Scientific Journal of Riga Technical University
Computer Science. Information Technology and Management Science
2011
Volume 49

Model-Based Supply Chain Management

Oksana Soshko, *Riga Technical University*

***Abstract* – The paper is focused on application of modelling and simulation approaches in supply chain management. First, essentials of multi echelon supply chain management are discussed including the functionality of supply chain information systems. Then, a variety of modelling and simulation approaches are analyzed in the context of supply chain management, for example, simulation, stochastic programming, business process modelling and reference model. Finally, some illustrative examples are provided on application of simulation and modelling approaches to supply chain management.**

***Keywords* –supply chain management, modelling, simulation**

I. Introduction

In spite of numerous research papers presenting mathematical methods, algorithms and models to support decision making in logistics and supply chain management, an application of the above-mentioned tools for effective supply chain management is still considered to be a big challenge in many companies. Especially it concerns small and medium-sized enterprises (SMEs) which are often financially limited for any innovation investigation, consulting or training. This is partly caused by a lack of understanding the essence of methods/models, their benefits, as well as insufficient level of expertise of employees. Therefore, development of the methodology aimed at explaining and describing application of mathematical modelling in the context of supply chain planning, analysis and management is highlighted by logistics experts as a topical task. Along with development of new methods and models, there is a need for the methodological aim which will support supply chain managers in explaining what kind of models can be used for solving the certain problem they have met with assuring mathematically based decision making. This methodology should consist of the following specific components: problem scope explanation and supply chain management tasks, a description of applied approaches, methods and tools, and case studies which illustrate possible application of the methodology.

The purpose of this paper is to outline main components in developing the aforementioned methodology. The paper is organised as follows. In the next part, the description of supply chain management is provided including multi echelon supply chain definition, description of supply chain uncertainties and multi echelon supply chain inventory management related issues. Then, mathematical and descriptive models are mentioned in the context of *supply* chain management such as simulation models, optimization models, analytical models and supply chain operation reference model (SCOR). Few illustrative examples are provided at the end of the paper to show potentials of application modelling approaches in supply chain management. The functionality of each model as well as their benefits are discussed at the end of the paper.

II. Multi Echelon Supply Chain Management

A. Supply Chain Definition

Nowadays, a variety of supply chain definitions can be found. Usually it is defined as a network of suppliers, factories, warehouses, distribution centres and retailers through which raw materials are acquired, transformed and delivered to the customer (see Fig.1).

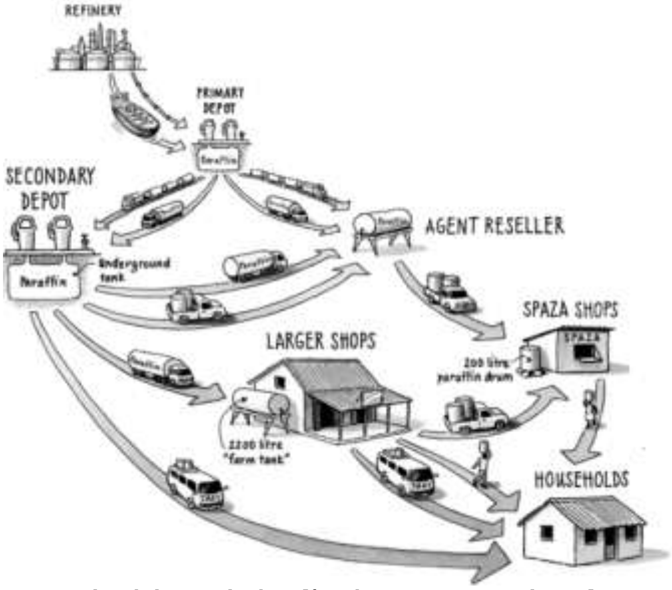

Fig. 1. Multi echelon supply chain [from http://www.greenwala.com]

This chain is characterized by a forward flow of materials and a backward flow of information. Traditionally, supply chain is illustrated as a framework for the conversion and movement of raw materials into final product through the four basic echelons, namely suppliers, manufacturers, wholesalers and retailers (see Fig. 2). Customers initialize all the processes within supply chain by ordering goods from retailers, which move the orders toward the whole supply chain. Therefore, such supply chains are usually called demand driven supply chains [1].

