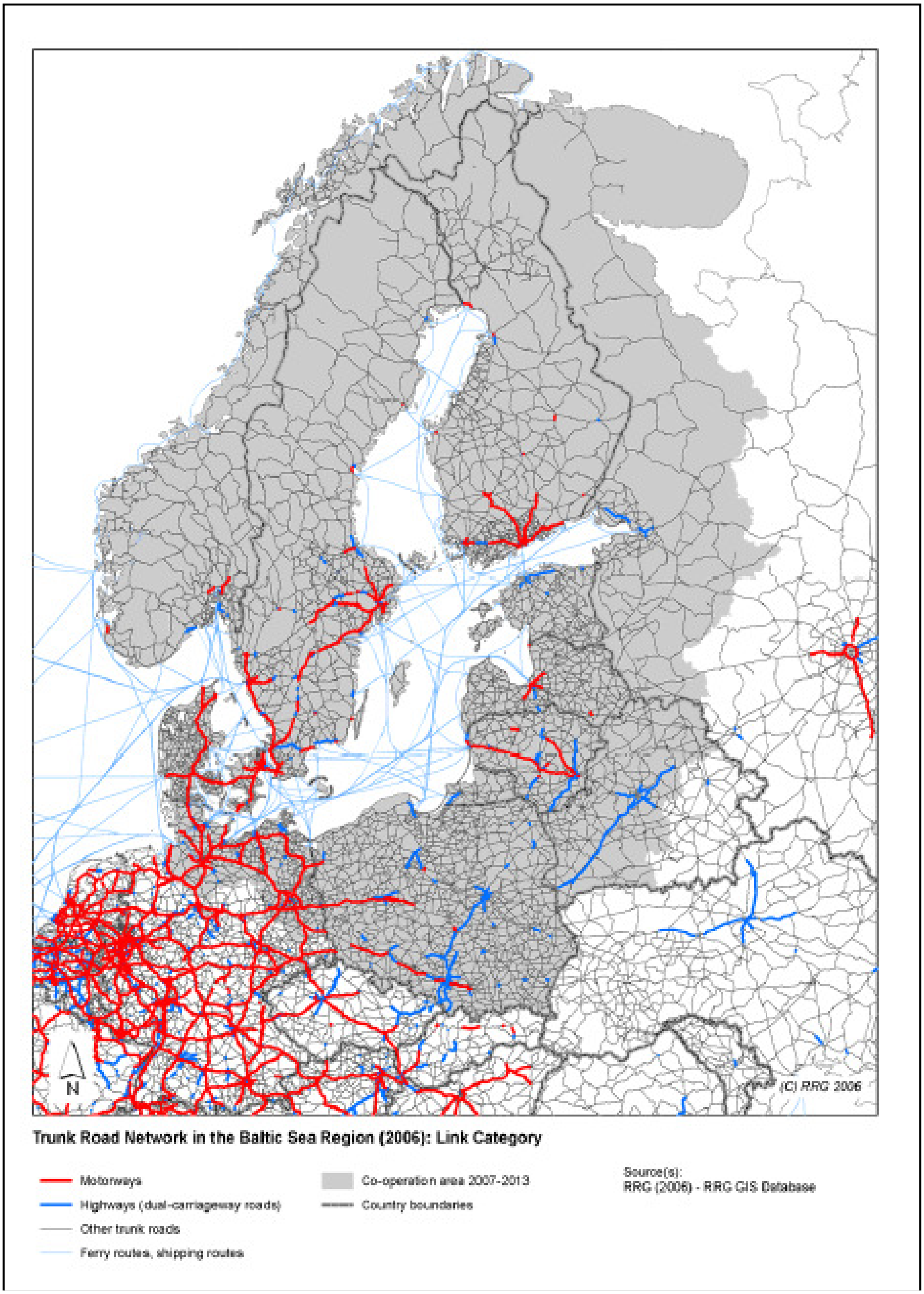

Figure 2. Road Infrastructure in the BSR in 2006 [9].

In 2006, road freight services accounted for 45.6% of the entire transport volume of the EU-27, shipping for 37.3% and rail for 10.5%. In national freight traffic, the predominance of road freight transport is even more obvious since it amounts to almost 80% of tonne-kilometres in the EU-27 [8]. Road transport offers greater flexibility than other types of traffic. Figure 2 provides an overview of the existing road infrastructure in the BSR and shows a dense road network, which is characterized by a good connection between the Baltic ports and the hinterland. Regionally, however, it has a different density or different forms.
The BSR includes four of the ten largest logistics markets of the enlarged EU-29: Germany, Poland, Finland and Norway. The German and Polish logistics markets are not completely included in the spatial separation of the BSR. Nevertheless, the following figures highlight the importance of logistics in this region. The total logistics expenditure referred to GDP is above-average in the BSR (8.7%) compared to the EU-29 (7.1%). In addition, Finland (14.4%) and Estonia (14.5%) had the highest proportion of logistics expenditure of GDP in 2008. Both in the BSR and in the EU-29, Germany by far had the highest volume of transport (3,597.3 million tonnes per year) as well as the highest logistics expenditure in 2008, € 218.1 billion (8.8% of GDP) [10].
The Logistics Performance Indicator (LPI) of the World Bank highlights the different development stages of logistics in the countries of the BSR. The evaluation of the LPI is mainly based on the following indicators: "Efficiency of the customs clearance process, quality of trade and transport-related infrastructure, ease of arranging competitively priced shipments, competence and quality of logistics services, ability to track and trace consignments, frequency with which shipments reach the consignee within the scheduled or expected time" [11, p. 4]. With these measures, the LPI ranked Germany as best logistics performer in 2010. Overall, three countries of the BSR (Germany (1st), Sweden (3rd), Norway (10th)) are ranked within the top ten of 155 countries. Finland and Denmark are ranked 12th and 16th and also belong to the top performers. The development of logistics in the Eastern European countries is not yet equal with the Western European ones. Poland (30th), Latvia (37th) and Lithuania (45th) are at least under the first third of logistics performers worldwide [11].
The brief overview of logistics in the BSR highlighted that road freight transport plays a decisive role. As today's business models as well as production and logistics systems (Just-in-Time, highly distributed production, outsourcing etc.) place increasing requirements on logistics operations, it is important to establish beneficial conditions for logistics to cope with these challenges. The allocation of adequate infrastructure and areas for the settlement of logistics enterprises are important issues. Furthermore, it is highly demanded to reduce risks for logistics service providers, manufacturers, and commercial enterprises as well as for the transnational road freight transport itself.

3. RISK MANAGEMENT IN TRANSPORT

This paper focuses on risk management applied to transnational road freight transport. For this purpose, as a brief introduction to the concept of risk management, there will be a theoretical classification. This will be followed by an overview of occurring risks in the transport sector and first results of a conducted workshop.

3.1. Fundamentals of Risk Management

Within the framework of decision theory, risks result from the uncertainty of future events, named the sources of risks or uncertainty [12]. On the one hand, in the case of certainty, it is doubtless which state of environment will occur. On the other hand, uncertainty in the broader sense encompasses risk as well as uncertainty in the narrower sense, depending on the level of knowledge about the probability of occurrence. In the case of risk, subjective or objective probabilities of occurrences are known. In the case of uncertainty, the decision maker only knows the potential states of the environment [13-14]. In 1921, Knight already distinguished between measurable uncertainty, also known as risk, and non-measurable uncertainty [15].

Even if risk is understood as related to its effect, there are different approaches between the disciplines. In the field of mathematics, the construct “risk” is defined as value-free, while in the field of business economics it is mainly understood as the opposite of a “chance”, thus a potential loss or damage [16-17]. This paper follows the latter approach.

It is necessary to implement risk management in enterprises to manage risks and their potential negative effects. Otherwise, enterprises could be endangered to the effect that profits are not realised. In Germany, e.g. the board of managing directors of limited companies and accordingly the management of companies with other corporate structures are obligated by law (KonTraG – Gesetz zur Kontrolle und Transparenz im Unternehmensbereich) to take measures, especially incorporating a monitoring system, to identify risks at an early stage, which endanger the continuance of the company. The undertaken measures are controlled in the annual audit. Similar acts are in force in the other BSR countries [18].

In dependence on the generic management process, the risk management process characterises a systematic approach to cope with risks. The process encompasses four stages: identification, assessment, management, and control [19].

Different potential risks can occur in companies. One approach to distinguish risks is to differentiate between the view of risks regarding their source or their impact. There are also other classifications which depend on their concept or purpose. Eberle [20] for example differentiates between the focus of flow, level of decision making, and level of risk. For the flow he describes logistical, financial, informational, and legal risks. On the level of decision, there are strategic, tactical, and operational risks. And finally on the level of risk, he distinguishes between bagatelle, small, medium, large and existence risks. Rogler [21] differentiates between supply, production, distribution, financial and personnel risks, depending on their area of operation. In the field of supply and distribution, transportation risks might occur. These risks are related to the terms default, quantity, quality, costs, and time and will be described in more detail in section 3.3.

3.2. Description of the C.A.S.H. Project

The C.A.S.H. project is part-financed through the Baltic Sea Region Programme 2007-2013. This programme is one of 13 transnational cooperation programmes of the EU and promotes regional development through transnational cooperation in the BSR. The European Regional Development Fund finances the programme with 208 million euro and the European Neighbourhood and Partnership Instrument with 22.6 million euro. Further 6 million euro is financed by the Norwegian national fund. The aims of the BSR programme are to foster innovations, to improve the internal and external accessibility, to use the Baltic Sea as a common resource, and to develop attractive and competitive cities and regions.

The C.A.S.H. project partnership is made up of 13 organisations in eight countries around the BSR. The project duration is 36 months until September 2012 and it has a 3.4 million euro budget. The project is co-ordinated by Turku School of Economics in Finland, as part of University of Turku. The project aims to develop practical solutions to make international road freight transport safer, more predictable and affordable in the BSR.

3.3. Empirical Results Regarding Risk Management

From January until April 2010 the authors conducted an empirical study to analyse the status quo of risk and risk management in business practice as part of the C.A.S.H. project. In this early stage of the project there was no focus on the different regions. This will be the case for the development of strategies, which will be described in more detail in section 4. In the following, results of the study will be presented.

The target group of the empirical study were German manufacturers (62 replies) and logistics service providers (25 replies). The respondents mainly had the following jobs or worked in the following areas: (administration) procurement, (administration) supply chain management, (administration) logistics, (administration) controlling, business management or member of the management board.

The definition of the EU was considered in order to distinguish the size range of enterprises [22]. 16 replies were from small, ten from medium, and 61 from large enterprises. The share of small, medium, and large companies of logistics service providers and manufacturing companies is illustrated in figure 3. Only a small proportion of replies comes from medium enterprises in both corporate forms, while large enterprises provide the majority [23].

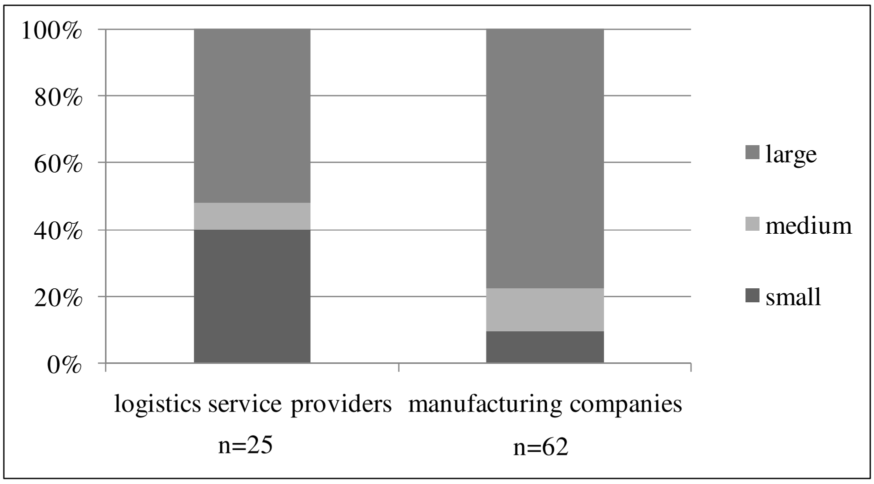

Figure 3. Percentage of small, medium and large enterprises of the replies of logistics service providers and manufacturing companies [23].

According to several telephone calls and emails, further company representatives tended to support the study, but they were not authorized by their supervisors to provide information. It can be assumed that the reason for this circumstance is the sensitive issue of risk management.

At the beginning of the questionnaire, participants were asked to indicate their understanding of the construct risk on the basis of a given statement. 88% positive and 12% negative responses show that most of the company representatives consider risk as a potential damage. Afterwards, the question was raised whether the enterprises have institutionalized risk management. 51 participants answered with "yes" (59%) and 35 with "no" (41%). The shares of manufacturing companies and logistics service providers are similar; however, they differ between the size ranges of enterprises: All large logistics service providers have institutionalized risk management, while this is only the case in about two thirds of the large manufacturing companies [23].

Even if only 60% of the responding enterprises have institutionalized risk management, almost all participants (90%) use tools to identify and analyse risks in their usual business processes. Nearly three quarters of those enterprises which have not institutionalized risk management stated that they apply risk identification and analytical tools in their daily processes (see figure 4). Used methods include the assessment of suppliers, financial checks, supplier self-reports, key performance indicators such as delivery reliability, quality assessment, credit checks and the failure mode and effects analysis (FMEA) [23].

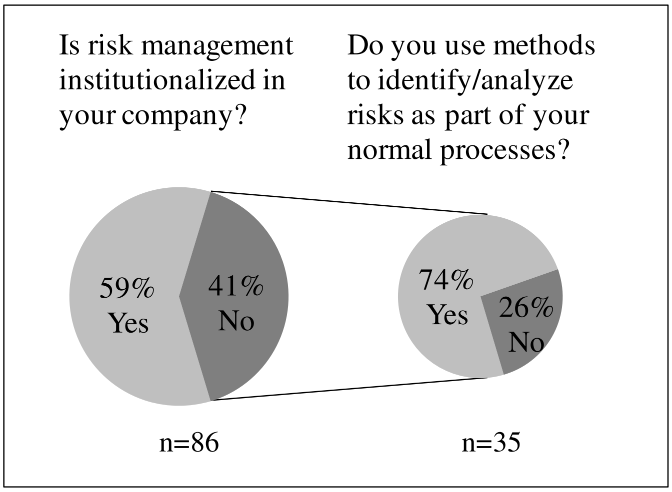

Figure 4. Application of risk analysis methods as part of usual processes in companies with no institutionalized risk management [following 23].

In a next step, company representatives were asked to generally appraise the importance of certain logistics risks for the logistics sector on a five-point Likert scale. Figure 5 shows the result. The delay/untimeliness of delivery (time risk) was regarded as the highest risk, followed by damage during transport (quality risk). The increase in transport costs (cost risk) was ranked close to the quality risk. The loss of the entire cargo (default risk) and the partial destruction during transport (quantitative risk) were ranked less important. Manufacturing companies rank transport risks as presented in figure 5. Logistics service providers on the other hand rank time risk as most important as well, but it is followed by costs and quality risks.

Since the 1980s, costs, quality, and time have been counted among the strategic success factors in companies. In recent years, the time factor was considered most important [24]. Following Schulte-Zurhausen [25], these three aspects form the “magic triangle” of project management. The relevance of these factors can be seen in the study, as in all cases time, quality and cost risks were regarded most important.

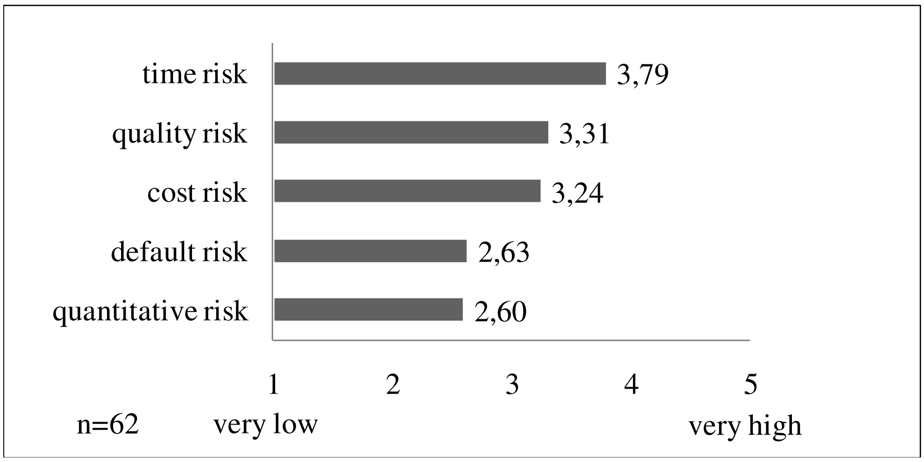

Figure 5. Relevance of transport risks for the logistics sector in general.

In the risk management process, the assessment of risks follows the identification of risks. While 8% of the company representatives report that they do not assess their risks, two thirds classify their risks qualitatively. 40% of the experts accurately quantify the two dimensions probability of occurrence and amount of damage. When answering this question, it was possible to agree with several statements or to reject them.

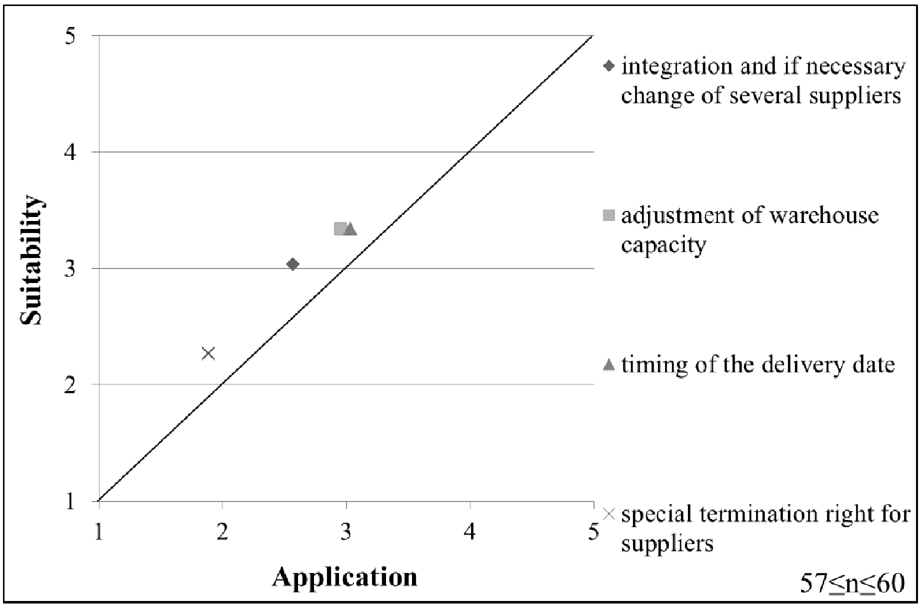

Figure 6. Suitability and application of logistics strategies in risk management for the supply side.

In order to manage the previously studied risks, four logistics strategies were evaluated with regard to their suitability and application (see figure 6). The figure only shows the responses of manufacturing companies, as not all of the strategies apply to logistics service providers.The respondents rated all specified strategies in the terms of suitability higher than in their actual application. The strategy to terminate the contract with suppliers was recognized as least suitable and applicable. The strategy to integrate or change several suppliers was applied and rated as quite suitable. The respondents rated the strategies to adjust the warehouse capacity and to change the timing of the delivery date to have additional buffer time as most suitable and applied. These results give a good impression about the common strategies in practice. Furthermore, this evaluation of logistics strategies in risk management for the supply side is the basis for the development of additional strategies, which can be applied in transnational road freight transport. This is one of the expected outputs of the C.A.S.H. project.

3.4. Workshop on Transport Risks

To be able to develop suitable and efficient logistics strategies to minimize risks in transnational road freight transport, it is necessary to identify transport risks at first. For this purpose, the authors conducted a workshop within the C.A.S.H. project with representatives of road police authorities from Denmark, Estonia, Finland, Germany, Lithuania, Norway and Sweden as well as researchers from Germany, Finland, Latvia and Lithuania. The workshop took place with 25 participants in Tallinn, Estonia, in June 2010.

The participants from police authorities were mainly in leading positions of units related to the control of Heavy Goods Vehicles (HGV). Some were even specialists in the field of dangerous goods. The researchers either worked in the area of business logistics or they were psychologists conducting studies in the field of logistics. The workshop aimed at finding as many transport risks as possible before starting to cluster the risks through a discussion.

As a result of the workshop, different kinds of risks were identified. They have been clustered according to the categories truck driver, company, truck and external risks (see figure 7).

The highest number and diversity of risks have been found within the category of truck driver risks. Furthermore, within this category risks have been classified into state, intentional erratic behaviour and unconscious erratic behaviour risks. Risks in the category "truck" have also been listed several times. Truck risks include risks in the field of basic equipment (condition of vehicle) as well as risks related to supplementary equipment. Risks in the category "company" were mentioned less often. Last but not least, some external risks were mentioned by the participants of the workshop. They were classified into the subcategories infrastructure, human behaviour and environment.

Although many transport risks have been named, the outcome of the workshop leads to the conclusion that possibly it is not an exhaustive overview of transport risks, especially as the main focus was on truck driver risks and representatives of logistics companies did not attend the workshop.

However, the identified risks in the field of transport show that due to their diversity a successful risk management must consider different perspectives. This is the reason why the C.A.S.H. project was initiated.

Within the different work packages of the C.A.S.H. project all stakeholders will be considered. Different perspectives are covered by scientists, psychologists, representatives of state authorities as well as by representatives of companies.

Chapter 4 describes the operational fields and different work packages of the C.A.S.H. project on how risks in the transnational road freight transport in the BSR can be reduced by considering comprehensive perspectives.

4. OPERATIONAL FIELDS OF THE C.A.S.H. PROJECT

The setup of the C.A.S.H. project supports the development of risk management strategies in the field of road freight transport in the BSR. The project consists of five work packages, which will be described in the following.

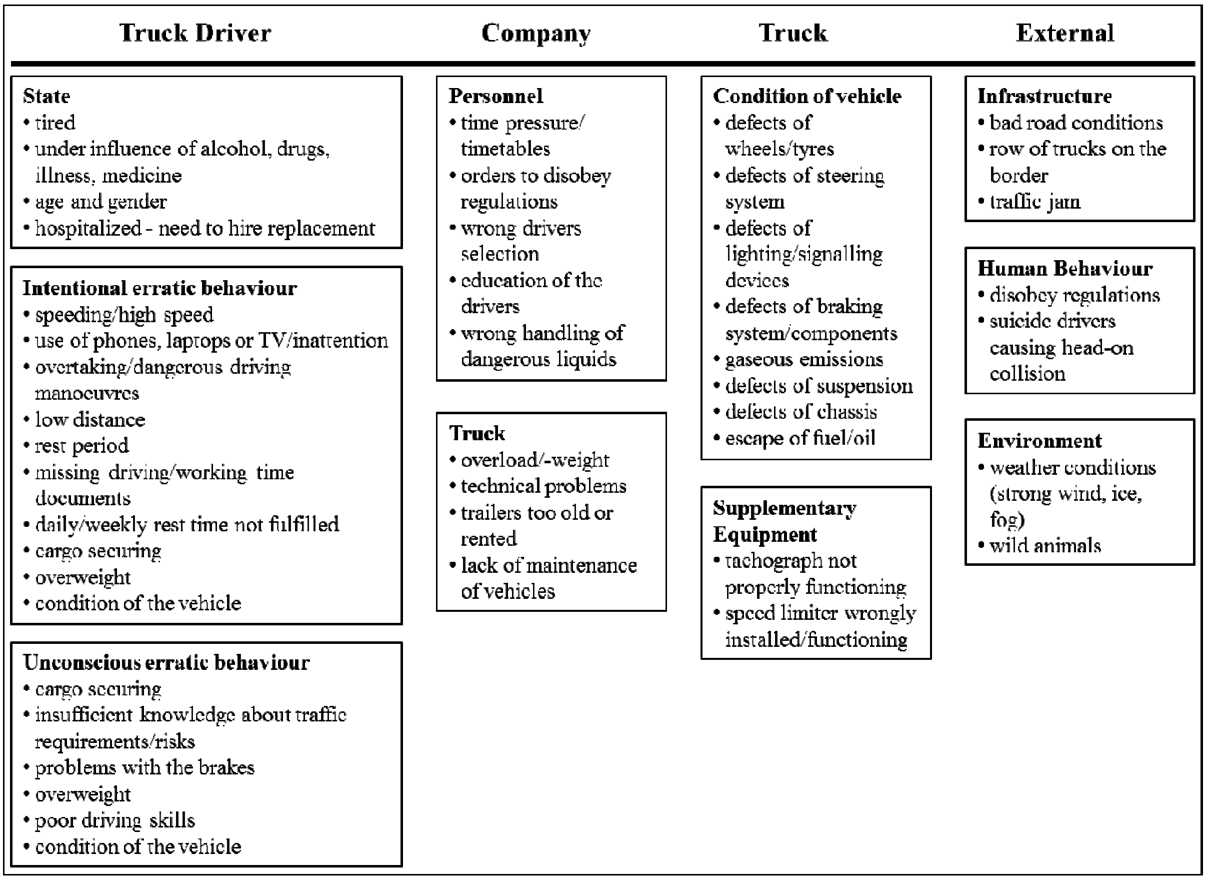

Figure 7. Workshop Results on Transport Risks.

The overall project management (first work package) as well as the dissemination activities (second work package) are in the responsibility of the Finnish University of Turku (Turku School of Economics).

The third work package is managed by the Norwegian Mobile Police Service. On the one hand, this work package conducts empirical research on the attitude and behaviour of HGV drivers regarding alcohol, drugs, fatigue, and traffic safety. On the other hand, an on-going study is led about the impact of the market structure on safety and security in the transport sector. First findings were published recently [26]. The collaboration of international scientists and psychologists within this work packages ensure a neutral perspective.

The National Traffic Police of Finland organises the fourth work package. This focuses on the cooperation between scientists and the national authorities, which are actively involved in the control process of HGV. Joint exercises and short term staff exchanges foster the exchange of knowledge about national control methods. This international cooperation is expected to lead to more efficient control processes and to build up an international network on the mid-management level between relevant authorities in the BSR.

The fifth work package leader is the Institute of Business Logistics and General Management at Hamburg University of Technology. The main aim of this work package is to analyse risks in the transnational road freight transport and to de-

velop strategies for risk management in this field together with representatives of companies and public authorities. First, an empirical study was conducted with representatives of companies to evaluate the industry view on risk and risk management (see section 3.3). Second, a workshop was held with all project partners to identify transport risks (see section 3.4). As a further planned activity, expert interviews with representatives of police authorities, public authorities, manufacturers, logistics service providers and associations will be conducted to be able to recommend risk management strategies, which can easily be applied in the field of road freight transport.
Moreover, this work package encompasses tests of equipment and IT systems relevant for the control of HGVs. The C.A.S.H. project will not finance investments itself, but will provide useful information for equipment and IT investments outside the project. It is planned to establish an international network in the field of research and development with users of HGV control equipment in the BSR.
Through the close linkage between the work packages within the project as well as the integration of police authorities, federal/regional authorities, manufacturers, logistics service providers, associations and universities, it is ensured that C.A.S.H. fosters the establishment of risk management methods for the transnational road freight transport in the BSR.

5. SUMMARY

Logistics and especially road transport is of increasing importance in the BSR. Concurrently, threats and risks occurring in the HGV traffic increase with the boost of freight and goods. Against this background, the C.A.S.H. project deals with the topic risk management applied in the road freight transport within the BSR. During the project, transport risks are identified, assessment methods will be adapted to this field and strategies for a holistic risk management in the transnational road freight transport will be developed. Although the project is still in its initial phase, first empirical results in the field of risk management could be presented. Furthermore, an overview of the upcoming project activities was given.

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COLLABORATIVE NETWORKS DECISION TAKING UNDER RISK CONSIDERING PSYCHOLOGICAL CHARACTERISTICS OF DECISION TAKER

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Abstract: This paper focuses on the elaboration of the special approach to decision taking in collaborative networks (CN). As CNs are characterized by a high level of complexity and uncertainty it is evident that there exist the necessity to take into account uncertainty factors while decision taking and introduce special tools into decision taking models. In the presented paper author underlines the difference between terms "uncertainty" and "risk" and it is underlined that "risk" has to be considered subjective term and must be analyzed within internal personal preferences of the decision taker. Then the special approach to understanding risk is given and a procedure of analysis is proposed. The presented approach facilitates comprehensive understanding of decision taking under risk in collaborative networks. Author believes that this research will help to develop risk tools and models in collaborative networks management.

1. INTRODUCTION

The term Collaborative Network is applied as a definition for various types of networks, such as Supply Chains, Value Chains, Virtual Enterprises, Extended Enterprises, and Simultaneous Engineering [1]. The main feature of these networks consists in strategic collaboration and resources coordination. As collaborative networks are complex systems, they are characterized by a high level of uncertainty that consist in uncertain interactions of participants, uncertain goals, external uncertainty and knowledge uncertainty [2]. All these factors cause risk while managing collaborative network and decision taking.
The difficulty here is to get the objective probability assessments of relevant processes; this task seems very hard and almost impossible. That is the reason why a decision taker is forced to use subjective uncertainty assessments to substantiate the choice he is making.
As a result a selection task appears to have a tree structure. At every furcation a decision taker should make his choice in favor of one of the directions. While selecting his path he considers expected positive results and their probabilities. So, the selected alternative depends on the applied model, in which decision taker's personal subjective characteristics form model parameters. Such characteristics may be prudence and caution or aggressiveness and faith in good luck. Last two characteristics describe his inclination to take risks. These characteristics may be formalized if we apply linguistic variables or fuzzy logic, but it seems to be a really hard task [3]. Meanwhile psychological characteristics

of decision taker play the considerable or even the main role. That is why it is very important to introduce into models the stated above factors in some form. As a result a model contains not only traditional formalized constructions, but also several concepts which are uncharacteristic for mathematical problem definition. In this paper we propose an approach to understanding risk and introducing personal psychological characteristics while decision taking.

2. LITERATURE OVERVIEW

As uncertainty and risks play important role while decision taking in collaborative networks, a lot of research was done in this field.

Harland et al. in their work “Risk in Supply Networks” [4] use the following definition of the term “risk” (R). It is the product of the probability (P) of a loss and the significance or impact (I) of the loss, related to an event: R=PxI. While assessing risks, they propose to use two directions that are presented in form of questions: i) How probable is it that an event will occur? ii) What is the significance of the consequences and losses? Their approach seems to be similar to DRISC model of Paulsson [5] or approach of Kaplan and Garrick [6], who underline that the risk depend not on the consequence of an event, but on the significance of that consequence, i.e. on the decision maker’s attitude to it. That is why from their points of view it becomes so important to introduce different methods and multiple approaches into risk management, even from other sciences.

Peck [7] also highlights that the classical risk theory focuses on “objective” risks meanwhile organizations and decision takers ought to take into account “perceived” risk. She notices one interesting tendency of outsourcing “risky” activities or transferring risk as a way to reduce risk, whereas much of the recent SCM literature, e.g. Martin Christopher [8], views outsourcing as a way to introduce risk because of loss of control over the supply chain. We would like to add, that while transferring risk it is absolutely necessary to take into account how risky is this transfer, because there could be a danger of delegating too much risk to a weaker supply chain participant.

The behavioral approach to risk management is very clearly introduced in **“**Buyer perceptions of supply disruption risk: A behavioral view and empirical assessment” by Ellis et al **[**9]. They transform and adapt a behavioral model of risk decision taking developed by Yates and Stone [10], where in opposite to the traditional risk management literature, there is a difference between two successive stages of risk decision taking: judgment and evaluation. Individuals will first judge the probability of loss and other relevant considerations, and then evaluate overall risk. They add a perception notion to all traditional risk characteristics – they introduce “the perceived likelihood of probability” and “the perceived severity of losses”. Their work may serve an initial step for future researchers who endeavor to investigate behavioral aspects of supply chain management risk.

3. RESEARCH

3.1. Background

Let us analyze a selection task between taking part in a lottery with a known number of results and their probability distribution on the one hand, and some guaranteed outcome. The standard classical approach to determining this outcome is to calculate the weighted average result of the lottery (statistical expectation). In case when a decision taker is indifferent whether to participate in a lottery or to get the outcome for sure (both variants are equal for him), the value of this calculated expectation (outcome) is usually called *"the deterministic equivalent of a lottery"*.

The described selection model has one special feature that makes it different from what is going on in real situations when it is necessary to make a choice. We can not be sure that the *weighted average* or as it is usually called *expected result* corresponds to one of possible results [11]. In other words it seems to us to be not correct to put together the expected result and the guaranteed outcome. Furthermore, we suppose that it is more interesting from practical point of view to compare the guaranteed outcome with other lottery parameters, e.g. with the maximal possible effect associated with one of the results. If this effect is higher than a guaranteed outcome, a decision taker interprets this effect as a temptation to participate in a lottery. On the other hand, if the probability of receiving the maximal effect is not high, this makes a decision taker to behave prudent. We believe that the formalization of the mentioned above opposite "forces" should be useful for those who elaborate decision taking models under risk.

3.2. The proposed approach and model

Let us analyze a lottery, when a decision taker may get the following results: u_1, u_2, u_3, u_4; their probabilities are p_1, p_2, p_3, p_4 correspondingly, and $\sum_{i=1}^{n} p_i = 1$.

Decision taker may participate in this lottery and get one of possible results, or do not participate and receive some sum for sure, e.g. deterministic equivalent u_0 ($u_0=\sum u_i p_i$) of the lottery.

The value (1) is considered as a level of decision maker's *temptation* that he feels about the lottery L.

$$\Delta(L)=u(L)-u_{act.}, \tag{1}$$

where u(L) is some value of the lottery L;

$u_{act.}$ is an actual guaranteed outcome that decision maker gets if he does not participate in a lottery L.

Let us suppose that there exist some value of positive result probability when a decision taker according to his *"voice of reason"* can not be attracted by a lottery even if the positive result is very high.

Let us introduce the proposed model.
The first step consists in determining decision taker's preferences, psychological aspects of his behavior that reflect his attitude to risk, i.e. his actions under factors *"temptation"* and *"voice of reason"*. Then these preferences should be compared in a certain way with the actual information about a lottery. After that a decision taker should tell us whether he participates in this lottery or he refuses. Fig.1 illustrates the described procedure.

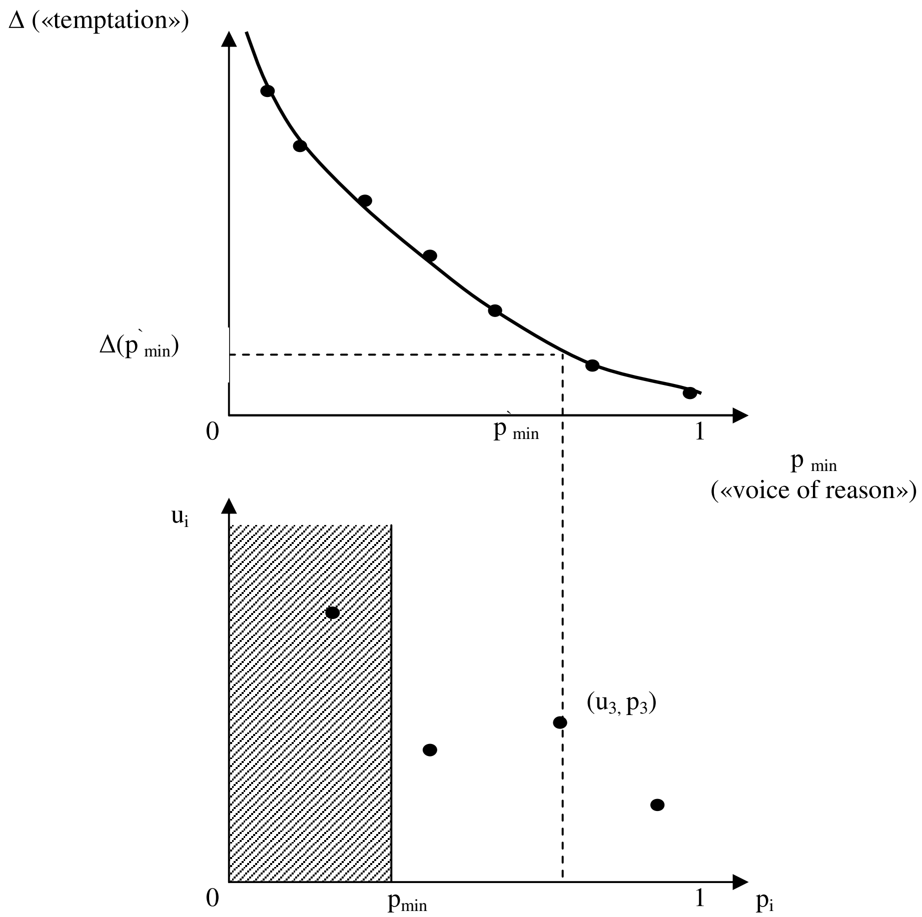

Fig.1: Decision taker's preferences and a real lottery

The upper graph is constructed on the base of decision taker interviewing that is carried out before he knows the details of a real lottery. The interview consists in one-by-one questions that concern the minimal value of "temptation" (Δ) that will be sufficient for the decision taker if the value of success probability is fixed (e.g. 1. Which Δ will be sufficient for you if p_{min} of success is 0,7? 2. Which Δ will be sufficient for you if p_{min} of success is 0,75? 3. Which Δ will be sufficient for you if p_{min} of success is 0,8? etc.). It is evident, that the obtained curve does not depend on a concrete lottery; it characterizes the subjective decision taker preferences only.

The lower graph illustrates the lottery results that are characterized by parameters (u_i, p_i). Also we can see on these graph that the grey area with probabilities less that minimal accepted by a decision taker probability (p_{min}), is excluded.

Further considerations may rely on the following scheme.

1) Decision taker should analyze the rest area of lottery outcomes. In order to do this he selects an outcome with maximal positive result. In our case it is an outcome with parameters (u_3, p_3): $u_3=\max\{u_2,u_3,u_4\}=u_{max}$.
2) The outcome probability p_3 is projected on the upper graph, where the level of $\grave{p}_{min}$ is determined.
3) Relying on the upper graph we should determine $\Delta(\grave{p}_{min})$, i.e. a minimal level of "temptation" under which due to the given success probability the decision taker is indifferent whether to participate in the lottery or to receive the guaranteed sum $u_{00}= u_{max} - \Delta(\grave{p}_{min})$. The value of u_{00} ought to be called an actual deterministic equivalent of a lottery for the decision taker.
4) The rule for decision taking about participation in a lottery seems to be quite evident.
   - 4.1. If the sum u_{act} proposed to the decision taker is higher than the value of an actual deterministic equivalent u_{00} which is determined for this lottery, he or she should refuse to participate in it as it seems more preferable for them to get the sum u_{act} for sure.
   - 4.2. If the proposed sum u_{act} is lower than the value of an actual deterministic equivalent u_{00}, the decision taker should prefer to participate in the lottery, because in that case "temptation" is stronger than "voice of reason".

The presented understanding of the term "deterministic equivalent of a lottery" should be considered not like just a formal attribute of a lottery, but an important characteristic of the system "decision taker – selection task". We suppose that this understanding makes it possible to regard the proposed approach as a model that is suitable for real decision taking tasks description.

4. RESULTS

As collaborative networks are economical structures that exist under the pressure of extremely high uncertainty, the problem of introducing uncertainty and risk factors into decision taking models seems to be very important and vital for such organization forms. Under uncertainty different people may behave in different way, understanding the same situation whether risky or not. So, the presented paper focuses on the elaboration of the special approach to decision taking, which is based on the idea that it is necessary to take into account personal considerations of a decision taker concerning risks. The two-stage approach consists in a decision taker's personal risky characteristics determination (two forces are introduced – "temptation" and "voice of reason") and then analyzing a real situation within these characteristics. The presented approach facilitates comprehensive understanding of decision taking under risk. We believe that this research will help to develop risk tools and models in collaborative networks management and control theory.

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УПРАВЛЕНИЕ ГЛОБАЛЬНЫМИ ЦЕПЯМИ ПОСТАВОК: АКТУАЛЬНЫЕ ТАМОЖЕННЫЕ АСПЕКТЫ

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Аннотация: в статье исследуется особенности формирования и развития глобальных цепей поставок. Товарные потоки, протекающие в рамках подобных цепей, могут неоднократно пересекать границы государств. В этой связи особое значение приобретает влияние таможенного аспекта на скорость их прохождения. В статье также рассмотрены условия создания и развития Таможенного союза между Россией, Белоруссией и Казахстаном, показано его влияние на формирование и управление глобальными цепями поставок.

GLOBAL SUPPLY CHAIN MANAGEMENT: ACTUAL CUSTOMS ASPECTS

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The purpose of the paper is to show the influence of the customs aspect on features of creation and development of global supply chains.
Research/ application methodology is based on system atical approach and logic simulation of interaction between participants of global supply chain.
Design of the paper:
The article consists of five parts. First part, “Introduction”, states actuality of chosen subject. Second part, “Features of global supply chains”, offers definition of global supply chain and shows its position in global economy and features of its development. Third part, “Global supply chain participants”, lists main players. In fourth part, “Influence of Customs Union on forming and managing of global supply chain”, features of creation and development of Customs Union between Russia, Kazakhstan and Belarus are considered and influence of Customs Union on forming and managing on global supply chain. Is shown fifth part, “Conclusion”, contains main conclusions and findings of the research.
Main result: of the research is showning how Customs Unions influence on efficiency of global supply chain management. The purpose of creation of Customs Union is growth of direct participants’ efficiency based on acceleration and growth of its quality of transport operations, storage and customs declaration.

Academic contribution of the article is defening the difference between global and international supply chain. National and international supply chains could be differentiated by the fact of location within one state or being spreaded between a number of states. National supply chains limited by one countrys territory, all of its links are located within one country, including suppliers and customers. That means all goods and services produced by contractors of national supply chain, were made of raw material and stuff extracted within one state and distributed in domestic market. I.e. all consumers including final-consumers are located in the same state.
International supply chains are not restricted by borders of one state. Different links of such chain can be located in different countries. Three levels of supply chain complexity could be distinguished: direct, extended ultimate supply chain[6]. Direct international supply chain consists of Focus Company (in common case – industrial or Trade Company), a supplier and consumer. In that case generally Focus Company determines the structure of supply chain and managing relations with contractors.
Global supply chain – is a type of international supply chain. Globalization as a process of creation of united global economy had a special influence on forming and creation of global supply chains. A core distinguishing of global supply chain is magnitude of business processes running inside supply chain.
Managerial insights of article is a clear definition of influence of Customs Union on forming and managing of global supply chain. Nowadays one of the most actual problems in post Soviet Union space is the creation of new Customs Union between Russia, Kazakhstan and Belarus. For all of three states creation of Customs Unions means creating united customs space without customs borders between Unions participants and united customs tariff and non-tariff policy.For successful realizing of the idea, it’s needed to provide smooth transition from difereentiated self regulation to joint managing of united customs territory within Customs Union. In case of such transition not being effective enough first off all interests of global chain participants.

1. ВВЕДЕНИЕ

Многие компании, как участники цепей поставок, оказываются вовлеченными в процесс мировой торговли и становятся участниками глобальных цепей поставок. При их управлении принципиальное значение принимает факт пересечения товарными и сопутствующими им потоками государственных границ. В связи с этим особое внимание необходимо уделять таможенному аспекту, который проявляется в процессе взаимодействия отдельных хозяйствующих субъектов – участников внешнеэкономической деятельности. На современном этапе развития мировой экономики одной из важнейших задач является совершенствование таможенной сферы путем использования средств таможенного администрирования для создания и эффективного управления глобальными цепями поставок.

2. ОСОБЕННОСТИ ГЛОБАЛЬНЫХ ЦЕПЕЙ ПОСТАВОК

По национальной принадлежности, т.е. в зависимости от того, ограничена ли цепь поставок территорией одного государства или нет, можно выделить национальные и международные цепи поставок.

Национальные цепи поставок ограничены территорией одного государства, все ее звенья находятся в пределах одной страны, включая поставщиков и потребителей. Это означает, что товары или услуги, произведенные контрагентами национальной цепи поставок, изготовлены из сырья и материалов, добытых или полученных на территории данной страны, и в дальнейшем реализованы через дистрибьюторскую сеть на внутреннем рынке. Т.е. все потребители, в том числе и конечные, также находятся в данной стране.

Международные цепи поставок не ограничены рамками одного государства, различные звенья такой цепи могут находиться на территории одной и более стран. Как известно [6], различают три уровня сложности цепей поставок: прямые, расширенные и максимальные цепи поставок. Это справедливо и в отношении международных цепей поставок. Прямая международная цепь поставок состоит из фокусной компании (обычно - промышленной или торговой фирмы), поставщика и потребителя. При этом, как правило, фокусная компания определяет структуру цепи поставок и управление взаимоотношениями с контрагентами по бизнесу.