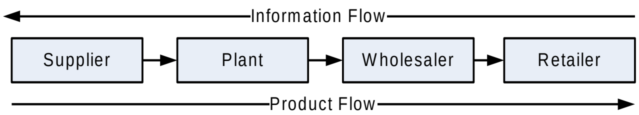

Fig. 2. Supply chain

A simple supply chain consists of four echelons; however in real applications the number of echelons is much bigger. In the supply chain, echelons are the places where inventory is kept. The number of echelons shows the complexity of the supply chain, therefore the methods and approaches aimed at management of such systems are usually related to multi echelon supply chain management by

- showing the complexity of supply chain and
- defining the requirement for supply chain as a holistic system management/modelling methods and approaches.

B. Supply Chain Management

Effective supply chain management becomes an essential task in all areas of business. Nowadays, supply chain management is defined as a set of approaches utilized to efficiently integrate suppliers, manufactures, warehouses and stores, so that merchandise is produced and distributed at the right quantities, to the right location, and at the right time, in order to minimize system-wide costs while satisfying service level requirements. In recent years, increased attention has been paid to the performance, design, and analysis of supply chain.

The complexity of supply chain management is related to the non-linear nature of the multi echelon supply chain (including the number of echelons), as well as uncertainty both inside and outside the supply chain, relatively micro and macro factors. Among macro factors there are material price fluctuations, demand fluctuation and seasonality, customs delays, variation of delivery times, component availability, currency fluctuations, changes in duties, customs. Strikes and terrorism are also named as macro factors that increase risk in supply chain management. In their turn, inbound variations, capacity constraints, production constraints, new product launches, order processing, forecast errors and suppliers' constraints are all associated to micro factors. Among the main uncertain factors, stochastic demand and lead time uncertainty are usually mentioned.

Traditionally, supply chain management tasks are categorized into three planning levels according to the time horizon they cover, namely operational, tactical and strategic levels (see Fig. 3).

Fig. 3. Supply chain management tasks hierarchy

The strategic level usually refers to the overall supply chain network design, therefore including decisions on location, size, number of production plants, distribution centres and suppliers. This level also takes into account sourcing and deployment plans for each plant, distribution centre and customer, as well as the flow of goods throughout the network. The time horizon considered at the strategic level is typically few years. To make the strategy work, some tactical decisions are required to deal with the implications of how the strategy may operate within the constraints imposed by various plant and line capacities, manpower, working practices, operational and transport costs. A tactical plan often forms the basis for what is to be done within the next six months to two years. The operational level can be considered as supply scheduling. Operational models usually consider the lowest level of detail on plant routing, product Bill of Materials, changeover and set-up times, and can be run several times per day to account for any disruption in the production phase.

In the context of the supply chain management under uncertainty, on the strategic level there is not enough exact information about uncertainties that impact long-term decisions. At this level, the supply chain infrastructure is laid down (such as the location of plants and warehouses) and the physical boundaries for tactical planning are provided, which are by definition inflexible to adaptation. On the other hand, at the operational level, characterized by timeframes of 1-2 weeks, the planning horizon is too short to react to uncertainties. Hence, most of the uncertainty could be handled adequately at the tactical planning level, which address planning horizons of one year, mostly employing stochastic values for customer demand, supplier lead times, production costs and/or price fluctuations [1].

Therefore, tactical planning is done within the constraints imposed by strategic planning, and operational decisions are strictly guided by tactical plans. However, due to dynamic environment of supply chain, the decision making becomes a continuous process which asks companies to react to changes almost in a real time. This defines the necessity for holistic approach in supply chain management, managing the system as a whole rather than in parts [2].