Разновидностью международных цепей поставок являются глобальные цепи поставок. На формирование и развитие таких цепей поставок особое влияние оказал процесс глобализации, который представляет собой создание единого мирового экономического пространства. Отличительной чертой глобальных цепей поставок является масштабность протекающих внутри цепей поставок бизнес-процессов. М. Кристофер [3] выделяет четыре фактора, определяющие основные отличия глобальных цепей поставок.

1) Увеличение времени поставок.
2) Удлинение сроков поставок и их ненадежность.
3) Консолидация многообразия и варианты распределения общей совокупности грузов.
4) Многообразие методов транспортировки и вариантов затрат.

В процессе глобализации цепи поставок выходят за рамки границ отдельных государств, национальная принадлежность и местонахождение продавцов и покупателей товаров и услуг утрачивают свое былое значение и не оказывают существенного влияния на формирование и развитие потоковых процессов. При этом товар может производиться в местах, приближенных к источникам сырья и, как правило, в регионах с низкой оплатой труда. Далее товар транспортируется в распределительные центры, а оттуда поступает в страны, где через дистрибьюторские сети попадает к конечному покупателю. Таким образом, товаропоток может неоднократно пересекать границы государств, звенья глобальной цепи поставок располагаться на территории многих стран и даже континентов.

Существует ряд особенностей, влияющих на формирование и управление глобальными цепями поставок. Эти особенности основываются на специфике движения товарных и сопутствующих потоков на всем протяжении цепи поставок. Среди таких отличий наиболее важными являются следующие особенности:

1) Сложность системы. Глобальная цепь поставок представляет собой сложную многоуровневую систему, в состав которой входит большое количество контрагентов, связанных между собой технологической цепочкой. Проектировать, а затем управлять подобной цепью поставок так, чтобы при этом затраты всей системы были минимальны и сервис оставался на заданном уровне очень сложно.
2) Риски и неопределенность. Неопределенность присущая глобальным цепям поставок может быть значительно выше, чем на национальном уровне, поэтому глобальные цепи поставок должны быть спроектированы таким образом, чтобы, с одной стороны, ограничить неопределенность настолько, насколько это возможно, а с другой, - в случае, если эта неопределенность возникает, продолжать эффективно функционировать. На неопределенность существенное влияние оказывает спрос, сроки поставок, уровни товарных запасов и заказов, производственные возможности, время транспортировки, природные и человеческие факторы и т.д.
3) Нормативно-правовая база. При управлении глобальными цепями поставок необходимо учитывать как международные правовые нормы, установленные различными конвенциями, так и особенности национальных законодательств тех стран, в которых расположены звенья цепи поставок.
4) Таможенный аспект. При управлении глобальными цепями поставок следует особое внимание уделять таможенному аспекту, который состоит в необходимости перемещения потоков через таможенные границы и соблюдения таможенных формальностей, связанных с декларированием грузов. В основе ускорения и упрощения реализации таможенных процедур лежит необходимость синхронизировать движение товарного, информационного и финансового потоков, т.е. параллельно с транспортировкой внешнеторговых грузов должно осуществляться таможенное оформление этих грузов и оплата таможенных пошлин и сборов.
5) Обширность территории. Глобальные цепи поставок могут быть настолько масштабны, что их звенья будут располагаться не только на территориях разных стран, но и континентов. Необходимо учитывать географическую разветвленность глобальных цепей поставок при организации транспортировки и хранения товаров, разработки тары и упаковки, определении сроков доставки и т.д.
6) Увеличение уровня товарных запасов. Большое количество звеньев цепи определяет и увеличение уровня товарных запасов, так как большие объемы запасов продукции объясняются опасением возникновения де-

фицита и, как следствие, может привести к сбоям в работе цепи поставок, а для производственных предприятий – к полной остановке производства, что влечет за собой серьезные убытки.

7) Конфликт интересов субъектов внутри глобальной цепи поставок. Многочисленность участников глобальных цепей поставок предопределяет и большое количество их интересов, зачастую прямо противоположных, возникает конфликт интересов участников цепи поставок. Например, целью поставщика является продажа больших партий продукции и получение экономии на масштабе, а целью продавца – покупка продукции небольшими партиями и, как следствие этого, сокращение уровня запасов в дистрибутивной сети. Таким образом, цели поставщиков напрямую входят в конфликт с желаниями продавцов.
8) Динамичность глобальных цепей поставок. Параметры глобальных цепей поставок постоянно меняются. Этому способствуют многочисленные обстоятельства, которые воздействуют на отношения внутри цепи поставок, такие как меняющийся спрос потребителей на национальных рынках и возможности поставщиков обеспечить потребности в производимой продукции.

Перечисленные особенности оказывают влияние на общий процесс формирования и последующее управление глобальными цепями поставок.

3. УЧАСТНИКИ ГЛОБАЛЬНЫХ ЦЕПЕЙ ПОСТАВОК

По своей сути, цепи поставок - это последовательности поставщиков и потребителей: каждый потребитель затем становится поставщиком для следующих (в более нижнем звене) видов деятельности или функций, и так продолжается до тех пор, пока готовый продукт не поступит к конечному пользователю. Поэтому можно говорить о своеобразной «сетевой структуре цепей поставок», в которой каждая компания (организация или отдельное структурное подразделение) поставляют друг другу материально-товарную продукцию или услуги, добавляя определенную стоимость к товару.

Поставщики и потребители первого уровня — это те организации, которые взаимодействуют (покупают или продают товары и услуги) непосредственно с фокусной компанией. Поставщики и потребители второго уровня — это поставщики поставщиков и потребители потребителей первого уровня и т.д. вплоть до начального поставщика (поставщика природных ресурсов) и конечного потребителя. Каждая компания может выстраивать свою цепь поставок, поскольку ее руководство видит именно свою компанию в качестве центральной и поэтому рассматривает потенциальных участников сетевой структуры, исходя в основном из интересов своей компании.

Многочисленные сложные операции, протекающие в глобальных цепях поставок, обусловили наличие в них различного рода посредников. При этом особое значение приобретают международные коммерческие посредники, способствующие осуществлению международных и внешнеторговых сделок.
В настоящее время к ним относятся:

- международные экспедиторы;
- транспортные компании;
- компании по управлению импортно-экспортными операциями;
- внешнеторговые компании и представительства;
- брокерские и агентские фирмы;
- порты и стивидорные компании;
- страховые компании;
- консалтинговые компании;
- финансово-кредитные учреждения;
- платежные системы и др.

При оказании посреднических услуг в глобальных цепях поставок особую роль играют консалтинговые компании, которые берут на себя функции управляющей компании, которая подбирает варианты для транспортировки, хранения, таможенного оформления грузов, занимается вопросами оплаты и т.д. Подобные компании принято называть «третьей стороной» или 3PL-провайдерами. Интегрированное взаимодействие с такими компаниями позволяет:

- проводить более полный мониторинг рынка;
- осуществлять подбор необходимых компаний-посредников;
- проводить сравнительный анализ услуг, предоставляемых компаниями и обеспечивать минимальный уровень издержек при заданном уровне сервиса;
- обеспечивать доступ к дорогостоящим информационным системам и технологическому оборудованию;
- ускорять проведение логистических операций;
- снижать риски.

4. ВЛИЯНИЕ ТАМОЖЕННОГО СОЮЗА НА ФОРМИРОВАНИЕ И УПРАВЛЕНИЕ ГЛОБАЛЬНЫМИ ЦЕПЯМИ ПОСТАВОК

На сегодняшний день одной из наиболее актуальных проблем развития глобальных цепей поставок на постсоветском пространстве является вступление России в Таможенный союз совместно с Казахстаном и Белоруссией. Для перечисленных стран создание Таможенного союза означает образование единого таможенного пространства с отсутствием таможенных

границ между участниками союза и единой таможенно-тарифной и нетарифной политикой.
Влияние Таможенного союза на формирование и управление глобальными управление цепями поставок, а также на эффективность деятельности участников цепей, оказывается посредством снижения значимости таможенного аспекта при прохождении границ стран-участниц Таможенного союза, так как этот союз предполагает отсутствие процедур таможенного декларирования. Таким образом, при пересечении товарными потоками границ стран-участниц Таможенного союза соблюдение таможенных формальностей, а именно таможенное оформление грузов и оплата таможенных пошлин и сборов, утрачивает свою необходимость. Это в значительной степени ускоряет и удешевляет процесс перемещения товаров через границы сопредельных государств.
Идея создания подобного союза между Россией и некоторыми странами СНГ существует еще с 1995 года с момента подписания Соглашения от 06.01.95 «О таможенном союзе между Российской Федерацией и Республикой Беларусь».
Новым этапом развития Таможенного союза послужило Решение Межгосударственного Совета №2 от 25.01.08 «О формировании правовой базы таможенного союза в рамках евразийского экономического сообщества».
В состав участников Таможенного союза входят Россия, Казахстан и Белоруссия. К числу возможных участников союза относят Киргизию и Украину.
Основными нормативно-правовыми документами, регулирующими таможенную деятельность на территории Таможенного союза, являются Таможенный кодекс Таможенного Союза и Единый таможенный тариф Таможенного Союза (ЕТТ), которые вступили в действие с 1 июля 2010 года. К лету 2011 года планируется завершить процедуры по формированию единой таможенной территории. От того, как будут развиваться взаимоотношения между тремя странами по поводу создания единого таможенного пространства, зависит и то, как и в какие сроки участники глобальных цепей поставок будут осуществлять таможенное декларирование товаров и транспортных средств, где будут располагаться границы союза и как будет развиваться таможенная логистическая инфраструктура.
Для успешного осуществления этих планов необходимо обеспечить плавный переход от самостоятельного регулирования таможенной сферы отдельными государствами к совместному управлению единой таможенной территорией в рамках Таможенного союза. В случае если такой переход окажется недостаточно эффективным, то в первую очередь пострадают интересы участников глобальных цепей поставок – импортеров и экспортеров товаров и организаций-посредников, оказывающих услуги в таможенной сфере.
Чтобы избежать этого, необходимо решение следующих задач:

1. Развитие таможенной логистической инфраструктуры. Изменение границ таможенной территории потребует развитие необходимой инфраструктуры в приграничных районах, которую, особенно в условиях кризиса, быстро создать невозможно. Это может привести к новым очередям на границах Таможенного союза, что, в свою очередь, приведет к снижению скорости движения потоковых процессов в глобальных цепях поставок.
2. Качество оказания логистических услуг и их стоимость. На территории Казахстана и Белоруссии на сегодняшний день стоимость услуг, связанных с таможенным декларированием товаров, их хранением и перемещением значительно ниже российских. Это неизбежно приведет к тому, что участники глобальных цепей поставок начнут пользоваться услугами белорусских и казахстанских компаний, техническая и технологическая оснащенность которых значительно отстает от российских коллег, что, несомненно, скажется на качестве оказываемых услуг. В тоже время, как показывает опыт, приход российских компаний на рынок таможенных услуг Казахстана и Белоруссии, скорее всего, повысит цены до уровня российских. При этом может сложиться парадоксальная ситуация: цены на логистические услуги вырастут (по крайней мере, на территории Белоруссии и Казахстана), а их качество может снизиться.
3. Корректировка размера ставок и механизма взимания НДС и акцизов. До сих пор остается неясным, каким образом, не смотря на принятие Таможенного тарифа, будет реализован механизм уплаты таможенных платежей по таким их видам как НДС и акцизы. На территории трех стран размеры ставок и механизмы взимания этих налогов различные.

5. ЗАКЛЮЧЕНИЕ

Управление глобальными цепями поставок представляет собой организацию, планирование, контроль и регулирование внешнеторговых потоков, включая его перемещение через границы сопредельных государств и доведение с оптимальными затратами ресурсов (в том числе на транспортировку, хранение, таможенное оформление и др.) до конечного потребителя в соответствии с требованиями рынка. При этом прохождение товарного и сопутствующих ему потоков через границу влечет за собой обязательную уплату всех необходимых таможенных пошлин, налогов и сборов при осуществлении таможенного декларирования товаров. Для осуществления эффективного управления глобальными цепями поставок необходимо координировать деятельность всех участников: поставщиков и потребителей разных уровней, производителей, посредников.
На эффективность управления глобальными цепями поставок оказывают влияние различные международные союзы. Одним из таких союзов является Таможенный союз между Россией, Белоруссией и Казахстаном, целью создания которого является, в том числе, повышение эффективности дея-

тельности непосредственных участников глобальных цепей поставок за счет ускорения и повышения качества операций по транспортировке, хранению и таможенному декларированию товаров.

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МЕТОД ОПТИМИЗАЦИИ ЛОГИСТИЧЕСКИХ ЗАТРАТ, УРОВНЯ ОБСЛУЖИВАНИЯ И ПОСТАВОК В ЛОГИСТИЧЕСКОЙ СИСТЕМЕ ПРЕДПРИТИЯ

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Аннотация: Разработан авторский метод оптимизации логистических затрат, уровня обслуживания и поставок в логистической системе предприятия. Метод оптимизации уровня обслуживания по критерию «минимум логистических затрат» интегрирован с методом безубыточности, что позволило достоверно установить корреляцию цен, классических и логистических затрат, поставок и потерь от уровня обслуживания.

METHOD OF OPTIMIZATION OF LOGISTICS COSTS, LEVEL OF SERVICE AND VOLUMES OF SUPPLIES IN THE LOGISTIC SYSTEM OF ENTERPRISE

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The purpose of Article: The aim of this work is to develop methodological bases of optimization of logistics costs, level of service and volume of delivery in the supply chain.
The method of investigation: Ehe following methods have been used in this work: structural and functional analysis, economic and mathematical modelling, methods of mathematical statistics and logistics; generalization and synthesis experiment.
The structure of presentation: The problem of cost management and management of service level in the supply chain is raised in the introduction. The first section represents the analyzed foreign literature, that deals with cost management, the level of logistics services, logistics, supply chain management. The second section describes the methodological foundations of the proposed approach. Section 3 provides a problem statement and a mathematical model. Main inferences are presented in the conclusion.
Main results: The method of optimization of logistics costs, service levels and volume of supplies in the logistics system of the enterprise is developed by the author. The method of service level optimization on the criterion «minimum of logistics costs» is integrated with the method of break-even point, which allowed to establish the correlation of prices, classic and logistics costs, service levels, supply, and losses from sub-optimal service levels. Graphical and analytical dependences of the analyzed parameters and variables of the model are identified. On the basis of statistical data of Chelyabinsk region enterprises the nature and dynamics of the curves in these models are revealed, specific configuration features are described.

Continuation of this method is economical and mathematical model of optimization of logistics costs, level of service and volume of supplies in the logistics system of an enterprise.
The main parameters of the model: the level of service$ logistics costs$ and losses associated with providing a certain level of service. Optimization of system parameters is organized in the following way. The logistics costs in the context of fixed and variable are determined. A relation between their values and the level of service is set. Then it is necessary to calculate the losses from sub-optimal level of service, which include the losses from leaving customers lost orders, "leaving" providers, discounts for finished product, ton and raw materials. Then general classical expenses (elements or objects) in the context of variable and fixed are defined; it depends on the volume of deliveries. Then the cumulative costs as the sum of classical and logistics costs are calculated. After this, taking into account the minimum amount of integral costs and losses, the optimum level of customer service is determined. According to our approach when determining the breakeven zone not only classic costs are used, but also the sum of integral costs and losses, which narrows this region largest volume of supply and reduces the magnitude of the effect of logistics. The optimum level of service found through a minimum amount of integral costs and losses is associated with the domain breakeven. As a result the optimal amount of supply of the enterprise is determined. Thus, the proposed method allows to determine the optimal logistics costs, level of service and volume of supplies company.
Scientific novelty: Scientific novelty of the exploration is to develop a method for optimizing logistics costs, level of service and supply logistic system of the enterprise, which, unlike the existing break-even method, is not only based on classical, but also on logistics costs, and takes into account the level of service and losses caused by suboptimal level of service.
Organizational and economic essence of the logistic effect is revealed.
Practical significance: Results of the research contribute to the understanding of optimization of a company logistics system. Having statistical data about the markets, the characteristics of supply, etc., the parameters of economic-mathematical model can be configured for a specific company. Mathematical tools add-in "Finding Solutions» Microsoft Excel can help to model the situation. Inferences and methodological developments have practical significance and can be used by managers and specialists of logistics departments.

1. ВВЕДЕНИЕ

Современный потребитель отдает предпочтение предприятию, способному доставить товар к заданному сроку («lead time»), в требуемом количестве, удобной таре, приемлемым размером партии, в соответствии с заказанным ассортиментом. Поэтому обеспечение высокого уровня логистического обслуживания является средством повышения конкурентоспособности.
Обслуживание потребителей – это процесс создания существенных выгод, содержащих добавленную стоимость, при условии поддержания минимальных затрат. Уровень логистического обслуживания выражается в высоком качестве выполнении заказов, отсутствии ошибок, качественном предоставлении услуг и постоянном стремлении к повышению уровня обслуживания, а также в соответствии уровня обслуживания стандартам потребителя, условиям договора. Не менее важным показателем логистической деятельности являются логистические затраты. Таким образом, ввиду взаимосвязанности категорий «уровень обслуживания», «логистические

затраты» и «прибыль», необходим эффективный инструментарий оценки и управления затратами и уровнем обслуживания в логистической системе.

2. ОБЗОР ИМЕЮЩЕЙСЯ МЕЖДУНАРОДНОЙ ЛИТЕРАТУРЫ

Изучением вопросов уровня обслуживания занимаются американские специалисты Баллоу Р., Кристофер М., Уотерс Д., Бауэрсокс Д. и Клосс Д. и др. М. Мак-Гиннис после проведения анализа выполнения заказов выявил, что уровню обслуживания придается большее значение, чем стоимости оказания услуг. Многие авторы отмечают, что логистика обеспечивает удовлетворение потребности заказчиков, относящихся к времени и месту наличия продуктов, а также к сопутствующим услугам.

Проблемами эффективного взаимодействия с потребителем (ECR) занимаются логисты из Германии Корстен Д, Пётцль Ю. и другие. Среди трудов германских специалистов, занимающихся проблемами управления затратами следует отметить работы Мюллендорфа Р. и Карренбауэра М., Циммермана К., Боутеллира Р. и др. Тематика безубыточности деятельности предприятия из-за своей популярности рассмотрена в трудах многих зарубежных авторов. Логистический подход и управление цепями поставок (SCM) рассмотрен во многих трудах Иванова Д.А. Однако вопросы оценки логистических затрат на организацию высокого уровня обслуживания во взаимосвязи с получаемой прибылью не рассмотрены.

3. ОПИСАНИЕ МЕТОДОЛОГИИ ИССЛЕДОВАНИЯ

Конечный результат работы любого предприятия – прибыль. Основные факторы прибыли: уровень обслуживания покупателей (на первом месте с позиций логистического подхода); затраты на достижение определенного уровня обслуживания; цена; затраты на производство и реализацию продукции (работ, услуг); потери от неоптимального уровня обслуживания (от «ухода» покупателей, от потери заказов, от «ухода» поставщиков, от скидок на готовую продукцию, от скидок по оплате за сырье). Рассмотрим графическую и математическую модели взаимосвязи результирующего показателя и факторов.

На рис. 1 представлена известная модель безубыточности предприятия, отражающая поставки, и результирующие показатели – совокупные затраты (факторы – переменные и постоянные затраты), выручку (факторы – цена и рыночные условия: объем спроса, уровень обслуживания покупателей, конъюнктура и др.) и прибыль. Под общими затратами понимается сумма переменных и постоянных затрат. Причем в данной модели используются так называемые классические затраты, то есть по элементам (материальные затраты, затраты на оплату труда, амортизация и прочие) или статьям.

Проанализируем конфигурацию кривых модели. Характер и динамика кривых в моделях, рассматриваемых далее, выявлены на основе анализа статистических данных предприятий Челябинской области. Общие затраты при нулевом объеме поставок представляют собой постоянные затраты (например, амортизация); с увеличением объема поставок они увеличиваются пропорционально за счет увеличения переменных затрат; далее по мере роста поставок возможно некоторое сокращение общих затрат за счет эффекта масштаба; затем общие затраты растут быстрее, чем увеличивается объем, так как каждая дополнительная поставка требует бóльших усилий, а, значит, и затрат. Кривая выручки выходит из начала координат, далее рост выручки опережает рост объемов продаж (за счет временного повышения цен при стратегии «снятия сливок», например); затем происходит пропорциональный рост выручки; далее рост замедляется (происходит насыщение рынка сбыта) и увеличение выручки происходит, например, за счет снижения цены (введение скидок), которое позволяет повысить количество и объем поставок; далее выручка с увеличением поставок становится величиной постоянной (за счет дальнейшего снижения цен) и далее происходит небольшой спад (потребители насыщены и их не мотивирует дальнейшее снижение цен). Кривая прибыли образована из разности выручки и общих затрат, ее значения обращаются в нуль дважды при двух разных объемах поставок, то есть точках безубыточности 1 и 2, в которых выручка равна общим затратам. Преодолев величину поставок O_1, прибыль увеличивается; затем на определенном участке ее рост сокращается и прибыль становится примерно постоянной при увеличивающемся объеме поставок; далее происходит снижение до объема O_2.

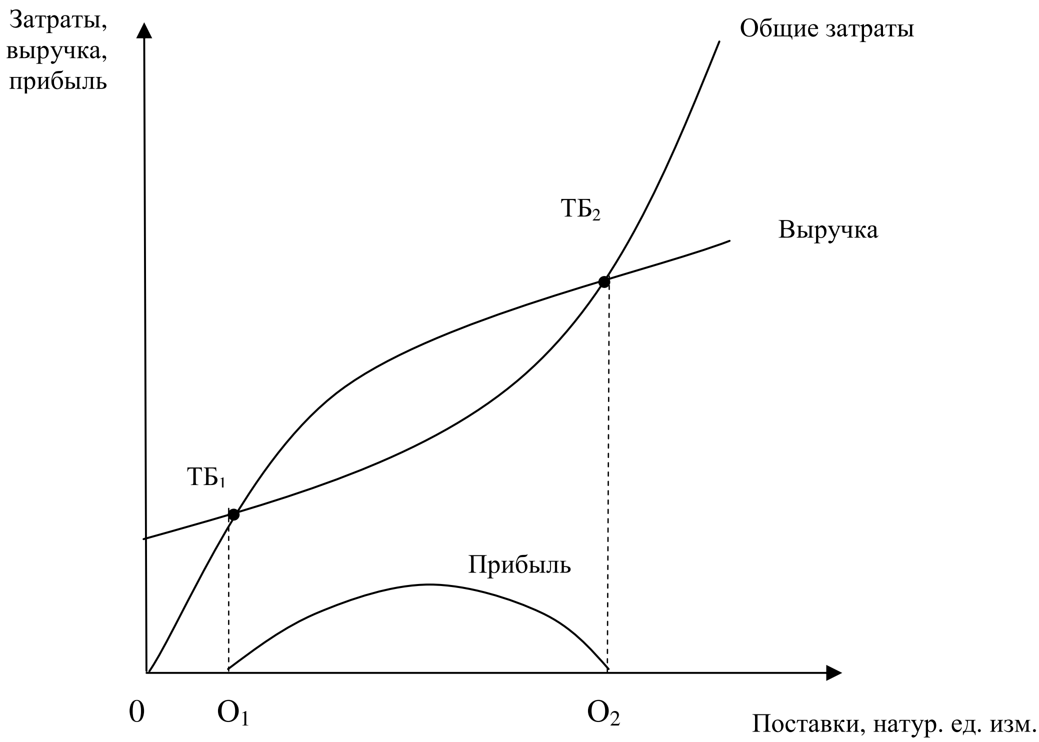

Рис. 1. Модель безубыточности предприятия (долгосрочный период)

На рис. 2 представлена логистическая кривая предприятия, где У* – оптимальный уровень обслуживания покупателей, З* – оптимальные логистические затраты. Под логистическими затратами понимаются затраты на выполнение логистических операций. Охарактеризуем конфигурацию логистической кривой. Предприятие несет постоянные логистические затраты на обслуживание, поэтому кривая выходит из точки, равной минимальным постоянным затратам. Особенностью логистических затрат является резкий рост их чувствительности к изменению качества работы логистической системы, и согласно исследованиям специалистов, начиная с 70% и выше затраты на сервис растут экспоненционально, при повышении уровня с 95 до 97% экономический эффект повышается на 2%, а расходы возрастают на 14%, и выше 90% сервис становится невыгодным.

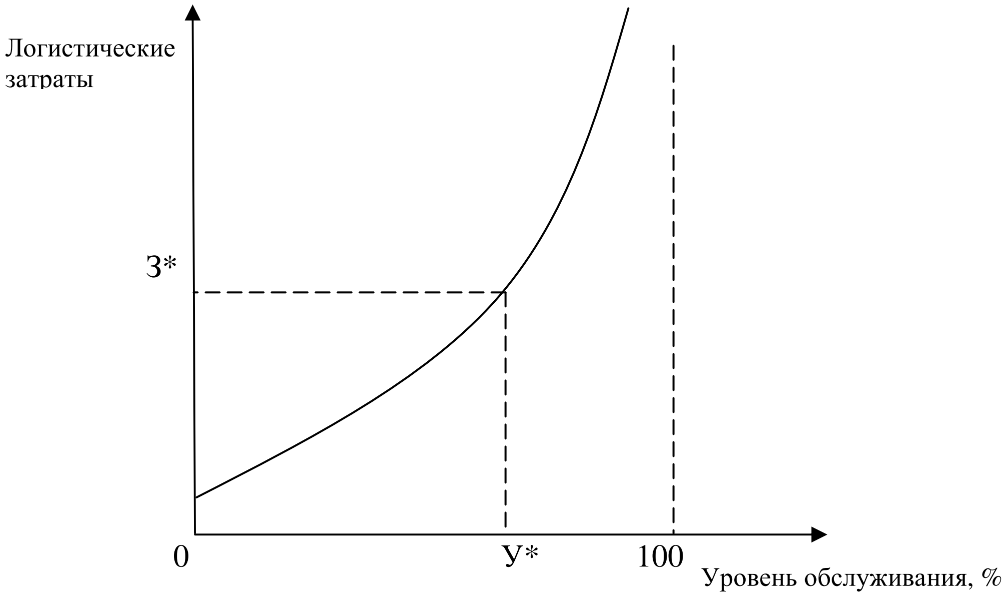

Рис. 2. Логистическая кривая предприятия

Величина затрат в модели безубыточности определяется числом поставок, а на логистической кривой – уровнем обслуживания.

Поместим обе модели (рис. 1 и рис. 2), зеркально перевернув модель безубыточности относительно денежной оси, в одну систему координат, где вертикальная ось затрат является общей и имеется две горизонтальные оси – уровень обслуживания покупателей и объем поставок. Совмещение представлено на рис. 3. Допущения модели:

1) интегральные затраты – это сумма логистических и классических затрат (под классическими затратами понимаются затраты, связанные с производством и реализацией: материальные, на оплату труда и т.д.);

2) количество поставок (О*), соответствующее оптимальному уровню обслуживания покупателей (У*), находится между двумя точками безубыточности, то есть приносит логистический эффект;

3) логистический эффект (ЛЭ) означает прибыль (здесь и далее будем разграничивать эти понятия, т.к. термин «прибыль» больше применим, когда употребляются классические затраты), а термин «логистический эффект» учитывает также логистические затраты, потери, альтернативные издержки); логистический эффект, соответствующий объему $О^{ЛЭмакс}$, означает не единственное значение, а зону, находящуюся левее и правее этой точки (обозначена серым цветом), где разница между значениями логистического эффекта незначительна.

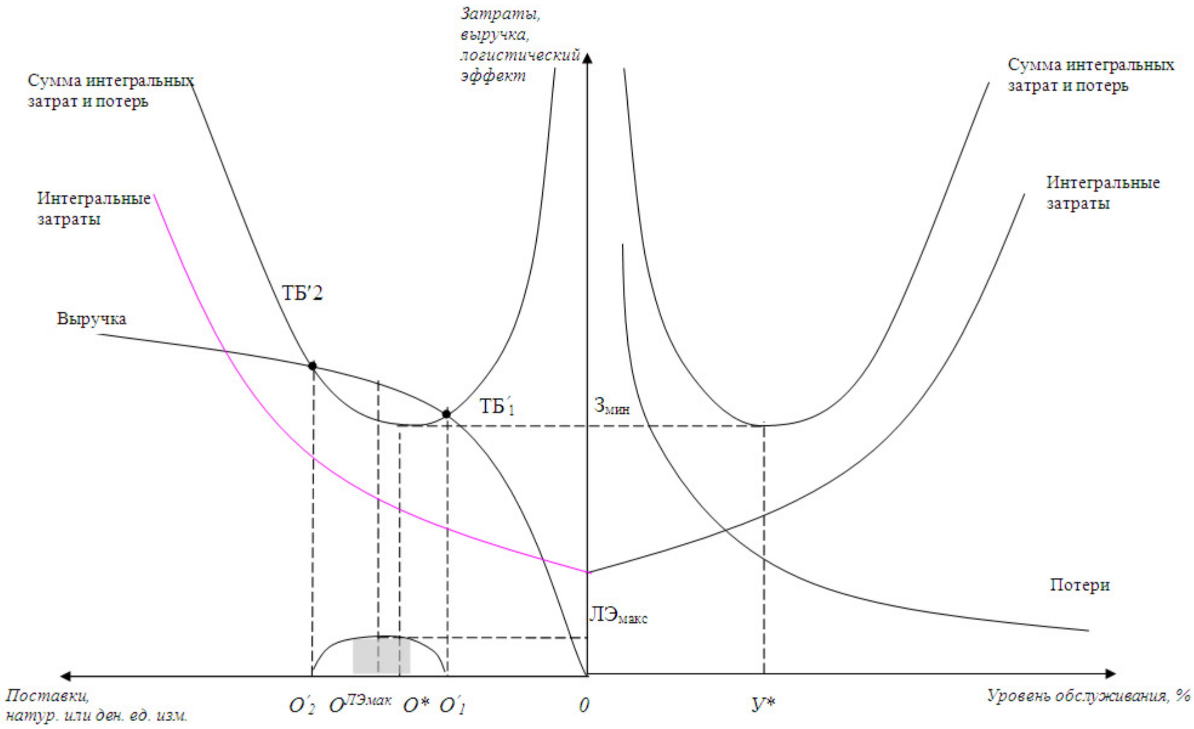

Рис. 3. Совмещенная модель логистической кривой и безубыточности

Потери при уровне обслуживания близком к 0% – максимальны; по мере увеличения уровня обслуживания происходит сокращение потерь; соответственно, чем ближе к 100%-му уровню обслуживания, тем потери становятся меньше, близкими к нулю; то есть наблюдается обратная зависимость. Добиваясь соответствия двух исходных моделей, введем в модель безубыточности потери, аналогичные модели логистической кривой. Логистика, одна из немногих наук, учитывающая потери и альтернативные издержки при принятии управленческих решений.

В левой части графической модели происходят изменения – протяженность зоны безубыточности сокращается влево и вправо. Также на величину потерь сокращается величина логистического эффекта. Для максимизации логистического эффекта необходимо управлять постоянными затратами 1) путем трансформирования их в переменные, что возможно при передаче бизнес-функций на аутсорсинг; 2) за счет сдачи в аренду недозагруженных производственных мощностей. Это позволяет расширить зону безубыточности и увеличить логистический эффект.

Продолжением данного метода является экономико-математическая модель оптимизации логистических затрат, уровня обслуживания и величиины поставок в логистической системе предприятия. Основные параметры модели: уровень обслуживания; логистические затраты; потери, связанные с обеспечением определенного уровня обслуживания. Оптимизация параметров системы осуществляется следующим образом (аналогичный алгоритм используется и при решении графическим способом). Определяются логистические затраты в разрезе постоянных и переменных. Устанавливается взаимосвязь их величины с уровнем обслуживания. Затем рассчитываются потери от неоптимального уровня обслуживания, которые включают в себя потери от «ухода» покупателей, от потери заказов, от «ухода» поставщиков, от скидок на готовую продукцию, от скидок по оплате за сырье. Далее определяются общие классические затраты (по элементам или статьям) в разрезе переменных и постоянных. Затем рассчитываются интегральные затраты как сумма классических и логистических затрат. После этого определяется оптимальный уровень обслуживания потребителей с учетом минимума суммы интегральных затрат. Согласно предлагаемому одходу при определении зоны безубыточности используются не только классические затраты, но и сумма интегральных затрат и потерь, которая сужает эту область по величине объема поставок и уменьшает величину прибыли. Найденный оптимальный уровень обслуживания через минимум суммы интегральных затрат и потерь сопоставляется с областью безубыточности. В результате определяется оптимальное количество поставок предприятия.

Приведем пример расчета с условными числами в качестве значений кривых, который при отсутствии реальных данных используется как пример к теоретической части статьи. Затраты на логистическое обслуживание (логистическая кривая) могут быть выражены следующей функцией:

$$\textit{Логистические затраты} = \left(e^{X} + X^{2} - 1\right) \cdot \frac{1}{10} + \frac{1}{5}, \qquad (1)$$

где X – уровень обслуживания, выражаемый в долях единицы от 0 до 1 или в процентах от 0% до 100% (%/100).

Потери от неоптимального обслуживания могут быть выражены таким образом:

$$\textit{Потери} = \frac{1}{100 \cdot (0{,}1 \cdot X + 0{,}01)} - \frac{1}{100}. \qquad (2)$$

Классические затраты могут быть выражены функцией:

$$\text{Классические затраты} = \left(e^{x/10} + \frac{x^2}{100} - 1 \right) \cdot \frac{10}{35} + \frac{1}{10}, \tag{3}$$

где x – объем поставок в единицах от 0 до 10.
Функция выручки будет иметь вид:

$$\text{Выручка} = \left(\sqrt{x} + \frac{x^2}{100} \right) \cdot \frac{1}{4}. \tag{4}$$

Тогда прибыль как разница между выручкой и классическими затратами может быть представлена функцией:

$$\text{Прибыль} = \left(\sqrt{x} + \frac{x^2}{100} \right) \cdot \frac{1}{4} - \left(e^{x/10} + \frac{x^2}{100} - 1 \right) \cdot \frac{10}{35} - \frac{1}{10}. \tag{5}$$

Функция логистического эффекта будет иметь вид:

$$\begin{aligned} ЛЭ = \left(\sqrt{x} + \frac{x^2}{100} \right) \cdot \frac{1}{4} - \left(e^{x/10} + \frac{x^2}{100} - 1 \right) \cdot \frac{10}{35} - \frac{1}{10} - \\ - \left(e^X + X^2 - 1 \right) \cdot \frac{1}{10} + \frac{1}{5} - \frac{1}{100 \cdot (0{,}1 \cdot X + 0{,}01)} + \frac{1}{100} \end{aligned}. \tag{6}$$

Примечания:
1. Все кривые нормированы по оси ординат от 0 до 1 условных денежных единиц. Это выполнено в связи с тем, что конкретные значения отсутствуют, а для сопоставления они должны быть в одном масштабе. С этой целью в формулы введены дополнительные коэффициенты и слагаемые.
2. Объем поставок также варьируется в условных единицах от 0 до 10.

Модель оптимизации затрат состоит из целевых функций и ограничений. Целевые функции означают максимизацию логистического эффекта и уровня логистического обслуживания. Ограничения связаны с необходимостью поддержания уровня обслуживания на уровне оптимального, проведения грамотной ценовой политики.
Целевые функции:

$$\begin{cases} \left(\sqrt{x} + \frac{x^2}{100} \right) \cdot \frac{1}{4} - \left(e^{x/10} + \frac{x^2}{100} - 1 \right) \cdot \frac{10}{35} - \frac{1}{10} - \left(e^X + X^2 - 1 \right) \cdot \frac{1}{10} + \\ + \frac{1}{5} - \frac{1}{100 \cdot (0{,}1 \cdot X + 0{,}01)} + \frac{1}{100} \to MAX; \quad (7) \\ X \to MAX. \quad (8) \end{cases}$$

По экономическому смыслу поставки и уровень обслуживания – величины неотрицательные, поэтому:

$$x \geq 0; \tag{9}$$

$$X \geq 0. \tag{10}$$

Ограничения:

$$\begin{cases} X \geq X^*; & (11) \\ Ц > \dfrac{\left(e^{x/10} + \dfrac{x^2}{100} - 1\right) \cdot \dfrac{10}{35} + \dfrac{1}{10} + \left(e^X + X^2 - 1\right) \cdot \dfrac{1}{10} + \dfrac{1}{5}}{x}; & (12) \\ x^{ТБ1} \leq x \leq x^{ТБ2}, & (13) \end{cases}$$

где X^* – оптимальный уровень обслуживания; *Ц* – цена единицы поставок; $x^{ТБ1}$, $x^{ТБ2}$ – безубыточные объемы поставок.

Для нахождения оптимального варианта выполнения заказов потребителей, означающего выполнение оптимального количества поставок с предоставлением оптимального уровня обслуживания потребителям при минимальной сумме классических, логистических затрат и потерь, необходимо выполнить их перебор.

4. РЕЗУЛЬТАТЫ

Разработан авторский метод оптимизации логистических затрат, уровня обслуживания и объема поставок в логистической системе. Метод оптимизации уровня обслуживания по критерию «минимум логистических затрат» интегрирован с методом безубыточности, что позволило достоверно установить зависимость цен, классических и логистических затрат, поставок и потерь от уровня обслуживания. Выявлены графические и аналитические зависимости анализируемых параметров и переменных модели. Продолжением метода является экономико-математическая модель оптимизации логистических затрат, уровня обслуживания и объема поставок в логистической системе предприятия.

Таким образом, предложенный метод позволяет определить оптимальные логистические затраты, уровень обслуживания и поставки предприятия.

5. ЗАКЛЮЧЕНИЕ

Результаты исследования способствуют повышению качества работы логистической системы. Выводы и методические разработки имеют практическую значимость и могут быть использованы руководителями и специалистами логистических подразделений предприятий.

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СТРАТЕГИЧЕСКОЕ УПРАВЛЕНИЕ ЦЕПЯМИ ПОСТАВОК НА ОСНОВЕ КОНТРОЛЛИНГА С ИСПОЛЬЗОВАНИЕМ СБАЛАНСИРОВАННОЙ СИСТЕМЫ ПОКАЗАТЕЛЕЙ

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Аннотация. Рассмотрены вопросы, связанные как с общей методологией стратегического управления цепями поставок, так и с применением инструментов реализации стратегического управления, в частности, касающиеся формирования и использования сбалансированной системы показателей (ССП) для контроллинга в цепях поставок. Внедрение ССП приведет к созданию единого информационного пространства и понимания направления развития всеми сотрудниками, участвующими в процессах поставок, что приведет к принятию обоснованных взвешенных решений в процессе контроллинга, направленных на реализацию стратегии, на всех уровнях управления.

STRATEGIC SUPPLY CHAIN MANAGEMENT BASED ON CONTROLLING WITH THE USE OF BALANCED SCORECARD

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Purpose of the paper is describing theoretical and methodical points and recommendations for strategic supply chain management based on controlling with the use of balanced scorecard (BSC).
Research/application methodology. Theoretical and methodological basis is points and methods of fundamental and applied sciences in the fields of economy, logistics, strategic management, finance, statistics, marketing, HR-management, knowledge management, theory of processes management, IT-management.
Design of the paper. In the paper the next points are sequentially examined:
- currency of strategic supply chain management issues studying is grounded, especially issues relating to planning and realization of logistics strategy;
- essence and purpose of BSC as a tool of strategic supply chain management is considered;
- necessity of logistics strategic objects system planning as a first step to BSC forming is grounded;
- algorithm of BSC supply chain processes forming and requirements to indexes included in BSC are presented;

- necessity of BSC integration to supply chain management tools (strategic and operation level) is grounded;
- controlling system an it's subsystems (strategic and current controlling) are examined;
- scheme of BSC using for strategic supply chain management based on controlling of logistics processes is presented;
- stepped algorithm of strategic and current controlling in supply chain with the use of BSC is presented.

Main results. Issues related both to the strategic supply chain methodology and tools of strategic management realization applying, particularly concerning to methodology of forming and using of BSC for controlling in supply chains, are examined. Implementation of controlling system will lead to creation of integrated information space in company and aweareness of direction of development by all the workers taking part in supply processes that will lead to taking well-grounded decisions by all levels of management directed at strategy realization.
Academic contribution consists in systematization and development of theoretical, organizational, methodological, scientific and practice points and recommendations in the sphere of strategic supply chains management based on controlling with the use of BSC, particularly:

1) Essence and purpose of BSC as a tool of strategic supply chain management is described, which is on condition of implementation of periodical measures system of development, revising, integration in supply chain management, training of workers, using for controlling will lead to taking well-grounded decisions by all levels of management directed at strategic tasks realization.
2) Necessity of logistics strategic objects system forming as a first step to BSC forming based on principle of corporate strategy decomposition by the directions of key aspects of activity – parts of future BSC, and key factors of success in logistics activity is grounded.
3) Taking into account the controlling system requirements, the requirements to indexes included into BSC are presented, the algorithm of BSC for supply chain processes forming is worked out.
4) The scheme of BSC using for strategic and current controlling is described, algorithm of controlling (taking into account both control, elimination of deviations of indexes and compensation of disturbances for deviations of indexes preventing) for supply chain processes with the use of BSC is introduced, and also the necessity of forming and support of knowledge database containing input data and results of BSC for information support of controlling system is grounded.
5) The system of efficiency criterions of strategic supply chain management based on controlling by results of project of developing, revising, implementation and using of BSC is introduced.

Managerial insights consists of developing of models and algorithms of strategic supply chain management based on controlling with the use of BSC. After adapting of developed models and algorithms to the special features of a company they can be used by the companies of all the business fields. The paper can be used in the process of teaching, training and personal development of supply chain management specialists.

В современных условиях жесткой конкурентной борьбы и быстро меняющейся окружающей ситуации многие компании осознают важность не только концентрации внимания на внутреннем состоянии дел и решении оперативных задач в деятельности цепей поставок, но и выработки продуманной стратегии и эффективного механизма реализации этой стратегии. Это обуславливает рост интереса многих компаний и научного сообщества к вопросам стратегического управления цепями поставок, поиску инструментов реализации стратегии, разработке механизмов доведения ее до всех сотрудников, интеграции в системы принятия управленческих решений на всех уровнях управления цепями поставок [6].

Актуальным подходом к управлению цепями поставок, ориентированному на достижение стратегических целей, является реализация системы контроллинга с использованием концепции сбалансированной системы показателей (ССП). Обращение к истории возникновения и развития концепции ССП показывает, что понятие ССП за время своего существования (с 1990 г.) значительно трансформировалось, пройдя путь от «системы измерения», - набора показателей оценки эффективности деятельности компании по реализации стратегии, состоящего из количественных показателей четырех групп - составляющих (предложенных разработчиками ССП Капланом Р. и Нортоном Д.): финансов, клиентов, внутренних бизнес-процессов и обучения и развития (способность роста и развития компании), взаимосвязанных причинно-следственными связями, до «системы управления», т.е. инструмента, который позволяет компании четко сформулировать стратегию и воплотить ее в реальные действия [2].

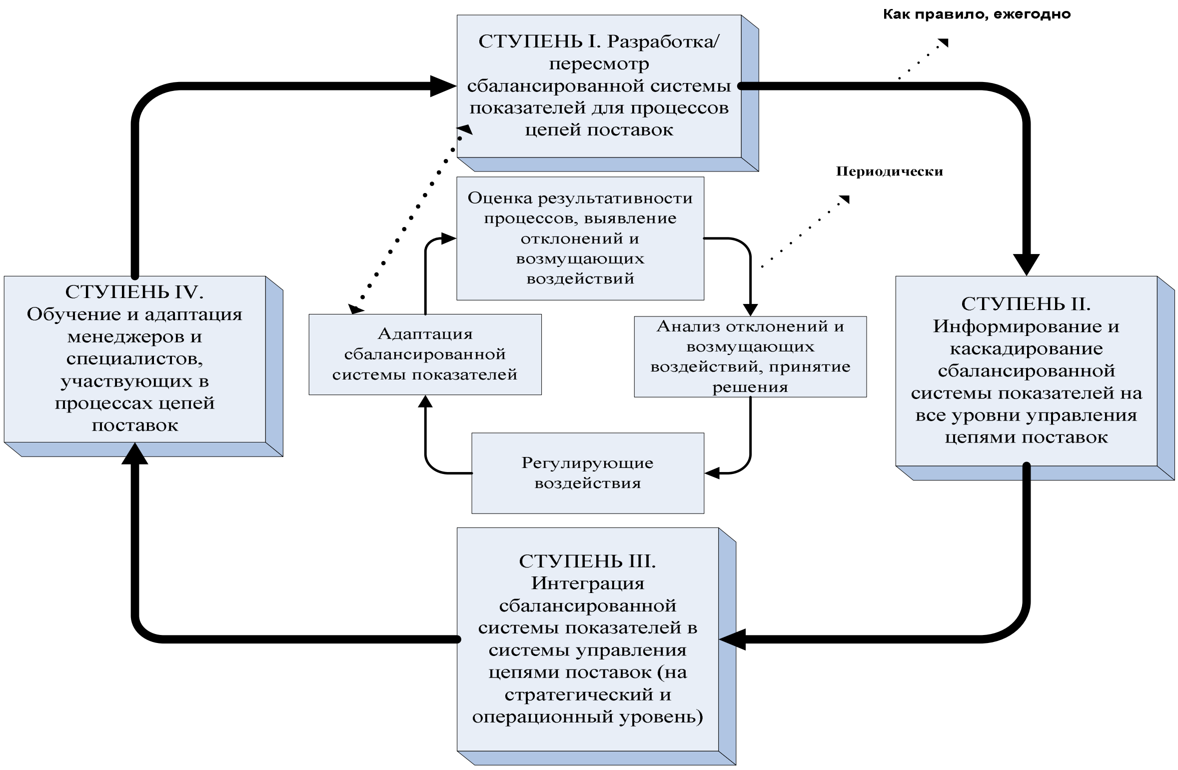

Рис. 1. Циклы менеджмента компании, использующей ССП для стратегического управления цепями поставок

Для успешного применения ССП в качестве инструмента стратегического управления цепями поставок компании проходят два параллельных цикла менеджмента, представленные на рисунке 1, а именно: внешний цикл -

цикл разработки (пересмотра) и внедрения ССП - представляющий собой четырехступенчатый процесс, а также внутренний цикл - цикл использования, включающий использование результатов ССП в системах оценки результативности логистических процессов и контроллинга [5].