C. Supply Chain Management Information Systems

The complexity of supply chain management sets requirements to supply chain management information system.

Supply chain management information systems are information systems used to coordinate information between internal and external customers, suppliers, distributors and other partners in the supply chain. They play an increasingly critical role in the ability of companies to reduce costs and increase the responsiveness of their supply chain [3].

However, in spite of a variety of information systems for supporting supply chain operations, the functionality of the systems may differ dramatically. This usually affects the process of supply chain management because implementation of improper information system may cause difficulties in company performance. Many surveys indicate disappointment of companies in the results achieved by their investments in supply chain management systems. Among the new principles of supply chain management, the employment of cross functional support system is pointed out, which allows breaking the functional perspective at both strategic and tactical levels [4].

For effective supply chain management, companies need process-oriented support systems that link across functions. Information systems which support only narrow functionality of supply chain cannot guarantee the appropriate support in decision making regarding the overall supply chain management.

The analysis of the information systems applied at Latvian companies shows that in most cases the implemented information system is usually operated as order transaction management system without supporting any decision making (see Fig. 4).

Fig. 4. Information systems functionality

Moreover, the information systems are treated sometimes as a black box for supporting the unknown processes. The most illustrative example is presented in [4]. It mentions a situation when multi million investment ERP (Enterprise Resource Management) system for kitchen Supplier Company almost for one year was used with default values for inventory management settings.

ERP systems make the majority among the information systems implemented for supply chain management due to the popularity of the ERP approach. However, often investments in ERP systems are not as cost-effective as it was expected. First of all, the implementation of ERP supposes business processes reengineering with regard to the ERP approach, which sometimes is not possible due to misunderstanding the necessity of this by a company's management. Another issue is related to the lack of understanding the potentials of ERP systems and/or the overestimating information system functionality. As mentioned above, even an expensive information system will not guarantee effective supply chain management without proper values of inventory management parameters calculated by applying inventory algorithms and analytical models.

Therefore, with or without implemented information system for supply chain management, the necessity of analytical tool to support decision making is evident. As can be seen from Fig. 5, this analytical tool may include a variety of modelling approaches which will guarantee that taken decision is mathematically proved and weighted before implementing it to the supply chain performance.

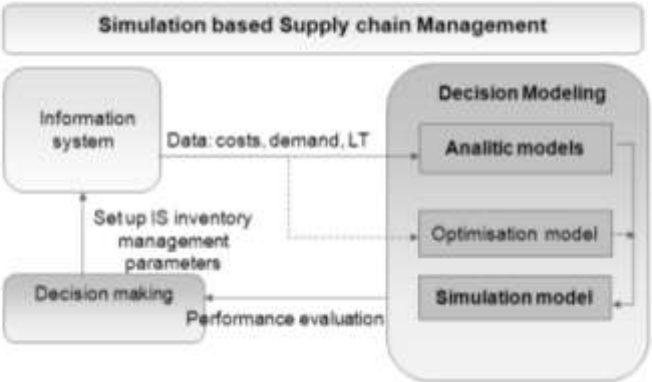

Fig. 5. Simulation-based supply chain management

The analytical component collaborates with information systems by receiving essential information for decision making (such as demand, lead times, transportation rates, inventory costs etc.) and providing it with appropriate settings values in the context of the planned decision.

Along with other modelling approaches such as analytical models, optimization models etc., simulation is an essential element of the analytical component in modelling-based supply chain management which allows evaluating the efficiency of mathematically obtained decisions.

III. Supply Chain Modelling Approaches

In recent years the number of modelling approaches to supply chain management has grown considerably. The experience of successful application of different modelling approaches is presented in a variety of scientific papers, however understanding precognitions of applying particular modelling algorithm to certain problem solving is within the competencies of its users.

Among the models presented in scientific publications related to supply chain management, the most famous ones are belonging to mathematical modelling. Mathematical models focus on solving one certain task in supply chain management; therefore they belong to the object-oriented approach. Besides mathematical models, there are also descriptive models aimed at analysis of supply chain process and their interrelations thus implementing the process-oriented modelling approach.

In the current paper it is assumed that mathematical models are aimed at obtaining any numerical results while descriptive models serve for describing the supply chain performance. In a traditional perspective, some models (for example, simulation models) can be referred to as both mathematical and descriptive models.

A. Descriptive Models

Among descriptive models, the most popular is supply chain operation reference model (SCOR) which is endorsed by the Supply-Chain Council (SCC). SCOR is based on five distinct management processes: Plan, Source, Make, Deliver, and Return.

The benefit of SCOR is a performance metrics which allow evaluating the process efficiency in supply chain. Besides SCOR model, any other descriptive and reference model can be used for description of supply chain including IDEF, DFD, UML etc [5], [6].

Descriptive models can be applicable to situations where the problems are not known exactly for identifying bottlenecks in supply chain performance. They are commonly used also in information system engineering; therefore they are useful to be elaborated before implementing new information systems. In the context of supply chain hierarchical planning, descriptive models provide advantages at the strategic planning level.

B. Mathematical Models

Mathematical models are aimed at obtaining numerical data which may support supply chain decision making.

Based on a task (management vs. analysis) and taking into consideration nature of the models variables (i.e. stochastic vs. deterministic), mathematical models applied for supply chains may be categorized as Fig.6 shows.

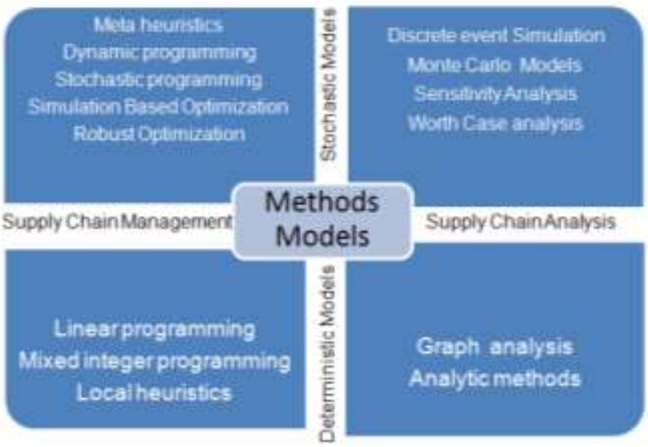

Fig. 6. Supply chain mathematical modelling methods

Due to many and influential sources of uncertainties and stochastic variation within supply chains, the most promising among others are models which can operate with stochastic data. In this context, simulation became a highly effective tool to support engineers and managers in decision making. Simulation takes into account the combined effect of variability, uncertainty and complex interdependencies between processes. Simulation by itself cannot guarantee that the modelled supply chain has the optimal performance. The use of simulation allows the decision maker to test the effect of alternative scenarios in order to select the best one. Due to that, optimisation of simulation models (or of supply chain model) has recently become an important technology in supply chain planning, design and management.

While simulation can yield detailed answers to the most frequently asked and well-known question – “What if?” -, only optimisation technology allows answering the question – “What’s Best?” Optimisation models are based on precise mathematical procedures for evaluating alternatives, and they guarantee that the optimum solution has been found to the problem as proposed mathematically. This is a process in determining exactly which combination of factor levels produces the best overall system response. Optimisation problem can be formulated as a task of finding an extreme of the unknown function representing the system quality. Optimisation of supply chain performance is usually pursued around the goals of cost reduction, capital reduction and service improvement.

The most used optimisation technique for decision making under uncertainty is stochastic programming. During the last years the number of stochastic programming application to complex supply chain management problems has grown considerably. The experience of its successful application to complex real life problem solving stimulates researchers to apply this technique to unsolved problems. Moreover, stochastic programming is often mentioned as a tool for creating a robust solution for a problem with uncertain input parameters.