Основываясь на классических этапах стратегического управления, можно определить процедуру стратегического управления цепью поставок на основе контроллинга с использованием ССП, включающую следующие этапы:

- анализ внутренней и внешней по отношению к участникам цепи поставок среды;
- планирование логистической миссии и стратегии, определяющей вклад процессов цепи поставок в реализацию корпоративной стратегии: разработка системы логистических стратегических ориентиров (СЛСО), разработка и внедрение ССП;
- реализация логистической стратегии, т.е. реализация мероприятий по приданию стратегической направленности всем решениям и действиям участников цепи поставок: интеграция ССП в системы управления цепями поставок, реализация системы контроллинга с использованием ССП;
- оценка эффективности стратегического управления цепями поставок.

Стратегическое управление цепями поставок включает этап планирования СЛСО, определяющих вклад процессов цепи поставок в реализацию корпоративной стратегии, на основании следующих принципов:

1) СЛСО для формирования ССП состоит из следующих элементов: миссия, стратегия, цели, задачи.
2) Разработка СЛСО осуществляется «сверху-вниз» - начинается с корпоративной миссии, заканчивается определением логистических задач (в направлении миссия - стратегия - цели - задачи).
3) СЛСО является частью системы корпоративных стратегических ориентиров, все элементы СЛСО связаны причинно-следственными связями.
4) Основным принципом определения стратегических ориентиров низшего уровня в системе является декомпозиция элементов высшего уровня.
5) Для формулирования логистических целей на основании логистической стратегии следует определить ключевые аспекты деятельности (проекции - составляющие будущей ССП) в логистике посредством декомпозиции корпоративных ключевых аспектов деятельности (финансовых и нефинансовых). Дополнительно возможно расширить перечень нефинансовых составляющих, включить, например: человеческий капитал, составляющую отношений с контрагентами, инновационные разработки, развитие информационных технологий, экология и проч.
6) Декомпозиция стратегических ориентиров в рамках СЛСО производится в двух направлениях: в направлении «сверху-вниз», то есть от стра-

тегии к целям и от целей к задачам, а также по горизонтали - от стратегии к целям по ключевым аспектам деятельности (составляющим будущей ССП), от целей к задачам по ключевым факторам успеха.

7) Формулирование целей и задач по принципам SMART (рекомендуется).
8) Стратегия, цели, задачи могут быть декомпозированы по видам бизнеса компании - холдинга, крупной корпорации.

Следует отметить, что на практике для получения конкурентных преимуществ компании следует выбрать конкретную направленность для логистической стратегии, что является ключевым решением, а в будущем становится особой компетенцией компании, определяемой факторами, которыми она управляет с повышенным вниманием и использует, чтобы отличиться от других участников рынка. К основным направлениям логистических стратегий относят: стратегии минимизации логистических издержек; стратегии повышения уровня сервиса для клиентов; стратегии минимизации времени поставок товаров или доставка точно ко времени, указанному заказчиком; стратегии предоставления услуг и товаров высокого качества, специализированных услуг и товаров; стратегии, направленные на оперативное реагирование на изменяющийся спрос и проч. Выбранное ключевое решение позволяет компаниям осуществлять приоритезацию при разработке системы стратегических ориентиров и аргументированное принятие решений всех уровнях управления.

На рисунке 2 приведен алгоритм формирования СЛСО как необходимого первого этапа формирования и использования ССП, разработанный с учетом представленных выше принципов.

Формирование СЛСО является необходимым первым шагом для формирования ССП, поскольку определяет:

- структуру ССП, фиксируя ключевые аспекты деятельности, определяющие составляющие ССП;
- содержание ССП, определяя задачи, достижение которых, выраженное через показатели ССП, способствует реализации логистических и корпоративных стратегических ориентиров;
- нормативы показателей ССП, характеризующие степень достижения логистических и корпоративных стратегических ориентиров.

Алгоритм формирования ССП для процессов цепей поставок представлен на рисунке 3. Следует отметить, что помимо логистических стратегических ориентиров информацией для формирования ССП являются карты бизнес-процессов цепи поставок компании (желательно - разработанные в соответствии со стандартами описания бизнес-процессов: IDEF, ARIS и проч.). Для показателей ССП на этапе формирования ССП рекомендуется определять (если возможно) перечень возмущающих воздействий для реализации системы контроллинга, комбинирующей управление по отклонениям и управление по возмущениям.

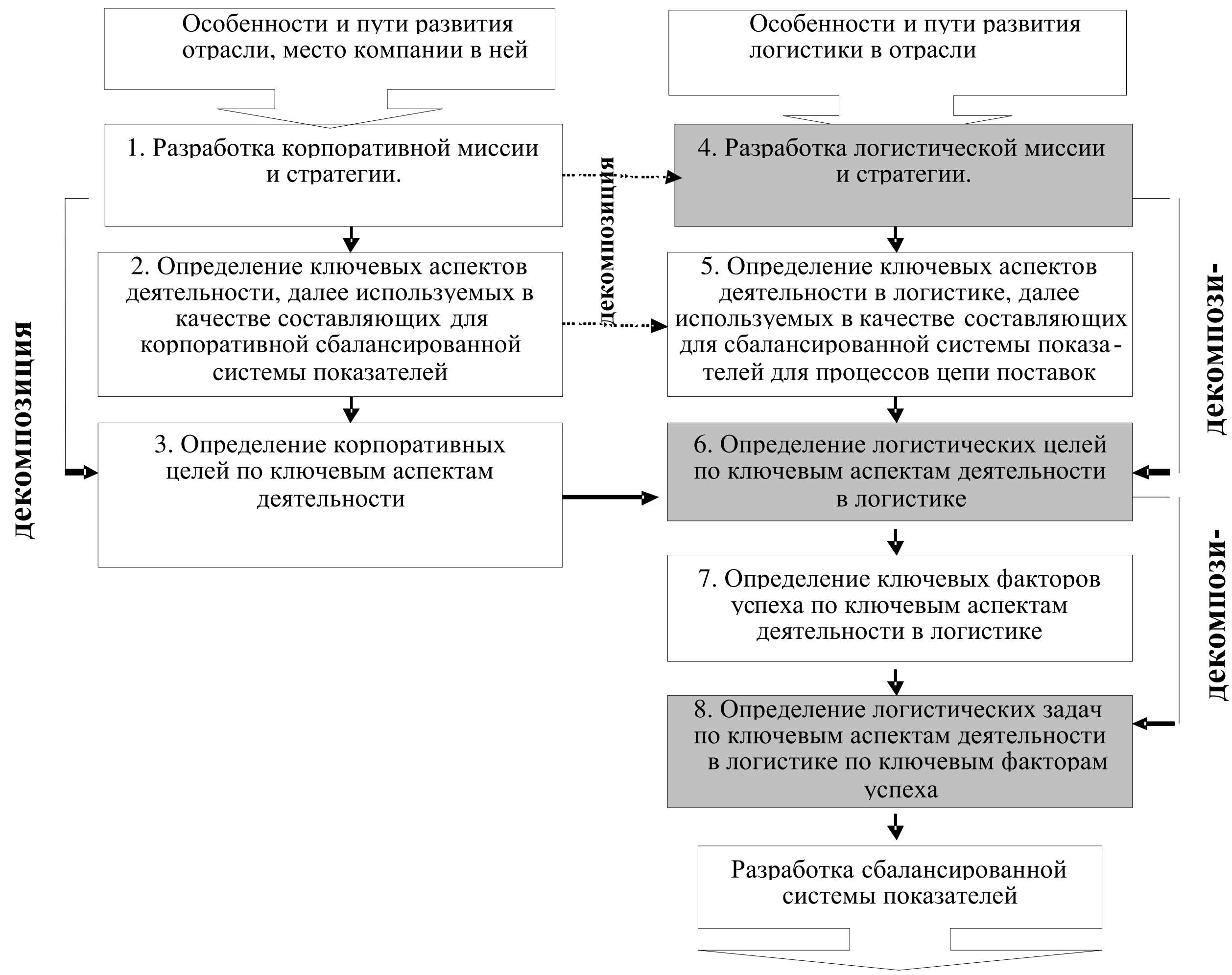

Рис. 2. Алгоритм формирования СЛСО

При формировании ССП следует учесть, что система контроллинга предъявляет требования к подконтрольным показателям, включаемым в ССП, а именно: связь показателей со стратегией, количественная формализуемость, наличие норматива, взаимосвязанность и проч. Важным требованием является необходимость для каждого бизнес-процесса, подразделения, исполнителя определить показатели, позволяющие проследить за динамикой работы, отражая результаты деятельности цепи поставок в предшествующие периоды (мониторинговые показатели), отражающие будущие результаты деятельности цепи поставок и служащие для корректировки логистического процесса в тех случаях, если он отклоняется от установленных критериев (контрольные показатели), выделить среди этих показателей управляющие - предназначенные для мотивации персонала, участвующего в процессах цепи поставок [3]. Следует отметить, что ССП, сформированная для процессов цепи поставок, является успешным инструментом стратегического управлении ими только тогда, когда она становится единым доступным источником информации для принятия управленческих решений, а также интегрируется с системами управления цепями поставок.

Рис.3. Алгоритм формирования ССП для процессов цепей поставок

Интеграция ССП в системы управления цепями поставок осуществляется - на стратегический уровень, в частности, в системы нормирования, планирования, бюджетирования и проч., в результате чего системы норм, планов, бюджетов цепи поставок приобретают единую направленность на реализацию стратегии, в свою очередь, придавая стратегическую направленность параметрам операционных систем управления в цепях поставок [5].

Участие контроллинга в управлении цепями поставок осуществляется на основе оценки, регулирования и контроля показателей, характеризующих состояние процессов цепи поставок на всех этапах осуществления деятельности. Контроллинг управляет процессами цепей поставок, являясь современной технологией, позволяющей интегрировать традиционные методы учета, анализа, планирования и контроля в единую систему получения, обработки и обобщения информации и принятия на ее основе системных обоснованных управленческих решений. Выделяют две подсистемы контроллинга - стратегический и текущий. Стратегический контроллинг помогает использовать преимущества и создавать новые потенциалы успешной деятельности цепи поставок, определяет цели и задачи для текущего контроллинга. К задачам текущего контроллинга относят учет, анализ, планирование и управление результатами деятельности компании, осуществление контроля, выявление и устранение текущих трудностей [4].

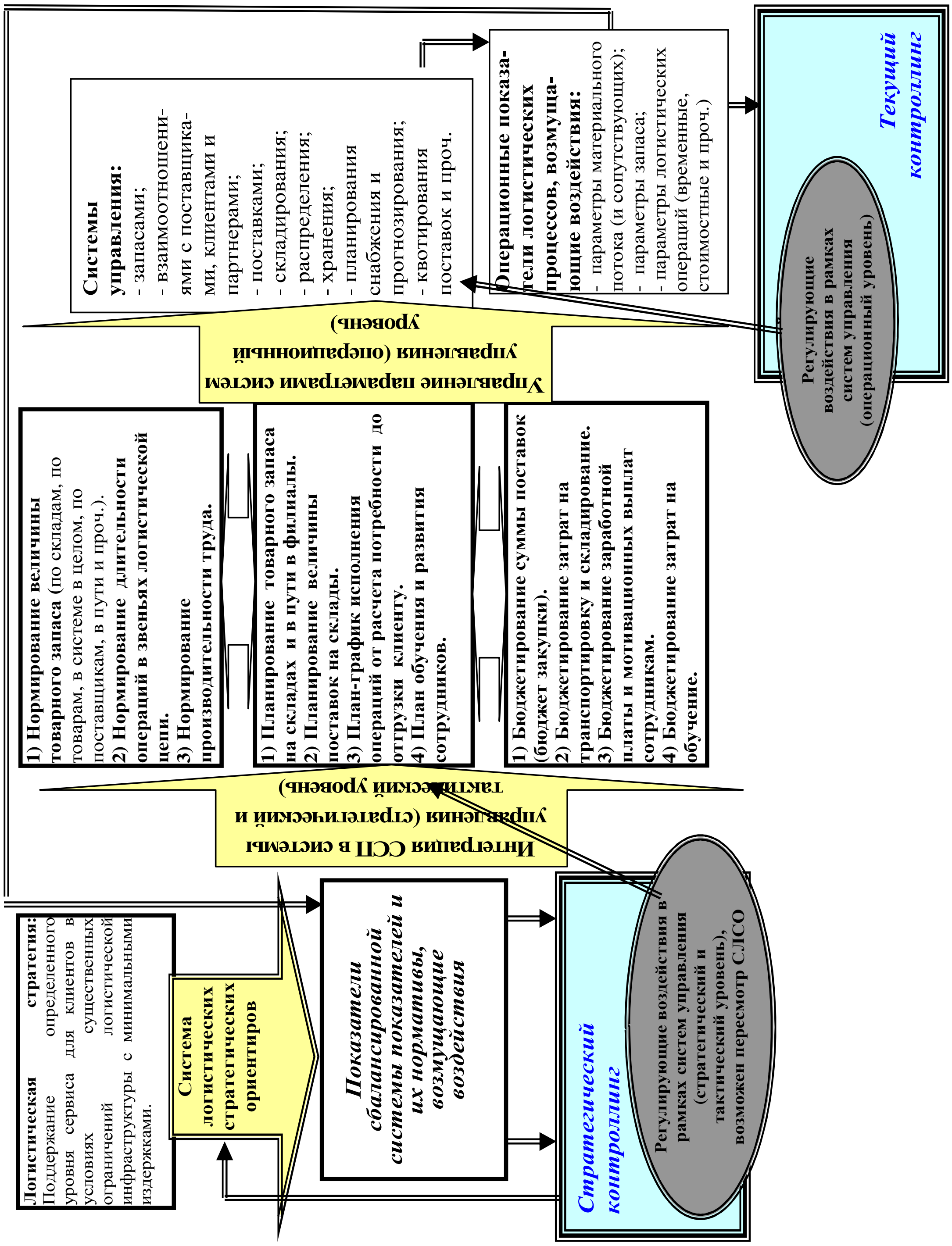

Рис.4. Схема использования ССП для стратегического управления цепью поставок на основе контроллинга

Концепция ССП в качестве инструмента стратегического контроллинга в цепи поставок представляет большой интерес из-за того, что основанная на системе логистических стратегических ориентиров, она предполагает включение показателей как финансового, так нефинансового характера, а также характеризующих как узкие места в текущей деятельности, так и возможные будущие отклонения от нормативов, что позволяет расширить информационную базу для принятия управленческих решений в процессе стратегического контроллинга [4].

Схема использования ССП для стратегического управления цепью поставок на основе контроллинга логистических процессов представлена на рисунке 4. Пошаговый алгоритм стратегического и текущего контроллинга в цепи поставок с использованием ССП представлен на рисунке 5. Данный алгоритм включает расчет и анализ интегральных показателей ССП, определяемых как средневзвешенное значение результатов показателей ССП, где весами выступают экспертно определенные веса логистических задач СЛСО.

Для реализации предложенного алгоритма контроллинга существует необходимость формирования и поддержания базы знаний, структуру которой формируют исходные данные для расчета, нормативы и результаты ССП, а также информация для мониторинга возмущающих воздействий. Требования к исходным данным для показателей ССП и базе знаний могут определить требования к изменению информационной системы компании по автоматизации учёта и управления движением материальных и сопутствующих им потоков.С целью достижения согласованности действий специалистов, участвующих в процессах поставок, с общей стратегией компании, самооценки и проверки согласованности действий со стратегией, в системе мотивации следует использовать в качестве входных данных управляющие показатели ССП.

Практическую реализацию циклов формирования, внедрения и использования ССП можно определить как проект, то есть совокупность действий и ресурсов, направленных на достижение результата, определяемого системой стратегических ориентиров, в определенные сроки в рамках выделенного бюджета. В систему критериев, определяющих эффективность стратегического управления цепью поставок на основе контроллинга по результатам реализации проекта по разработке (пересмотру), внедрению и использованию ССП следует включать критерий, характеризующий успешную реализацию стратегии компании, критерий эффективности процессов цепи поставок в свете реализации стратегии, а также критерий, определяющий реализацию мероприятий по разработке, внедрению и использованию ССП для контроллинга в рамках установленного бюджета.

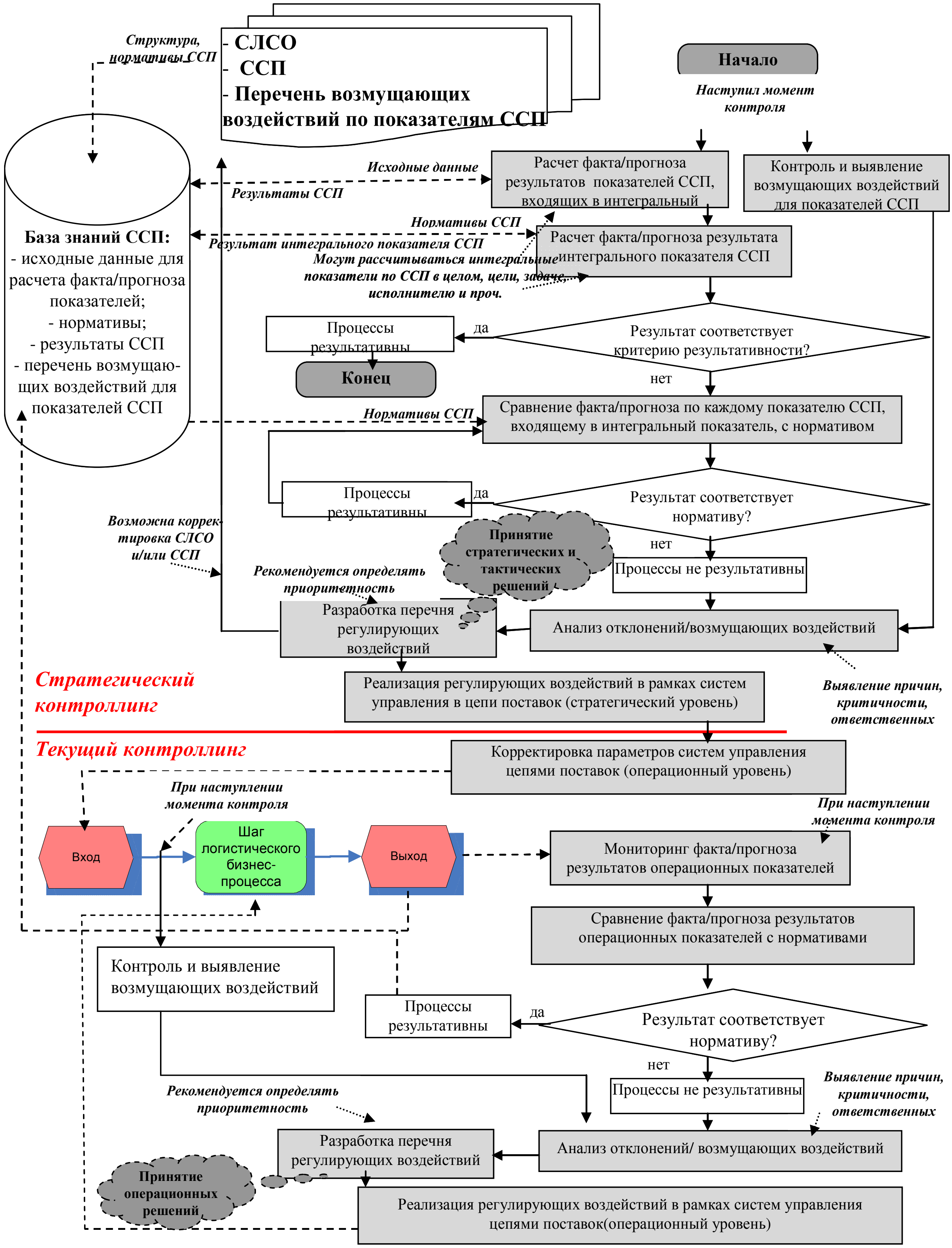

Рис. 5. Алгоритм контроллинга процессов цепей поставок с использованием ССП

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ANSÄTZE UND EMPFEHLUNGEN ZUR GESTALTUNG EINER BALANCED SCORECARD FÜR DIE LOGISTIK

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Zusammenfassung: Vor dem Hintergrund einer zunehmenden Angleichung und Substituierbarkeit der Produkte verschiedener Hersteller hinsichtlich Funktionalität, Qualität, Design und Preis kommt der Logistik eine zentrale Bedeutung als Wettbewerbsfaktor zu. Der hohe Einfluß der Logistik auf den Unternehmenserfolg ist empirisch nachgewiesen. Die Nutzung der der Logistik innewohnenden Potentiale zur Steigerung des Unternehmenserfolgs setzt jedoch die Implementierung eines leistungsfähigen Logistikcontrolling voraus. Dabei sind Logistikkosten und Logistikleistungen gleichermaßen zu berücksichtigen. Ein Instrument, das diese Anforderung erfüllt, ist die Balanced Scorecard. Für den adäquaten Einsatz der BSC in der Logistik sind jedoch Anpassungen inhaltlicher und ggf. struktureller Art notwendig. Daher wurden in der Literatur zahlreiche Vorschläge zur Gestaltung einer Balanced Scorecard für die Logistik gemacht. Der Beitrag gibt einen Überblick über die für die Logistik entwickelten BSC-Konzepte und leitet daraus Gestaltungsempfehlungen für die Entwicklung einer Logistik-BSC ab.

APPROACHES AND RECOMMENDATIONS FOR THE DEVELOPMENT OF A LOGISTICS BALANCED SCORECARD

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Purpose of the paper
The increasing assimilation and substitutability of different firms' products in terms of functionality, quality, design and price make logistics a more and more important success factor. The high impact of logistics on a firm's success is empirically proved. In order to use the ability of logistics to increase a firm's success it is crucial to implement an adequate logistics controlling system. This system must take care of logistics costs and logistics performance at the same time. An instrument which meets this requirement is the Balanced Scorecard. In order to use the BSC adequately to control logistics processes, some modifications are necessary. Against this background, several suggestions have been made in literature concerning the design of a BSC for logistics. This paper provides an overview over these concepts and gives some recommendations for the development of a BSC for logistics.

Research/application methodology
In order to identify the approaches of a Logistics Balanced Scorecard discussed in literature, the relevant (especially German) literature in the field of logistics controlling published since 1992 was analysed.

Design of the paper
After working out the motivation of analysing Logistics Balanced Scorecards, the paper provides an overview of the approaches which could be identified in literature and classifies them according to different criteria. Subsequently, the approaches are analysed in detail, especially with regard to the perspectives proposed for a Logistics Balanced Scorecard. The insights gained from this analysis are used to give some recommendations for the development of a Logistics Balanced Scorecard. Some remarks on the implementation process of a Logistics Balanced Scorecard complete the paper.

Main results
For the logistics function of an industrial or commercial enterprise, the four traditional perspectives should be amended by a supplier perspective, because the suppliers' performance is as crucial for the delivery service a firm can provide to its customers as its own service capability. For logistics service providers, an additional cooperation perspective is recommended which represents aspects of the collaboration with sub-providers. Analogously to the suppliers' role in an industrial or commercial enterprise, the delivery service a logistics service provider is able to provide to its customers depends to a high degree on the performance of the sub-providers it works together with.

Academic contribution
The paper provides an overview of the current state of discussion of an important topic in the field of logistics controlling.

Managerial insights
Although the development of a Balanced Scorecard always is an individual process, some general recommendations as given in the paper at hand facilitate and abbreviate the implementation process in practice considerably.

1. PROBLEMSTELLUNG

Die zunehmende Angleichung und Substituierbarkeit der Produkte verschiedener Hersteller hinsichtlich Funktionalität, Qualität, Design und Preis hat eine immer stärkere Verlagerung des Wettbewerbs von der Primärleistungsebene (Produkt) auf die Sekundärleistungsebene (Serviceleistung) zur Folge. Eine hochgradig wettbewerbsrelevante Serviceleistung stellt der Logistikservice dar, der zunehmend über den Kauf eines Produktes bzw. über die Auftragsvergabe entscheidet [18]. Somit wird die Logistik als Servicefunktion zur bedarfsgerechten Bereitstellung von Gü-

tern zu einem strategischen Erfolgsfaktor, indem sie einerseits über niedrige Logistikkosten zu einer günstigen Kostenposition beiträgt und andererseits über kurze Reaktions-, Durchlauf- und Lieferzeiten, eine hohe Lieferflexibilität, Termintreue und Informationsbereitschaft insbesondere bei der Erfüllung individueller Kundenwünsche einen Beitrag zur Erhöhung des Kundennutzens und damit zur Differenzierung gegenüber den Wettbewerbern liefert. Empirische Studien belegen den hohen Einfluß, den die Logistik auf den Unternehmenserfolg hat [8], [9].
Die Nutzung der Potentiale der Logistik zur Steigerung des Unternehmenserfolgs setzt die Unterstützung des Logistikmanagement durch ein leistungsfähiges Logistikcontrolling voraus, das die Logistikleistungen und -kosten und deren Beitrag zum Unternehmenserfolg in geeigneter Form mißt und transparent macht. So wie die Erfolgswirksamkeit der Logistik ist auch der positive Einfluß eines gut ausgebauten Logistikcontrolling auf den Logistikerfolg (und damit wiederum auf den Unternehmenserfolg) empirisch nachweisbar [3].
Die Studien zeigen ferner, daß überlegene Logistikleistungen einen deutlich stärkeren Einfluß auf den wirtschaftlichen Erfolg eines Unternehmens ausüben als niedrige Logistikkosten: "Kostenreduzierungen wirken zwar schnell und unmittelbar, sind aber in ihrem Ausmaß begrenzt. Umgekehrt sind die Wirkungen hoher logistischer Performance eher mittel- und langfristiger Natur, ihre Erfolgswirkung übertrifft die von Kostenreduzierungen in ihrem Umfang aber bei weitem. Logistik kann damit beides: Sie läßt sich in den Dienst kurzfristiger Kostensenkungsprogramme stellen und ist gleichzeitig in der Lage, die Wettbewerbsposition strategisch maßgeblich zu verbessern."[39]
Damit dies auch tatsächlich gelingt, wird ein ausgewogenes Controlling von Logistikkosten und Logistikleistungen benötigt. Als geeignetes Controlling-Instrument, das die Kosten- und die Leistungsseite gleichermaßen berücksichtigt, hat sich die Balanced Scorecard erwiesen. Für den adäquaten Einsatz dieses Instruments in der Logistik sind jedoch Anpassungen inhaltlicher (Integration logistikrelevanter Kennzahlen in die vier Standard-Perspektiven) und ggf. struktureller Art (Modifikation von Art und Anzahl der Perspektiven) notwendig [35]. Daher wurden in der Literatur sowohl von theoretischer als auch von praktischer Seite zahlreiche Vorschläge zur (Um-) Gestaltung der Balanced Scorecard im Hinblick auf ihren Einsatz zur Steuerung der Logistik gemacht. Im folgenden wird ein Überblick über die für die Logistik entwickelten BSC-Konzepte gegeben und daraus eine Gestaltungsempfehlung für die Entwicklung einer Logistik-BSC abgeleitet. Im Mittelpunkt der Analyse stehen die für eine Logistik-BSC vorgeschlagenen Perspektiven, um Anregungen für die Konzeption einer unternehmensindividuellen Logistik-BSC zu geben.

2. SYSTEMATISIERUNG DER GESTALTUNGSANSÄTZE

Die in der Literatur unterbreiteten Vorschläge zur Gestaltung einer Balanced Scorecard für die Logistik lassen sich nach verschiedenen Kriterien systematisieren (vgl. **Abb. 1**):

- Nach der Art der vorgenommenen Anpassung des Grundmodells der BSC an die spezifischen Bedürfnisse der Logistik sind Ansätze, die lediglich logistikbezogene Kennzahlen in die klassischen Perspektiven der BSC integrieren (rein inhaltliche Anpassung) von solchen zu unterscheiden, die zusätzlich Modifikationen in Bezug auf die Perspektiven der BSC vornehmen (inhaltliche und strukturelle Anpassung).
- Im Hinblick auf den Anwendungskontext der Konzepte bzw. den Stellenwert der Logistik für das betrachtete Unternehmen ist weiter dahingehend zu differenzieren, ob sie für ein Industrie- oder Handelsunternehmen, für die die Logistik eine Unterstützungsfunktion zur Erfüllung des eigentlichen Kerngeschäfts darstellt und die Logistikleistungen somit als Sekundärleistungen anzusehen sind, oder für einen Logistikdienstleister entwickelt wurden, dessen Kerngeschäft in der Erbringung von Logistikleistungen für andere Unternehmen besteht (Logistikleistungen als Primärleistungen).
- Nach dem Detaillierungsgrad kann zwischen Vorschlägen, die sich (nur) auf die Gesamtlogistik beziehen und solchen, die die Gesamtlogistik eines Unternehmens (alternativ oder zusätzlich) in einzelne Teilbereiche zerlegen, unterschieden werden.
- Schließlich können rein konzeptionelle Ansätze von solchen differenziert werden, die aus Praxisprojekten entstanden sind. Letztere sind in **Abb. 1** kursiv dargestellt. Sofern das Unternehmen, für das die BSC entwickelt wurde, genannt wird, ist der Name in Klammern hinter den Autoren angegeben.

Die in **Abb. 1** angeführten Ansätze sind allesamt für die laufende Steuerung der Logistik gedacht. Im Gegensatz dazu präsentieren Baumgarten/Pladeck eine Balanced Scorecard zur Unterstützung der Implementierung neuer Logistiksysteme [1]. Da das Management derartiger (durch ihre Einmaligkeit gekennzeichneter) Projekte völlig andere Anforderungen an das Controlling stellt als die laufenden Führungsaktivitäten, wird dieser Ansatz jedoch aus der folgenden Analyse ausgeschlossen. Ebenfalls nicht näher betrachtet werden Balanced Scorecards für das Supply Chain Management [33].

Auch wenn diese teilweise mit den hier diskutierten Logistik-BSCs gleichgesetzt werden [19], da beide Logistikaspekte thematisieren, besteht ein fundamentaler Unterschied darin, daß sich letztere auf komplette Wertschöpfungsketten (Supply Chains) beziehen und die Logistik (lediglich) als einen Teilaspekt des Supply

Chain Management beinhalten, während erstere explizit und ausschließlich zur Steuerung der Logistik eines einzelnen Unternehmens entwickelt wurden.

<table>
<tr><th></th><th>Rein inhaltliche Anpassung</th><th>Inhaltliche und strukturelle Anpassung</th><th></th></tr>
<tr><td rowspan="2">Industrie und/oder Handel</td><td>– Engelke/Rausch [11]
– Engelhardt [10]
– Borsum/Kämpf/Kern [5]
– Liberatore/Miller [24]
– *Eschenbach/Haddad* [12]
– *Kindel/Lang/Schwarz/ Sommerer (Blechformwerke Bernsbach)* [22]</td><td>– Siepermann [31], aufgegriffen durch Vahrenkamp [36]
– Piontek [25], aufgegriffen durch Gerberich [16]
– *Stölzle* [34]
– *Karrer/Placzek/Stölzle* [21] bzw. *Placzek/Köhler* [26]
– *Galgenmüller/Gleich/Gräf (DaimlerChrysler)* [14]
– *Caplice/Sheffi (Digital Equipment)* [6]</td><td>Gesamt-logistik</td></tr>
<tr><td>– Binner [2]</td><td>– Weber [38]</td><td>Teilbereiche</td></tr>
<tr><td rowspan="2">Logistik-dienst-leister</td><td>– Clausen/Erdmann/Schmidt [7]
– Göpfert [17]
– Borsum/Kämpf/Kern [5]
– *Vulpius (Deutsche Bahn)* [36]
– *Boecker (F.S.G.)* [4]</td><td>– Karrer/Petzold [20]</td><td>Gesamt-logistik</td></tr>
<tr><td colspan="2">– *Schneider (Schenker)* [27]-[30]</td><td>Teilbereiche</td></tr>
</table>

Abb. 1: Gestaltungsansätze einer Logistik-BSC

Ebenso enthalten auch für Einkauf und Materialwirtschaft konzipierte Balanced Scorecards [32] logistikbezogene Ziele und Kennzahlen, diese decken jedoch mit der Beschaffungslogistik nur einen Teilbereich der gesamten Logistik eines (Industrie- oder Handels-) Unternehmens ab und werden demzufolge ebenfalls aus der weiteren Betrachtung ausgeschlossen.

3. ANALYSE DER GESTALTUNGSANSÄTZE

Bei der Analyse der Gestaltungsansätze ist zunächst grundlegend dahingehend zu differenzieren, welchen Stellenwert die Logistikleistungen für das betrachtete Unternehmen haben, d.h. ob es sich bei den Logistikleistungen um Primärleistungen und bei dem betrachteten Unternehmen somit um einen Logistikdienstleister handelt, oder ob ein Industrie- oder Handelsunternehmen betrachtet wird, für das die Logistik eine Sekundärleistungsfunktion repräsentiert.

Gestaltungsansätze für Industrie- und Handelsunternehmen

Bei den Ansätzen für Industrie- und/oder Handelsunternehmen sind vor allem die vorgeschlagenen strukturellen Anpassungen von Interesse.

Weber präsentiert ein System von Logistik-BSCs, das sich aus je einer BSC für die Beschaffungs-, Produktions-, Distributions- und Gesamtlogistik zusammensetzt. Da Quellen und Senken des Material- und Warenflusses für die Logistik gleichermaßen bedeutsam sind, sollten neben kundenbezogenen Zielen explizit auch lieferantenbezogene Ziele in einer Logistik-BSC berücksichtigt und mit Hilfe entsprechender Kennzahlen operationalisiert werden. Um diesen das gleiche Gewicht zu verleihen wie den kundenbezogenen Zielen und Kennzahlen, integriert Weber in die Scorecards für die logistischen Teilbereiche zusätzlich zur Kundenperspektive, die die Senken des Material- und Warenflusses repräsentiert, jeweils eine *Lieferantenperspektive* für die Quellen der Material- und Warenflüsse. Die Verbindung zwischen den drei Logistik-Teilbereichs-Scorecards ergibt sich daraus, daß die Kundenperspektive eines vorgelagerten logistischen Teilbereichs die Belange des jeweils nachgelagerten Teilbereichs und die Lieferantenperspektive eines nachgelagerten Teilbereichs die Belange des jeweils vorgelagerten Bereichs abbildet. Auf die Integration einer Lern- und Entwicklungsperspektive wird auf dieser Ebene im Sinne einer Komplexitätsreduktion verzichtet, zumal sich hier keine nennenswerten Unterschiede zwischen den einzelnen logistischen Teilbereichen feststellen lassen. Ihre Berücksichtigung erfolgt daher erst auf der Ebene der Gesamtlogistik. Die Scorecard für die Gesamtlogistik enthält neben Finanz- und Lern- und Entwicklungsperspektive eine *Koordinationsstruktur-* und eine *Koordinationsprozeßperspektive* zur Abbildung der Leistungsfähigkeit der Logistik bei der Koordination der betrieblichen Wertschöpfungsprozesse als Kernaufgabe der Logistik, wobei die Koordinationsstrukturperspektive den Koordinationserfolg über strukturelle Maßnahmen (z.B. explizite Berücksichtigung logistischer Belange bei der Produktentwicklung und -gestaltung) und die Koordinationsprozeßperspektive das Ausmaß laufender Koordinationsaktivitäten mißt. Da Lieferantenaspekte mit der Lieferantenperspektive der Beschaffungslogistik-BSC und die Kundenbeziehungen mit der Kundenperspektive der Distributionslogistik-BSC vollständig abgedeckt sind, kann auf diese Perspektiven auf der Ebene der Gesamtlogistik (wiederum vor dem Hintergrund der Komplexitätsreduktion) verzichtet werden [38].

Auch andere Autoren integrieren in ihre (für die Gesamtlogistik konzipierte) Logistik-BSC zusätzliche Perspektiven:

- Am häufigsten wird eine *Lieferantenperspektive* empfohlen [16], [21], [25], [26], [31], [36]. Die Begründung ist jeweils ähnlich wie bei Weber. Als Alternative zu einer solchen wird auch eine Erweiterung der Kundenperspektive um Lieferantenaspekte als Möglichkeit genannt; die resultierende Perspektive wird dann als *Marktperspektive* bezeichnet [31]. Eine Lieferantenperspektive wird allerdings auch unabhängig vom Anwendungskontext der Logistik vorgeschlagen [14].

- Um die Logistik-BSC unternehmensstrategiekonform ausrichten zu können, muß die Logistikstrategie mit der Strategie des Gesamtunternehmens verknüpft werden. Zu diesem Zweck erweitert Stölzle das Grundkonzept der BSC um eine *Strategieperspektive*, deren Aufgabe darin besteht, den Beitrag der Logistik zur Umsetzung der Gesamtunternehmensstrategie aufzuzeigen [34].

Um die Logistik-BSC nicht mit Perspektiven zu überfrachten, wird die Einführung einer neuen Perspektive meist durch den Verzicht auf eine andere, im Grundmodell der BSC enthaltene Perspektive oder die Zusammenlegung zweier originärer Perspektiven kompensiert:

- Im Modell von Weber entfallen (wie bereits erläutert) auf Ebene der Teilbereichs-Scorecards die Lern- und Entwicklungsperspektive und auf Ebene der BSC für die Gesamtlogistik die Kunden- und die Prozeßperspektive [38].
- Auch andere Autoren verzichten in ihren (gesamtlogistikbezogenen) Ansätzen auf die Lern- und Entwicklungsperspektive mit der Begründung, daß diese im Vergleich zu den übrigen Perspektiven eher logistikunspezifisch ist und somit im Sinne einer Komplexitätsreduktion in einer Logistik-Scorecard am ehesten entfallen kann [31]. In der Praxis ist ein Wegfall der Lern- und Entwicklungsperspektive in einer Logistik-BSC auch dann zu beobachten, wenn keine zusätzliche Perspektive implementiert wird [6], [23].
- Als Alternative zu einem völligen Verzicht auf die Lern- und Entwicklungsperspektive nehmen Karrer/Placzek/Stölzle bzw. Placzek/Köhler eine Zusammenlegung mit der internen Prozeßperspektive vor und bezeichnen die resultierende Perspektive (übersetzt) als "*Mitarbeiter und Prozesse*". Begründet wird dies mit dem engen Zusammenhang zwischen effektiven und effizienten Logistikprozessen einerseits (interne Prozeßperspektive) und der Leistungsfähigkeit und Leistungsbereitschaft der Mitarbeiter und Informationssysteme andererseits (Lern- und Entwicklungsperspektive) [21].
- Galgenmüller/Gleich/Gräf hingegen spalten die Lern- und Entwicklungsperspektive der klassischen BSC in die beiden Perspektiven "*Führung und Mitarbeiter*" sowie "*Innovationen, Lernen und Wissen*" auf und nehmen somit eine Gegenposition zu der oben angesprochenen Auffassung hinsichtlich der Bedeutung der Lern- und Entwicklungsperspektive für eine Logistik-BSC ein. Hintergrund dieser Modifikation ist die Verbindung der Balanced Scorecard mit dem EFQM-Modell [14].
- Piontek und (darauf aufbauend) Gerberich fassen schließlich Finanz- und Kundenperspektive zu einer als "*Ansprüche des Unternehmens*" bezeichneten Perspektive zusammen [16], [25]. Diese Idee stammt aus einer von Eschenbach für

die Materialwirtschaft konzipierten Balanced Scorecard [13]. Die Zusammenlegung der beiden Perspektiven läßt sich in Bezug auf die Materialwirtschaft damit begründen, daß diese ausschließlich interne Kunden versorgt. Auf die Logistik trifft dieses Argument allerdings nicht zu, da diese mit der Distributionslogistik immer auch in Kontakt zu den externen Kunden tritt.

Von den Gestaltungsvorschlägen für Industrie- und Handelsunternehmen mit rein inhaltlicher Anpassung bedarf lediglich der Ansatz von Binner einer kurzen Erläuterung [2]. Binner unterteilt die Logistik in sechs sog. Hauptprozesse (Vertrieb, Entwicklung, Beschaffung, Produktion, Distribution und Entsorgung) und sieht für jeden Teilbereich eine aus den vier klassischen Perspektiven bestehende Balanced Scorecard vor. Für jede Perspektive schlägt er Struktur- und Leistungskennzahlen sowie Logistikkennzahlen vor. Im Gegensatz zum Ansatz von Weber stehen die einzelnen Scorecards unverbunden nebeneinander.

Gestaltungsansätze für Logistikdienstleister

Die in der Literatur vorgestellten Ansätze für Logistikdienstleister behalten überwiegend die vier von Kaplan/Norton vorgeschlagenen Perspektiven bei und ordnen die logistischen Ziele und Kennzahlen diesen Perspektiven zu [4], [7], [17], [36].
Eine Ausnahme bildet der Vorschlag von Karrer/Petzold, welcher zwei strukturelle Modifikationen vorsieht: Zum einen wird die Kundenperspektive um eine Abbildung der Konkurrenzverhältnisse erweitert und als *Marktperspektive* bezeichnet. Zum anderen wird eine *Kooperationsperspektive* zur Erfassung kooperationsrelevanter Sachverhalte bzgl. der (langfristigen) Zusammenarbeit mit den Verladern hinzugefügt. Diese bezieht sich in erster Linie auf das kundenindividuelle Geschäftsfeld der Kontraktlogistik, während kundenbezogene Ziele, Kennzahlen und Maßnahmen, welche standardisierte Netzdienstleistungen betreffen, in der Kundenperspektive abgebildet werden. Durch diese Trennung soll eine bessere Abstimmung zwischen beiden Leistungsbereichen erreicht werden [20].
Schenker gliedert seine Balanced Scorecards auf Abteilungsebene in die Perspektiven *Markt*, *Produktion* und *interne Prozesse*. Innerhalb jeder Perspektive werden finanzielle Kennzahlen und Werttreiber unterschieden [28]. Der genaue Inhalt der drei Perspektiven bleibt allerdings ebenso offen wie die Struktur der Balanced Scorecard auf Unternehmensebene.
Abb. 2 liefert einen zusammenfassenden Überblick über die vorgestellten Gestaltungsansätze einer Logistik-BSC. Teilweise vorgenommene Umbenennungen von Perspektiven, die aber nicht mit vom Grundmodell abweichenden Inhalten einhergehen, bleiben dabei unberücksichtigt.

4. GESTALTUNGSEMPFEHLUNGEN FÜR EINE LOGISTIK-BSC

Wie die bisherigen Ausführungen gezeigt haben, besteht in der Literatur kein Konsens bzgl. der Struktur einer Logistik-BSC. Daher sollen im folgenden die von den zitierten Autoren vorgebrachten und im vorigen Abschnitt umrissenen Argumente einer kritischen Analyse unterzogen und daraus Gestaltungsempfehlungen für eine Logistik-BSC abgeleitet werden. Dabei ist wieder eine grundlegende Unterscheidung zwischen Industrie- und Handelsunternehmen einerseits und Logistikdienstleistern andererseits vorzunehmen.

Gestaltungsempfehlungen für Industrie- und Handelsunternehmen

Unbestritten ist die Relevanz der *Finanzperspektive*. Mit ihrer Hilfe kann überprüft werden, ob die Umsetzung der Logistikstrategie erfolgreich war und welchen Beitrag die Logistik zum (finanziellen) Unternehmenserfolg leistet.

Die *Kundenperspektive* soll Aufschluß darüber geben, inwieweit die Logistik die Ansprüche der Kunden erfüllt. Dabei kann es sich um externe und/oder interne Kunden handeln. Auch wenn kein externer Kundenkontakt besteht, z.B. weil die Distributionslogistik auf einen Logistikdienstleister übertragen wurde oder ein innerbetrieblicher Logistikteilbereich wie die Beschaffungs- und Produktionslogistik betrachtet wird, wirken sich die von der Logistik bereitgestellten Leistungen aufgrund ihrer Querschnitts- und Koordinationsfunktion maßgeblich auf den von den (externen) Kunden wahrgenommenen Lieferservice und damit die Kundenzufriedenheit aus, welche ihrerseits das (künftige) Kaufverhalten und damit die Umsatzerlöse bestimmt. Eine Zusammenlegung mit der Finanzperspektive kommt vor dem Hintergrund der empirisch nachgewiesenen hohen Bedeutung der Logistikleistungen für den Unternehmenserfolg daher nicht in Frage.

In der *internen Prozeßperspektive* geht es um die effektive und effiziente Gestaltung der Logistikprozesse. Die Effektivität der Abläufe ist Voraussetzung für ein hohes Lieferserviceniveau und beeinflußt somit die Erreichung der Ziele der Kundenperspektive. Effiziente Prozesse ermöglichen niedrige Logistikkosten und wirken sich unmittelbar auf die monetäre Zielerreichung aus. Aufgrund der Vielfalt, Komplexität und Heterogenität der Logistikprozesse sollte zumindest in Industrieunternehmen, für die die Logistik einen entscheidenden Wettbewerbsfaktor darstellt, auf eine Zusammenlegung der internen Prozeßperspektive mit anderen Perspektiven verzichtet werden.

Da es sich bei der Logistik um einen personalintensiven Leistungsbereich handelt, haben eine anforderungsgerechte Qualifikation sowie die Motivation der Mitarbeiter einen großen Einfluß auf die Effizienz und Effektivität der Logistikprozesse. In kundennahen Bereichen beeinflußt das Mitarbeiterverhalten zudem unmittelbar die Kundenzufriedenheit. Die Mitarbeiter der Logistik können ihre Arbeit aber nur dann zur Zufriedenheit der externen und internen Kunden erledigen, wenn ihnen die notwendigen Informationen zeitgerecht zur Verfügung stehen. Nach diesen Überlegungen ist die Bedeutung der *Lern- und Entwicklungsperspektive* für eine Logistik-BSC nicht zu unterschätzen, auch wenn die darin enthaltenen Ziele und Kennzahlen kaum logistikspezifisch sein werden. Um die in den übrigen Perspektiven abgebildeten (logistikspezifischen) Ziele zu erreichen, ist eine Überwachung der Einhaltung der Zielvorgaben dieser Perspektive durch den Funktionsbereich Logistik unabdingbar.

Anwendungskontext, Detaillierungsgrad und Perspektiven → Autor(en) ↓	Industrie und/oder Handel	Logistikdienstleister	Gesamtlogistik	Logistikteilbereiche/Abteilungen	Finanzperspektive	Kundenperspektive	Interne Prozeßperspektive	Lern- und Entwicklungsperspektive	Lieferantenperspektive	Strategieperspektive	Koordinationsstrukturperspektive	Koordinationsprozessperspektive	Kooperationsperspektive	Ansprüche des Unternehmens	Marktperspektive (Kunden und Lieferanten)	Marktperspektive (Kunden und Konkurrenz)	Marktperspektive	Produktionsperspektive	Mitarbeiter und Prozesse	Führung und Mitarbeiter	Innovationen, Lernen und Wissen
Engelke/Rausch	x		x		x	x	x	x													
Engelhardt	x		x		x	x	x	x													
Borsum/Kämpf/Kern	x		x		x	x	x	x													
Liberatore/Miller	x		x		x	x	x	x													
Kindel/Lang/Schwarz/Sommerer	x		x		x	x	x	x													
Eschenbach/Haddad	x		x		x	x	x	x													
Binner	x			x	x	x	x	x													
Siepermann und Vahrenkamp	x		x		x	x	x		x						(x)						
Piontek und Gerberich	x		x				x	x	x					x							
Stölzle	x		x		x	x	x	x		x											
Karrer/Placzek/Stölzle	x		x		x	x			x										x		
Galgenmüller/Gleich/Gräf	x		x		x	x	x													x	x
Caplice/Sheffi	x		x		x	x	x														
Weber	x		x	x	x/o	o	o	x	o		x	x									
Clausen/Erdmann/Schmidt		x	x		x	x	x	x													
Göpfert		x	x		x	x	x	x													
Borsum/Kämpf/Kern		x	x		x	x	x	x													
Vulpius		x	x		x	x	x	x													
Boecker		x	x		x	x	x	x													
Schneider		x	x	x			o										o	o			
Karrer/Petzold		x	x		x		x	x					x			x					
Legende	x = Perspektiven der Gesamtlogistik-Scorecard o = Perspektiven der Teilbereichs-/Abteilungs-Scorecards																				

Abb. 2: Perspektiven einer Logistik-BSC

Trotz der hohen Bedeutung von Mitarbeitern und Informationssystemen für die Erreichung der Logistikziele erscheint eine weitergehende Aufspaltung der Lern- und Entwicklungsperspektive allerdings nicht erforderlich.
Insbesondere in Zeiten abnehmender Fertigungstiefen hängt der Lieferservice, den ein Unternehmen seinen Kunden bieten kann, nicht nur von den eigenen Logistikleistungen, sondern in zunehmendem Maße auch von der logistischen Leistungsfähigkeit der Lieferanten ab. Um die Zusammenarbeit mit den Lieferanten adäquat überwachen und steuern zu können, ist die Integration einer gesonderten *Lieferantenperspektive* sinnvoll. Eine Abbildung lieferantenbezogener Aspekte in der Kundenperspektive und deren Erweiterung zu einer Marktperspektive erscheint zum einen in Anbetracht der unterschiedlichen Zielsetzungen, die ein Unternehmen stromaufwärts und stromabwärts verfolgt, und zum anderen aufgrund der in der Regel getrennten Organisationseinheiten, die mit der Erreichung dieser Ziele betraut sind, nicht zielführend. In logistischen Teilbereichs-Scorecards kann es sich bei den Lieferanten auch um vorgelagerte Unternehmensbereiche handeln, deren (logistische) Leistungsfähigkeit den Lieferservice entscheidend mitbestimmen, den der betrachtete Teilbereich seinen (internen oder externen) Kunden bieten kann.
Die Hauptaufgabe der Logistik besteht in der Sicherstellung reibungsloser Güter- und Informationsflüsse. Zu diesem Zweck müssen die Aktivitäten der Funktionsbereiche Beschaffung, Produktion und Absatz miteinander koordiniert und aufeinander abgestimmt werden. Um die Bedeutung der Koordinationsleistungen der Logistik herauszustellen und deren Erfolg zu messen, kann der Logistik-BSC eine *Koordinationsperspektive* hinzugefügt werden. Andererseits werden die Koordinationsleistungen von den (führenden) Logistikmitarbeitern wahrgenommen, und deren Erfolg schlägt sich unmittelbar in effektiven und effizienten Prozessen, zufriedenen Kunden, einer reibungslosen Zusammenarbeit mit Lieferanten und (letztendlich) niedrigen Kosten nieder, so daß Koordinationsaspekte nicht nur ebensogut in den übrigen Perspektiven erfaßt werden können, sondern es durch die Integration einer Koordinationsperspektive fast zwangsläufig zu Überschneidungen mit anderen Perspektiven kommen würde. Vor diesem Hintergrund sollte auf eine separate Koordinationsperspektive besser verzichtet werden. Völlig übertrieben wären in jedem Fall zwei Koordinationsperspektiven, wie sie Weber vorschlägt.
Ebenfalls überflüssig erscheint schließlich die von Stölzle vorgeschlagene *Strategieperspektive*, da eine untergeordnete Scorecard wie die Logistik-BSC grundsätzlich auf die übergeordneten Scorecards auszurichten ist und der Strategiebezug generell bei sämtlichen Zielen und Kennzahlen gewährleistet sein sollte.

Gestaltungsempfehlungen für Logistikdienstleister

In Bezug auf die vier Standardperspektiven gelten die für Industrie- und Handelsunternehmen angestellten Überlegungen hier grundsätzlich analog. Ein kleiner Un-

terschied besteht lediglich bei der Kundenperspektive, die sich bei Logistikdienstleistern ausschließlich auf die Bedürfnisse der externen Kunden, d.h. der Verlader bezieht.
Darüber hinaus erscheint für Logistikdienstleister die Integration einer *Kooperationsperspektive* angebracht. Im Gegensatz zum Vorschlag von Karrer/Petzold sollte diese aber nicht zur Abbildung der Zusammenarbeit mit Verladern im Rahmen der Kontraktlogistik dienen (das kann besser von der Kundenperspektive geleistet werden, die von den Autoren vorgenommenen Zuordnung standardisierter Leistungen zur Kundenperspektive und kundenindividueller Leistungen zur Kooperationsperspektive erscheint ohnehin künstlich), sondern Aspekte der Zusammenarbeit mit Sub-Dienstleistern aufnehmen. Die Kooperationsperspektive wäre dann das Äquivalent zur Lieferantenperspektive der Logistik-BSC für Industrie- und Handelsunternehmen.
Die Berücksichtigung von Konkurrenzverhältnissen, wie sie von Karrer/Petzold in Form der Erweiterung der Kundenperspektive zu einer Marktperspektive angesprochen wird, ist logistikunspezifisch und soll daher an dieser Stelle nicht weiter thematisiert werden.

5. IMPLEMENTIERUNG EINER LOGISTIK-BSC

Die Erstellung einer Logistik-BSC setzt aufgrund des expliziten Strategiebezugs des BSC-Konzepts das Vorhandensein einer Logistikstrategie voraus, wobei der Erstellungsprozeß der BSC auch dazu genutzt werden kann, sich über die Logistikstrategie klar zu werden und Konsens darüber herzustellen. Während die Logistikstrategie bei einem Logistikdienstleister naturgemäß mit der Unternehmensstrategie identisch ist, ist sie bei Industrie- und Handelsunternehmen zunächst aus letzterer abzuleiten [5]. So erfordert eine auf Unternehmensebene verfolgte Differenzierungsstrategie eine andere Ausrichtung der Logistik als beispielsweise eine Kostenführerschaftsstrategie.
Bei der Ableitung der Ziele und Kennzahlen einer Logistik-BSC wird in der Literatur unabhängig vom Anwendungskontext (Industrie-/Handelsunternehmen oder Logistikdienstleister) die Ergänzung der üblichen, von Kaplan/Norton empfohlenen Top-down-Vorgehensweise vom Führungs- in das Leistungssystem durch ein Bottom-up-Vorgehen vom Leistungs- in das Führungssystem vorgeschlagen. Durch dieses Gegenstromverfahren bei der Implementierung wird nicht nur die Strategieorientierung der Logistikprozesse, -ziele und -kennzahlen (Top-down-Vorgehen), sondern auch die Realisierbarkeit der Strategie (Bottom-up-Vorgehen) sichergestellt, indem durch eine Analyse der Logistikprozesse Steuerungsprobleme identifiziert und über entsprechende Ziele und Kennzahlen explizit und unmittelbar in der BSC berücksichtigt werden. Stellt man bei der Gegenüberstellung der top-down

und bottom-up abgeleiteten Ziele und Kennzahlen unüberbrückbare Diskrepanzen fest, ist das ein Zeichen dafür, daß man über eine Anpassung der Logistik- und ggf. sogar der Unternehmensstrategie nachdenken muß [20], [21], [35].
Im Hinblick auf den Roll-out, d.h. das Herunterbrechen der BSC auf untergeordnete Organisationseinheiten zeigt das Gestaltungskonzept von Weber, daß die Perspektivenstruktur nicht unbedingt auf allen Ebenen übereinstimmen muß (auch wenn das bei dem hier unterbreiteten Gestaltungsvorschlag der Fall ist).

6. FAZIT

In Bezug auf die Gestaltung einer Balanced Scorecard für die Logistik besteht in der Literatur kein Konsens. Das gilt insbesondere für die Logistik von Industrie- und Handelsunternehmen, aber auch für Logistikdienstleister. Im Mittelpunkt der Diskussion stehen die in eine Logistik-BSC sinnvollerweise zu integrierenden Perspektiven. Die von den verschiedenen Autoren vorgebrachten Argumente für die von ihnen vorgeschlagene Struktur wurden vorgestellt und einer kritischen Analyse unterzogen. Daraus wurde schließlich ein Vorschlag für die Gestaltung einer Logistik-BSC für Industrie- und Handelsunternehmen einerseits und für Logistikdienstleister andererseits abgeleitet. **Abb. 3** faßt die vorgeschlagene Struktur und insbesondere die Zusammenhänge zwischen den Perspektiven noch einmal in graphischer Form zusammen.

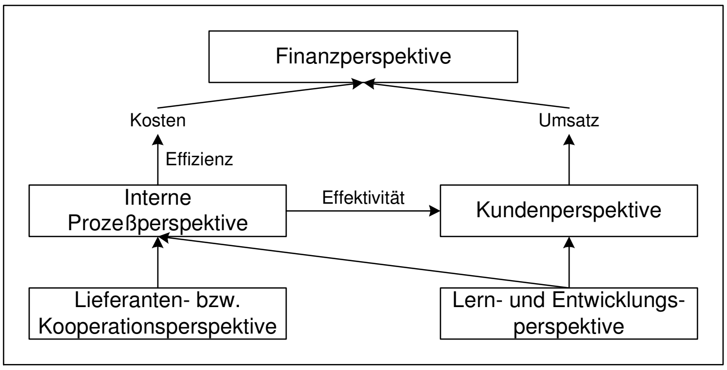

Abb. 3: Gestaltungsvorschlag für eine Logistik-BSC

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МОДЕЛИРОВАНИЕ ЦЕНООБРАЗОВАНИЯ В ЦЕПИ ПОСТАВОК ПРЕДПРИЯТИЯ

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Аннотация: В условиях нарастания интеграционных процессов ключевые резервы адаптации и развития предприятий заключаются в использовании инструментария концепции SCM. В настоящее статье приведен метод ценообразования в цепи поставок готовой продукции производителя как фокусной компании с учетом разных режимов взаимосвязи его потоковых процессов.

SIMULATION OF THE PRICE FORMATION IN THE SUPPLY CHAIN OF AN ENTERPRISE

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Purpose of the article is to improve the methodology tools of the organization and management of flow processes in the industrial enterprise supply chain.

Research method

Structure-function analysis; system, intersystem and synergy approaches; economic-mathematical modeling, methods of mathematical statistics and logistics, generalization and synthesis, experiment.

Data layout

A method comprising scientific novelty and practical significance has been proposed on the basis of business nature revealed and classification of supply chains' types. This method is able to determine the selling prices of products in the "pull" and "push" modes of supply and gain knowledge in logistics and SCM.

Principal results

Theoretical fundamentals in supply chain organization have been proposed. The novelty manifests itself in the innovative method of flow system delay. Based on intersystem and synergistic approaches that imply the high subjects' integrity and environment uncertainty, an innovative methodology for organizing and optimizing the chain including material resources'

suppliers «up the chain» and finished products' consumers «down the chain» of the industrial enterprise as a target company has been proposed. The author has set up, substantiated and proved the hypothesis that the supply chain is stable and efficient if the supply providers, production and distribution of all its members are synchronized with each other in time and cost. One of the **goals** within this framework is to develop pricing methodology tools in the supply chain of industrial enterprises. The author considers the chain based on the "push" delivery principle where finished products are in stock and delayed payment is available for the customer (dynamic supply chain). In this case, the manufacturer as a target company has to bear some additional expenses in comparison with delivery payment upon receipt, which selling price serves as a basis amount. Lending costs (the price of credit resources) should be paid off by logistic charge to the base price.

Minimum charge is used in the case of sale with delayed payment equal to the optimal delay of incoming cash flow, the deviation from this value increases the seller's costs, and therefore the compensating extra charge is added to the base value charge. In the second type of the chain, based on the "pull" principle of supply, finished goods are delivered according to the order (delayed supply chain). In this case, the manufacturer suffers additional losses in comparison to the prompt payment of goods, the selling price of which serves as the base value. Logistic losses should be considered as a discount to the base price.

The proposed method of calculating the sales prices of goods allows determining the optimal sales prices in transactions in the "pull" and "push" modes of supply, and allows maintaining distribution and pricing policies of manufacturer in particular as a target company in the supply chain.

Scientific novelty of this research is to develop some methodology to shape the pricing policy in the supply chain. The developed method for forming the selling price of finished goods in dynamic and delayed supply chains, in contrast to existing methods is based on classical and logistics costs that arise in case of non-instantaneous delivery. This method allows determining the optimum selling prices of products in a dynamic and delayed supply chains as well as forming the optimal parameters of flow processes in the supply chain of the enterprise.

Practical significance

The results achieved allow us to move from intuitive to scientific substantiation of managerial decisions taken by management of industrial enterprises while forming the policy to control the flow processes. Outputs and the method aids developed have practical significance and can be used by managers and specialists of logistics office structures of enterprises.

1. ВВЕДЕНИЕ

Сегодня, в условиях протекания интеграционных процессов, ключевой задачей развития большинства предприятий становится обеспечение адаптивности, устойчивости, конкурентоспособности, эффективности. Существенные резервы здесь заключены в использовании инструментария логистики и концепции SCM, предполагающей интегрированное управление поставщиками, перевозчиками, производителями, дилерами, дистрибьюторами и потребителями как единым целым. Важнейшим аспектом при формировании оптимального экономического потока в цепи является ценообразование на продукцию его участников. Целью является разработка метода ценообразования в цепи поставок. Объектом исследования является фокусная компания- производитель в цепи поставок. Предметом исследования являются организационно-экономические отношения, возникающие в процессе ценообразования реализуемой готовой продукции.

2. ОБЗОР ИМЕЮЩЕЙСЯ ЛИТЕРАТУРЫ

Экономические аспекты логистики рассмотрены в работах В.И. Сергеева, В.Н. Дыбской, О.Д. Проценко, Д.Т. Новикова, Н.К. Моисеевой, Л.Б. Миротина, А.Г. Некрасова, Д.А. Иванова, Б.В. Соколова, В.С. Лукинского, В.В. Щербакова, Д. Дж. Клосса, Д. Дж. Бауэрсокса, М. Линдерса, М. Кристофера, Д. Уотерса, Й. Кэшеля и др. Ключевым экономическим аспектом логистики и SCM являются вопросы идентификации классических и логистических затрат и их влияния на цены. Анализ современного состояния ценообразования в логистике позволил установить, что недостаточно проработаны теоретическая и методическая базы формирования цен закупаемых материальных ресурсов и реализуемой готовой продукции, процесс ценообразования основывается на классическом подходе и не учитывает логистические издержки и потери, возникающие при запаздывании потоковых процессов. Актуальность и практическая значимость указанной проблемы определили выбор темы исследования, постановку целей и задач, содержание.

3. ОПИСАНИЕ МЕТОДОЛОГИИ ИССЛЕДОВАНИЯ

Рассмотрим цепь, построенную по принципу «выталкивания» поставки, когда готовая продукция есть на складе и предоставляется отсрочка оплаты ее покупателю (динамичная цепь поставок) (рис 1а) [5]. В этом случае производитель как фокусная компания несет дополнительные издержки по сравнению с оплатой по факту поставки, цена реализации которого принимается за базовую величину. Затраты по кредитованию (цена кредитного ресурса) должны окупаться некой суммой – логистической наценкой к базовой цене. Тогда фактическая цена продукции для реализации с отсрочкой оплаты будет определяться:

$$Ц_{факт}= Ц_{б}+\text{Цена кредитного ресурса}= Ц_{б}+\text{Наценка}. \quad (1)$$

По своей организационно-экономической сути наценка является трансакционными издержками покупателя, направленными на получение продукции от производителя при запаздывании оплаты:

$$\text{Наценка (цена кредитного ресурса)} = У^{дз*}+(У^{дз}_{факт}- У^{дз*}), \quad (2)$$

где $У^{дз*}$ - оптимальные интегральные издержки на данный объем продаж в кредит, $У^{дз}_{факт}$. - фактические интегральные издержки на данный объем продаж в кредит, $\Delta У^{дз}=(У^{дз}_{факт} - У^{дз*})$ – отклонение фактических затрат от оптимальных.

При оптимальном запаздывании оплаты x^* наценка будет составлять в расчете на 1 рубль базовой цены:

$$Н_б = У^{дз*}/М_к, \qquad (3)$$

где $Н_б$ - наценка для оптимального объема продаж (безусловная наценка), $М_к$ - объем продаж в кредит.

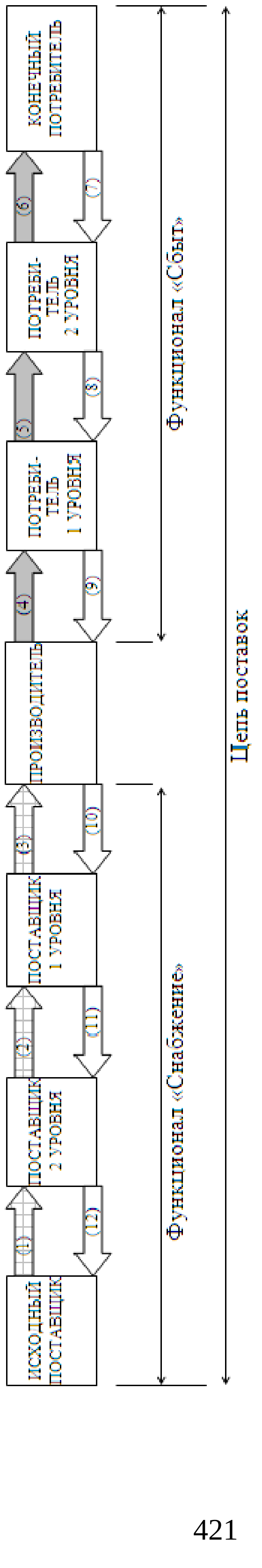

Рис. 1а. Цепь в режиме выталкивания поставки: (1), (2), (3) – материальные ресурсы; (4), (5), (6) – готовая продукция; (7), (8), (9), (10), (11), (12) – оплата

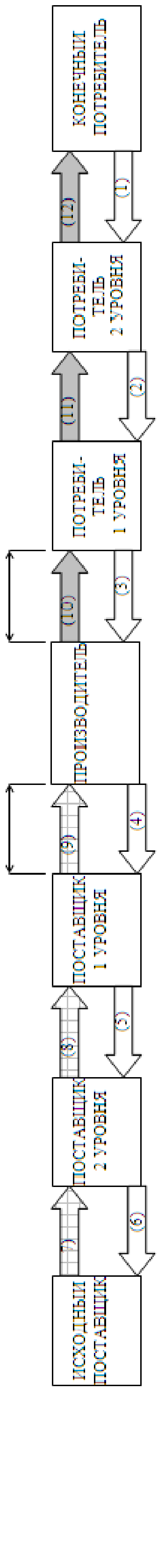

Рис. 1б. Цепь в режиме вытягивания поставки: (1), (2), (3), (4), (5), (6)– оплата; (7), (8), (9) – материальные ресурсы; (10), (11), (12) – готовая продукция

Введем понятие «наценка компенсирующая» дополнительные затраты при отклонении от оптимального запаздывания в расчете на один рубль выручки от продажи с запаздыванием оплаты:

$$Нк=ΔУ^{дз}/М_{к.} \qquad (4)$$

Итоговая наценка будет состоять из безусловной и компенсирующей наценок:

$$Н_{итог}=Н_{б}+Н_{к\,.} \qquad (5)$$

При отклонении $Δx=x_{факт}-x^{*}$ от оптимального запаздывания наценка $Н_{итог}$ будет изменяться следующим образом (см. рис. 2).

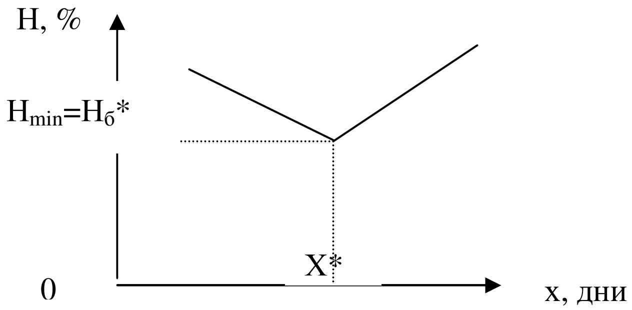

Рис. 2. Изменение наценки в зависимости от запаздывания оплаты

Менеджерам по продажам целесообразно использовать сетку наценок (см. табл. 1).

Таблица 1 Сетка наценок

Отклонение от оптимального запаздывания $Δx=x_{факт}-x^{*}$, дней	$0-x^{*}$ $x_{факт}=0$	x_i-x^{*}	0 $x_{факт}=x^{*}$	x_i-x^{*}
Фактические затраты $У^{ДЗ}_{факт}$, руб.	$У^{дз}_{факт}(0)$	$У^{дз}_{факт}(x_i)$	$У^{дз*}$	$У^{дз}_{факт}(x_i)$
Оптимальные затраты У*, руб.	$У^{дз}*$	$У^{дз}*$	У*	$У^{дз}*$
Отклонение фактических затрат от оптимальных $ΔУ=У_{факт}–У^{*}$, руб.	$У^{дз}_{факт}(0)–У^{дзз}*$	$У^{дз}_{факт}(x_i)–У^{дзз}*$	0	$У^{дз}_{факт}(x_i)–У^{дзз}*$
Базовая наценка $Н_б$ на 1 рубль базовой цены, руб.	$У^{дз*}/М_к$	$У^{дз*}/М_к$	$У^{дз*}/М_к$	$У^{дз*}/М_к$
Компенсирующая наценка $Н_{комп}$ на 1 рубль базовой цены, руб.	$ΔУ^{кз}(0)/М_к$	$ΔУ^{кз}(x_i)/М_к$	0	$ΔУ^{кз}(x_i)/М_к$
Итоговая наценка $Н_{итог}=(Н_б+Н_к)$ на 1 рубль базовой цены, руб.	$Н_б+Н(0)$	$Нб+Н_к(x_i)$	$Н_б$	$Н_б+Н_к(x_i)$

Итоговая наценка $Н_{итог}=(Н_б+Н_к)$, %	$(Н_б+Н(0))$* 100	$(Нб+Нк(x_i))$* 100	$Н_б$*100	$(Н_б+Н_к(x_i))$*100

В табл. 2 представлен расчет наценок для поставок 100 млн. руб. в год для одного из промышленных предприятий Челябинска, при величине скидки от запаздывания оплаты до 10% и поставке на одного контрагента в среднем 500 000 руб. в год. Минимальная наценка применяется при продаже с отсрочкой платежа, равной оптимальному запаздыванию оплаты, при отклонении от этого значения затраты поставщика возрастают, поэтому к базовой наценке добавляется компенсирующая наценка.

Таблица 2 Сетка наценок

Отклонение от оптимального запаздывания $\Delta x=x_{факт}-x^*$, дней	15	10	5	0 $x^*=18$, дней	5	10	15	20	25	30	35
Итоговая наценка $Н_{итог}=(Н_б+Н_к)$, %	10	9.5	9.3	9.2	9.3	9.4	9.8	10.1	10.3	10.6	10.9

Рассмотрим цепь, построенную по принципу «вытягивания» поставки, когда готовая продукция поставляется под заказ (отложенная цепь поставок) (рис 1б). В этом случае производитель несет дополнительные потери по сравнению с оплатой товара точно в срок, цена реализации которого принимается за базовую величину. Логистические потери (другими словами, цена кредиторской задолженности) должны отражаться скидкой к базовой цене. Тогда фактическая цена для продажи с отсрочкой поставки:

$$Ц_{факт} = Ц_б + \text{Цена запаздывания поставки (цена кредиторской задолженности)} = Ц_б - \text{Скидка}. \quad (6)$$

По своей организационно-экономической сути скидка является трансакционными издержками производителя, направленными на привлечение покупателя своей продукции и заключение договора при немгновенной поставке:

$$\text{Скидка (цена запаздывания)} = У^* + (У_{факт} - У^*), \quad (7)$$

где $У^*$– оптимальные интегральные затраты на данный объем продаж в отложенной цепи поставки продукции, $У_{факт}$. – фактические интегральные затраты, $\Delta У=(У_{факт} - У^*)$ – отклонение фактических затрат от оптимальных.

При оптимальном запаздывании поставки x^* скидка будет составлять в расчете на 1 рубль базовой цены:

$$С_б = У^*/Вб, \tag{8}$$

где $С_б$ – скидка для оптимального объема продаж, Вб – выручка в отложенной цепи поставок.

Введем понятие «скидка компенсирующая» дополнительные потери при отклонении от оптимального запаздывания:

$$Ск = ΔУ/Вб. \tag{9}$$

Итоговая скидка будет состоять из безусловной и компенсирующей скидок

$$С_{итог} = С_б + С_к. \tag{10}$$

При отклонении от оптимального запаздывания итоговая скидка будет изменяться следующим образом (см. рис. 3).

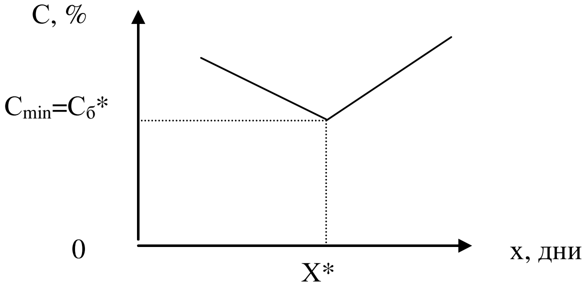

Рис. 3. Изменение скидки в зависимости от запаздывания поставки

Аналитическое представление величины итоговой скидки от запаздывания поставки продукции:

$$С_{итог} = С_Б + С_К = \frac{у^*}{В_Б} + \frac{(у - у^*)}{В_Б} = \frac{у}{В_Б}. \tag{11}$$

Минимальная скидка применяется при продаже с отсрочкой поставки, равной оптимальному запаздыванию поставки; при отклонении от этого значения потери производителя возрастают, поэтому к базовой скидке добавляется компенсирующая скидка. Менеджерам по продажам целесообразно использовать сетку скидок (см. табл. 3). Результаты моделирования представлены на рис. 4.

Таблица 3 Сетка скидок

Отклонение от оптимального запаздывания $Δх=х_{факт}–х^*$, дней	0–х* $х_{факт}=0$	$х_i–х^*$	0 $х_{факт}=х^*$	$х_i–х^*$
Фактические затраты $У_{факт}$, руб.	$У_{факт}(0)$	$У_{факт}(х_i)$	$У^*$	$У_{факт}(х_i)$
Оптимальные затраты У*, руб.	У*	У*	У*	У*
Отклонение фактических затрат от оптимальных $ΔУ=У_{факт}–У^*$, руб.	$У_{факт}(0)–У^{з}*$	$У_{факт}(х_i)–У^*$	0	$У_{факт}(х_i)–У^*$
Базовая скидка $С_б$ на 1 рубль базовой цены, руб.	$У^*/Вб$	$У^*/Вб$	$У^*/Вб$	$У^*/Вб$
Компенсирующая скидка $С_{комп}$	ΔУ(0)/Вб	$ΔУ(х_i)/Вб$	0	$ΔУ(х_i)/Вб$

на 1 рубль базовой цены, руб.				
Итоговая скидка $С_{итог}$=($С_б$+$С_к$) на 1 рубль базовой цены, руб.	$С_б$+С(0)	Сб+$С_к$(x_i)	$С_б$	$С_б$+$С_к$(x_i)
Итоговая скидка $С_{итог}$=($С_б$+$С_к$), %	($С_б$+С(0))* *100	(Сб+Ск(x_i))*100	$С_б$*100	($С_б$+$С_к$(x_i))* 100

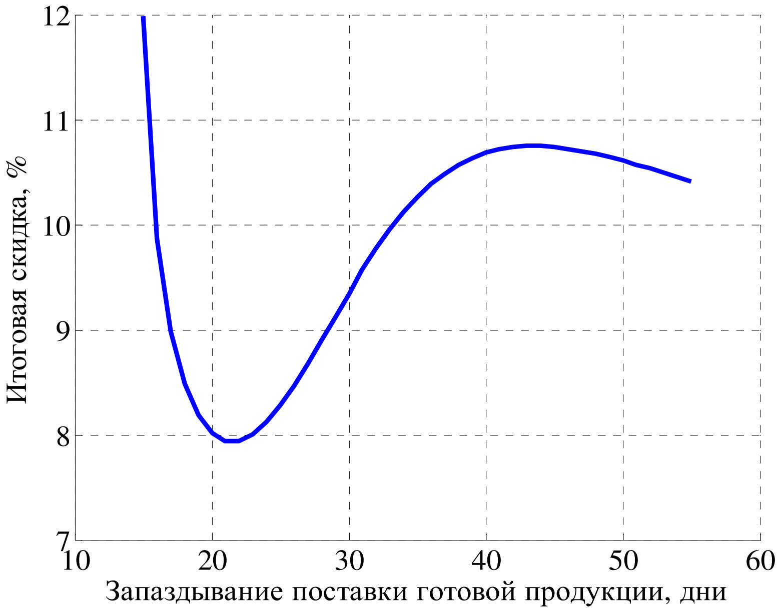

Рис. 4. Зависимость величины итоговой скидки от запаздывания поставки готовой продукции

4. РЕЗУЛЬТАТЫ

Научная новизна исследования заключается в разработке метода формирования цены реализации готовой продукции, который, в отличие от существующих, основывается на выявленных классических, трансакционных и логистических затратах, возникающих при немгновенной поставке, и позволяет определить оптимальные цены реализации продукции в цепях динамичной и отложенной поставок. Выявлены графические и аналитические зависимости анализируемых параметров и переменных модели. На основе статистических данных предприятий Челябинской области выявлены характер и динамика кривых в рассматриваемых моделях, описаны особенности их конфигурации. Практическая значимость работы заключается в том, что полученные результаты позволяют перейти от интуитивного к научному обоснованию управленческих решений, принимаемых менеджментом предприятий в процессе управления затратами и ценами в логистической цепи. Выводы и методические разработки имеют практическую значимость и могут быть использованы руководителями и специалистами логистических и экономических подразделений предприятий.

5. ЗАКЛЮЧЕНИЕ

Предложенный метод расчета цены реализации продукции позволяет определить оптимальные цены в режимах вытягивания и выталкивания поставки, «тонко» настроить сбытовую и в частности ценовую политику производителя как фокусной компании в цепи поставок, что позволит определить и достигнуть «поле интересов» участников цепи поставок.

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ОСНОВНЫЕ НАПРАВЛЕНИЯ СОВЕРШЕНСТВОВАНИЯ ЛОГИСТИЧЕСКОГО ПРОЦЕССА ГОСУДАРСТВЕННЫХ ЗАКУПОК УЧРЕЖДЕНИЙ ОБРАЗОВАНИЯ.

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Аннотация: В данной статье рассмотрена организация материально – технического обеспечения учреждений образования в рамках национального проекта «Образование». Уточнена совокупность целей учреждений образования, действующих на рынке в качестве покупателя, выявлена совокупность логистических действий, и предложен комплекс мер по управлению цепями поставок материально-технического обеспечения учреждений образования.

THE MAIN DIRECTIONS OF LOGISTICS IMPROVEMENT OF GOVERNMENT PURCHASES IN EDUCATIONAL INSTITUTION

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Purpose of the paper
The paper investigates the problems of material – technical supply of educational institutions within the national project "Education". The purpose of the paper is to study the problem of educational institutions behavior in the market as a buyer.

Research/application methodology
Resource maintenance of educational institutions is being discussed in the paper using the whole range of economic impact methods along with marketing and logistics instruments. Resource maintenance system is multilateral as management is aimed not only at physical material resources shifting but also at maximum economic profitability environmental protection and etc.

Design of the paper
At the beginning we that argue that the problem under review is actual nowadays. We also set forth the arms and the purposes of our investigation.
Further the paper reports on decision taking measures and suggests standard operational actions of educational institutions being a buyer in the market. In conclusion we offer chain management steps on material – technical supply of educational institutions.

Main results

The paper has investigated the problems which have to be solved in government purchases organization for education. We have suggested the algorithm of improvement of government purchases logistic process. We have shown the topical character of the problem and defined the purposes of educational institution as a buyer. We have suggested standard logistic activity of educational institutions. A set of chain management measures on material technical supply of Russian educational institutions within national project "Education" has been developed.

Managerial insights

Investigation results can be applied for rationalization and improvement of government purchases logistics in different spheres of economic activity.

XXI век характеризуется глобальными изменениями, происходящими в экономике, науке, технике, технологии. Отличительной чертой современного мирового экономического развития является формирование в развитых странах мира информационного общества, основой которого является производство услуг. Сердцевину производства услуг составляют образовательные услуги, развитие личности и формирование нового знания. В качестве ведущего фактора экономического роста и развития хозяйственной системы выступает образование.

Сегодня связь между современным, качественным образованием и перспективой построения гражданского общества, эффективной экономикой и безопасностью государства очевидна. Для страны, которая ориентируется на инновационный путь развития, жизненно важно дать системе образования стимул к движению вперед – это и есть первоочередная задача приоритетного национального проекта «Образование».

Для реализации данной задачи в национальном проекте «Образование» предусмотрено несколько взаимодополняющих подходов. Во-первых, выявление и поддержка «точек роста». Государство стимулирует учреждения и целые регионы, внедряющие инновационные программы и проекты.

С другой стороны, ряд направлений проекта нацелен на обеспечение доступности, выравнивание условий получения образования: обеспечение для всех школ высокоскоростного доступа к глобальным информационным ресурсам, размещенным в сети Интернет, поставки учебного оборудования и школьных автобусов, организация образования для военнослужащих.

При этом проект предполагает внедрение новых управленческих механизмов. Кроме того, проект привносит значительные изменения в механизмы финансирования образовательных учреждений. Бюджетные средства на реализацию программ развития, как правило, направляются непосредственно в образовательные учреждения, что способствует развитию их финансовой самостоятельности.

В настоящее время в России процесс государственных закупок регламентируется федеральным законом «О размещении заказов на поставки товаров, выполнение работ, оказание услуг для государственных и муниципальных нужд» (94-ФЗ). Благодаря принятию данного закона в России сформировалась система норм государственного регулирования государственных закупок, появился механизм санкций за их нарушение, закон принципиально изменил систему государственного заказа. Однако данный закон не свободен от недостатков, в первую очередь к ним стоит отнести ориентацию на ценовые критерии, в ущерб качественным показателям. Многие нормы закона допускают множественность толкований, что приводит к противоречию с нормами Гражданского кодекса.

Одна из системных проблем – это оценка эффективности государственных закупок. На сегодняшний день эффективность оценивается как результат соблюдения требований 94-ФЗ. Однако целью госзакупок все- таки является обеспечение потребностей государственных заказчиков в товарах и услугах, а не соблюдение закона.

Существо процесса управления закупками состоит в постановке цели и организации процесса ее достижения с точки зрения последовательности действий, сроков, создания необходимых условий для работы и т.д. Решающая роль в повышении эффективности государственных закупок для народного образования принадлежит логистике, так как стандартная совокупность логистических действий государственной организации – покупателя состоит в определении собственных нужд в товарах и услугах; конкурентном выборе продавца, или размещении государственного заказа; заключении государственного контракта на поставку товаров (услуг, работ) и исполнении ранее заключенного государственного контракта, а также в организации и выполнении информационных и контролирующих действий.

Ресурсное обеспечение учреждений образования должно строиться с использованием всего арсенала методов экономических воздействий в соединении с инструментарием маркетинга и логистики. Система ресурсного обеспечения является многоаспектной, так как управление направлено не только на физическое перемещение материальных ресурсов, но и на достижение при этом их рационального использования, противозатратности, максимальной экономической выгоды, сохранности окружающей среды и т.д.

Важнейшим элементом ресурсного обеспечения учреждений образования является материально-техническое обеспечение. Процесс материально-технического обеспечения порождает огромный объем информации, зависящей от количества поставщиков, наименований ресурсов, конъюнктуры рынка, платежеспособности потребителей и т.д. Система материально-технического обеспечения является весьма информационноемкой, поэтому она может успешно функционировать только в условиях всеобщей компьютеризации. Современная электронно-вычислительная техника позволяет обеспечивать адекватное экономико-математическое, имитационное, ситуационное моделирование материальных потоков, что создает необходимые условия для эффективного управления процессом материально-технического обеспечения, т.е. его логистизации.

Характер формирования логистических цепей учреждений образования во многом определяется макроэкономическими показателями, а также развитием и состоянием материльно-технической базы системы образования. В первую очередь к ним относятся:

- нормативная и законодательная база, составляют правовую основу организации материально-технического обеспечения учреждений образования и формирования хозяйственных связей между участниками цепей поставок;
- уровень логистического сервиса, определяющий наличие транспортных компаний, специализированных складских комплексов способных оказать всю совокупность сопутствующих услуг по доставке и хранению товаров;
- развитие транспортных коммуникаций, которые определяют схему доставки товаров.

Процесс закупок товаров для целей народного образования имеет не только общегосударственные цели, которые обусловлены тем, что данная организация есть всего лишь представитель государства на рынке, но и своего рода технические цели, которые непосредственно стоят перед государственным покупателем в процессе его рыночных действий, и которые можно условно назвать целями «рациональности». К ним мы предлагаем относить:

- временную рациональность закупок: покупка товара или услуги должна быть осуществлена в те сроки, в какие это необходимо для обеспечения ее функционирования;
- стоимостную рациональность: затраты на покупку товара (услуги) в расчете на единицу товара не должны превышать размеров, которые предусмотрены в смете затрат;
- качественную рациональность: в процессе покупки товара (услуги) государственная организация-покупатель должна обеспечить заданные потребительские характеристики (качества) продукции;
- торговую рациональность: достаточность и целесообразность расчетных и поставочных процедур по закупаемому товару.

Логистические цели учреждений образования, действующих в качестве покупателя на рынке представлены на рис. 1. Таким образом, главные логистические цели учебных заведений в процессе осуществляемых ими закупок для целей народного образования не просто состоят из того или иного их набора, но все они требуют оптимального сочетания между собой по срокам, ресурсам, качеству, расчетным и поставочным процедурам.

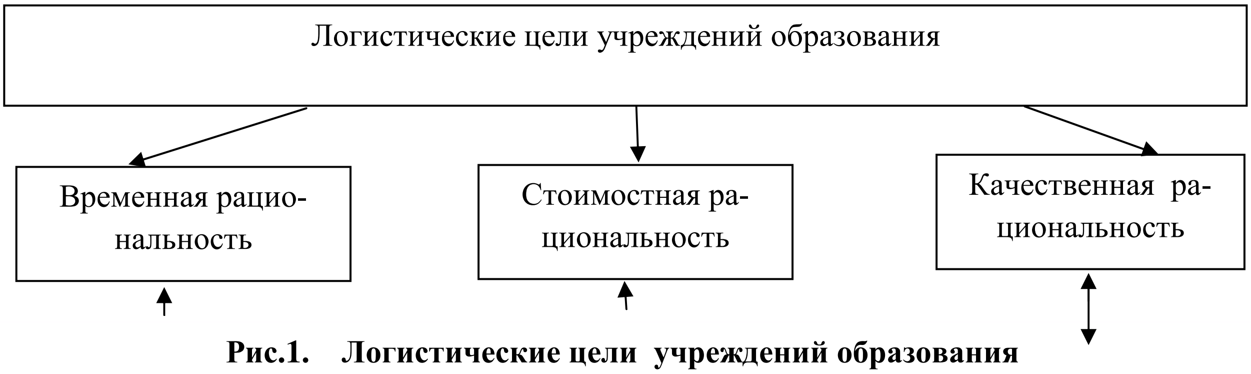

Рис.1. Логистические цели учреждений образования

По отношению к учебному заведению-покупателю данные логистические цели есть лишь цели рационализации, но не цели максимизации или минимизации соответствующих показателей. Однако рыночная диалектика государственного логистического процесса состоит в том, что именно такого рода логистические цели применительно к учебному заведению и позволяют относительно минимизировать совокупные денежные ресурсы государства на покупку товаров и услуг.

С позиций логистического процесса закупки товаров или услуг учебным заведением – покупателем как единого целого его деятельность представляет собой некоторую совокупность обязательных действий, которые могут быть сгруппированы следующим образом:

- определение потребности в товарах и услугах;
- размещение заказов на поставку товаров и услуг на основе конкурентного выбора поставщика;
- заключение государственного контракта на поставку товаров и услуг;
- исполнение заключенного государственного контракта (прием поставки);
- обязательное информационное обеспечение и внешний контроль (рис.2.)