C. Summary

There are plenty of modelling approaches which could be successfully applied to support decision making in supply chain management. Some of them, such as linear programming, mixed linear programming, dynamic programming, as well as analytic models belonging to operation research models are traditional tools described in plenty of state-of-the-art books and manuscripts focused on supply chain management, whereas others, like heuristics approaches, combined models, simulation models etc. are brightly described in scientific publications. In spite of this, the current issue for companies is related to the application of these models into daily management decisions. Most often, challenging is (1) what kind of models to apply and (2) when it is necessary to use the appropriate model for solving particular task in supply chain management. So, essential is the understanding of modelling application precognitions (see Table 1).

At the strategic level, descriptive models are useful for analysing “AS IS” performance of supply chain and its processes. Descriptive model may serve as a conceptual model for optimisation and simulation models. Optimisation models are aimed at obtaining supply chain parameter settings which will guaranty its best performance, for example, the location of new supply chain facilities, the capacity of warehouse etc. Simulation model may assist in conducting “What if” analysis of the solved problem with extended number of variables. For example, what will be the utilization of new facility if the population density in selected location is changed?

At the operational level, the most effective are simulation models. Simulation allows reacting rapidly on changes in tactical/strategic plans by means of a ready-made simulation model. Optimisation models, except fundamental linear programming models, are usually time-consuming in both developing and computational speed.

TABLE I
SUPPLY CHAIN MODELLING APPROACHES

	Models		
	Descriptive	Simulation	Optimisation
Format	Structure diagrams, IDEF, DFD, SCOR	Computer program with appropriate algorithm	Functions, equations, constraints and objective
Goal	Business process analysis; information system enhancement, integration; company performance analysis	visualization, system design, performance analysis, what if analysis	Performance optimization
Tools	ARIS, AllFusion Process Modeler, ERwin Modeler etc.	AnyLogic, ARENA, ProModel, Simul8, Simplex3	LINGO, AMPL-ILOG, Risk Evolver

IV. CASE STUDIES

This section provides some illustrative examples on application of the above mentioned simulation based supply chain management framework to solving of particular tasks.

The first case study "Beer Game: inventory management" is focused on multi echelon supply chain management tactical planning related to inventory management. It is an academic example demonstrating the potentials of mathematical programming in supply chain management.

The next case study "King Coffee Service: inventory management" is elaborated as a real-case example which is based on data of Latvian distributor of coffee products in the Baltic States. This example shows how small companies may apply different modelling approaches for developing a tool to support tactical decision making in inventory management.

A. Beer Game: Inventory Management

Supply chain considered within the case study is a single product linear supply chain, consisting of four echelons, namely manufactory, distributor, wholesaler and retailer. A fifth echelon is constituted by the market, passing on the customer's demand to the retailer echelon. The task is to produce and deliver units of beer: the factory produces and the other three echelons deliver the beer units until they reach the external customer at the downstream end of the supply chain.

The objective of the decision making is to find the amount of beer quantity to order by minimizing the total cost, i.e., the sum of the backlog costs and inventory costs over all periods and for all echelons. Decision should be made for time horizon of 52 weeks. The demand of end customer and lead time are stochastic and presented by normal distribution. King Coffee Service: Inventory Management.