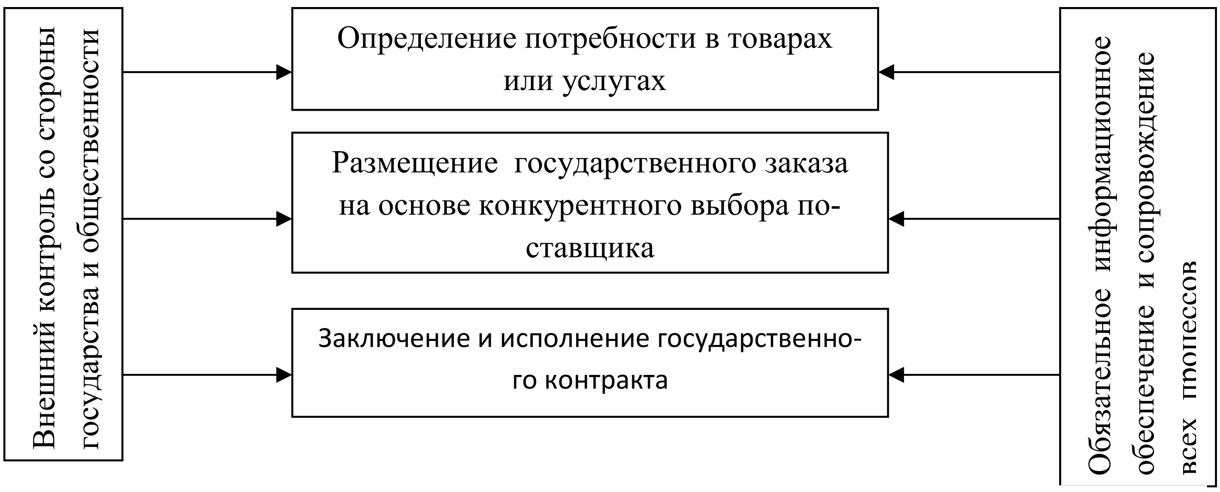

Рис.2. Совокупность логистических действий учреждений образования.

Необходимость управления поставщиками в государственном логистическом процессе достаточно очевидна, ибо разумное управление любым процессом всегда идет на пользу общему конечному результату.

В данном случае можно выделить следующие основные положительные моменты процесса такого управления:

- происходит процесс отбора оптимальных поставщиков по государственным контрактам;
- выявляются «слабые» звенья логистического процесса поставок в данном учреждении образования;
- накапливается информация о положительном опыте других учреждений образования;
- стимулируется улучшение логистического процесса в данном учреждении образования, как в функциональном, так и в организационном плане.

Комплекс мер по управлению поставщиками и поставками включает следующие основные элементы:

1) составление программы снабжения учреждения образования на основе определения его государственных нужд в пределах выделяемых ассигнований из бюджета и внебюджетных источников (если таковые имеются). Такая программа может включать:

- распределение закупаемых благ по видам и существенным характеристикам;
- распределение закупаемых благ по специфическим рынкам;
- распределение закупаемых благ по потенциальным группам поставщиков;

2) поиск потенциальных поставщиков и информирование их о торгах (приглашение к участию в торгах). Для этого необходима реализация нескольких функций:

- создание и ведение разнообразных баз данных о своих потенциальных поставщиках;
- информационные функции, связанные как с информированием поставщиков, так и с получением различного рода информации от потенциальных поставщиков;

3) подготовка договорных условий поставки будущих государственных контрактов:

- расчеты предельных цен закупок;
- порядок доставки грузов;
- сроки поставки;
- размеры поставочных партий грузов;

4) управление поставщиками по уже заключенным государственным контрактам:

- налаживание обратной связи с поставщиками;
- непрерывная целенаправленная работа с поставщиками.

Процесс государственных закупок с позиции относительной минимизации совокупных расходов государства на покупку товаров и услуг учреждениями образоавния, усиления их конкурентных позиций на рынке и уменьшения возможностей для любых форм существования коррупции нуждается в дальнейшем совершенствовании и рационализации.

Основные направления совершенствования логистического процесса государственных закупок учреждениями образования:

- автоматизация и электронизация процесса государственных закупок и поставок;
- стандартизация логистического процесса государственных закупок:
- стандартизация документации;
- стандартизация закупочных процессов;
- стандартизация товаров и услуг;
- разделение расходов на оплату товаров и услуг и на логистическую деятельность;
- повышение конкурентного характера государственных закупок;
- рационализация закупочной деятельности на уровне учреждения образования (рис.3).

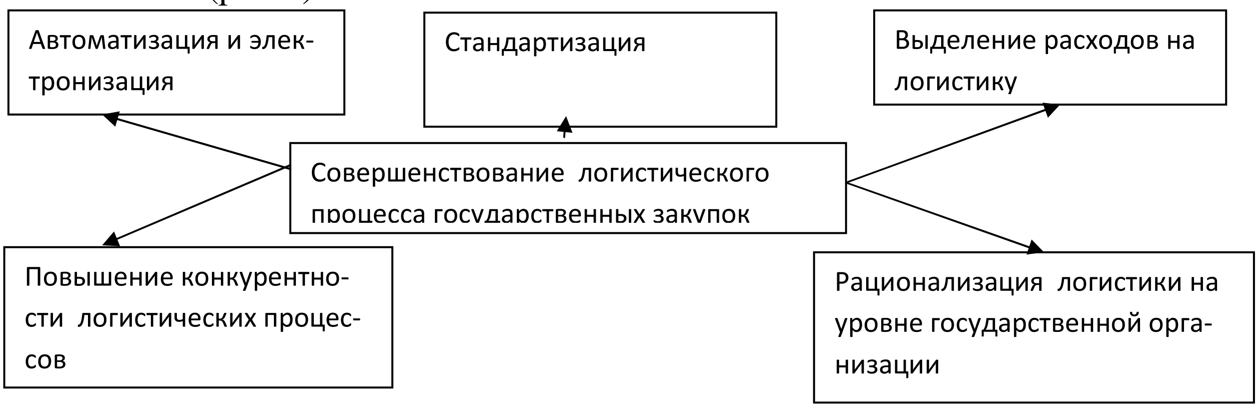

Рис.3. Основные направления совершенствования логистического процесса государственных закупок

По своему прямому назначению государственные расходы на покупку товаров и услуг следует разделять на два принципиально разных типа расходов, которые несет каждое учреждение образования, действующее как покупатель на рынке:

- расходы на оплату товаров и услуг – денежные средства, которые оно расходует на собственно оплату закупаемых товаров и услуг по заключенным государственным контрактам;
- логистические расходы – это расходы по осуществлению всего процесса закупки и поставки товаров и услуг. Данного рода расходы обычно

«распылены» между рядом статей расходов в учреждении образования. Зарплата служащих, занимающихся закупками, финансируется в составе расходов на оплату труда, различного рода материальные расходы скрыты в соответствующих статьях сметы и т.д.

В целях управления со стороны государства логистическим процессом вышеприведенные типы государственных расходов следует четко разделить, и в стандартную смету расходов учреждений образования ввести самостоятельный раздел расходов на логистику или выделять данные расходы в качестве подстатей уже имеющихся статьях сметы. Совершенствование логистического процесса государственных закупок обязательно найдет свое выражение и в части расходов на логистику, которые объективно должны сократиться за счет различных усовершенствований, связанных с автоматизацией и стандартизацией всех логистических процессов. Но это будет трудно отследить, если величина этих логистических расходов неизвестна, в силу их распыления по многим статьям сметы затрат.

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РАЗВИТИЕ ТРАНСПОРТНО-ЛОГИСТИЧЕСКОЙ ИНФРАСТРУКТУРЫ В АЗИАТСКОЙ ЧАСТИ РОССИИ – СТРАТЕГИЧЕСКОЕ НАПРАВЛЕНИЕ РЕАЛИЗАЦИИ ТРАНЗИТНОГО ПОТЕНЦИАЛА СТРАНЫ В СИСТЕМЕ ЕВРОАЗИАТСКИХ МЕЖДУНАРОДНЫХ ТРАНСПОРТНЫХ КОРИДОРОВ

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Аннотация: Доклад посвящен комплексным научным исследованиям в области стратегического планирования развития транспортно-логистической инфраструктуры в Азиатской части России и формирования региональных макро логистических систем в зоне тяготения к национальным и международным транспортным коридорам (МТК) для обеспечения реализации транзитного потенциала России в глобальной системе евроазиатских МТК.

THE DEVELOPMENT OF TRANSPORT AND LOGISTICAL INFRASTRUCTURE IN ASIAN PART OF RUSSIA IS THE STRATEGIC DIRECTION OF REALIZATION OF TRANSIT POTENTIAL OF THE COUNTRY IN EUROASIAN INTERNATIONAL TRANSPORT CORRIDORS (ITC) SYSTEM

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Abstract: The paper is devoted to comprehensive research in the field of strategic planning of development transport and logistical infrastructure in Asian part of Russia and the formation of regional macro logistic systems in zoon of national and international transport corridors (ITC) to ensure the implementation of transit potential of Russia in the global system of ITC.

The general purpose of this report is to ground that the development of transport and logistical infrastructure in Asian part of Russia is a strategic direction of competitiveness increasing of Russian transport complex and realization of transit potential of the country in Euroasian ITC global system.

The report includes four sections: introduction, principal exposithen, methodology and results anticipated. In the capacity of main methodology in the report is consumed the complex approach to the creation of regional transport and logistical systems/

1. Introduction.

Russian transport strategy for the period till 2030 provides:

- Basic transport network formation without breaks and bottlenecks;

- Disproportions liquidation in transport infrastructure level of development a in separate regions of the country;
- Priority infrastructural projects Realization providing unity of transport system;
- Development of a basic transport network on principles of national transport corridors;
- National transport corridors connection with the international transport corridors of the European and Asian transport systems.

Formation and development Purposes of International transport corridors in Russia territory are:

- Reliability and efficiency increase for the Russian foreign trade transportations. Conditions maintenance;
- Additional transit flow involving to Russian transport system of the country;
- domestic and foreign investments attraction on transport infrastructure development;
- conditions Creation for regions development acceleration located in a zones close to International transport corridors;
- integration providing with the Russian transport in the European and world transport systems as the equal in rights partner.

2. The Russian competitive advantages in global system of the international transport corridors

The factors providing Russia competitive advantages in global system of the international transport corridors:

- Presence of the developed transport infrastructure whith provides the shortest ground way on direction from Asian-Pacific region to Europe;
- Positioning in the market of transit transportations as the equal in rights partner offering to transport community transit resources, meeting the requirements of a new century;
- Exclusively favorable geographical position in the center of a geostrategic triangle: EU Countries - East Asia Countries - NAFTA Countries.

Basic elements of a International transport corridors logistical infrastructure are multimodal logistical centers which functions, on the commercial basis, providing the coordinated interaction of all transport types and other participants of the logistical process, considered as strategic points of Russia economy growth.

Multimodal transport logistical centers are the multipurpose terminal complex placed in transport network junction, carrying out functions of a logistical distribution centre with a full complex of the service and commercially business services which provides:

- Coordination and interaction of various types of transport;
- Cargo processing;
- Short-term and long storage;
- Necessary customs procedures Performance;
- Complex forwarding service ;
- cargoes delivery to clients based on logistical technologies from-door-to-door and JIT;
- Technological, bank, information-analytical, etc. kinds of service

According to the western experts to 2015 in the largest world transport junction will be created 60-70 multimodal transport logistical centers which will be connected by intermodal transport corridors n with regional logistical systems. This systems will provid an output to every cargosender and cargoreceiver. Such scheme of cargoes delivery organization will provide efficiency increase distributive process more than 30-40 %.

In large federal multimodal centers, such as the Moscow, Leningrad, Novosibirsk, Gorki, Kaliningrad, Krasnodar, Sverdlovsk, Krasnoyarsk, Irkutsk and Khabarovsk transport junctions, network of regional terminals and the logistical centers creation incorporated in regional logistical transport and distributive systems on the basis of formation uniform organizational-economic, information, scientific and technical is expedient .

Regional multimodal transport logistical centers formes: in Northwest (St.-Petersburg), Central (Moscow and the Moscow area), Southern (Rostov-na-Don and Novorossisk - Krasnodar territory), Volga region (Nizhni Novgorod, Samara and Astrakhan), Uralsk (Ekaterinburg) federal districts, in regions of Siberia and the Far East .

In conditions of economic globalization one of large sources of Russia incomes, first of all regions of Siberia and the Far East, can become use benefits from economic-geographical position between three highly developing regions: Northern America, the European Union and the countries of Asian-Pacific economic cooperation.

Geopolitic, social and economic value gets development Siberia and the Far East transport complex, maintenance of reliable communications with all regions of the country, involving in operation of the richest natural resources and inflow to these areas of able-bodied population, economy rise and increase in gross national product, steady development of Siberia and the Far East in structure of uniform geopolitic and social and Russian Federation economic space.

3. The Baikal macroregion is a Russia transport and communication gate in the countries of the Central, East and Southeast Asia

Russia Geopolitic interests have demanded the announcement of macroregion Pribaikalsky and the Far East strategic Russia regions is the centre of information, human and financial streams.

In the territory of Irkutsk area, Buryatiya Republic and Zabaikalsk area there are objective preconditions for formation international multimodal logistical centers, the centers of wholesale trade and distribution, the innovative service and business service created on a corporate basis.

In this part of the report is presented:

- Geoeconomic preconditions of the development of transport and logistical infrastructure on the territory of the Baikal region (Irkutsk and Chita areas, republic Buryatiya) in the adjacent zone to national and international transport corridors.
- The basis of development and placing a basic network of terminal complexes, logistical centers and industrial and logistical parks in large transport spots and the centers of cargo formation as strategic points of economy growth of the Baikal region.
- The complex approach to the creation of regional transport and logistical systems (RTLS).
- The formation of the Baikal regional information-telecommunication subsystem integrated into national and international Euroasian information system. Manufacturing and transport integration on logistics principles. Methodology of formation and organizational structure of regional management of the Baikal macrologistical platform (BR MLP).
- The estimation of the requirement for investments and social and economic efficiency for the development of transport and logistical infrastructure, formation of integrated transport and logistical systems in the Baikal region.
- The development of transport and logistical infrastructure as the way to the accelerated development of the Baikal region, attraction of additional cargo streams, including transit, and integration of Russian transport complex into the system of Euroasian ITC.

4. Results anticipated

Formation in territory of macro Baikal area provides creation 31 multimodal transport logistical centers and is estimated in $2500 million and takes 10 years. It will give $8-10 billion in integratet economical effect and return on investments - 7,5-8 years in addition. It will be created about 35000 workplaces and $900 million tax revenues in all levels budgets.

Formation in Siberia regions and the Far East network of multimodal logistical centers and terminal complexes is necessary points of the regional economy growth, base of business and commercial activity, additional freight traffics and investment to industrial and transport infrastructure development, new workplaces creation and providing inflow of an additional manpower from other country regions

Development of international logistics centers network and regional transport logistical systems formation is accompanied by multiplicate effect which will be shown in other economy sectors: building complex; wholesale and foreign trade; bank and technological service; equipment manufacture for terminals; development of regional commodity markets and services, information and telecommunication systems and, finally, - increase in a gross regional product and gross national product.

1. ВВЕДЕНИЕ

В условиях глобализации мировой экономики, создания крупных транснациональных корпораций и интеграции транспорта ряда государств в мировую транспортную систему осуществляется интенсивный процесс формирования международных транспортных коридоров (МТК), обеспечивающих ускоренное продвижение крупных товароматериальных потоков между различными странами и континентами.

В соответствии с определением группы экспертов комитета по транспорту ЕЭК ООН, **под международным транспортным коридором (МТК) понимается** часть национальной или международной транспортной системы, обеспечивающая значительные международные грузовые и пассажирские перевозки между отдельными странами и континентами, включающая в себя подвижной состав и стационарные устройства всех видов транспорта, работающих на данном направлении, а также совокупность технологических, организационных и правовых условий осуществления этих перевозок.

Целью формирования и развития МТК на территории России является: обеспечение условий для повышения надежности и эффективности российских внешнеторговых перевозок; вовлечение дополнительных транзитных грузопотоков на транспортные коммуникации страны; привлечение отечественных и иностранных инвестиций на развитие транспортно-логистической инфраструктуры; создание условий для ускорения развития регионов страны, расположенных в зоне тяготения к трассам МТК; обеспечение интеграции российского транспорта в евроазиатскую и мировую транспортные системы в качестве равноправного партнера.

Первостепенное значение для обеспечения конкурентоспособности транспортного комплекса России и реализации транзитного потенциала в глобальной системе евроазиатских МТК приобретает развитие транспортно-логистической инфраструктуры в Азиатской части страны.

2. КОНКУРЕНТНЫЕ ПРЕИМУЩЕСТВА РОССИИ В СИСТЕМЕ ЕВРОАЗИАТСКИХ МТК

Факторы, обеспечивающие России конкурентные преимущества в глобальной системе МТК: наличие развитой транспортной инфраструктуры, обеспечивающей кратчайшее наземное сообщение на направлении Европа – Азиатско-Тихоокеанский регион; позиционирование на рынке транзитных перевозок в качестве равноправного партнера, предлагающего транспортному сообществу транзитные ресурсы, отвечающие требованиям нового века; исключительно благоприятное географическое положение в центре геостратегического треугольника: Страны ЕС – Страны Восточной Азии – Страны НАФТА (см. рис.1).

Развитие международных транспортных коридоров отвечает как внешним, так и внутренним экономическим интересам Российской Федерации, учитывая, что основные грузопотоки внешнеторговых и транзитных перевозок концентрируются по осям Запад – Восток и Север – Юг и совпадают с главными направлениями перевозок в межрегиональном сообщении внутри России, в районе тяготения которых сосредоточено свыше 80% населения и промышленного потенциала Российской Федерации.

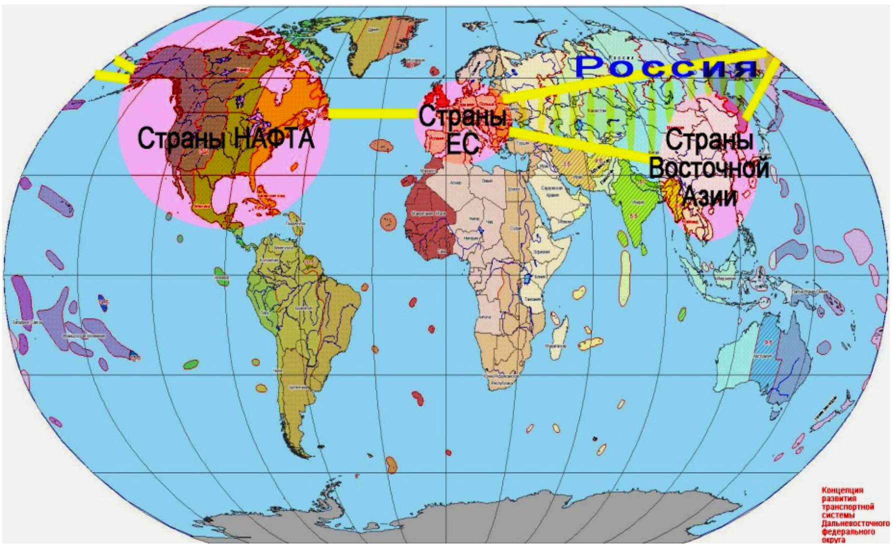

Рис. 1. Геостратегический треугольник XXI века [1]

Одной из приоритетных подпрограмм ФЦП «Развитие транспортной системы России на период до 2015 года» является подпрограммы «Развитие экспорта транспортных услуг». В подпрограмме подчеркивается, что важным элементом транспортной стратегии является формирование международных транспортных коридоров, проходящих по территории России. Оно открывает новые экономические возможности в связи с глобализацией экономики и кардинальным увеличением объемов товарообмена между государствами и континентами. На рис. 2 представлены объемы внешнеторгового оборота между основными регионами мира. Общий объем перевозок грузов в контейнерах между Западной Европой и Восточной Азией составляет более 8 млн. TEU при суммарной стоимости товарной массы свыше 350 млрд. долларов США. Эти перевозки осуществляются, в основном, традиционным южным морским путем, срок доставки грузов по которому достигает 35-40 суток. В перспективе Россия в состоянии переключить значительную часть транзита между Восточной Азией и Европой (до 10 – 15 процентов) на свои транспортные коммуникации и сократить общее время транспортировки грузов в 2 – 3 раза [1].

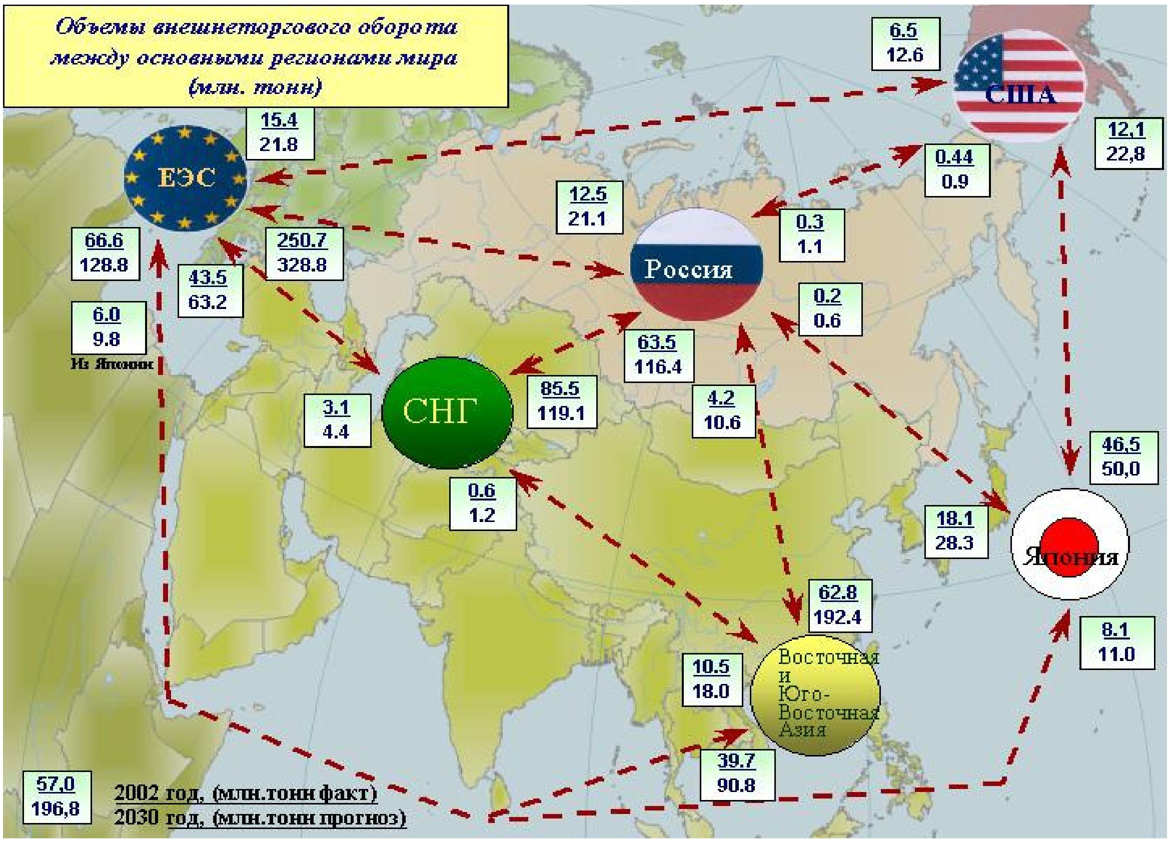

Рис. 2. Объемы внешнеторгового оборота между основными регионами мира (млрд. долл. США) [1]

На рис. 3 показаны основные направления Евроазиатских транспортных связей и Евроазиатские МТК «Север – Юг» и «Запад – Восток», проходящие по территории России. Россия, занимающая более 30 процентов территории Евразийского континента и располагающая высокоразвитой транспортной системой, объективно является естественным сухопутным мостом, обеспечивающим транзитные связи на этом направлении. Однако мощный транзитный потенциал России пока используется слабо – транзитные перевозки контейнеров составляют в настоящее время лишь около 1,0 % от их общей величины. Между тем как в ряде европейских стран — Польше, Германии, Венгрии, Австрии, Нидерландах и др. транзит превращен в доходные статьи бюджетов. Так, в Нидерландах доля доходов от транзита составляет более 40% от общего объема доходов от экспорта услуг [1].

Рис. 3. Основные направления Евроазиатских транспортных коридоров

В настоящее время и в Европе и в Азии признается основополагающее значение интегрированной и четко функционирующей евроазиатской наземной транспортной системы**,** которая облегчила бы международную торговлю и туризм и способствовала бы экономическому развитию стран на всем евроазиатском континенте. Наибольшая степень готовности для реализации евроазиатского наземного транспортного коридора имеется у транссибирского контейнерного моста, основой которого служит действующая Транссибирская железнодорожная магистраль, протянувшаяся на 10 тысяч километров Она представляет собой как бы стержень коридора, использование которого позволяет на 8 тыс км сократить путь между Европой и Северной Азией и экономить от 8-10 до 20-25 суток транзитного времени. Важное стратегическое значение имеют железнодорожные перевозки между Европой и Азией на базе интеграции экономического и технологического потенциала железнодорожных систем Запада, РФ и Востока, оптимизация взаимодействия с железными дорога-ми Германии, Финляндии, КНР в части гармонизации правовой и технологической базы международных перевозок. Большое значение для дальнейшего развития Транссиба имеют восстановление Транскорейской железной дороги и соединение ее с Транссибирской магистралью, создание сухопутного моста от Республики Корея в Западную Европу через РФ. В настоящее время в мировой торговле интенсивно нарастают евразийские торгово - экономические связи. Транссиб может сыграть здесь важную роль как альтернатива кружным океаническим маршрутам между странами АТР и Европой.Для реализации транзитного потенциала Транссиба необходимо создание в Азиатской части России опорной сети логистических центров, обеспечивающих внедрение современных логистических сквозных технологий и транспортно-логистического сервиса, соответствующего международным стандартам.

В условиях глобализации мировой экономики первостепенное геополитическое и социально-экономическое значение приобретает развитие транспортно-логистической инфраструктуры Сибири и Дальнего Востока, для обеспечения надежных связей со всеми регионами страны, вовлечения в эксплуатацию богатейших природных ресурсов и притока в эти районы трудоспособного населения, устойчивого развитие Сибири и Дальнего Востока в составе единого геополитического и социально-экономического пространства Российской Федерации [2].

3. КЛАСТЕРНЫЙ ПОДХОД К ФОРМИРОВАНИЮ РЕГИОНАЛЬНЫХ ТРАНСПОРТНО-ЛОГИСТИЧЕСКИХ СИСТЕМ

Те**нденции последних лет свидетельствуют, что наиболее успешной формой ведения биз**неса в ряде отраслей и регионов, взаимосвязанных производств, на транспорте и в сфере услуг являются крупные холдинги и транснациональные корпорации, а также интеграция хозяйствующих субъектов, включая предприятия малого и среднего бизнеса, в инновационные кластеры.

Формирование кластеров ускоряет процесс развития отрасли, ведет к росту инноваций и повышению конкурентоспособности государства на мировом рынке. Динамичность и гибкость кластеров, способность адаптироваться к изменениям внешней среды и рыночной конъюнктуры является их основным преимуществом перед другими формами организации экономических систем. Показателен опыт создания кластеров в Японии, экономика которой изобилует системами субподрядных и субконтрактных связей между крупными, средними и малыми предприятиями. Типичный японский кластер формируют одно относительно крупное головное предприятие, имеющее статус компании-лидера, и два-три уровня субподрядных фирм, расположенных обычно в географической близости к нему. При этом субподрядчики первого уровня связаны с головным предприятием долгосрочными договорами. Связи поставщиков второго и последующих уровней регламентируются субподрядчиками первого уровня.

Согласно классическому определению основоположника кластерного подхода профессора гарвардского университета Майкла Портера, ***кластер - это группа географически соседствующих взаимосвязанных компаний и связанных с ними организаций, действующих в определенной сфере, взаимодополняющих друг друга и усиливающих конкурентные преимущества, как отдельных компаний, так и кластера в целом [4].***

Большой интерес представляет применение кластерного подхода к развитию логистической инфраструктуры, формированию региональных транспортно-логистических систем и межрегиональных макро логистических платформ. Для реализации основных конкурентных преимуществ Новосибирского мультимодального транспортного узла в Стратегии социально-экономического развития Новосибирской области на период до 2025 г. предложено формирование ряда территориально-отраслевых кластеров, в том числе в качестве одного из приоритетных - транспортно-логистического кластера (ТЛК), создание которого превратит Новосибирский транспортный узел в один из главных транспортно-логистических центров востока России.

В ТЛК Новосибирской области функции системных интеграторов (компаний - лидеров) будут выполнять логистические центры федерального, межобластного и областного уровней (см. рис. 4), имеющие тесные взаимосвязи с многочисленными крупными, средними и малыми предприятиями (перевозчиками, экспедиторами, информационными, финансовыми, страховыми компаниями и др.), на основе производственно-технологической, научно-технической и коммерческой интеграции.

Рис. 4. Транспортно-логистический кластер Новосибирской области

В Новосибирской области объективно сформировалась потребность в создании комплекса современных транспортно-логистических центров. Это связано, прежде всего, с исключительно благоприятным геостратегическим положением Новосибирского транспортного узла в системе МТК, с обслуживанием международных транзитных грузов в западном, восточном и южном направлениях, а также с развитием активности крупных оптовых и розничных торговых сетей на территории, как Новосибирска, так и ближайших регионов. С участием инвесторов формируются три крупные транспортно-логистические инфраструктурные зоны: Западная, Восточная и Южная (см. рис. 5) [2].

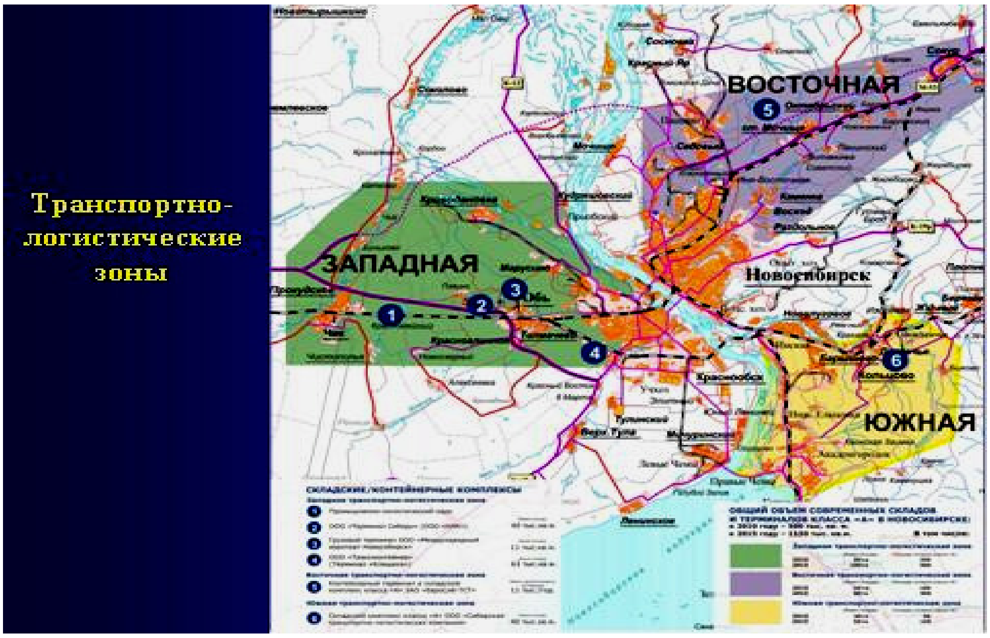

Рис. 5. Формирование крупных транспортно-логистических инфраструктурных зон на территории Новосибирской области

Разработан и реализуется проект создания Промышленно-логистического парка (ПЛП) на площади в 2000 га, на территории, прилегающей к аэропорту Толмачево, в Западной транспортно-логистической зоне. Достигнута договоренность о создании терминально-складских комплексов на территории ПЛП компаниями: «Евразия-Логистик» (800 тыс. кв. м. складов), «ПНК – Толмачево» (100 тыс. кв. м.), «Имморосиндастри», «Комтех-Новосибирск», «Кей Си Групп», «СибОфисСтрой». Площадь логистических комплексов, складов и терминалов класса «А» составит 1300 тыс. кв. м. Объем инвестиций в транспортно-логистическую инфраструктуру Новосибирской области составит 35 млрд. руб.

Прототипом кластерного подхода в сфере транспорта и транспортно-логистической инфраструктуры являются разработанные в ряде регионов России целевые комплексные программы и стратегические доктрины формирования региональных транспортно-логистических систем (РТЛС), в которых в качестве интегратора выступает товароматериальный и сопутствующие информационный, финансовый и сервисные потоки, общие цели ведения бизнеса, согласованные с региональными целями социально-экономического развития. Такие программы и стратегии разработаны и поэтапно реализуются в Московском регионе, Санкт-Петербурге, Нижнем Новгороде, Самаре, Екатеринбурге, в Тюменской, Иркутской, Новосибирской области и в Республике Бурятия.

Большой интерес, как с научной, так и с практической точки зрения представляет формирование региональных транспортно-логистических систем (РТЛС) и межрегиональных макро логистических платформ (МЛП) на территории федеральных округов, в частности в Сибирском федеральном округе (СФО). С учетом административно-территориального устройства Сибирского Федерального округа при определении границ МЛП были выделены три крупные зоны, адекватные экономическим округам, на территории которых предложено формирование Западно-Сибирской, Восточно-Сибирской и Байкальской макрологистических платформ:

Западно-Сибирскую макрологистическую платформу* (*ЗС МЛП) представляют Омская, Томская, Новосибирская и Кемеровская области, Алтайский край и республика Алтай; ***Восточно-Сибирскую макрологистическую платформу (ВС МЛП)*** – Красноярский край с Таймырским и Эвенкийским автономными округами, республики Хакасия и Тыва; ***Байкальску.ю макрологистическую платформу (БМЛП)*** - Иркутская область, республика Бурятия и Забайкальский край (см. рис.6).

В соответствии с кластерным подходом регионами-лидерами в соответствующих МЛП СФО станут Новосибирская область, Красноярский край и Иркутская область, объединяющие вокруг себя соседние менее экономически развитые регионы на основе научно-технической, производственно-технологической, транспортно-логистической и коммерческой интеграции.Функции интеграторов транспортно-логистического процесса (4 PL провайдеров) в МЛП СФО будут выполнять мультимодальные логистические центры, создаваемые в крупных транспортных узлах СФО.

Общее управление межрегиональными макрологистическими платформами в СФО целесообразно осуществлять в рамках работы межрегиональной ассоциации «Сибирское соглашение» (МАСС), Межрегиональной Ассоциации руководителей предприятий, посредством работы которых осуществляется межрегиональное взаимодействие, в частности по разработке и реализации региональных целевых программ и стратегий социально-экономического развития регионов Сибири. Макрологистические платформы в Сибири интегрированы в единую систему связи и информации, посредством функционирующей цифровой системы связи на магистрали Москва – Хабаровск, магистральных телекоммуникаций ОАО «Ростелеком», ЗАО «Магистраль – Телеком», работа которых позволяет осуществлять функционирование макрологистической системы России в целом. Большинство сибирских банков, таких как ОАО «Сибакадембанк», ОАО «Урало-Сибирский Банк», ОАО «Ханты-мансийский Банк», а также крупные российские банки как ОАО «Сберегательный банк РФ», ОАО «ВнешторгБанк», ОАО «Банк Москвы», ОАО «ГазпромБанк» и другие имеют разветвленную региональную сеть.

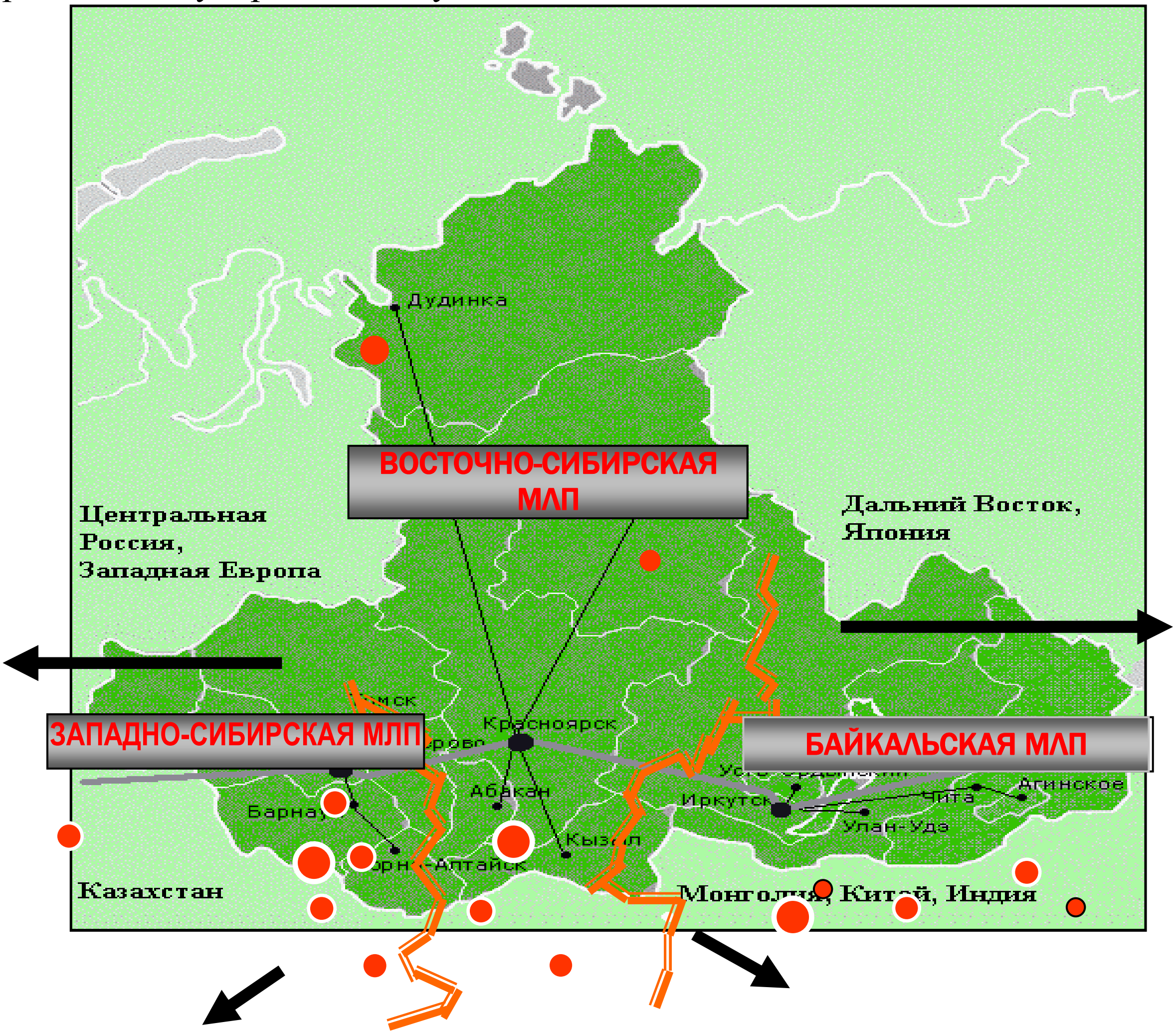

Рис. 6. Территориальная структура макрологистических платформ в Сибирском федеральном округе [4]

Система кадрового обеспечения функционирования и развития логистических платформ в Сибири обладает стабильно высоким потенциалом, который представлен ведущими научно-исследовательскими, инновационными и образовательными учреждениями, Сибирским отделением Российской академии наук, а также Сибирским филиалом Международного центра по подготовке специалистов в области логистики (МЦЛ ГУ-ВШЭ). Институционально-правовой основой функционирования и взаимодействия макрологистических платформ в Сибири являются российские законодательные акты, а также региональные законодательные акты и программы социально-экономического развития регионов Сибири.

4. РАЗВИТИЕ БАЙКАЛЬСКОГО МАКРО РЕГИОНА КАК СТРАТЕГИЧЕСКИ ЗНАЧИМОГО РЕГИОНА ДЛЯ РОССИЙСКОЙ ФЕДЕРАЦИИ

Геополитические интересы России потребовали объявления Байкальского макро региона стратегическим регионом России, для которого должны быть созданы центры притяжения товароматериальных, информационных, людских и финансовых потоков [2, 3].

В Иркутской области, Республике Бурятия и Забайкальском крае имеются объективные предпосылки для создания опорной сети мультимодальных транспортно-логистических центров (МТЛЦ) с терминальными комплексами, центрами оптовой торговли и дистрибьюции, инновационного, сервисного и коммерчески-делового обслуживания, рассматриваемых как стратегические точки роста экономики региона, и последующего формирования Байкальской межрегиональной макро логистической платформы (БР МЛП) [2].

Принципиальная схема размещения опорной сети МТЛЦ на территории БМЛП представлена на рис. 7 [2,3].

Факторы, способствующие формированию Байкальской региональной макро логистической платформы (БР МЛП) как прототипа инновационного транспортно-логистического кластера: благоприятное геополитическое положение Байкальского региона; близость региона к активно развивающимся странам АТР; высокий экологический потенциал территории озера Байкал, как объекта мирового природного и экологического наследия; создание в Прибайкальском регионе особой экономической зоны туристско-рекреационного типа и развитие туристического бизнеса; развитие новых производств на базе инновационных технологий и создание интегрированных производственно-транспортных зон (ИПТЗ); переход от отраслевой системы управления к преимущественно кластерной политике управления; комфортный этносоциальный климат; наличие свободной рабочей силы; относительно высокий образовательный уровень населения; наличие крупных промышленных предприятий с элементами высокотехнологичных производств; крупные запасы минеральных и топливных ресурсов национального и международного значения;транзитные возможности» национального и международного масштаба; перспективы создания нового МТК «Улан-Удэ – Улан-Батор – Пекин; устойчивые торговые связи с Монголией и рядом провинций Китая; высокий потенциал для создания совместных предприятий и реалиизации международных проектов; наличие высоко развитой информационной сети и телекоммуникационных технологий; развитие процессов сотрудничества в рамках Байкальского региона и Сибирского федерального округа.

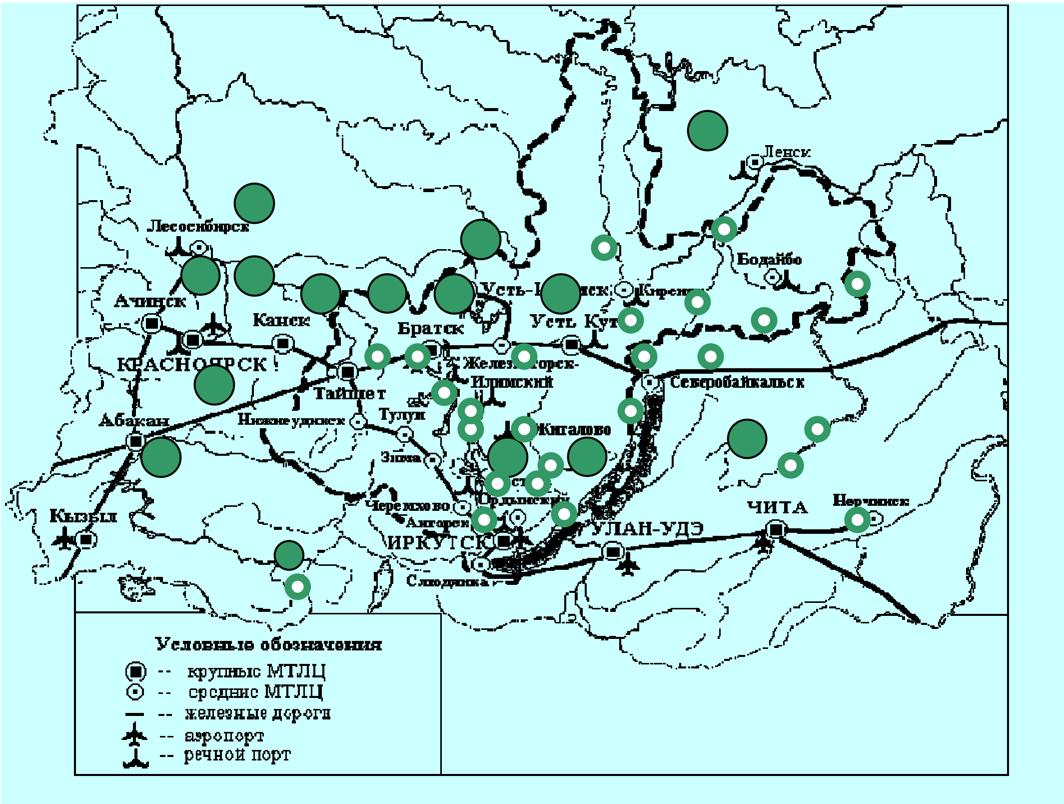

Рис. 7. Схема размещения МТЛЦ на территории Восточной Сибири и Байкальской МЛП

Создание на территории Байкальского региона опорной сети ТЛЦ и терминальных комплексов, объединенных в Байкальскую региональную макро логистическую платформу (БР МЛП) на основе формирования единого информационного и нормативно-правового пространства с подсистемами финансового и кадрового обеспечения, явится необходимыми точками роста экономики региона, способными вызвать деловую и коммерческую активность, привлечь дополнительные грузовые потоки и необходимые на развитие инфраструктуры инвестиции, создать новые рабочие места и обеспечить приток дополнительных трудовых ресурсов из других регионов страны.