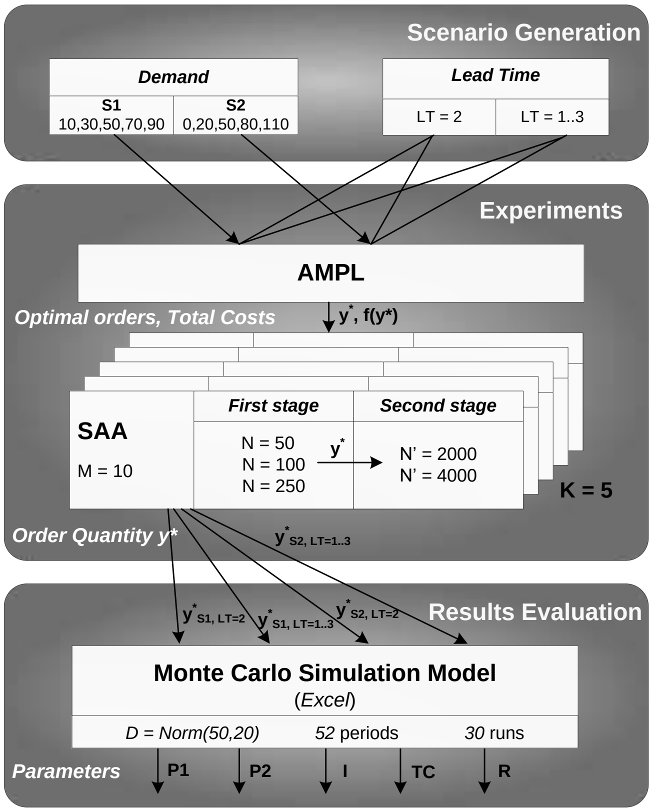

Fig. 7. Modelling approaches solving Beer Game case study

In the case study several modelling approaches are applied (see Fig. 7). Optimisation model is created to calculate inventory control setting at all echelons in respect to minimizing the total costs of supply chain, including inventory costs and backlog costs. The optimization model belongs to scenario approach of stochastic programming as stochastic values of demand and lead time are represented by means of scenarios [7]. Optimisation model is expressed by means of AMPL. The developed optimization model allows verifying different inventory management approaches, for example, centralized/decentralized supply chain management, as well as testing different inventory control algorithms, e.g., with and without outsourcing. The Sample Average Approximation (SAA) method is applied in the case study for evaluating the obtained solution of stochastic model.

Simulation model of the same supply chain is developed using Excel Spreadsheet. It allows estimating the performance of the supply chain under optimized inventory control parameters through the time horizon of one year. Based on simulation results, the following performance metrics are obtained as service level, average inventory level, and system robustness in regard to service level [8], [9].

B. King Coffee Service: Inventory Management

In the case of King Coffee Service (KCS), the problem is also related to inventory management. KCS is an international company with head office located in Riga (Latvia) and representatives in Lithuania and Estonia. All material flows are managed through Latvia. The company receives goods from manufacturers directly, skipping wholesaler echelon from a typical supply chain structure. The inventory is held in the company's private warehouse. However, the company rents storage facilities in a public warehouse in order to achieve best service for its main customer, who has storage facilities in the same place. Other customers, as well as KCS representatives in the Baltic States are served from KCS's private warehouse. The goal is to improve inventory management in the company.

As a first step, an analysis of existing inventory management system is performed based on historical data obtained from company's information system.

During this analysis, the necessity of developing descriptive model of company's business process related to inventory management has appeared for better understanding of inventory management system at the company as well as the related functionality of the implemented information system. While elaborating the process model, it was found out that information system supported only inventory transaction; however inventory management decision as order quantity and order time, both are set up based on manager empirical experience.

Based on ABC analysis, main products are selected for future analysis when analytic inventory control models are applied in order to calculate inventory control settings [10].

To evaluate the performance of applied inventory models, simulation model is created by means of Excel Spreadsheet (see Fig. 8). Simulation models are created for all modelled inventory strategies. They are run for period of 52 weeks (tactical horizon) with 30 replications. Replication number is obtained empirically, however an analysis is made by using confidence interval method to prove the sufficiency of 30 replications.