Учитывая достаточно высокую потребность в инвестициях на формирование в Байкальском регионе опорной сети из 31 МТЛЦ (см. рис. 6), оцениваемую в 2,5 млрд. долл., необходима разработка рациональных финансовых схем реализации проектов развития транспортно-логистической инфраструктуры с привлечением механизма государственно-частного партнерства. Наряду с развитием сети ТЛЦ, в рамках формирования БР МЛП потребуется развитие института логистических посредников – организаторов системы грузо-и товародвижения в регионе, включая перевозки грузов в прямом смешанном (интермодальном) сообщении по системе Евроазиатских МТК.

В настоящее время в регионах Сибири функционирует ряд федеральных и международных компаний, имеющих статус оператора интермодальных

перевозок грузов, таких как «Сибирский интермодальный сервис», «Транссибирский экспресс», «Трансконтейнер», «Русская тройка».
Формирование на территории Байкальского макро региона интегрированной макрологистической платформы основано на развитии логистического управления процессом товародвижения и требует создания эффективной системы государственной поддержки и регулирования, а также формирования соответствующих органов управления функционированием и развитием БР МЛП.
По предварительной оценке, осуществленной на основе данных проектов-аналогов, формирование Байкальской межрегиональной макрологистической платформы (БМЛП)) потребует порядка 2,5 млрд. долл. США (75 млрд. руб.) инвестиций, в том числе на развитие транспортно-логистической инфраструктуры – порядка 1500–1800 млн. долл. США (45,0–54,0 млрд.руб.) и обеспечит срок окупаемости инвестиций в 7,5–8 лет, за 10-ти летний период эксплуатации сформирует интегральный экономический эффект порядка 8-10 млрд. долл. США (240–300 млрд. руб.) и создаст дополнительно в регионе 35-40 тыс. новых рабочих мест.
Перспективы развития Байкальского макро региона как стратегически значимого региона для Российской Федерации связаны с решением следующих стратегических задач: разработка значительного природно-ресурсного потенциала Байкальского региона; транспортное освоение территории и снижение пространственных дисбалансов; внедрение инновационных технологий и создание интегрированных производственно-транспортных зон (ИПТЗ); формирование Северо-Иркутской, Северо-Бурятской ИПТЗ на базе освоения природных ресурсов зоны БАМ и развития логистической инфраструктуры Северо-Байкальского и Ново-Уоянского транспортных узлов; развитие логистической инфраструктуры и формирование Байкальской межрегиональной макро логистической платформы (БМЛП); реализация туристско-рекреационного потенциала Иркутской области, Забайкальского края и Республики Бурятия; развитие государственно-частного партнерства и привлечение инвестиций крупных российских и иностранных компаний расширение сотрудничества с регионами СФО, Забайкалья и ДФО, а также с соседними государствами – Монголией и Китаем; реализация транзитного и экспортно-импортного потенциала Иркутской области, Забайкальского края, Республики Якутия Саха и Республики Бурятия, Байкальского региона в целом; обеспечение реализации геоэкономических интересов России в зоне Азиатско-Тихоокеанского региона, Юго-Восточной Азии и развитие Евроазиатского экономического сотрудничества.

5. ЗАКЛЮЧЕНИЕ.

Создание мощного промышленного потенциала в районах Сибири и Дальнего Востока на базе реализации социально-ориентированной стратегии развития транспорта и формирования интегрированных производственно-транспортных комплексов, обладающих развитой сетью путей сообщения и транспортно-логистической инфраструктурой, станет важным этапом в обеспечении подъема экономики и повышении уровня жизни населения в нашей стране, явится объективной предпосылкой возвращения России статуса мирового лидера и достойного партнера в международном сообществе государств с рыночной экономикой.

Развитие в Азиатской части России в зонах тяготения к российской части МТК опорной сети ТЛЦ и формирование на их основе региональных транспортно-логистических систем и макрологистических платформ обеспечит реализацию транзитного потенциала России в глобальной системе евроазиатских МТК и будет сопровождаться значительным мультипликативным эффектом, который будет проявляться в других отраслях экономики, в развитии региональных рынков товаров и услуг и, в конечном итоге, - в увеличении валового регионального продукта (ВРП) и валового внутреннего продукта (ВВП) страны.

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ИЕРАРХИЯ ЗАКОНОВ ЛОГИСТИКИ

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Аннотация: Сформулированы объективные законы функционирования логистических систем, определяющие основные направления сокращения издержек в цепях поставок.

THE HIERARCHY OF LOGISTICS LAWS

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Abstract: the paper contains the objective laws of functioning of logistics systems, which determine the main directions of expenses reduction in the delivery chains. Logistics is often called a young science. Any science is featured by some laws. The laws describe steady relations, connections and interdependences of processes and objects, which are the subject-matter of this science. So far the inner laws of logistics have not been stated yet. The aim of the report is reasoning of definition of logistics laws and determination of their hierarchy.

The directions of total expenditures reduction in the logistics chains have been singled out in order to make use of these directions in all links of a logistics chain. The directions of total expenditures reduction in a logistics chains have been examined, the definitions of logistics laws have been offered and their hierarchy has been determined. The description of scientific novelty and practical significance of received results have been stated in conclusion.

In all links of a logistics chain there occurs the movement of goods. The less are the movements, the less are the costs of their delivery. Hence we can state one of logistics laws – THE LAW OF TRAFFIC SAVING. The efficient inventories control is essential for optimization of logistics expenses. In case of surplus inventories there occurs “freezing” of monetary funds. The surplus inventories require the storage space, staff, equipment and other expenses. Hence we can state THE LAW OF INVENTORIES SAVING.

During the delivery from a supplier to a receiver the goods are excluded from the economic circulation. They cannot be sold, used in the technological process. In this case the bigger are the losses, the longer is the time of material flow. In order to decrease these losses, it is necessary to take into consideration THE LAW OF SAVING OF TRAFFIC FLOW TIME.

It is known that logistics expenses per one unit of cargo decrease in case of consignment enlargement. It is the consequence of THE LAW OF FLOWS ENLARGEMENT. This law functions regardless of where and in what way the goods move: in a transport vehicle in the international traffic movement or within a warehouse.

Intersection of raw material flows, feedstock, parts is considered to be inadmissible at the industrial enterprises. Intersection of currents at the warehouses is also undesirable, as well as ruptures of material flows. All these examples illustrate the operation of THE LAW OF UNIFLOWNESS. Parameters of chains of logistics system must be mutually harmonized. Sizes of transport vehicles must be multiple of sizes of unit loads. Lifting capacity of cranes must fit the lifting capacity of transport and the weight of unit loads. The interval of arrival of transport vehicles must fit the pace of work of a loading mechanism. All these requirements are the consequence of THE LAW OF PROPORTION.

The inner laws of logistics must not contradict the general requirement of saving of total expenditures in a logistics chain. This requirement should be considered as a general law of logistics.

So far in the available literature there has not been any systematized statement of logistics laws, the observance of which ensures reduction of total expenditures in a logistics chain. There has been known only empirical recommendations, relating to decision making in specific situations.

For the first time suggested by the author statements of laws were offered for a public discussion in 2007, and in the following year the report was made at the conference DR-LOG. At the same time, in 2008, the university of Velicotyrnovsk published the author`s article in Bulgarian language. Further development of technologies in logistics is possible on the basis of knowledge of inner laws of logistics. The correct understanding of mutual correlation of logistics laws makes it possible to determine the rational methods of organization of goods delivery and to choose the most efficient ones.

1. ВВЕДЕНИЕ

Логистику часто называют наукой. При этом обычно уточняют, что данная наука охватывает транспортировку, хранение и другие операции, которые выполняются при доставке товаров и других грузов к месту назначения. Нередко подчеркивают, что логистика – это молодая наука. Гораздо реже обращают внимание на то, что логистика, как практическая деятельность, существует с глубокой древности. Когда возникли товарные потоки, тогда же появилась необходимость управлять ими. Так и появилась логистика. Классический пример логистической цепи – Великий шелковый путь. Эпоха Великих географических открытий вызвана стремлением найти самые короткие и дешевые пути товарных потоков. Однако, как наука, логистика действительно еще очень молода. Можно подумать, что здесь есть противоречие. С одной стороны, логистика имеет длительную историю и выдающиеся достижения. С другой стороны, логистика очень молода, как наука. Здесь нет противоречия, это так и есть. Можно привести в качестве примера физику, в частности, такой ее раздел, как механика. В античное время были известны оригинальные решения в этой области. Один из самых известных специалистов-механиков во всей истории человечества – это Архимед. Он изобретал поразительной сложности механизмы для поднятия тяжестей, метательные машины и многое другое. Однако законы механики появились только в конце XVII века, когда их сформулировал великий Ньютон. Это произошло примерно через 19 столетий после того, как при штурме Сиракуз римский солдат убил Архимеда. С точки зрения жизни одного человека, 19 веков – это целая вечность. И все это время механика развивалась, как практическая деятельность, хотя ее законы еще не были сформулированы. Механика широко использовалась людьми с античных времен, а ее законы стали известны относительно недавно, всего 300 лет. Для любой науки характерным является наличие законов. Законы описывают устойчивые отношения, связи и взаимозависимости процессов и объектов, которые составляют предмет данной науки. В логистике пока не сформулированы ее внутренние законы. Это является одним из проявлений молодости логистики как науки.

2. ЦЕЛЬ

Есть ли у логистики законы? Известно, что любая деятельность в экономике осуществляется по экономическим законам. Известны закон спроса и предложения, закон стоимости и другие. Эти законы действуют также и в логистике. Кроме того, у логистики есть свои внутренние законы. Так как логистика молодая наука, то ее внутренние законы еще предстоит сформулировать. Целью доклада является обоснование формулировок законов логистики и установление их иерархии. Тем самым автор пытается внести свой скромный вклад в решение этой проблемы.

3. МЕТОД

Предлагается определять внутренние законы логистики, исходя из того, как следует обеспечивать сокращение затрат в логистической цепи. Необходимое требование состоит также в том, чтобы эти законы действовали во всех звеньях логистической цепи, а не только, например, на складе, или только на транспорте или только на отдельных видах транспорта. Законы логистики должны иметь общий характер применительно ко всем этапам движения материального потока. Чтобы сформулировать внутренние законы логистики, выделим направления сокращения совокупных затрат в логистической цепи таким образом, чтобы эти направления могли использоваться во всех звеньях логистической цепи. Таким образом можно сформулировать 6 внутренних законов логистики (рис. 1).

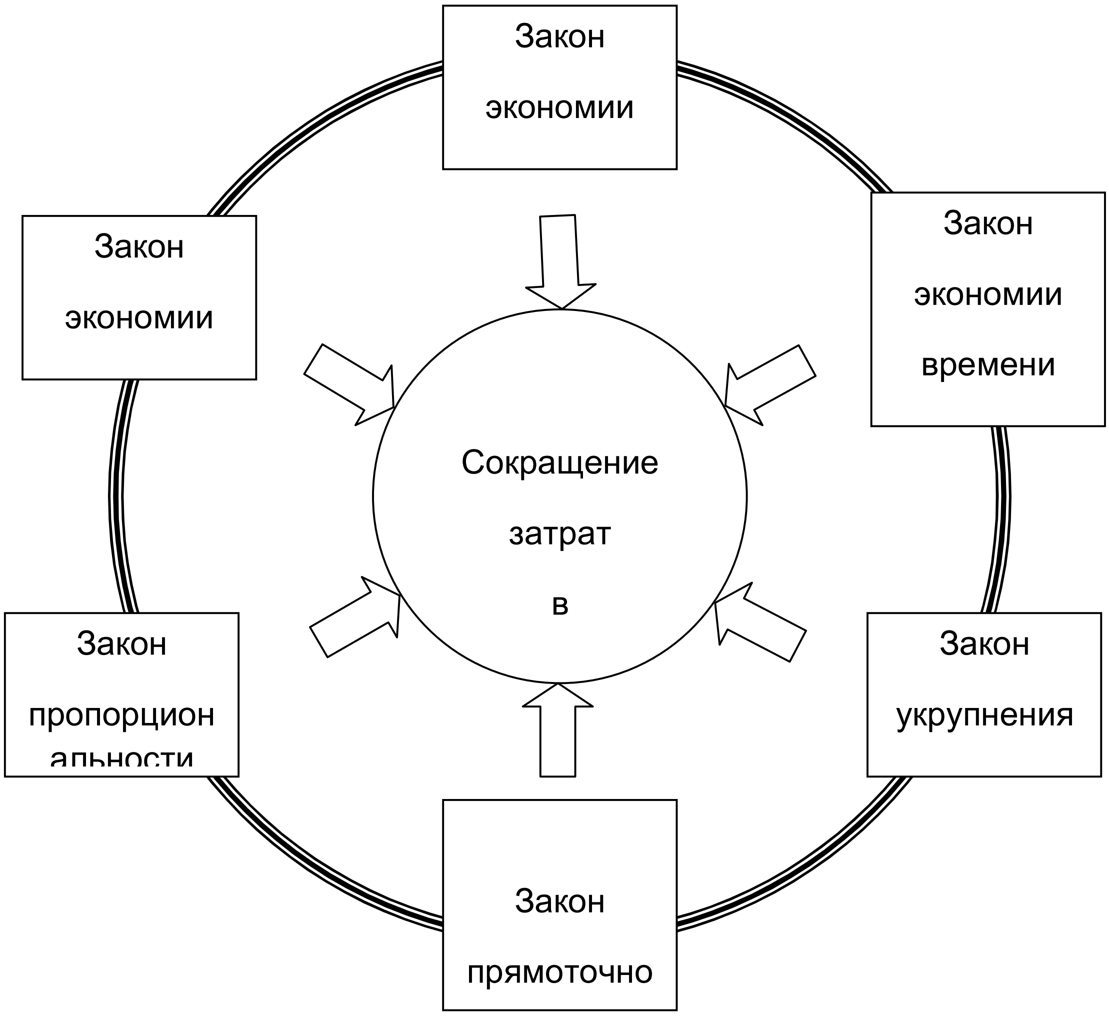

Рис. 1. Иерархия законов логистики

4. СТРУКТУРА ИЗЛОЖЕНИЯ

Далее будут рассмотрены направления сокращения совокупных затрат в логистической цепи, предложены формулировки законов логистики и определена иерархия законов логистики. В заключение будет дана характеристика научной новизны и практической значимости полученных результатов.

5. РЕЗУЛЬТАТЫ

5.1. Закон экономии движения

Во всех звеньях логистической цепи происходит перемещение товаров. Во время перевозки груз перемещается на транспортном средстве. На складе товар перемещается из зоны приема в зону хранения, а из зоны хранения – в зону отпуска. Любое перемещение товара требует привлечения техники и персонала и увеличивает затраты. Следовательно, чем меньше происходит перемещений товара, тем меньше затраты на его доставку. Отсюда можно сформулировать один из законов логистики – ЗАКОН ЭКОНОМИИ ДВИЖЕНИЯ. Смысл этого закона в следующем. Чем меньшее расстояние проходит материальный поток, тем эффективнее организована логистическая система. На транспорте нерациональными могут быть все виды пробегов. Следует стремиться к сокращению не только порожних пробегов, но и груженых, если они производятся не по кратчайшему расстоянию. Другой вариант нерациональных груженых пробегов связан с возвратом товара, когда грузополучатель отказывается его принять. Сокращение пробега транспортных средств приводит к уменьшению их необходимого количества для перевозки общего объема доставляемых клиентам товаров. Сокращение численности используемого транспорта приводит к уменьшению всей совокупности затрат, связанных с эксплуатацией парка подвижного состава.

Закон экономии движения действует на всех объектах логистической цепи, в том числе и на складах. При организации работы склада основная цель такая же – сократить движение персонала и техники как в процессе подготовки и отправки заказа, так и при приеме поступившего товара. На складе борьба против лишнего движения ведется путем оптимизации внутрискладских грузопотоков. Одно из направлений — минимизация перемещений комплектовщиков (отборщиков) товара путем размещения товаров повышенного спроса возле зоны отпуска склада. Считается, что эта мера дает почти двукратное сокращение расстояний, которые за смену проходят по складу отборщики. Еще одним примером действия данного закона является технология кросс-докинга, когда товар на складе вообще не перемещается в зону хранения, а перегружается на транспортные средства для доставки получателю.

5.2. Закон экономии запасов

Большое значение для оптимизации логистических затрат имеет рациональное управление запасами. Известно, что недостаточные запасы могут привести к невыполнению заказов потребителей. В условиях эффективной транспортной системы эта проблема легко решается доставкой нужного товара из распределительного склада или от производителя. Проблема избыточных запасов более серьезна. Если они есть, то возникает «замораживание» денежных средств, использованных для приобретения запасов. Ведь они не используются в обороте, а деньги уже потрачены. Надо также учитывать, что излишние запасы требуют для своего хранения складские площади, привлечение персонала, использование техники и другие затраты. Важным элементом затрат на хранение является стоимость земли под строительство склада. Исходя из этих соображений, можно сформулировать еще один закон логистики – ЗАКОН ЭКОНОМИИ ЗАПАСОВ. Он используется при реализации логистических технологий «lean production» («тощее производство») и «just-in-time» («точно вовремя»).

5.3. Закон экономии времени движения потока

Во время движения от поставщика к получателю товар исключен из экономического оборота. Его нельзя продать, нельзя использовать в технологическом процессе. Потери в этом случае тем больше, тем дольше время движения материального потока. Чтобы уменьшить эти потери, надо учитывать ЗАКОН ЭКОНОМИИ ВРЕМЕНИ ДВИЖЕНИЯ ПОТОКА. Время в пути включает в себя не только время транспортировки, но и время перегрузочных операций, время промежуточного хранения при передаче товара с одного вида транспорта на другой, время таможенных процедур и т.д. Следствием закона экономии времени движения потока является рассмотрение перевозимого груза в качестве запаса в пути. В этом случае перевозимый груз считается включенным в технологический процесс еще до своего прибытия к получателю. Исходя из этого, составляются производственные планы загрузки оборудования, привлечения ресурсов и т.д. В торговле определенными категориями товаров распространены фьючерсные контракты, когда товар многократно продается во время своей транспортировки. При этом поставкой товара завершается небольшой процент таких сделок, а остальные сделки завершаются выплатой разницы в цене. Фьючерсные контракты можно рассматривать как средство противодействия исключению товара из оборота на время своего перемещения, что тоже является проявлением закона экономии времени движения потока.

5.4. Закон укрупнения потоков

Известно, что логистические издержки на единицу груза сокращаются при увеличении партии груза, доставляемого по логистической цепи. Это является следствием ЗАКОНА УКРУПНЕНИЯ ПОТОКОВ. Этот закон действует независимо от того, где и каким образом перемещается товар: в транспортном средстве в международном сообщении или в пределах склада. Для укрупнения грузовых единиц используются контейнеры и пакеты. Для перемещения укрупненных грузовых единиц используются транспортные средства большей грузовместимости. Этот закон проявляется и при выборе вида транспорта. Партия груза, перевозимая железнодорожным или водным транспортом, значительно превышает по своему размеру партию груза, перевозимую автомобилем. За счет этого цена единицы транспортной работы при автомобильных перевозках в среднем на порядок выше, чем при перевозках по железной дороге или морем. Есть еще одно следствие закона укрупнения грузопотоков, которое проявляется в технологии «postponement» (откладывание, отсрочка), устанавливающей точку рассредоточения материального потока по направлениям доставки. В самом общем случае товар может распределяться получателям на разных этапах: на стадии изготовления у производителя; на стадии упаковки; на стадии маркировки и размещения этикеток. Чем позже производится рассредоточение материального потока (чем дольше срок отсрочки, задержки распределения товара по потребителям), тем больше возможностей для унификации процессов производства и доставки, а также и для укрупнения материального потока.

5.5. Закон избавления потоков от разрывов и пересечений (закон прямоточности)

На промышленных предприятиях считается недопустимым пересечение потоков сырья, заготовок, комплектующих, незавершенного производства и готовой продукции. Также нежелательно пересечение потоков на складах. Когда планируют подъездные пути в пунктах погрузки и разгрузки, предпочтительной является сквозная или, в крайнем случае, кольцевая схема движения автотранспорта. В этом случае траектории движения автомобилей не пересекаются. Нежелательны разрывы материальных потоков, когда груз перегружается с одного вида транспорта на другой. Например, на морские паромы груз из железнодорожных составов, как правило, не перегружается, а вагоны вместе с грузом размещаются на пароме. При этом заметно уменьшается использование грузовместимости парома, поскольку высок коэффициент тары, так как вместе с полезным грузом перемещаются и вагоны. Однако в целом получается полезный эффект за счет уменьшения степени разрыва материального потока. Другим примером разрыва материального потока является использование лифтов на складе: товар сначала перемещается к лифту, потом спускается (или поднимается) к месту выполнения операций с ним (комплектации заказа, размещении на хранение и т.д.). Все эти примеры иллюстрируют действие ЗАКОНА ПРЯМОТОЧНОСТИ.

5.6. Закон пропорциональности

Параметры звеньев логистической системы должны быть гармонизированы по отношению друг к другу. Размеры транспортных средств должны быть кратны размерам грузовых единиц. Грузоподъемность кранов должна соответствовать грузоподъемности транспорта и весу грузовых мест. Интервал прибытия транспортных средств в грузовой пункт должен соответствовать ритму работы погрузочного (разгрузочного) механизма. График использования производственных мощностей должен соответствовать установленному режиму труда и отдыха персонала. Количество транспортных средств и их грузовместимость должны соответствовать величине грузопотока. Все эти и другие аналогичные требования вытекают из ЗАКОНА ПРОПОРЦИОНАЛЬНОСТИ. Следование этому закону обеспечит соответствие друг другу пропускной способности последовательных звеньев логистической цепи, предупредит возникновение заторов в движении потока, исключит появление «бутылочных горлышек».

5.7. Иерархия законов логистики

Внутренние законы логистики не должны противоречить общему требованию экономии совокупных издержек в логистической цепи. Это требование следует рассматривать в качестве общего закона логистики. Необходимое требование заключается в том, что законы логистики не должны противоречить известным экономическим законам, которые имеют более высокий статус по отношению к законам логистики.

6. НАУЧНАЯ НОВИЗНА

До настоящего времени в доступной литературе отсутствует систематизированное изложение законов логистики, соблюдение которых обеспечивает сокращение совокупных затрат в логистической цепи. Известны эмпирические рекомендации, касающиеся принятия решений в конкретных ситуациях. К таким рекомендациям относятся, например, так называемые «золотые правила логистики». Первое «правило» рекомендует: а) максимально приблизить дистрибутивную цепь к точкам сбыта; б) использовать дистрибутивную цепь как можно чаще; в) на логистических участках значительной протяженности использовать транспорт возможно большей грузовместимости. Второе «правило» сформулировано более лаконично и рекомендует минимизировать параметрический ряд грузовых единиц, перемещаемых по логистической сбытовой цепи. Соответственно, в этом случае минимизируется также параметрический ряд транспортных средств. Конкретное проявление это «правило» имеет в контейнеризации и пакетировании грузов. Третье «золотое правило» рекомендует размещать склад в распределительной цепи как можно ближе к конечным торговым точкам (за счет этого получается выигрыш на транспортировке), либо, наоборот, как можно ближе к месту производства товара (если склад распределительной цепи выполняет функции сортировки). В большинстве случаев рекомендации «золотых правил логистики» могут применяться на практике, однако возможны ситуации, когда выбор места размещения складов решается на основе анализа целого ряда факторов, а не только в зависимости от выполняемых складами функций. Нетрудно видеть, что эти «правила» представляют собой частные случаи сформулированных выше законов логистики, таких, как закон укрупнения потоков (при размещении распределительного склада вблизи точек сбыта и при размещении накопительно-сортировочного склада рядом с производителями) и закон пропорциональности при гармонизации параметрических рядов грузовых единиц и транспортных средств.

Впервые предложенные автором формулировки законов были вынесены им на публичное обсуждение в 2007 году, а в следующем году состоялся доклад на российско-немецкой конференции по логистике DR-LOG. Тогда же, в 2008 году, на болгарском языке Великотырновским университетом была опубликована статья автора по этой теме.

7. ПРАКТИЧЕСКАЯ ЗНАЧИМОСТЬ

Приведенная выше аналогия с физикой позволяет понять, почему целостное представление о логистике как интегрированном подходе к управлению материальными потоками и запасами стало характерным только для второй половины XX века. Тогда возникла идея интегрированного логистического управления (ILM – Integrated Logistics Management). С этой идеей связаны концепция полной стоимости (Total Cost Concept) и пооперационного контроля стоимости (Aktivity Based Costing). Стали распространяться такие бизнес-концепций, как «Производство, ориентированное на потребителя» (CFM — Customer Focused Manufacturing), «Управление цепями поставок» (SCM — Supply Chain Management). Получили внедрение основанные на этих концепциях технологии ERP — Enterprise Resource Planning (планирование ресурсов предприятия) и CRM — Customer Relationship Management (управление взаимоотношениями с клиентами). Можно утверждать, что в современном виде логистика возникла 30 – 40 лет назад.

Среди причин заметного ускорения развития логистики в конце XX века можно выделить четыре основных:

1) в мире на смену индустриальному обществу пришло общество потребления; это привело к резкому увеличению товарных потоков; заметно повысилась доля грузов, перевозимых в стандартизированных контейнерах и на паллетах;
2) кардинально возросла степень глобализации экономики;

3) повысилась конкурентность рынков сбыта, что поставило одной из важнейших целей бизнеса повышение эффективности продвижения продукции к потребителю;
4) произошло интенсивное развитие вычислительной техники и информационных технологий, которые принципиально изменили возможности управления логистическими операциями.

Дополнительно надо отметить, что стандартизация грузовых единиц привела к революционным изменениям в технологии и организации транспортно-складского процесса. Что касается развития и практического использования информационных технологий, то здесь ведущей оказалась роль науки, достижения которой были быстро восприняты практической логистикой. Появилось программное обеспечение для расчета маршрутов, автоматизации учетных функций и всего документооборота, технические средства для контроля движения транспортных средств и грузов с использованием, например, спутниковых технологий. Широко внедряются автоматизированные системы управления складами.

Дальнейшее совершенствование технологий в логистике возможно на основе знания внутренних законов логистики. Правильное понимание соотношения законов логистики между собой позволяет определить рациональные методы организации доставки товаров и выбрать из них наиболее эффективные.

ФОРМИРОВАНИЕ ЛОГИСТИЧЕСКОЙ СЕТИ ОБРАЗОВАТЕЛЬНЫХ УЧРЕЖДЕНИЙ ДЛЯ ИННОВАЦИОННОЙ ЭКОНОМИКИ РЕГИОНА

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Аннотация: В статье представлены теоретические основы и практические рекомендации по развитию механизма управления инновационной инфраструктурой образовательных услуг в экономических системах. Разработана модель взаимодействия участников инновационной деятельности в современных условиях, уточнена роль инновационной инфраструктуры - образовательного консорциума региона и определены его функции в адаптивной цепи подготовки выпускников для инновационного процесса.

THE FORMATION OF EDUCATION ESTABLISHMENTS' LOGISTICS NET OF INNOVATIVE ECONOMY OF THE REGION

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The aim of the article: The theoretical basis and practical recommendations concerning the development of managerial mechanism of educational services innovative infrastructure in economic systems are presented in the article. According to the contemporary conditions the model of the participants' innovative interaction is carried out. The role of innovative infrastructure (the educative consortium of the region) is specified. Its functions in the adaptable chain of graduates' training are determined for innovative process. The new methodical basis of a graduates' new type formation, the creation of new forms of educational establishments interaction with the outside, the development of educational infrastructure are also determined in the article. The algorithm of logistics approach application to the innovative participants' activity and their education infrastructure as the form of integrative logistics system of innovations provision is worked out. The characteristic features, forms and methods of educative process concerning to the innovative management and logistics needs are given in the article. The place and the role of contemporary education and its structures in increasing of innovations are revealed. The supplying necessity of informative educational provision by the means of logistics is motivated.
Methods of research: For the realizing of the formulated objects different methods were used, i. e. the dialectic methods of cognition, that provides complex and objective character of the learning; method of scientific abstraction; methods of systems analysis; methods of evolutional analysis; methods of experts analysis; methods of modeling (systems, logical, economic-statistical, imitative); objective, subjective, structural-functional methods, the

method of purposeful management, and also the building principles of economic-managerial structures. The organization of logistics service based on the use of modern and perspective developing forms was chosen as the methodological basic of the given research.
Scholarly works on logistics, strategic management, innovations management, and also the concepts presented in the works of contemporary foreign and Russian economists are served as theoretical and methodological basic.
Structure of the work: The structure of the work is determined by the aim of the research and the formulated objects.
Principal results: The importance of the research is determined by the containing idea and recommendations about the logistics support of informative-educative mechanism of business, science and education structural integration. They create real opportunities for effective introduction of scientific achievements in production, formation of favourable investment climate on the regional level and training a new creative-thinking graduate.
Scientific novelty: The main indications of educational services logistisations – creation of regional educative consortium that would realize the task standing before the educational establishments of higher education – training of graduates appropriate to the innovative period of economic development are scientifically grounded. A principally new approach to the formation of a new graduate type is advanced. A new approach to the educational establishments' management, the formation of new forms of interaction between state, business and educational establishments on the basis of logistics, that present a training process as supplying chain management, are the sufficient condition for providing our state competitiveness on the innovative base.
The theoretical importance is in the development of logistics management's scientific base in the period of innovative economy, and elaboration of conceptual thesis of organizing economic mechanism of educational establishments management applied to regional educational establishments of higher education.
The logistic principles and organizing economic basis of modern scientific-innovative complex of educative services are formulated.
The particular participation forms of educational establishments in flexible innovative interaction are determined. According to the innovative type of economy development the main directions of educative process' changes by the means of logistics are substantiated.
Practical importance: The new requirements and conditions of formation and development of educational services market are worked out. The reasons of revealing and activization of intellectual creative activity in different spheres of public life are summarized and systematized. It allows increasing the level of this process controlling, to create competitive potential in academic plans, training holders of a bachelor and a master degree, and building new interaction forms in educational establishments of higher education. It becomes possible on the basis of net approach – creation of educational consortiums vertically – on the sphere level – and horizontally – on the regional level. The theoretical results are brought to the level of methodic approaches and concrete recommendations. They allow providing rational management in educational establishments of the Russian Federation and its regions with regard of world tendencies of innovative development and integration of inter-economy connections in the global economy.

1. ВВЕДЕНИЕ

Российская система образования должна измениться для того, чтобы в большей степени соответствовать потребностям времени и экономики. Опыт зарубежных государств, ранее определивших приоритетность перехода к инновационно-ориентированной экономике в качестве стратегического направления своего развития, показывает четкую взаимосвязь между уровнем развития инновационной инфраструктуры и скоростью освоения инноваций. Неразвитость связей между основными участниками инновационной деятельности и отсутствие действенных механизмов коммерциализации результатов научной мысли остаются основным препятствием на пути построения конкурентоспособной российской инновационной системы, что обусловливает актуальность развития механизма управления инновационной инфраструктурой организаций образования и определяет выбор темы исследования.

Подход к ВУЗу как к инновационно-креативной системе подразумевает как динамику изменений в вузе, так и его внешней среде, что возможно с помощью применения новых подходов к организации деятельности ВУЗа - построение логистических сетей, адаптивных цепей поставок, создание виртуальных организаций, моделирование логистических систем.

Вместе с тем, эффективная деятельность организации невозможна без адекватной системы управления. При этом, как со стороны высшего учебного заведения, так и со стороны государства, необходимы определенные усилия для развития инновационной инфраструктуры. Эффективное взаимодействие всех подсистем и элементов национальной инновационной системы (государство, образование, наука, бизнес) позволит сформировать, на наш взгляд, применимую для всех систему создания и управления инновациями в экономике государства.

В докладе The Economist Intelligence Unit «Тенденции в экономике, индустрии и корпоративной жизни. Прогноз на 2020 год» особый акцент делается на том, что нематериальная составляющая будет основой приращения добавленной стоимости компаний. Согласно данным того же Аналитического бюро, психологический портрет менеджера будущего включает в себя такие качества, как образованность, интеллектуальная развитость, креативность, навыки аналитического мышления.

Обзор имеющейся международной литературы

В работах В.Атояна, Д. Белла, Э.Брукинг, С.Глазьева, П. Друкера, Д. Львова, О. Милютиной, Р. Нельсона, Д.Норта, М. Портера и других даны основы теории управления знаниями, определены базисные принципы взаимодействия науки и производства, организационные формы их координации, изложены фундаментальные положения концепции информационной экономики и научно-технических циклов.

Исследованиям, проводимым в области логистики, посвящены труды Б.Аникина, Д.Новикова, О. Проценко, В. Щербакова, Л. Миротина, В. Сергеева, Л. Сосуновой и др.

Значительный вклад в развитие теории инноваций и инновационного менеджмента внесли Д. Гэлбрейт, М. Догсон, , В. Кингстон, Я. Кук, П. Майерс, Ф. Никсон, Б. Санто, Б. Твист, Й Шумпетер, Ф. Янсен, а также ряд российских исследователей: В. Атоян,А. Жабин, А. Карлик, , С. Носков, Б. Татарских, В. Тюрина и др.

Вопросам специфики современной экономики, роли человеческого капитала и ее развитии посвящены работы Г. Беккера, Д. Белла, Дж. Коулмана, Х. Ламперт, Н. Мэнкью, Р. Рассела, П. Самуэльсона, К. Хаксевера, Н.Горелова, О.Мельникова.

Вместе с тем комплексное изучение вопросов формирования логистической сети образовательных учреждений; создания, развития и определения эффективности инфраструктуры инновационной деятельности образовательных услуг не получило достаточно широкого развития в трудах отечественных и зарубежных ученых.

Описание методологии исследования

Организационно-методические разработки теории управления, теории новой экономики, оценки интеллектуального капитала, изложены в трудах отечественных и зарубежных ученых-экономистов, социологов, психологов, исследователей экономики труда и управления.

В классификации знаний, разработанной экспертами Европейской комиссии, среди других названы квалификации (компетенции), получаемые в процессе обучения в высших учебных заведениях, корпоративном секторе, на профессиональных курсах или являющиеся результатом профессионального опыта работников во всех секторах экономики, включая исследовательский сектор.

Знание по своей природе обладает интеграционной способностью. Оно помогает человеку понять смысл сложной и иногда противоречивой информации. Управление знаниями стремится к объединению, коммуникациям и обеспечению сотрудничества. Образовательные организации, пытающиеся создать и распространить знания, должны позаботиться о структуре. Им необходимо иметь концептуальную систему, чтобы направлять свою деятельность и измерять процесс, разделять общие взгляды и использовать знания для общей основы обмена знаниями и сотрудничества.

Согласно стратегии развития России до 2020 года целью государственной политики в области развития науки и технологий является стратегия инновационного развития страны, опирающаяся на реализацию человеческого потенциала, на наиболее эффективное применение знаний и умений людей для постоянного улучшения технологий, экономических результатов, жизни общества в целом.

Высшей задачей образовательного процесса на всех его стадиях становится развитие у человека сбалансированного навыка к получению и созданию нового знания, а также применению этих знаний на практике, с учетом принципов научного мировоззрения.

Процесс инновационного развития региона не может быть обусловлен лишь инновациями в промышленности, что отражено в известной классификации инноваций, представленной в таблице 1 [1].

Таблица 1

Классификация инноваций

Классификационный признак	Классификационные группировки инноваций
1. Область применения.	Управленческие, организационные, социальные, промышленные, торговые и др.
2. Этапы НТП, результатом которых стала инновация.	Научные, технические, технологические, конструкторские, производственные, информационные.
3. Степень интенсивности.	«Бум», равномерная, слабая, массовая.
4. Темпы осуществления инноваций.	Быстрые, замедленные, затухающие, нарастающие, равномерные, скачкообразные.
5. Масштабы инноваций.	Трансконтинентальные, транснациональные, региональные, крупные, средние, мелкие.
6. Результативность.	Высокая, низкая, средняя.
7. Эффективность инноваций.	Экономическая, социальная, экологическая, интегральная.

Успех инновационной системы в большей степени зависит от формы управления. Можно выделить три группы управления: рынки, которые включают обратные и прямые связи, а также горизонтальные связи; иерархические структуры (бюрократические), с односторонними потоками средств, умений и знаний; и структуры взаимодействия, такие как сети «потребитель – производитель». Главным итогом научно-технического и инновационного развития XX столетия является, по мнению ряда ученых, преодоление исторической изолированности науки как самодостаточной сферы деятельности, отказ от линейных методов организации инновационных процессов и формирование сетевых систем создания и рыночного освоения новшеств.

Вместе с тем, в случае высокой дифференциации социально-экономического развития регионов к каждому из них потребуется индивидуальный подход, который должен быть сформирован на уровне государства с участием администраций заинтересованных регионов.

В исследованиях по инновационной системе важное место занимают измерение и оценка потоков знаний и информации, так как технологическое развитие во многом является результатом сложного комплекса взаимосвязей между участниками системы. Для абсолютно всех стран, вне зависимости от выбранной стратегии и уровня технологического развития важны следующие направления – создание цепочек взаимодействия между бизнесом и созидателями знаний и технологий; постоянное совершенствование инфраструктуры информационно-коммуникационных технологий; развитие системы образования, включая высшие учебные заведения. Для регионов, в этой связи, на наш взгляд, необходимо создать цепочку взаимодействия между ВУЗами.

Конкурентное преимущество должно быть основано на реагировании на потребности конечного потребителя, а не на соперничестве. Основные положения управления цепочкой были сформулированы еще в 1982 г. Оливером и Уэббером. Управление цепочкой поставок рассматривает саму цепь как единую организацию; требует принятия стратегических решений; требует системной интеграции.

Из данного подхода естественным образом следует, что цепочки поставок необходимо рассматривать именно как сети. При этом термины могут быть взаимозаменяемыми, лишь с той разницей, что термин «сеть» описывает более сложную структуру, в которой связи между компаниями носят двухсторонний характер, и движение ресурсов происходит в разных направлениях.

Оптимизация процесса поставок неизбежно ведет к росту взаимозависимости среди партнеров по цепочке поставок. Партнерам, возможно, придется выработать ряд механизмов для контроля. Хантер и др. комментируют: «У обеих организаций останется независимое правление, но будет набор похожих механизмов управления, подходящих для их совместных трудовых отношений, что в какой-то степени будет соответствовать условиям интеграционной модели организации».

Логистика в современных условиях отождествляется с процессом управления и рассматривается как интегральный инструмент менеджмента, способствующий достижению стратегических, тактических или оперативных целей организации бизнеса. При оказании услуг базовой и инновационной логистики особое внимание должно быть уделено вопросам формулирования принципов принятия оптимальных решений

Инновационную логистику можно рассматривать как совокупность научных знаний, методов и навыков по изучению и рациональной оптимальной организации любых потоковых процессов с целью повышения эффективности их конечных результатов за счет выявления и использования дополнительных, скрытых резервов управления.

Использование инновационной логистики в области медицины и здравоохранения, туризма, спорта, юриспруденции, банковских услуг, транспортно-экспедиционных услуг позволяет получить приращение результатов. Потребность в применении инновационной логистики назрела и при оказании образовательных услуг. Ведущая роль творческих услуг в развитии новой экономики невозможна, на наш взгляд, без формирования адекватного механизма рынка управленческих услуг как особой сферы интеллектуально-креативной деятельности при разработке нормативных моделей управления при обеспечении их управляемости и разработки на этой основе основополагающих принципов и методов, позволяющих повысить эффективность управления рынком образовательных услуг.

Необходима интеграция интеллектуального капитала и его креативной составляющей для обеспечения конкурентоспособности, как материального производства, так и сферы услуг, в том числе и образовательных, что на практике позволит наиболее полно реализовать новые образовательные технологии как результат интеллектуально-креативной деятельности. Качество подготовки управленческих кадров в России заметно отстает от западных стандартов. Вузы страны должны разрабатывать образовательные программы в соответствии со спецификой региона. Структурные сдвиги в национальной экономике, обусловленные ее переходом на рыночную основу, пробудили интерес экономистов к рынку услуг, самому феномену услуг, в том числе образовательных, которые «выражаются в обучении потенциальных (будущих) и нынешних работников» [3]. В условиях модернизации экономики выпускники ВУЗа должны приобрести новые компетенции, так как необходимы работники для внедрения новых технологий в производство и коммерческую деятельность, следовательно, необходимо развитие новых профессий для инновационного развития общества.

Высокая социальная значимость рынка услуг для общества делает этот рынок социально-ориентированным, где механизмы конкуренции играют подчиненную роль по сравнению с механизмами государственного регулирования.

Синтез образовательного процесса, научных исследований при поддержке федеральных и региональных органов власти в процессе формирования единой инновационной сети может стать реальным путем инновационного возрождения экономики, активизации ее научно-технического потенциала. Сложность и многоплановость проблем информационно-образовательного обеспечения инновационных процессов очевидна: подготовка и переподготовка кадров для научно-технической и инновационной деятельности в условиях рыночной экономики, включая обучение целевых «менеджерских команд» для управления реализацией конкретных предпринимательских проектов; продвижение научно-технических разработок и наукоемкой продукции на региональные, межрегиональные, федеральный и зарубежный рынки.

Дезинтеграция, искусственное разделение сферы образования, научного творчества и инноваций стало одной из причин заметного ослабления инновационного потенциала российской экономики. Объективная необходимость модернизации системы образования возникла как реакция на требования рыночной экономики.

Характерной чертой современной «новой экономики» является развитие сетевых организаций. Сеть — это устойчивая система связей между людьми и организациями. Сетевые организации не используют иерархические структуры. Они представляют организации нового типа, выполняющие весь жизненный цикл производства продукции, маркетинг, сбыт, обслуживание и системную интеграцию. Предприятия, организованные по сетевому принципу, имеют большую эффективность благодаря взаимодействию между всеми участниками цепи поставок.

В соответствии с системным подходом к инновационной деятельности необходим поиск новых организационно-экономических форм интеграции науки, образования и инноваций. Трансформацию ВУЗов региона целесообразно осуществлять в направлении формирования образовательного консорциума (отраслевого, территориального) в рамках которого может осуществляться подготовка нового типа специалиста, бакалавра, магистра на базе вовлечения персонала и студентов вузов в инновационную деятельность. При этом важно обеспечить кооперацию консорциума с другими организациями региона с целью «встраивания» вновь формирующейся структуры в инновационную региональную и общероссийскую сеть [2].

Признаки гибкой цепочки поставок как нельзя лучше подходят для описания деятельности образовательного консорциума ВУЗов региона, а именно:

1. Чуткость к потребителю.
2. Цепочку поставок следует рассматривать как сеть партнеров, у которых есть общая цель работать вместе, чтобы удовлетворить нужды конечного потребителя образовательных услуг.
3. Сеть рассматривается как система бизнес-процессов, так как соединение возможностей этих процессов создает мощность и синергию для данной сети.

4. Использование информационных технологий между потребителями образовательных услуг и вузами для обмена данными создает виртуальную цепочку поставок (например, в виде образовательного портала) консорциума.

Таким образом, гибкая цепочка поставок является хорошим практическим подходом к организации логистических возможностей вокруг индивидуального спроса конечного потребителя образовательных услуг – выпускника ВУЗа.

Образовательный консорциум призван стать системообразующим компонентом и центральным звеном региональной инновационной системы, создающим интегрированную инновационную сеть региона, что позволит добиться получения синергетического эффекта в сетевой модели взаимодействия различных участников инновационного процесса.

То, что мы иногда называем системами, на самом деле может не отвечать требованиям систем в строго научном понимании, так как многие из них плохо организованы и не обладают интегративными свойствами; свойство или потенциал таких систем не больше, чем сумма свойств или потенциалов составных элементов. Многие существующие логистические системы являются псевдосистемами, так как не удовлетворяют основным системным требованиям. Каждая система должна рассматриваться во взаимодействии с другими системами того же уровня иерархии с учетом синергизма и взаимодействия.

Системный подход к формированию современного специалиста заключается в интеграции отдельных элементов в единую логистическую систему, способную адекватно реагировать на изменения факторов внешней среды [1]. Меняется характер рыночной конкуренции: конкуренция отдельных компаний перерастает в конкуренцию союзов и альянсов в цепи поставок. Это требует разработки новых форм и методов управления, интеграции и координации деятельности партнеров в сфере производства, торговли, предоставления услуг, в том числе образовательных.

Достижение стратегических целей повышения качества высшего профессионального образования может быть возможным при интеграции ВУЗов на основе сети и логистических систем. Работа ВУЗов в рамках логистических сетей предоставляет ряд преимуществ, которые, в свою очередь, приводят к существенному снижению общих затрат с одновременным повышением качества функционирования всей системы. В современных условиях успех компании зависит не только от наличия собственных ресурсов, но и умения привлекать ресурсы и рыночные возможности других участников цепочки поставок на основе партнерского сотрудничества. Таким образом, новой институциональной моделью вузовского образования в этой связи является консорциум ВУЗов. Можно сказать, что консорциум, осуществляя брокерскую связь между студентами и традиционными вузами, может предоставлять как курсы высшей школы, так и аспирантские курсы, программы продолженного образования и подготовительные курсы для абитуриентов. Наиболее важно то, что консорциум дает возможность получить степени и сертификаты тех ВУЗов, которые входят в консорциум. Следовательно, обучаясь в ВУЗе, студент сможет выбрать более качественную образовательную услугу в рамках консорциума.

Управление цепочками поставок – это весь процесс взаимодействия как внутри, так и вне компании, направленный не только на учет и управление цепочкой поставок, но и на оптимизацию затрат, возникающих в процессе взаимодействия. Цепь поставок представляет собой интегрированную структуру, в рамках которой организация объединяет усилия со своими поставщиками, чтобы эффективно довести продукцию до своих потребителей. Таким образом, деятельность консорциумов ВУЗов можно рассматривать как ту или иную цепь поставок.

Результаты

В статье обобщены и развиты методологические подходы к анализу состояния и развития методов и механизмов оценки и экономического использования потенциала ВУЗов в подготовке креативных менеджеров, адаптированных к новым условиям экономики.

Выявлены условия и закономерности функционирования сферы образовательных услуг, определены особенности ее формирования в инновационной экономике, приводящие к возможности подготовки нового типа менеджера. Уточнены теоретико-методологическое обоснование сущности и содержательной интерпретации понятия «управление цепочкой поставки» применительно к образовательным услугам. Предложена концептуальная модель управления образовательными учреждениями, использующая подходы и принципы многоуровневой логистической координации применительно к деятельности сложноструктурированных иерархических систем. Выработаны конкретные рекомендации и предложения по формированию комплекса образовательных услуг с использованием инновационной логистики.

Заключение

Россия не сумеет создать эффективное рыночное хозяйство и достойно войти в глобальную экономику без крупномасштабной сферы услуг с развитым транспортом, связью, торговлей, финансово-кредитным и страховыми секторами, комплексом деловых и образовательных услуг и другими отраслями услуг, отвечающими новым требованиям.

Чтобы максимально реализовать свои возможности ВУЗу, в борьбе за абитуриента, необходимо хорошо изучить свои сильные и слабые стороны, провести соответствующие маркетинговые исследования и создать организационную структуру по выполнению соответствующих функций, отвечающую концепции логистики. Иначе говоря, определить макроуровень логистического сервиса. После макросегментации, обоснования стратегии и формирования структуры соответствующих служб консорциума необходимо провести микросегментацию с разработкой тактики соответствующих действий на рынке, корректировкой механизма реализации образовательных услуг.

Образовательный консорциум региона позволит получить новую систему, способную повысить эффективность функционирования ВУЗов, что достигается снижением совокупных издержек и концентрацией ресурсов знаний в области образования.

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THE FORMATION OF REGIONAL LOGISTICS CENTER BASIS OF REGIONAL AND NATIONAL INFRASTRUCTURE

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1. INTRODUCTION

The article describes the general economic conditions and characteristics of the Omsk region, affecting the process of establishing the logistics infrastructure. Published graphical model of regional logistics infrastructure, consisting of many elements. Finally, put the proposal to use an integrated approach in forming a regional logistics infrastructure.

2. MAIN RESULTS

In the region there is a lack of multimodal transport and logistics center (MTLTS) to coordinate the cooperation of all parties to transport and logistic systems - products of the manufacturers, carriers, freight forwarders, trade brokers, banking institutions, insurance companies, service industries and some others. In order to form, effective functioning and development of the logistics infrastructure of Omsk region mutually beneficial partnerships and logistics systems, formed on the territory of Trans-Baikal and the Siberian Federal District, as well as organization of strategic interaction with international and federal program in the field of logistics.Thus, the further development of the economy Omsk region should co-transmitting the formation of a regional logistics infrastructure. Regional logistics infrastructure and its components must be ahead in its development, all other sectors of the economy and social sphere region. Otherwise backward logistics infrastructure will hinder the development of the region on the whole. Figure 1 provides an overview graphic model of the main elements proposed to create a logistics infrastructure of Omsk region. This model includes a set of elements, combined in the two sub-systems: functional and secure. In turn, functional subsystem consists of three interrelated elements:

- Omsk transport hub, providing entrances and exits from the region of various goods, trunk and local transport of goods and delivering them to consumers;
- logistics intermediaries, organizers of goods and merchandise of the region and beyond;
  - regional distribution centers, which is coordination and interaction modes of transport, the concentration of traffic, their distribution to areas of transport and groups customers.

Regional logistics infrastructure

Functional subsystem | **Providing subsystem**

Omsk the transport hub	Logistic-mediators	The regional distribution centers	Information ensuring	Financial ensuring	Legal ensur-ing (or legal provision)	Scientific and technical and staffing en-suring
Magistralnaya network of com-munitytion of ways to climb-ezdnymi ways; Objects trans-tailor infrastructure, Regional Transport Management	Wholesale trade govye from mul-lion;Distribyu-Torah;Freight forwarders; Car-riers, agents, dile-market, brokers, Informa-tion and con-salting compa-nies and others	Industrial enterprises; Wholesale bases and centers wholesale trade, Centers Dist-ribyutsii	VC and ASU different trans-tailoring business, VC and ITS centers in wholesale trade and distribyuto-ditch	Regional and Federal banking structure; private investors; financial-industrial group;	Russian Government ,the State Duma, The Gov-ernment of the Omsk area of; Municipal adminastrat-siya Omsk	Omsk Institute of RGTEU; SIBADI; OmSU im.Dostoevsk ogo; Training centers; con-sulting struc-ture

Fig.1 Elements of the proposed logistics infrastructure of Omsk region

To ensure the system serves both support and integrate functions include elements of individual sub-projects Market:

- computing and information centers, transport organizations, wholesale trade cen-ters, terminal facilities, etc., in general, presented lyayuschie Integrated Regional Information System;
- regional and federal banking structure, financial-industrial groups, private inves-tors, etc.
- higher education institutions engaged in training professionals in the field of logis-tics, training centers, organizing workshops and training in logistics, consulting structure - they all define the scientific, technical and staffing for the regional lo-gistics infrastructure;
- federal and regional authorities, Local Governments, as well as the licensing and certification, providing the first state support and regulation in the product on the territory of the region.

Itself, a favorable geographical position of Russia and Omsk region can not provide the volume growth of transit traffic, seriously affect the regional economy and the Russian budget. Must overcome the weakness of national and regional logistic trans-port infrastructures. The main directions of modernization and development of logis-tics infrastructure of the Omsk region is the establishment of a regional logistics cen-ter, as well as repair and construction of highways, upgrading the vehicle fleet. Russia with its vast territory, different levels of socio-economic and economic and geographical conditions for successful integration into the Euro-Asian transport corridors, create a network of regional logistics centers capable of providing reception, cargo handling, consolidation and dispatch of material flow in different directions. Furthermore, it should harmonize the legislation of Russia and other countries involved in international transport corridors. The solution of these problems will allow Russia to substantially strengthen its position in the global market of transit services, and the region will provide a solution such socio-economic tasks, such as: increasing employment by creating jobs, attracting investment, expanding the market for transportation and logistics services.

3. AKADEMIC CONTRIBUTION

Provides an overview of graphical models of the main elements proposed for the creation of logistic infrastructure of the Omsk region. This model includes a set of elements, combined in two subsystems: a functional and secure.

4. MANAGERIAL INSIGHTS

Development of regional logistics infrastructure will eventually allow for: to solve the socio-economic problems of the region, increase employment by creating new jobs and attract investment, increase revenues from the system makrologisticheskoy operation and expansion of the consumer market for transportation and logistics services.

ФОРМИРОВАНИЕ РЕГИОНАЛЬНЫХ ЛОГИСТИЧЕСКИХ ЦЕНТРОВ ОСНОВА РАЗВИТИЯ РЕГИОНАЛЬНОЙ И НАЦИОНАЛЬНОЙ ИНФРАСТРУКТУРЫ

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Аннотация: В статье раскрываются особенности региона, влияющие на процесс формирование логистической инфраструктуры и создание регионального логистического центра. Рассматривается сущность и виды логистических центров. В заключении выносится предложение о необходимости создания сети региональных логистических центров с целью интеграции России в мировую логистическую систему.

Развитие глобализации, возникновение кризисных ситуаций заставляет пристально изучать новейшие экономические тенденции, влияющие на уровень конкурентоспособности национальной и региональной экономики. Острая борьба за лидирующее место в экономике XXI столетия требует исследований в области условий и факторов, определяющих экономическое развитие региона. Особое место в этом направлении занимают исследования и проекты в области логистики. Это объясняется, с одной стороны, стремительным развитием логистики и её использованием в различных отраслях экономики, а с другой стороны – для выхода региональной экономики на цивилизованный уровень развития необходимы налаженные связи, взаимодействие и интеграция экономических субъектов, как внутри страны, так и за её пределами.

Говоря о государственной политике можно отметить, что переход от экспортно-сырьевой к инновационной модели экономического роста страны требует реализации комплекса преобразований по нескольким направлениям. В частности, актуальным является не только закрепление и расширение глобальных конкурентных преимуществ России в традиционных сферах (энергетика, транспорт, сельское хозяйство, переработка природных ресурсов), но и создание региональных логистических центров с целью формирования современной транспортно-логистической инфраструктуры страны.

В этой связи нами будет рассмотрена региональная логистическая инфраструктура и её составляющие, обоснована необходимость создания логистического центра в Омском регионе.

1. РЕГИОНАЛЬНАЯ ЛОГИСТИЧЕСКАЯ ИНФРАСТРУКТУРА

Во время визита в Париж вице-премьер РФ Сергей Иванов обозначил некоторые тенденции в российской национальной логистической системе следующим образом: «Общий объем российского рынка транспортно-логистических услуг может увеличиться до 2015 года примерно в три раза, с 48,5 до 151 млрд. долл. Причем среднегодовые темпы роста составят около 15 процентов. Вместе с тем, идёт рост инвестиций в портовую и терминальную инфраструктуры, складское хозяйство. Сотни миллиардов рублей уже вложены в развитие портов Балтики, продолжается развитие Тихоокеанского направления, нарастает процесс консолидации отрасли и формирование крупных холдингов» [5].

Как известно в состав рыночной инфраструктуры входят институты, оказывающие посреднические услуги в различных областях хозяйственной деятельности. Комплекс элементов, отвечающих за процесс товародвижения материальных и сопровождающих их информационных, финансовых потоков на региональном уровне можно представить как логистическую инфраструктуру. Модель региональной логистической инфраструктуры, объединяющая две подсистемы, функциональную и обеспечивающую представлена на рис.1.

Региональная логистическая инфраструктура

Функциональная подсистема | **Обеспечивающая подсистема**

Омский транспортный узел;	Логистические посредники	Региональные распределительные центры	Информационное обеспечение	Финансовое обеспечение	Нормативно-правовое обеспечение	Научно-техническое и кадровое обеспечение
Магистральная сеть путей сообщения с подъездными путями; Объекты транспортной инфраструктуры; Региональные управления транспортом	Оптовые торговые посредники; Дистрибьюторы ; Экспедиторы; Перевозчики, агенты, дилеры, брокеры; информационные и консалтинговые компании и др.	РРЦ промышленных предприятий; Оптовые базы и центры оптовой торговли; Центры дистрибью-ции	ВЦ и АСУ разных транспортных предприятий; ВЦ и ИЦ центров оптовой торговли и дистрибьюторов	Региональные и федеральные банковские структуры; частные инвесторы; финансово-промышленные группы	Правительство РФ; Госдума; Правительство Омской области; Муниципальная админастрация	Омский ин-т РГТЭУ; СИБАДИ; ОМГУ им.Достоевского; Учебные центры; консалтинговые структуры

Рис.1.Элементы логистической инфраструктуры Омского региона [1]

В свою очередь функциональную подсистему представляют три взаимосвязанные элемента:

- Омский транспортный узел, обеспечивающий входы и выходы из региона различных грузов, магистральные и местные перевозки грузов и их доставку конечным потребителям;
- логистические посредники, организующие систему товародвижения и выполняющие специализированные услуги в регионе и за его пределами;
- региональные распределительные центры (РРЦ), а также дистрибьютерские центры, центры оптовой торговли, в которых осуществляется координация и взаимодействие разных видов транспорта, концентрация грузопотоков, грузопереработка и их распределение по направлениям перевозки и группам обслуживаемых клиентов.

К обеспечивающей системе, выполняющей одновременно поддерживающие и интегрирующие функции, относятся элементы, представляющие отдельные субъекты рынка:

- вычислительные и информационные центры транспортных организаций, центров оптовой торговли, терминальных комплексов и т.д., в целом представляющие интегрированную региональную информационную систему;
- региональные и федеральные банковские структуры, финансово-промышленные группы, частные инвесторы и т.д.
- высшие учебные заведения, осуществляющие подготовку специалистов в области логистики, учебные центры, организующие практические семинары и тренинги в области логистики, консалтинговые структуры – все они определяют научно-техническое и кадровое обеспечение региональной логистической инфраструктуры;
- федеральные и региональные органы государственной власти, местное самоуправление, а также органы лицензирования и сертификации, оказывающие государственную поддержку и регулирование процессов товародвижения на территории региона.

Практика свидетельствует, что логистическая инфраструктура существенно влияет как в целом на социально-экономическое развитие региона, так и на бизнес отдельных компаний и организаций. Однако с одной стороны отсталая логистическая инфраструктура может сдерживать развитие региона в целом. С другой стороны, спонтанное, не скоординированное создание разрозненных субъектов инфраструктуры в регионе только усугубляет изоляцию хозяйствующих структур. Это подтверждает необходимость комплексного подхода к формированию механизмов интеграции производственного, торгового, транспортного и складского хозяйства региона в комплексную систему товародвижения.

Необходимо отметить, что в регионе ощущается отсутствие весьма весомого элемента логистической инфраструктуры - мультимодального транспортно-логистического центра (МТЛЦ), позволяющего скоординировать взаимодействие всех участников логистической системы - производителей продукции, перевозчиков, экспедиторов, торговых посредников, банковских структур, страховых компаний, индустрии сервиса и ряда других субъектов.

2. ПОНЯТИЕ И СУЩНОСТЬ ЛОГИСТИЧЕСКИХ ЦЕНТРОВ

В учебном пособии д.э.н., профессора Л.Б.Миротина можно найти следующее определение: «Логистические центры (парки) – это рыночные предприятия, осуществляющие координацию логистического (складского и транспортного) обслуживания и информационного обеспечения, а также их контроль»[3]. В последние годы всё чаще говорят о необходимости создания сети региональных логистических центров в России. Логистические центры, объединяя на одной платформе компании разных отраслей и транспортные коммуникации, устанавливают качественно новые стандарты в обслуживании клиентов и управлении логистикой.

Другими словами, логистический центр может быть представлен пунктом стыковки максимально возможного числа разнообразных транспортных средств, для организации эффективных и ресурсосберегающих грузоперевозок. По своей сути логистический центр - совокупность участников процесса товародвижения: экспедиторов, поставщиков услуг, логистических операторов с оптимально удобным расположением на территории региона. Концентрация на одной территории отдельных, экономически не зависящих субъектов сопровождается эффектом синергии ресурсов и образованием, так называемого логистического кластера. При этом синергетический эффект может проявляться в: совместном использовании разнообразных погрузочно-разгрузочных механизмов, подъёмно-транспортного оборудования, консолидации отправок в одном направлении от разных поставщиков, совместной закупочной деятельности и т.д.

На территории логистического центра могут быть организованы таможенные посты и парки автомобильного транспорта, привлечены экспедиционные фирмы, финансовые организации, созданы торговые объекты, объекты информационного обеспечения, охранные агентства, построены мотели и рестораны, т.е. наличие большого числа мелких компаний и фирм, осуществляющих специализированные услуги.

Логистические центры в зависимости от выполняемых задач и функций можно разделить на следующие категории:

- международные логистические центры распределения (International Logistics Center of Distribution – LCD);
- региональные логистические центры распределения (RLCD);
- локальные логистические центры распределения (LLCD);
- логистические торгово-распределительные центры (Trade Logistics Center of Distribution – TLCD);
- Центры логистических услуг (Center of Logistics Service – CLS) [3].

Региональный логистический центр выступает как элемент системы в виде координирующего органа, обеспечивающего решение задач по привлечению товаропотока в регион, формированию эффективных логистических цепей, распределению грузопотоков в зависимости от пропускной способности транспортной инфраструктуры региона и провозной способности различных видов транспорта.

Положительным моментом в развитии данного направления в Омском регионе является разработка долгосрочной целевой программы Омской области «Развитие объектов транспортной инфраструктуры Омской области (2010-2016 годы)», утверждённая постановлением Правительства Омской области от 07.10.2009г № 183-п. Основными ожидаемыми результатами данной программы значатся: завершение строительства международного аэропорта «Омск-Фёдоровка»; создание условий для формирования мультимодального транспортного узла [2]. В настоящее время около 20% грузов во всём мире перевозятся авиационным транспортом. И всего 2% авиационный транспорт используется в России. Эта диспропорция обусловлена отсутствием современной авиационной инфраструктуры в России, современных аэропортов, грузовых терминалов.

Строительство современного аэропорта сыграет важную роль в развитии внешнеэкономических связей Омской области, позволит осуществлять перевозки пассажиров и грузов не только на территории Российской Федерации, но и транзитные перевозки из Европы, европейской части России в среднеазиатские страны СНГ, Китай, страны Юго-Восточной Азии. Омская область, находясь на пересечении транспортных коридоров, соединяющих Европу с Дальним Востоком, Казахстаном и Китаем, имеет все предпосылки для создания крупнейшего в Сибири логистического центра в районе аэропорта «Омск-Фёдоровка». Развитие региональной логистической инфраструктуры во многом определяется её географическим месторасположением.

3. ГЕОГРАФИЧЕСКАЯ ОСОБЕННОСТЬ ОМСКОЙ ОБЛАСТИ

Омская область расположена в юго-западной части Сибирского федерального округа. Она занимает площадь 141,1 тыс.кв.км. и граничит с республикой Казахстан, Тюменской, Новосибирской и Томской областями России. Отличительной особенностью местоположения области служит то обстоятельство, что она является приграничной территорией. На протяжении 1187км в южной части она граничит с Казахстаном, что создаёт определённые возможности в осуществлении взаимных контактов со средней Азией. На протяжении 1325 км она граничит с Уральским федеральным округом, что благоприятствует развитию экономических связей с Екатеринбургской и Челябинской областями и нефтегазоносными районами Тюменской области, на Востоке Омская область на протяжении 978 км граничит с Томской и Новосибирской областями федерального округа. В южной части области проходят железная дорога «Трансиб» и автомобильные дороги федерального значения «Байкал» и «Тюмень-Омск». Территорию области с юга на север пересекает судоходная река Иртыш, дающая дополнительную связь с северными территориями. Область имеет разветвлённую сеть транспортных коммуникаций. Её территорию пересекает Транссибирская железнодорожная магистраль, соединяющая западные и восточные районы страны, а также северные территории России с областями Республики Казахстан и Средней Азии. По территории Омской области проходит 752 км железнодорожных путей общего пользования; 17,5 тыс. км автомобильных дорог, из которых 729 км – дороги федерального значения; 1474км внутренних водных судоходных путей, порядка 665км нефте - и нефтепродуктов. Таким образом, автомобильные и железные дороги, водные пути и воздушные линии, пересекающие территорию Омской области следует рассматривать не как замкнутые сети, а как разумные и рациональные переходы, обеспечивающие мультимодальность использования различные видов транспорта.

Анализ мировой и российской практики социально-экономического развития территорий, позволил выделить некоторые направления актуальные для Омского региона:

- продолжить формирование и развитие интегрированной логистической инфраструктуры региона, что в свою очередь будет сопровождаться оптимизацией товарных потоков на региональном потребительском рынке;
- приступить к разработке «Стратегии развития транспортно-логистического комплекса Омского региона».
- установить партнёрские взаимоотношения с территорией Забайкалья и Сибирского федерального округа;
- создавать нормативно-правовую базу, а также научно-методическое обеспечение транспортно-логистической деятельности;
- на основе государственно-частного партнёрства реализовывать инвестиционные проекты, направленные на модернизацию региональной логистической инфраструктуры: строительство терминалов, дистрибутивных центров, обновление парка транспортных средств, ремонт и строительство транспортных магистралей, в т.ч. создание регионального логистического центра.

Эффективная организация логистической инфраструктуры создает её увязку с экономическим развитием региона и страны в целом. В частности экономические выгоды, связанные с активным участием страны в глобальной торговой системе, рассматриваются нами как наиболее важные. В связи с этим интерес представляет анализ направлений движения товарных потоков в мировом масштабе, складывающихся в настоящее время. Первое место по импорту занимает Китай (на его долю приходится 16,2 %).

4. АНАЛИЗ НАПРАВЛЕНИЙ ДВИЖЕНИЯ ТОВАРНЫХ ПОТОКОВ

В последние десять лет ситуация складывается таким образом, что страны Азиатско-Тихоокеанского региона, в силу культурных и экономических особенностей, стали местом сосредоточения основных центров товарного производства, центров формирования товарных потоков. Рынки потребления, сосредоточены в Западной, Восточной и Центральной Европе, а так же в Скандинавских странах. Поток товаров из центров мирового производства в центры мирового потребления постоянно растет. Мировая торговля устанавливает направление, структуру, динамику грузопотоков, организацию и технологию транспортных процессов. Экспортно-импортные перевозки и международный транзит обслуживают международные транспортные коридоры – ключевые элементы транспортно-логистической инфраструктуры любой страны. Так, на территории Евразии действует три сухопутных международных евроазиатских коридора - Север-Юг, Транссиб и ТАЖД, а также два морских маршрута – Северный морской путь и Южный морской путь.

Анализ мировой морской торговли показал, что основным евроазиатским транспортным коридором, обслуживающим большую часть грузопотока в направлении Азия - Европа в настоящее время, является Южный морской путь. Альтернативные транспортные коридоры, проходящие по территории Российской Федерации, такие как Северный морской путь, Транссиб, Север-Юг, хотя и располагают высокими пропускными способностями и значительно экономят время грузов в пути, но имеют свои недостатки, которые тормозят поток транзитных грузов в современном приоритетном направлении по территории России. Мировое бизнес-сообщество несет убытки и продолжает использовать не самые короткие и удобные пути, а поэтому ищет новые способы для установления транспортного диалога Европа – Азия. В этой связи уникальное географическое положение России позволяет рассматривать нашу страну в качестве естественного моста, обеспечивающего транзитные связи на направлении Европа - Азия. В настоящее время используется лишь 5-7 % транзитного потенциала РФ. Страна ежегодно теряет из-за отсутствия транзита порядка 15 млрд долл. [6].

Вместе с тем, международные торговые компании оценивают национальный рынок логистики как молодой, развивающийся и перспективный. Европейская экономическая комиссия, оценив таможни, инфраструктуру и компетенции специалистов, занятых в данной отрасли, присвоила России лишь 99-е место среди 150 стран мира в рейтинге развития логистики. Вряд ли стоит списывать столь скромные позиции в этом рейтинге только на кризис.

5. ЗАКЛЮЧЕНИЕ

Само по себе выгодное географическое положение России и Омского региона не может обеспечить прирост объемов транзитных перевозок, серьёзно повлиять на региональную экономику и российский бюджет. Следует преодолеть слабую национальную и региональную транспортно-логистичскую инфраструктуру. Основными направлениями модернизации и развития логистической инфраструктуры Омского региона является создание регионального мультимодального логистического центра, а также ремонт и строительство транспортных магистралей, обновление парка транспортных средств. России с ее огромной территорией, различным уровнем социально-экономических и экономико-географических условий, для успешной интеграции в систему евроазиатских транспортных коридоров, необходимо создать сеть региональных логистических центров, способных обеспечивать приём, грузопереработку, консолидацию и отправление материальных потоков в разных направлениях. Кроме того, следует гармонизировать законодательство Российской Федерации и других стран-участниц международных транспортных коридоров. Решение перечисленных проблем позволит России существенно усилить свои позиции на мировом рынке транзитных услуг, а региону обеспечит решение такие социально-экономических задачи, как: повышение уровня занятости населения за счёт создания новых рабочих мест, привлечение инвестиций, расширение рынка транспортно-логистического сервиса**.**

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ПОСТРОЕНИЕ ЛОГИСТИЧЕСКОЙ СИСТЕМЫ ВЗАИМОДЕЙСТВИЯ ПРЕДПРИНИМАТЕЛЬСКИХ И ВЛАСТНЫХ СТРУКТУР (НА ПРИМЕРЕ ЛЕСОПРОМЫШЛЕННОГО КОМПЛЕКСА РЕГИОНА)

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Аннотация: Цель статьи состоит в теоретическом обосновании и практической апробации подходов построения логистической системы многосторонних партнерств на примере лесопромышленного комплекса региона.

THE BUILDING OF LOGISTICS SYSTEM OF ENTREPRENEURSHIP AND GOVERNMENT BODIES INTERACTION (ON THE EXAMPLE OF THE REGIONAL TIMBER INDUSTRY COMPLEX)

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Abstract: The aim of the article consists in the theoretical substantiation and practical approbation of logistics system of many-sided partnerships building on the example of the regional timber industry complex.

1. ВВЕДЕНИЕ

Важным фактором устойчивого экономического развития и достижения нормального уровня жизнеобеспечения населения является формирование цивилизованного современного предпринимательства в экономическом пространстве России. Экономические достижения, в том числе высокие темпы экономического роста, инвестиции, нововведения во многих странах с рыночной экономикой напрямую зависят от реализации предпринимательского потенциала.

Развитие предпринимательства в ресурсодобывающих и обрабатывающих отраслях играет важную роль в проведении государственной промышленной политики, в том числе в лесопромышленном комплексе, который имеет значительный потенциал, но не занимает ведущих позиций в экономике России.

Важной экономической задачей в таких условиях становится выявление путей и мер активизации взаимодействия субъектов предпринимательской деятельности с государством в лесопромышленном комплексе и построение логистической системы.

Обзор имеющейся международной литературы.

Значительный вклад в разработку теории предпринимательства внесли фундаментальные исследования М. Вебера, И. Кирцнера, Ж.-Б. Сэя, Й. Шумпетера и др. Современные исследования, посвященные данной проблеме, были осуществлены отечественными и зарубежными учеными, такими как М.Г. Лапуста, М. Мескон, А. Хоскинг, В.Г. Яроцкий, и др.

По проблеме институциональных аспектов отношений между государством и частным сектором опубликованы фундаментальные труды Д. Кейнса, Д. Локка, А. Смита, и др.

Различные проблемы сотрудничества институтов предпринимательства и власти с разных позиций анализировались в трудах таких ученых, как В.Г. Варнавский, В.А. Михеев, М. Портер, А.Д. Радыгин, Ф.И. Шамхалов и др. В их исследованиях уделено внимание проблемам формирования и функционирования интегрированных групп в условиях рыночной экономики.

Комплексные и всеобъемлющие исследования проблем взаимодействия предпринимательских и властных структур, по мнению автора, не дают полной картины состояния и динамики развития их сотрудничества, как в России, так и в регионах.

Недостаточно разработаны вопросы организации взаимодействия предпринимательских и властных структур в лесопромышленном комплексе. Имеющееся исследования по данной теме либо носят общесистемный характер, либо затрагивают отдельные аспекты прикладного использования, что не позволяет увязать теоретические и методологические положения с актуальными проблемами реального построения и развития организационно-экономического механизма формирования логистической системы взаимодействия предпринимательских и властных структур в лесопромышленном комплексе России.

Описание методологии исследования

Определение понятия предпринимательства всегда относилось к разряду дискуссионных. В результате выполненного исследования обоснована необходимость акцента в определении предпринимательства на сотрудничестве и взаимовыгодных отношениях с использованием новых форм и методов в целях быстрого реагирования и адаптации предпринимателя к новым условиям для достижения коммерческого успеха.

Автор с учетом мировых тенденций развития экономики предлагает уточнить существующее определение предпринимательства следующим образом: предпринимательство - инициативная самостоятельная деятельность граждан, направленная на получение прибыли или личного дохода, осуществляемая от своего имени, под свою имущественную ответственность или от имени и под юридическую ответственность юридического лица, основанная на сотрудничестве и взаимовыгодных отношениях с государством, партнерами по бизнесу, потребителями и обществом с целью формирования взаимовыгодных отношений в логистической системе многостороннего партнерства.

От эффективного сотрудничества предпринимательской системы с различными государственными структурами, а также внешней средой зависит развитие предпринимательских структур и общества. Общепризнанного определения частно-государственного взаимодействия (ЧГВ) не сложилось по причине чрезвычайного разнообразия видов и форм сотрудничества.

Частно-государственное взаимодействие раскрывается через описание классификационных признаков участников взаимодействия. Совокупность признаков прослеживается из исследований определения предпринимательства, где проявляется ряд синергетических принципов, а именно принцип эффективности взаимодействия. Поэтому, автором предложена структура классификационных признаков участников частно-государственного взаимодействия (рис.1), позволяющая дать объективную оценку рассматриваемого явления.

Данные характеристики признаков не являются полным перечнем всего многообразия специфических особенностей ЧГВ, поэтому существует определенная сложность и условность трактовки такого многогранного понятия, каким является ЧГВ. Таким образом, выделенные признаки частно-государственного взаимодействия будут трансформированы в его основные функции при поиске новых возможностей для достижения наилучших результатов сотрудничества предпринимательских и властных структур в рамках логистической системы на четко разработанных принципах паритетного взаимодействия предпринимательских и властных структур [1].

В целях разработки организационно-экономического механизма формирования взаимодействия предпринимательских и властных структур предлагается рассматривать лесопромышленный комплекс России как единую макроэкономическую систему, учитывающую всех участников независимо от формы собственности и нормативно-правовую базу, соответствующую рассматриваемой инфраструктуре рынка (рис. 2.).

Формулировка основополагающих условий и направлений формирования взаимодействия предпринимательских и властных структур позволяет утверждать, что их проявление определяет организационно-экономический механизм частно-государственного сотрудничества в лесопромышленном комплексе (рис 3).

Рис.1. Структура классификационных признаков участников частно-государственного взаимодействия

Автором выделены составляющие механизма формирования взаимодействия предпринимательских и властных структур в лесопромышленном комплексе: формы (сервисные контракты, управляющие контракты, аренда и временная передача прав, концессионные соглашения, участие в капитале); методы (административно-законодательные, финансово-экономические); структура; нормативно-правовая база.

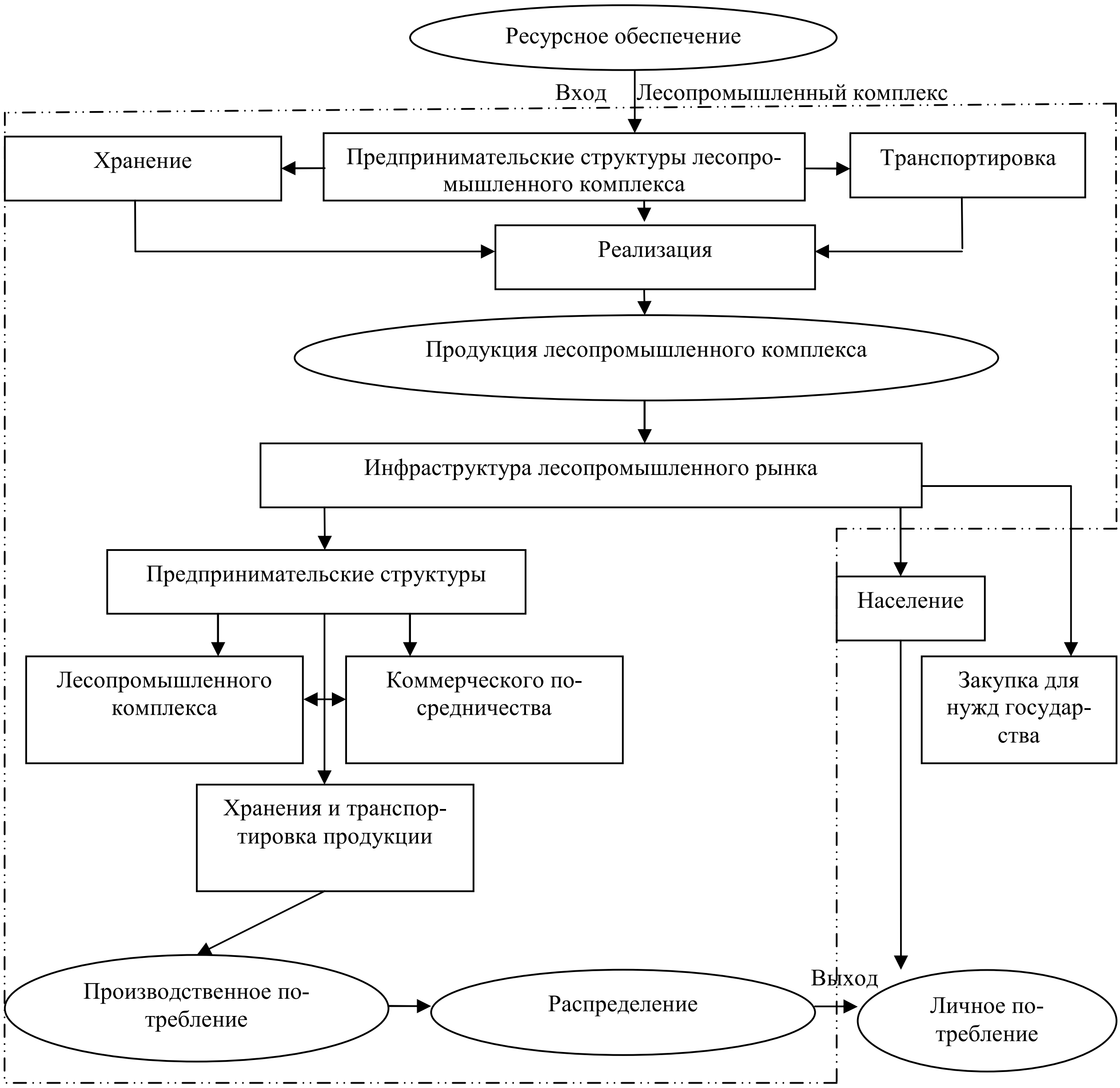

Рис.2. Макроэкономическая система лесопромышленного комплекса.

Анализ законодательства по государственной поддержке предпринимательства позволяет сделать вывод об отсутствии согласованности между федеральными и региональными органами государственной власти при оказании государственной поддержки предпринимательским структурам.

В целях согласования действий и координации взаимодействия предпринимательских и властных структур в лесопромышленном комплексе, где большую роль играет реальный диалог между предпринимательскими структурами, профильными правительственными ведомствами, учеными и экологами, предлагается создание организационной структуры – Центр содействия и развития лесопромышленного комплекса (ЦСРЛК), который позволит всем заинтересованным лицам действовать на паритетных условиях (рис. 4).

Рис.3. Основополагающие условия и направления формирования ЧГВ на примере лесопромышленного комплекса

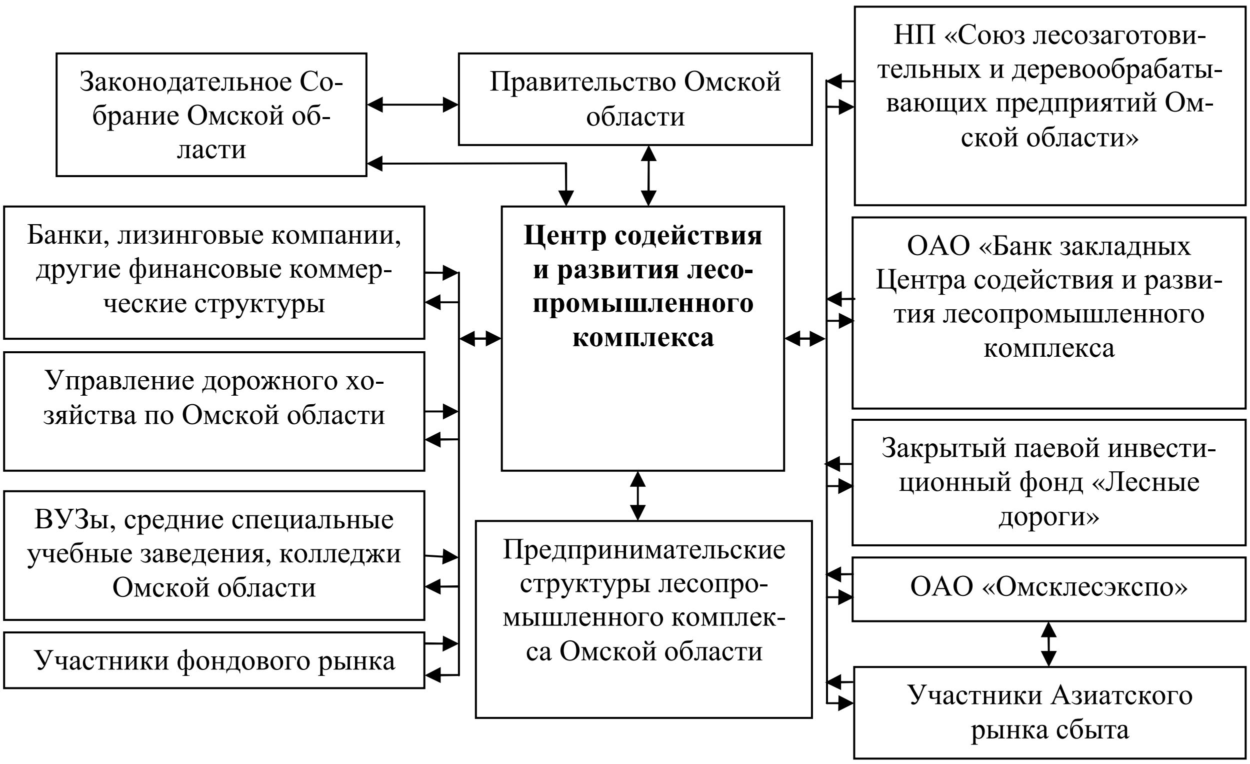

Рис.4. Взаимодействие участников рынка лесопромышленного комплекса Омской области [6].

Именно когерентное поведение элементов диссипативных структур, возникающих при взаимодействии предпринимательских и властных структур является тем катализатором, который ускоряет их самоорганизацию.

Создание логистической системы взаимодействия представляется как выбор имеющихся альтернатив и выстраивание цепочки участников рынка лесопромышленного комплекса. Выбор может осуществляться в рамках бизнес-процессов, определяющих развитие лесопромышленного комплекса, но в любом случае неотъемлемой составляющей стратегий выбора будет являться интеграция деятельности участников. Таким образом, ЦСРЛК выступает координатором данного взаимодействия.

Определены функции ЦСРЛК применительно к лесопромышленному комплексу Омской области: учреждение и управление ОАО «Омсклесэкспо», ЗПИФ «Лесные дороги», ОАО «Банк закладных Центра содействия и развития лесопромышленного комплекса»; лоббирование бизнес-проектов предпринимательских структур Правительства Омской области в Правительстве Российской Федерации; участие в разработке единой политики развития лесопромышленного комплекса Омской области; организация привлечения дополнительных инвестиций; изучение рынков сбыта, труда, инноваций.

Взаимодействие ЦСРЛК с названными участниками представлены как открытая архитектура логистической системы, позволяющая уточнить их функции применительно к новым условиям взаимодействия, а также создать возможности к расширению круга партнеров.

Таким образом, созданный Центр позволит оптимизировать ресурсные потоки в лесопромышленном комплексе, что в свою очередь будет способствовать сочетанию интересов производителей и потребителей, формируя логистическую систему - соответствующую инфраструктуру институционально-функционального обеспечения взаимодействия предпринимательских и властных структур.

Обеспечение системности взаимодействия предпринимательских и властных структур в лесопромышленном комплексе рекомендуется реализовать на принципе паритетности.

Сделать оценку эффективности этого взаимодействия предлагается на основе методики с применением экспертных оценок, что наиболее приемлемо при рассмотрении и оценке большого количества качественных критериев.

Систематизированы последствия отсутствия и наличия результатов взаимодействия предпринимательских и властных структур, что позволило организацию и взаимодействие этих структур представить в виде следующего выражения:

$$F=\sum^{N} zk(xi, yj)\rightarrow max, \qquad (1)$$

К=1

где, xi-переменная, отражающая вклад властных структур в результат взаимодействия;
yj-переменная, отражающая вклад предпринимательских структур в результат взаимодействия;
zk-результат взаимодействия предпринимательских и властных структур.
Результаты оценки представляются в виде двоичной системы: 0-характеризует отсутствие результата, 1-характеризует наличие результата.

F→max, при xi, yj=1;

F→min, при xi, yj=0.

В Совете директоров Центра выделены группы представителей от предпринимательских и властных структур, действующих на постоянной основе, вектор деятельности которых будет направлен на получение результата по критериям, выявленным и систематизированным в результате наличия взаимодействия.
В группу от властных структур предложено включить представителей федеральных и региональных структур, компетенция которых содержит функции Центра, а от предпринимательских структур отобрать авторитетные компании и представителей отраслевых и профессиональных союзов отражающих различные виды деятельности.
Процент голосов целесообразно, на наш взгляд, распределить на паритетной основе, с тем, чтобы у каждой из сторон не было возможности провести решение, выгодное только одной из сторон, причем выбор участников групп будет проводиться на конкурсной основе.
Поставленная задача решается с помощью оптимизационных методов и моделей в управлении экономическими системами в части теории игр и принятия решений с использованием метода аддитивной оптимизации и функции свертывания критериев.
Оптимальная оценка результата взаимодействия по выбранному критерию обеспечивается максимальным значением функции цели:

$$F_i = \sum^{n} \lambda_j * a_{ij}, i = \overline{1,m} \qquad (2)$$

Оценка взаимодействия предпринимательских и властных структур с участием ЦСРЛК позволяет выявлять недостатки и дополнительные возможности в улучшении взаимодействия предпринимательских и властных структур в этой отрасли на базе паритетного сотрудничества [2].

Результаты

Анализ предмета исследования – теоретических, методических и практических аспектов построения логистической системы формирования взаи-

модействия предпринимательских и властных структур позволил сделать следующие выводы.
Отсутствие общепризнанного определения частно-государственного взаимодействия не сложилось по причине чрезвычайного разнообразия видов и форм сотрудничества.
Оценка взаимодействия предпринимательских и властных структур с участием Центра содействия и развития лесопромышленного комплекса позволила выявить недостатки и дополнительные возможности в улучшении взаимодействия предпринимательских и властных структур в этой отрасли на базе паритетного сотрудничества.
В целях формирования логистической системы взаимодействия предпринимательских и властных структур, лесопромышленный комплекс России рассмотрен как единая макроэкономическая система, учитывающая всех участников, независимо от формы собственности и нормативно-правовой базы, соответствующей рассматриваемой инфраструктуре рынка.

Заключение

Решение актуальных теоретических и практических проблем формирования логистической системы взаимодействия предпринимательских и властных структур способствует устойчивому развитию конкурентоспособных предпринимательских структур в рамках сотрудничества с властными структурами и обществом в целом на паритетных условиях.
Частно-государственное взаимодействие раскрыто через описание классификационных признаков участников взаимодействия. Совокупность признаков прослеживается из исследований определения предпринимательства, где проявляется ряд синергетических принципов, а именно принцип эффективности взаимодействия. Сформирована структура классификационных признаков участников частно-государственного взаимодействия, что позволит трансформировать их в основные функции при поиске новых возможностей для достижения оптимальных результатов сотрудничества предпринимательских и властных структур.
Формулировка основополагающих условий и направлений формирования взаимодействия предпринимательских и властных структур позволила определить составляющие логистической системы частно-государственного сотрудничества в лесопромышленном комплексе и соответственно выделить: формы (сервисные контракты, управляющие контракты, аренда и временная передача прав, концессионные соглашения, участие в капитале); методы (административно-законодательные, финансово-экономические); нормативно-правовая база и определена структура (ЦСРЛК).
Центр содействия и развития лесопромышленного комплекса необходимо создать в организационно-правовой форме открытого акционерного общества (со 100% участием регионального Правительства), что создаст все ус-

ловия для частно-государственного взаимодействия в целях соблюдения приоритетов социально-экономического развития, сбалансированности общественных и частных интересов, государственной гарантированности режима наибольшего инвестиционного благоприятствования на территории региона, приоритетной государственной поддержки инвестиционной деятельности.

Организация взаимодействия предпринимательских и властных структур с участием Центра содействия и развития лесопромышленного комплекса требует постоянного мониторинга, особенно на этапе становления. Оценка эффективности этого взаимодействия базируется на основе методики с применением экспертных оценок, аддитивной оптимизации и функции свертывания критериев, что наиболее приемлемо при рассмотрении и оценке большого количества качественных критериев. Систематизированы последствия отсутствия и наличия результатов взаимодействия предпринимательских и властных структур.

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IS IT TRUE THAT "SUPPLY CHAIN MANAGEMENT IS "MORE THAN A NEW NAME FOR LOGISTICS"?

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Abstract: The purpose of the paper is to specify essence and differences of the following definitions "Logistics", "Supply Chain Management" and "Value Chain Management", to establish their hierarchy and interconnections and to create a modern model of Logistics.

1. INTRODUCTION

Now enterprises have serious problems in using of logistics and supply chain management in their activity. These problems are the consequence of indistinct delimitation of these definitions. Stock and Boyer (2009, pp. 690-691) confirm that: "Without an inclusive or encompassing definition [SCM - note of author], it will be difficult for researchers to develop supply chain theory, define and test relationships between components of SCM, and develop a consistent stream of research that "builds" on what has gone before (at least in a comprehensive way). Without the adoption of a uniform definition accepted by researchers, confusion will continue to hinder the study and further development of SCM; and research will extend in various directions, rather than build upon itself (i.e. creating synergy in research)".

There are some attempts to create these definitions. For example, Cooper, Lambert, and Pagh (1997) suggested that Supply Chain Management: More Than a New Name for Logistics. Whether it is true? The author supposes that the problem can be solved if to consider logistics and supply chain management, using two basic approaches: as enterprises management conceptions and as their activity kinds. In this paper the author will research logistics and supply chain management as enterprises management conceptions.

2. LITERATURE REVIEW

There are numerous definitions of "supply chain management" which are necessary to classify for their better learning. For example:

- Delfmann and Alberts (2000) have created table containing a brief overview of different SCM understandings such as (1) approach; (2) concept; (3) perspective; (4) philosophy, and (5) technique;
- Mentzer et al. (2001) have argued that definitions of SCM can be classified into three categories, namely: (1) a management philosophy; (2) the imple-

mentation of a management philosophy; and (3) a set of management processes;

- Min and Mentzer (2004) have supposed that SCM includes: (1) nothing more than a different name for integrated logistics (Tyndall et al., 1998); (2) a management process (La Londe, 1997); (3) a form of vertical integration of firms (Cooper and Ellram, 1993); and (4) a management philosophy (Ellram and Cooper, 1990);
- Mentzer et al. (2008) suppose that modern concepts of supply chain management have the following aspects: (1) coordination/collaboration with suppliers and customers; (2) demand and supply side matching; and (3) a flow perspective;
- Using the qualitative analysis software NVivo, Stock and Boyer (2009) examined 166 definitions of supply chain management that have appeared in the literature to determine important components of an integrated definition of SCM. Three broad themes of SCM are identified by them, including: (1) activities; (2) benefits; and (3) constituents/components.

Thus, using definitions of SCM and their groups created during last decade, it is possible not only to specify but to enlarge the ideas of Delfmann and Alberts (table 1).

Table 1: Understandings of SCM according to the author

Understanding (SCM is seen as …)	**Author/s**
Approach	Johannsson (1994), Simchi-Levi et al. (2003), Gunasekaran/McGaughey (2003), Koh/Tan (2006), Koch (2007),
Concept	Bechtel/Jayaram (1997), Schary/SkØtt-Larsen (1995)
Perspective	Ellram (1991)
Philosophy	Cooper/Lambert/Pagh (1997), Ellram/Cooper (1990), Svensson (2002)
Technique	Turner (1993)
Integrated logistics	Tyndall et al. (1998)
Form of vertical integration of firms	Coyle/Bardi/Langley (2003), Tommelein/Walsh/Hershauer (2003), Piplani/Fu (2005), Stonebraker/Liao (2006), Global Supply Chain Forum (GSCF) (2007)
Management process	LaLonde (1997), Mejza/Wisner (2001), Stock/Lambert (2001), CSCMP (2005), Harrison/van Hoek (2005), Meredith/Shafer (2007), Webster (2008), Monczka et al. (2009)
Coordination/collaboration with suppliers and customers	Mentzer et al. (2001), Stank/Keller/Daugherty (2001), Bowersox/Closs/Cooper (2002), Arunachalam (2003), Jonsson/Zineldin (2003), Cachon/Lariviere (2005), Griffith/Harvey/Lusch (2006)
Network of facilities	Frazzelle (2002)
A flow perspective	Bloomberg/LeMay/Hanna (2002), European Logistics Association (ELA) (2005), Seuring (2004), Ballou (2006), Borade/Bansod (2007)
Innovation	Saad/Jones/James (2002)

Having studied the table 1 the author got the following results:

- Number of "supply chain management" classification signs is extremely increasing. On the one hand, this tendency helps for better understanding of the SCM essence, but on the other hand it makes analysis and SCM definitions usage more difficult and less conforming to real market situation. To decide this problem it is necessary to create SCM signs classification;
- It is possible to structure SCM signs (table 1) according to the data of figure 1;

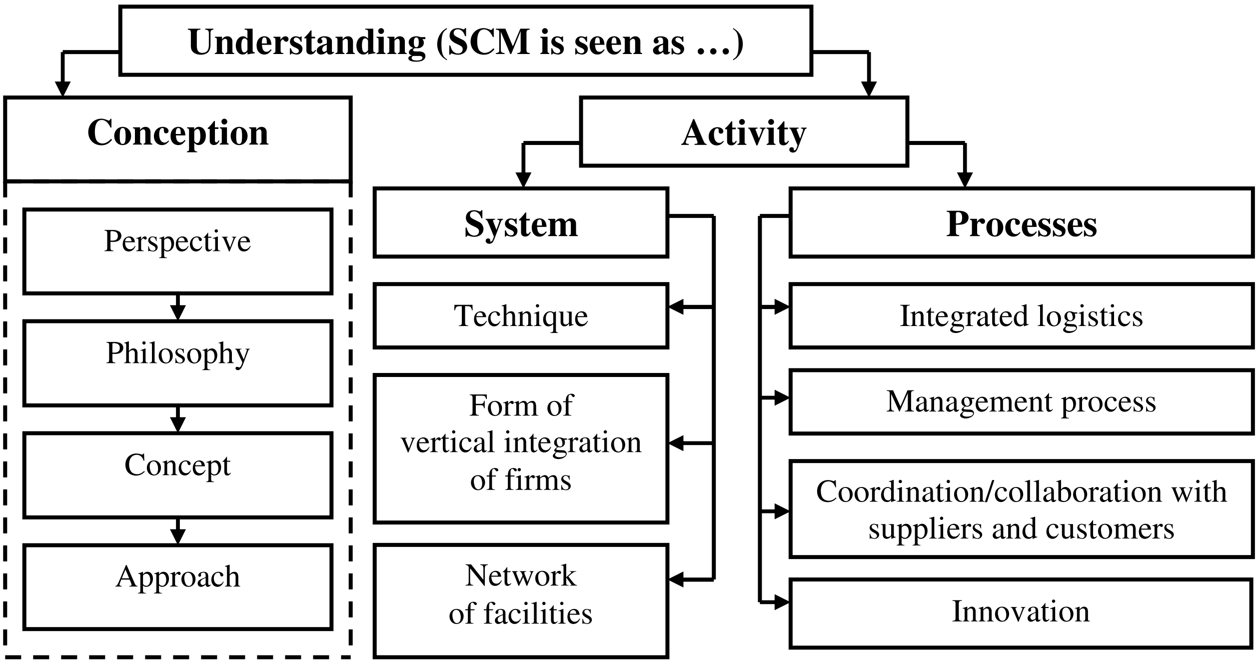

Figure 1: SCM-signs classification structure

- The author believes that any management kind including SCM is supposed to have: (1) the management activities preparation; and (2) their real fulfillment. In the first case it is possible to speak about enterprises management conception, and in the second case it is possible to speak about specific kind of enterprises activity;
- "Enterprises management conception" has the following hierarchical sequence of SCM classification signs usage (top-down): perspective (including flow perspective) - philosophy - concept - approach;
- "Enterprises activity kind" provides for designing, formation and management systems (as statics of management) and processes usage (as dynamics of management) for enterprise objectives achievement;
- In author's opinion, the following SCM classification signs are signs of "system" as foundation of enterprises activity kind: (1) technique; (2) form of vertical integration of firms; and (3) network of facilities;

- The following SCM-signs have to be the part of "processes" classification sign: (1) integrated logistics; (2) management process; (3) coordination/collaboration with suppliers and customers; and (4) innovation.

Many years practitioners and academicians were confused between "logistics" and "supply chain management", the usage of each term varied according to knowledge and experience of the individual and/or company. For example, Simchi-Levi, Kaminsky, and Simchi-Levi (2003, p. 2) admit that they do "not distinguish between logistics and supply chain management."

In other words the problem is not solved at the present time, although many researchers suggest that logistics (or logistics management) is the part of SCM (for example, Simchi-Levi et al. (2003), Chen and Paulraj (2004), Gibson, Mentzer, and Cook (2005), CSCMP (2005), Gourdin (2006), Ballou (2006), Bowersox et al. (2007)). In particular, Ballou (2006, p. 382) notices that: "The scope of logistics is being limited to the boundaries of the function within a firm and is primarily concerned with activity administration, which was not the early view. Interfunctional and interorganizational management seem to be within the purview of supply chain management rather than logistics".

It is possible to see two different courses of events concerning this problem. On the one hand, logistics is connected with resources flows management directly (for example, Cooper et al. (1997), Tilanus (1997), Johnson et al. (1999), Crompton and Jessop (2001), Waters, D. (2003), Harrison and van Hoek (2005), CSCMP (2005)). On the other hand, SCM absorbs flows being the additional research object and, thus, it changes logistics research object. For example, logistics is defined by (Bowersox, 2005) as composed of materials management, physical distribution management, credit rating, insurance and delivery promises, and at the same time Bloomberg, LeMay, and Hanna (2002, p.1) believe that: "supply chain management is the process of planning, organizing, and controlling the flow of materials, and services from suppliers to end users/customers".

It is obviously that sometimes some researchers don't differentiate between logistics and logistics management (figure 1), though the author considers them to be different. Author intends to achieve the objective of this paper using the following preconditions:

- In author's opinion, the most valuable and least demanded definition of logistics for further analysis and usage is the definition, sometimes called the layperson's definition of logistics (the Seven Rs) which was mentioned, for example Coyle, Bardi, and Langley (2003), and Russell (2007): ensuring the availability of the right product, in the right quantity and the right condition, at the right place, at the right time, for the right customer, at the right cost. It is easily seen that this definition includes elements of marketing complex ("product", "place", and "customer") and as it will be seen later on elements of logistics complex ("quantity", "condition", "time", and "cost") which the author will use later on for substantiating his view point:

- Marketing and logistics are the stages of enterprises management conceptions which may include, for example, SCM as a separate stage;
- Each stage has its own business-processes, including, for example, logistics management;
- It is necessary to consider logistics as enterprises management conception and logistics management as the kind of enterprises activity (or business-process) as part of logistics and/or SCM;
- It is possible to create the integrated logistics conception which will include stages of enterprises management conceptions and the enterprises activity kinds, including SCM and, accordingly, logistics management.

3. DETERMINATION OF ENTERPRISES MANAGEMENT CONCEPTIONS DEVELOPMENT SEQUENCE WHICH INCLUDES LOGISTICS AND SCM

Lewis and Suchan (2003, p. 312) declare that: "logistics research may need a growth-inducing language about logistics managerial behavior, a new set of theoretical constructs that will help researchers reframe and thus "resee" their thinking and research designs in ways that help them break from variance theories and the larger positivist paradigm."

The author will follow this idea using view points of different researchers upon enterprises management conceptions. For example:

Ansoff (1965) substantiated four basic stages of modern economics:

- 1820 - 1900 - the industrial revolution stage;
- 1900 - 1930 - the large output stage;
- 1930 - 1950 - the marketing stage;
- Since 1950 till now - postindustrial stage or «century of discounts» according to Peter Drucker's opinion (1992).

These stages may be called the stages of macroeconomics development.

A detailed discussion on the evolution of supply chain management was provided by Prida and Gutiérrez (1998). The authors presented three aspects of the supply chain management evolution: (1) material management, (2) industrial logistics, and (3) quality management.

Coyle, Bardi and Langley (1996) divided the development of logistics into three stages: (1) Physical Distribution or outbound logistics system (during 1960s and 1970s); (2) Integrated Logistics Management (during the 1970s and 1980s); (3) Supply Chain Management (from 1980s to 1990s).

Mejza and Wisner (2001) determined the scope of processes that are being integrated across organizational borders and indicated that a large number of companies that practice supply chain management are attempting to integrate logistics, marketing, and operations-oriented processes across supply chains.

In Ross's opinion (2003), the SCM concept could be held in five management stages. The first stage can be described as the era of internal logistics departmentalization. In the second stage, logistics began the migration form organizational decentralization to centralization of core functions driven by new attitudes associated with cost optimization and customer service. Stage three can be called as integrated logistics management. Stage four is supply chain management era with the strategic view of supply chain and after 2000s can be called as e-supply chain management era.

Ballou (2006) suggested the outline of evolution of supply chain management since 1960 till present time in the following sequence: (1) Purchasing/Materials management, and Physical Distribution; (2) Logistics; (3) Supply Chain Management. Mentzer et al. (2008) have created a supply chain management map which includes logistics, marketing and production/services. The given view points may be summarized. The author suggests considering three stages of enterprises management by analogy with Ansoff (1965) and view points of other authors: manufacturing management (the mass manufacture stage), marketing (the marketing stage) and logistics, which includes two "waves" (the postindustrial stage). These stages may be referred to microeconomics development stages or enterprises management conceptions.

The conclusion was made in literature review, that it is possible to research manufacturing management (further - management), marketing, and logistics jointly as:

- Enterprises management conceptions;
- Kinds of enterprises activity.

Author thinks that two of six possible combinations are supply chain management and value chain management.

4. ESTABLISHMENT OF BASIC MANAGEMENT OBJECTS WHICH DETERMINE THE ESSENCE OF ENTERPRISES MANAGEMENT CONCEPTIONS AND SUBSTANTIATION OF THEIR COURSE DEVELOPMENT

With the help of three first components of marketing components the logisticians can create their own complex, being the basis for "value chain management". In fact this is the first half of logistics complex and this half is formed in the following way (Figure 1):

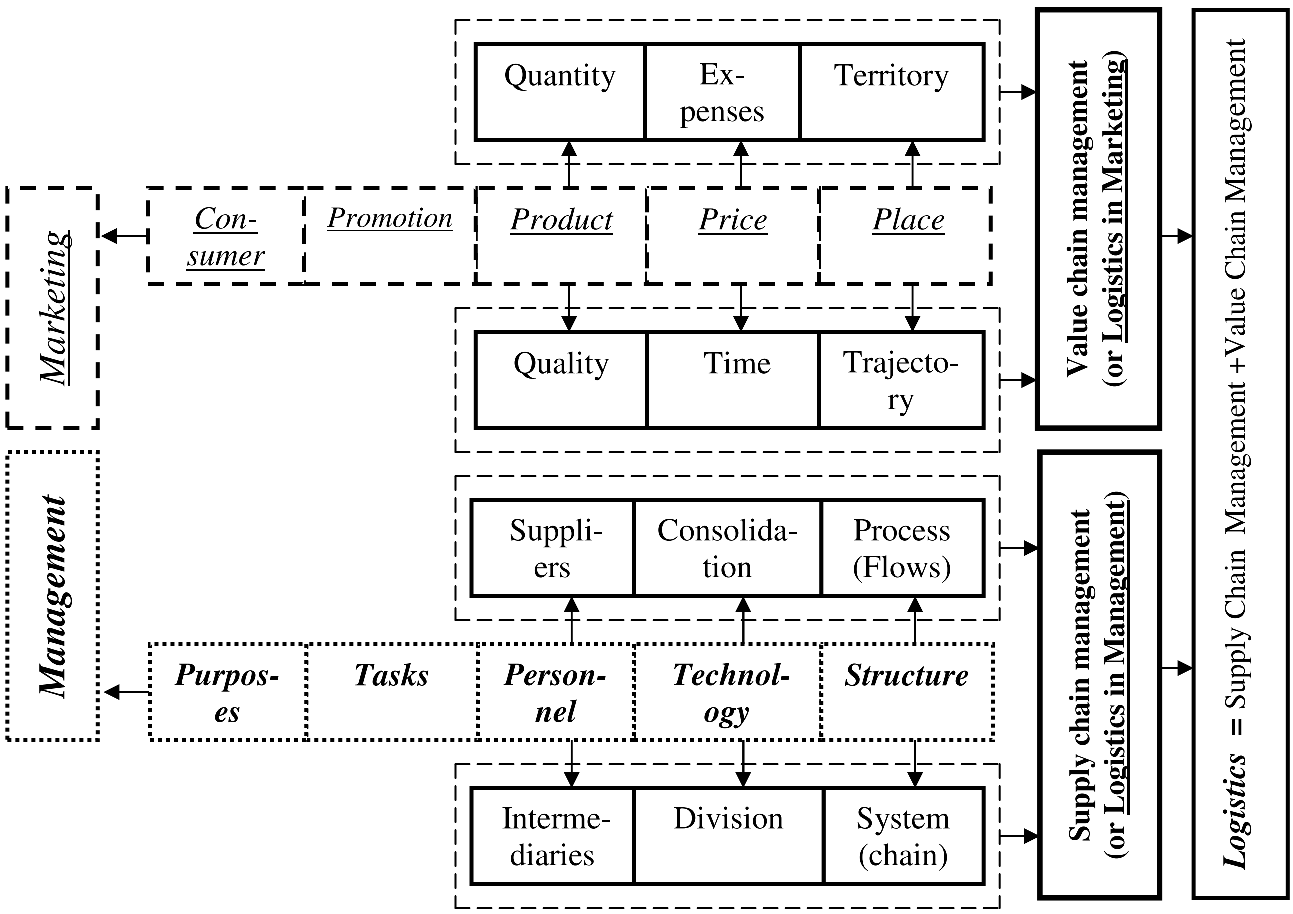

Figure 1: Components of management, marketing, and logistics

Author supposes to distinguish enterprise internal variables between different experts in the following way. Managers have to bear responsibility for fulfillment of enterprises "purposes" and "tasks", logisticians have to help managers to control and to fulfill components "personnel", "technology", and "structure" outside of the given enterprises. These components allow to create the basis for supply chain management formation or the second half of logistics complex (figure 3).

It is easy to see that logisticians don't intend to replace functions of managers and experts in marketing. As it is seen (Figure 1) supply chain management is logistics in management, and value chain management is logistics in marketing. Author draws the readers' attention to the following:

- Logistics doesn't replace manufacturing management and helps managers to fulfill processes connected with designing, formation and delivering of values to consumers within and outside the enterprise; logistics operates with participants of supply chains (suppliers, intermediaries, enterprise personnel), creates and moves the resources flows, fulfills processes connected with such resources flows management using supply chains;
- Logistics doesn't replace marketing as enterprises management conception and provides the consumers' needs satisfaction and the control of these

needs with the help of communications policy; logistics helps experts in marketing to fulfill processes connected with treating of consumers' individual orders as these orders have different of quantity, quality, expenses and time parameters, and supply chains should fulfill these orders, serving definite territories according to definite trajectories;

- Logistics being the enterprises management conception eliminates barriers between participants of supply chains within and outside enterprises on all parts of resources movement trajectories.

5. THE AUTHOR'S DEFINITIONS OF LOGISTICS, SUPPLY CHAIN MANAGEMENT AND VALUE CHAIN MANAGEMENT AND ESTABLISHMENT OF INTERCONNECTIONS BETWEEN THEM

In author's opinion, it is received necessary and sufficient number of arguments to substantiate the following definitions of logistics, supply chain management and value chain management. Differences between these definitions are indicated by the words in *italics*.

Value Chain Management is an intermediate enterprises management conception which is connected with the influence of management subject on the resources flow *trajectory*, so to create consumers' value who are allocated on definite *territory*, ordered the definite *quantity* of products and services of definite *quality* in definite *time,* and who agree to pay *expenses* of an enterprise (of supplier) which are connected with designing, creation and delivery of these products and services.

Note: if resources flows parameters do not vary during their movement, it can be examined as a special case of consolidation / division.

Supply Chain Management is an intermediate enterprises management conception connected with the influence of management subject on the linearly located links of logistical s*ystem* (*suppliers* and *intermediaries*) which provide *consolidation / division* of resources *flow* objects according to the purposes of its consumers.

Logistics is an enterprises management conception which is connected with the influence of management subject on the resources *flows* which move according to certain *trajectories* with the help of logistics *system* links (*suppliers* and *intermediaries*), which fulfill *consolidation/division* of given flows objects so to provide the end-consumers located in certain *territory*, with maximum *value* within the framework of *quantity*, products and services *quality* parameters and coordinated parameters of *time* and *expenses* for their manufacturing and realization.

Thus, supply chain management and value chain management as logistics components are extra enterprises management conceptions.

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РОЛЬ ИНСТРУМЕНТАРИЯ ЛОГИСТИКИ В ФОРМИРОВАНИИ ЦЕННОСТИ ИННОВАЦИЙ ДЛЯ ГОСУДАРСТВА И БИЗНЕСА

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Аннотация: Статья посвящена вопросам формирования и оценки ценности инноваций на различных уровнях: государства, цепи поставок, субъектов бизнеса. Определяется роль инструментария логистики в формировании ценности инноваций, приводятся значения необходимого перспективного понимания ценности инноваций и других инструментов логистики для достижения лидирующих позиций государства в мировой экономике.

THE ROLE OF LOGISTICS TOOLS IN THE VALUE FORMATION OF INNOVATIONS FOR STATE AND BUSINESS

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Purpose of the paper: The article is devoted to the ways of forming and estimating the value of innovations at different levels: state level, supply chain level, subjects of business level. The role of logistics toolkit is defined for the value formation of innovations; perspective importance of innovations' value is outlined as well as other logistics instruments which are used for reaching the leading position of the state in the world economy.
Research/application methodology: While writing the article general scientific research methods were used: analysis and synthesis.
Design of the paper: Successively the notion of innovations and their interrelation with value creation are developed, comparison of value and innovation creation processes is given; the notion of innovation value is considered at different levels and main functions are fetched out, processes adding value to innovations are appraised; differences in innovations' value appraisal from the state and business perspectives are disclosed; the notion of logistics toolkit is given as well as its role in value formation of innovations, the directions for future logistic toolkit are revealed.
Main results: In the article the notions of innovations and logistic toolkit are defined, interrelation is shown and the influence of the state and business on the perception of categoric concept "value of innovations, logistics toolkit groups are identified and the directions for future logistic toolkit are given.
Academic contribution: Understanding of the difference of innovations' value for the state and business is of great importance both from scientific and practical point of view, which is expressed in creating different models of forming value for these categories.

Depicting innovations as a part of logistic toolkit has an important meaning for the development of logistics in Russia,
Managerial insights: The results of the survey can be used for Russian strategy of innovative development or some parts of it, as well as for practical activity of different companies working in different areas of economy related to logistics.

1. ВВЕДЕНИЕ

Вопросу инновационного развития на протяжении последних двух десятилетий посвящено немало научных исследований, и только в последние годы мы видим развитие данного вопроса не только в теории, но и на практике. Исследования стали носить более практический характер, и, наконец, в сознании людей сформировалось понимание того, что же такое «инновация». Согласно опросу, проведенному ВЦИОМ в 2007 [4] г. 53% респондентов не знают, что это такое, но тем не менее, большинство считают инновации необходимым условием процветания России (рис. 1).

Рис. 1. Результаты опроса общественного мнения ВЦИОМ, 2007 г.

Во многом такое непонимание сути инноваций может быть обусловлено тем, что в «Концепции инновационной политики Российской Федерации на 1998-2000 годы» [1] основной акцент делается на наукоемкие технологии в топливно-энергетическом комплексе, машиностроении, металлургии и других отраслях народного хозяйства, в настоящее время достаточно далеких от основной массы населения, занимающейся в основном торговлей. Следовательно, восприятие инноваций строилось на понимании того, что это очень сложный механизм, требующий участия в разработке творческих коллективов научно-исследовательских институтов, конструкторских бюро и т.д. Сегодня акценты сместились, и речь в большей степени идет о создании малых инновационных предприятий, в том числе при вузах, которые могут вести разработки для улучшения работы отдельных субъектов народного хозяйства, разрабатывать новые образцы товаров народного потребления и совершенствовать стандарты обслуживания.

К числу инноваций в области логистики можно отнести именно совершенствование стандартов обслуживания, совершенствование логистического инструментария, уже успешно применяемого многими компаниями, задействованными в цепях поставок, а также «изобретение» и апробацию инновационных инструментов логистики. Вместе с тем следует уточнить понятие инноваций в его современной трактовке и общепринятом понимании.

2. ПОНЯТИЕ ИННОВАЦИЙ И ИХ ВЗАИМОСВЯЗЬ С СОЗДАНИЕМ ЦЕННОСТИ

Термин «инновация» происходит от латинского «novatio», что означает «обновление» (или «изменение»); приставка «in» переводится с латинского как «в направлении», т.е. дословно «Innovatio» — «в направлении изменений». Здесь мы видим движение, процесс. Логистика, как известно, управляет потоковыми процессами, следовательно, логистическая составляющая обязательно присутствует в любых инновациях. Действительно, для того, чтобы произошло какое либо изменение, необходимо осуществление следующего процесса – «идея – инвестиции – разработка – внедрение – получение результата». Данная цепочка последовательности событий идентична цепочке создания ценности (рис. 2).

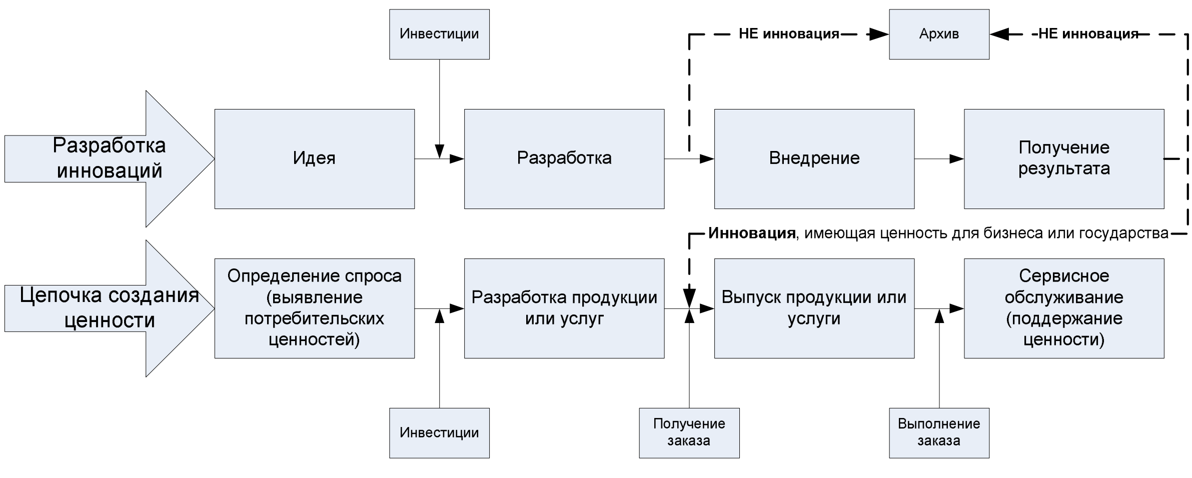

Рис. 2. Сравнение и взаимосвязь процессов разработки инноваций и процесса создания ценности

При этом результат должен быть востребован бизнесом или государством, а не просто быть результатом, задокументированным и помещенным в архив с пометкой «постоянное хранение». Для того, чтобы результат интеллектуальной деятельности был востребован бизнесом или государством, он должен представлять для них определенную ценность.

Ценность могут представлять различные виды инноваций, как продуктовые (новые материалы, комплектующие, полуфабрикаты), так и процессные (новые технологии, новые методы организации и управления). При этом инновации могут быть вызваны как развитием рынка, так и развитием науки и техники, а также потребностями производства или цепи поставок. В последнем случае должен выполняться принцип пропорциональности, т.е. если на одном из производственных участков (у одного из участников цепи поставок) применяется современное оборудование, с большей производительностью и другими возможностями, то это должно повлечь внедрение инноваций на других производственных участках (у других участников цепи поставок). Следует также отметить, что в зависимости от глубины вносимых изменений выделяют радикальные, улучшающие и модификационные инновации, в разной степени создающие ценности для государства и бизнеса.

3. ЦЕННОСТЬ ИННОВАЦИЙ

В своей работе мы не будем касаться вопросов потребительской ценности инноваций, мы будем говорить исключительно о ценности инноваций для государства и бизнеса, т.к. прерогатива логистики – изучение стратегии, тактики и технологии доведения ценности (продукции) до конечного потребителя. И на этом пути необходимы инновации, как с точки зрения стратегии (уровень государства), так и с точки зрения тактики (уровень цепи поставок) и технологии (уровень субъектов бизнеса) (рис. 3).

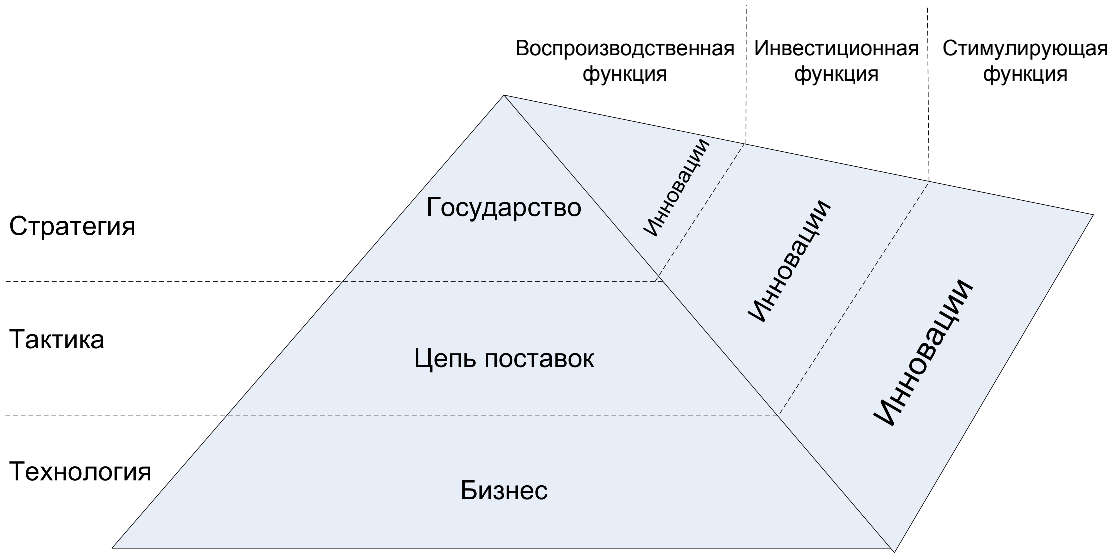

Рис. 3. Взаимосвязь инноваций различного уровня и их функций

Следует отметить, что инновации разных уровней выполняют все три функции инноваций: воспроизводственную, инвестиционную и стимулирующую. Причем для стратегического уровня государства в большей степени характерна воспроизводственная функция, для цепи поставок – инвестиционная, а для субъектов бизнеса – стимулирующая. Воспроизводственная функция означает, что инновация представляет собой важный источник финансирования расширенного воспроизводства [2]. Смысл воспроизводственной функции состоит в получении прибыли от инновации и использовании ее в качестве источника финансовых ресурсов. Использование прибыли от инновации для инвестирования составляет содержание инвестиционной функции инновации и на уровне цепи поставок может представлять собой инвестиции в развитие логистической инфраструктуры. На уровне бизнеса в первую очередь выполняется стимулирующая функция, т.к. получение предпринимателем прибыли за счет реализации инновации прямо соответствует основной цели любой коммерческой организации.

Так в чем же ценность инноваций? Здесь также можно выделить как минимум две ценности, имеющие стратегическое и экономическое значение. Стратегическая ценность инновации будет определять развитие государства в долгосрочной перспективе, предопределять его позицию в геополитике, а экономическая ценность инновации определяется ростом прибыльности, расширением масштабов бизнеса и возможностей накопления для последующего реинвестирования капитала. При определении экономической ценности инноваций следует руководствоваться ценностью процессов с точки зрения инноваций, т.к. инновации в более значимых процессах будут иметь больший экономический эффект. Здесь следует обратиться к матрице процессов, придающих ценность, Роберта Гарднера [3] (рис. 4).

Несомненно, что с точки зрения специалистов различных подразделений значимость процессов будет меняться. Так, для сотрудников финансовых служб «управление финансами» и «контроль за кредитами» будет иметь первостепенное значение, впрочем, также как и для инвесторов. Поэтому в данной матрице приводится условная важность (значимость) процессов, в первую очередь, имеющая наибольшую ценность с точки зрения формирования ценности на уровне технологии.

4. РАЗЛИЧИЯ В ОЦЕНКЕ ЦЕННОСТИ ИННОВАЦИЙ

Точно также как для специалистов различных структур и служб компании для государства и бизнеса ценность одного и того же результата инновационной деятельности различна. Действительно, ценность – это важность, значимость, польза, полезность чего-либо[1]. Однако, значимость и полез-

[1]Определение из Википедии – свободной энциклопедии // http://ru.wikipedia.org/wiki/ценность

ность присущи предметам и процессам не от природы, а являются субъективными оценками конкретных свойств предмета или ожидаемых результатов процесса. Если обратиться к рисунку 3, то мы видим, что находясь на различных уровнях и ставя во главу угла соответствующие ценности, государство и бизнес исходят из разных позиций оценки ценности инноваций. Так, для государства первоочередной задачей является обеспечение воспроизводства, тогда как для бизнеса – извлечение прибыли.

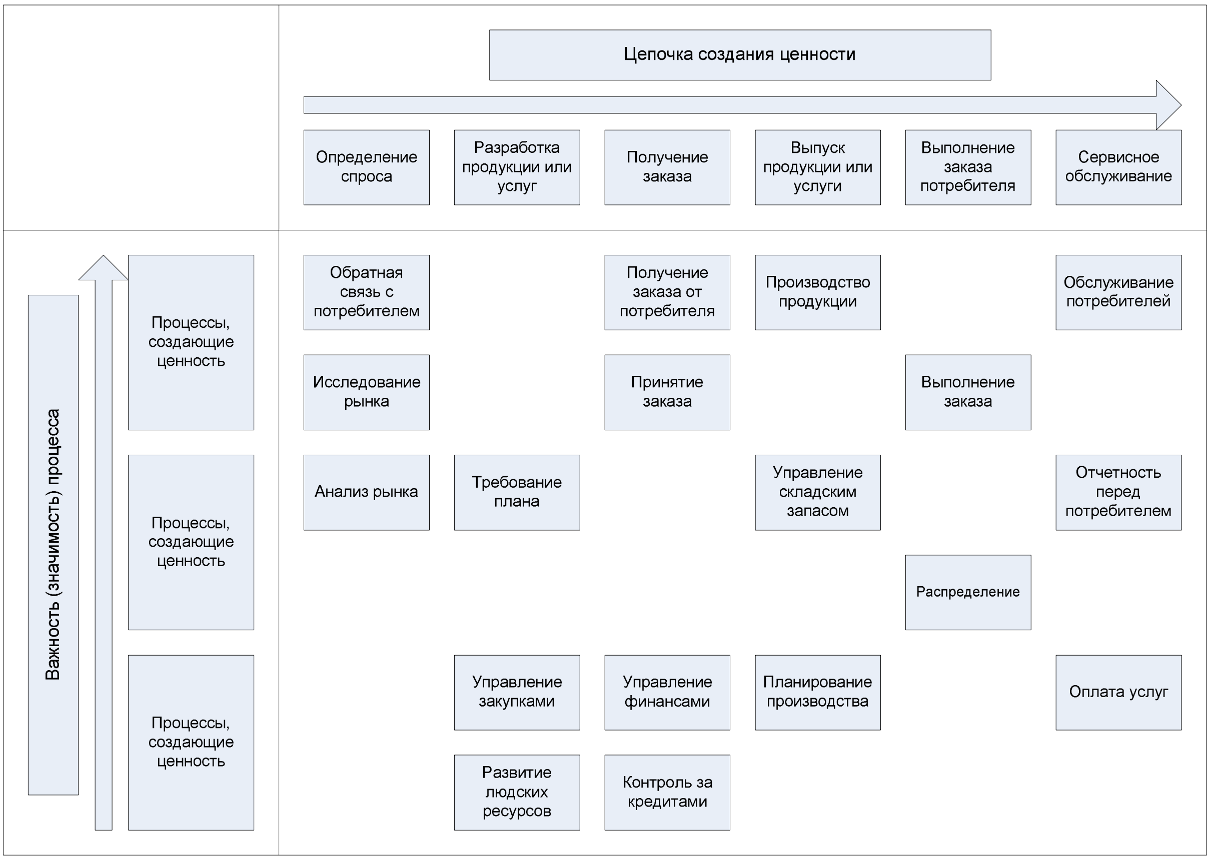

Рис. 4. Матрица процессов, придающих ценность [3]

Однако, сегодня принято говорить о социальной ответственности бизнеса, и ее идея действительно проникает в умы руководителей компаний различных отраслей и сфер деятельности, различных масштабов. В дальнейшем, по нашему мнению, различия в оценке и формировании ценности инноваций, как впрочем, и других ценностей, у государства и бизнеса будут сокращаться. Уже сегодня корпорации учитывают интересы общества, берут на себя ответственность за влияние их деятельности на заказчиков, партнеров, работников и даже заинтересованные стороны общественной сферы. В качестве положительной стороны этого общественного явления можно назвать многочисленные преимущества от того, что компании работают на более широкую и продолжительную перспективу, чем краткосрочная прибыль. Отрицательная сторона этого явления – в некотором роде попытка подменить роль правительств в качестве контролера и ослабление фундаментальной экономической роли в бизнесе.

5. ИНСТРУМЕНТАРИЙ ЛОГИСТИКИ И ЕГО РОЛЬ В ФОРМИРОВАНИИ ЦЕННОСТИ ИННОВАЦИЙ

Для того, чтобы понять, что может быть отнесено к инструментарию логистики, обратимся к понятию инструментария, приводимому в «Толковом словаре русского языка» Д.Н. Ушакова и «Новом словаре русского языка» Т.Ф. Ефремовой. «Инструментарий» в словаре Д.Н. Ушакова это «подбор, совокупность инструментов, употребляемых в какой-либо специальности». В словаре Т.Ф. Ефремовой приводится два значения: «Инструментарий – 1) набор каких-либо инструментов; 2) совокупность средств, применяемых для достижения чего-либо». Таким образом, мы видим, что, во-первых – инструментарий применяется в определенной области, во-вторых – представляет собой совокупность средств, а в-третьих – его применение направлено на достижение какой-либо цели. Исходя из этого, *логистический инструментарий* – совокупность средств, направленных на достижение целей логистической деятельности. К таким средствам можно отнести следующие укрупненные группировки: непосредственно инструменты, методы, инновации, инфраструктурное обеспечение и стратегию.

Если опираться на структуру формирования ценности инноваций, то условно можно выделить три блока «обоснование-анализ-результаты» (рис. 5.)

Рис. 5 иллюстрирует роль инструментария логистики в структуре формирования ценности инноваций, а на рис. 6 представлено его значение для государства и бизнеса в настоящем и будущем.

Анализируя данные рис. 6, мы видим, что сегодня развитию инноваций придается все еще недостаточное значение. Пожалуй, инновации – одна из сфер, которой придается наименьшее значение. Причинами этого является высокая потребность в инвестициях, которой препятствует неблагоприятный инвестиционный климат. Методам также уделяется недостаточное внимание, особенно со стороны бизнеса, в силу следующих причин: устаревшие методы прошлых лет утратили свою актуальность, а новые методы разрабатываются недостаточно активно, во-первых из-за их также быстрого устаревания, во-вторых из-за отсутствия специалистов, способных описать и задокументировать новые методы, в-третьих из-за отсутствия понимания важности этого процесса и, наконец, в-четвертых из-за политики компаний, опасающихся раскрыть свое ноу-хау.

Что касается инструментов, по их ценность высока и в перспективе будет повышаться и для государства. Как положительный момент хочется отметить, что инфраструктуре придается сегодня серьезное значение.

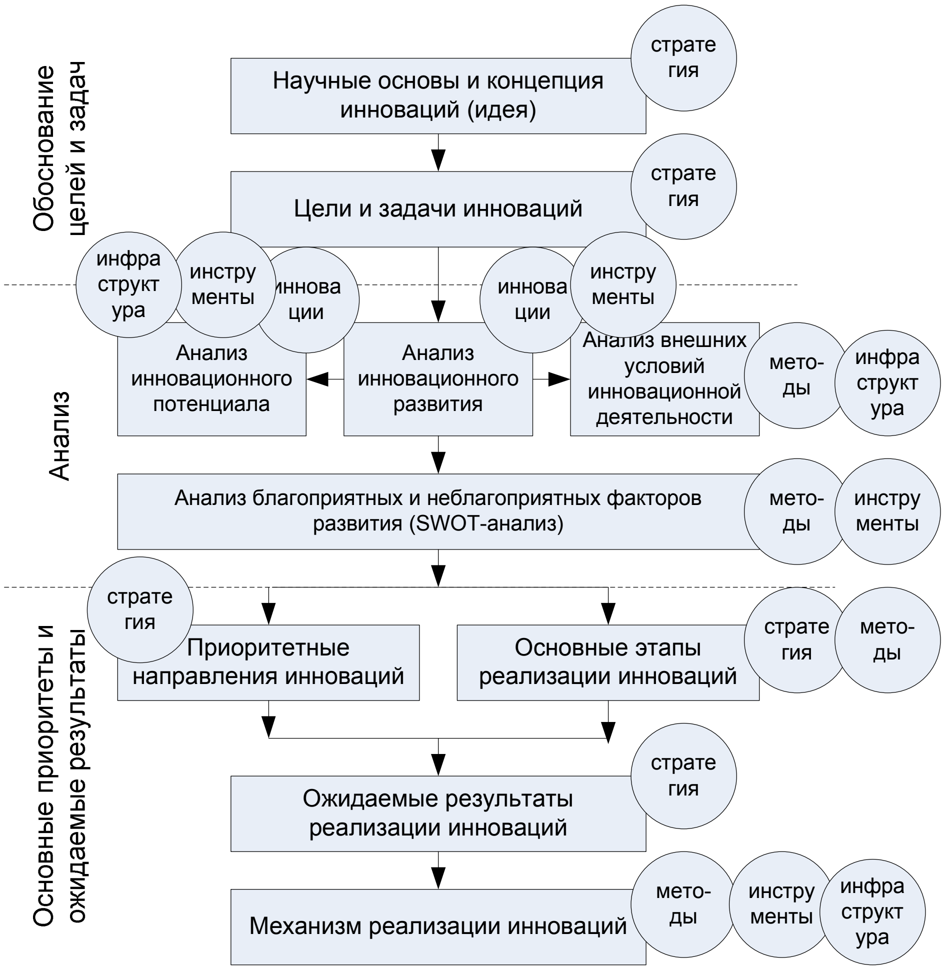

Рис. 5. Роль инструментария логистики в структуре формирования ценности инноваций

6. ЗАКЛЮЧЕНИЕ

Подводя итоги, отметим, что понимание инноваций, их ценности различно для государства и бизнеса в силу различий их природы и выполняемых функций. Рассматривая инновации как один из инструментов логистики, мы приходим к выводу, что их роль велика на этапе анализа ценности инноваций, а заданный вектор развития понимания ценности инноваций позволяет говорить о формировании инновационной сферы, активизации инновационной деятельности, повышении конкурентоспособности национальной экономики.

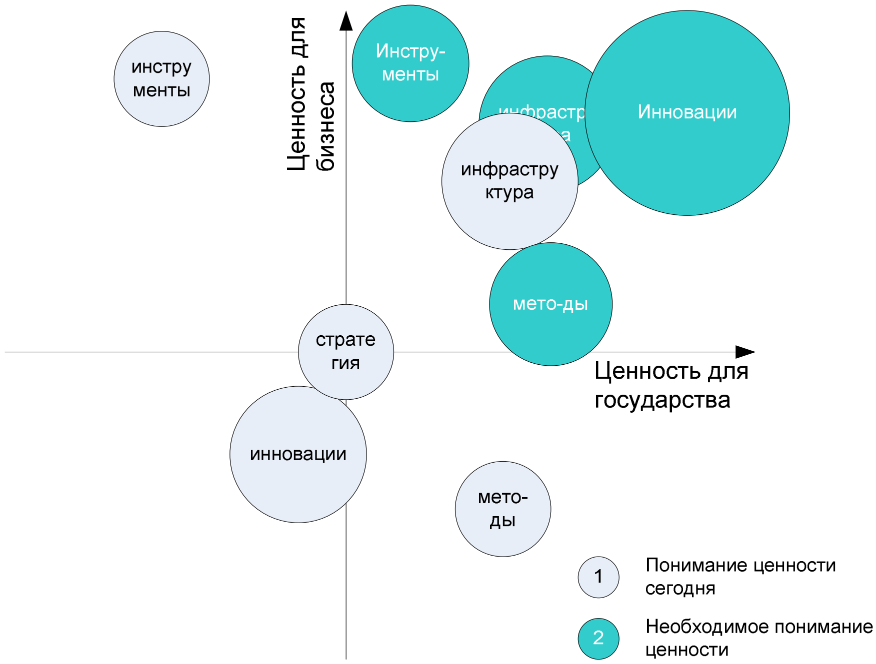

Рис. 6. Понимание ценности инноваций и других инструментов логистики сегодня и необходимое понимание в перспективе

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