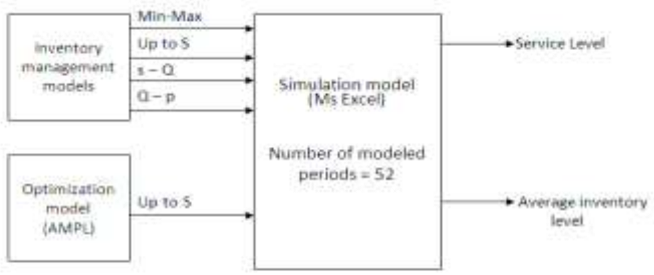

Fig. 8. Modelling approach in KCS case study

The following performance indicators are selected for analysis of efficiency of applied inventory models: service level as a percentage that indicates the chance of demand coverage during the replenishment; service level indicating the percentage of demand covered at time; average inventory and a dispersion of results.

Simulation results showed that the most appropriate inventory strategy for the company is "min-max". However, before making the final decision and implementing it to the company inventory management system (including corresponding parameters set-up at company's information system), an optimization model is created by means of AMPL modelling language. The obtained results are then evaluated with the help of simulation model, however comparing with analytic models' results, optimization provided a lower customer service level. This is due to applying 100% customer service factor in analytical models, in turn when optimization model deals with stochastic scenarios and does not consider safety stocks. In fact, application of scenario approach of stochastic programming in inventory management is rational if there is some lack of data required for traditional analytic algorithms, for example, mean and dispersion of demand or lead time cannot be precisely expressed.

This case study is focused on enhancement of inventory management system in the company "KCS". During the research, an empirical study was conducted to analyze current situation of the inventory management in the company. However, detailed analysis is done for one product, i.e. Coffee 3200, which is the company's leading product. Simulation results show that "min-max" is the most appropriate strategy.

V. Conclusions

Nowadays, supply chain management is often a challenge to its managers. It is mainly caused by a nonlinear nature of supply chain along with increasing number of its echelons which are usually spread globally. Other challenges are related to product complexity with stochastic demand, as well as high service level requirements operating in high business competition environment. Diversity of information technologies, including supply chain information systems and applied IT standardization variety among supply chain echelons may cause additional issues in supply chain management.

In spite of that, requirements for nowadays supply chain management are incredibly high. It should be optimized by this ensuring the best performance operating in uncertain environment. Supply chain might also be agile reacting through the ability to respond quickly to customer demand by reducing operating costs. It also should be robust with regard to handling uncertain events with minimal loss.

The above-mentioned issues define the necessity of developing the decision support framework for supply chain management which allows obtaining and evaluating supply chain performance parameters. Simulation and optimization models are the essential components of the framework, however the importance of descriptive models of supply chain, for example, SCOR model, becomes evident in the context of strategic planning and supply chain management information system implementation.

The disappointment in the outcome produced by investments into supply chain management information systems shows that any company may benefit from developing the analytic framework which supports decision making.

Acknowledgements

Author expresses the deepest gratitude to the Department of Industrial Management of Ghent University (Belgium), namely Professor Hendrik Van Landeghem and Professor El-Houssaine Aghezzaf, for scientific guidelines while working

on application of stochastic programming to multi echelon supply chain management.

References

[1] H. Van Landeghem, H. Vanmaele, “Robust planning: a new paradigm for demand chain planning” in *Journal of Operations Management*, 20: 2002, pp.769-783.
[2] H. Singh, “Next-generation Supply Chain Optimization”. [Online]. Available: ttp://www.comm.pdx.edu/faculty/Sussman/sussmanpage.htm [Accessed: Sept. 12, 2010].
[3] T. S. McLaren, M. Head, and Y. Yuan, “Supply Chain Management Information Systems Capabilities: An Exploratory Study of Electronics Manufacturers” in *Information Systems and e-Business Management*, Vol. 2, No. 2, 2004, pp. 207-222.
[4] T. Laseter, and K. Oliver, *When will Supply Chain Management Grow Up?* [Online] Available: http://www.strategy-business.com/press/16635507/03304 [Accessed: Sept. 10, 2011].
[5] V. Kasi, "Systemic Assessment of SCOR for Modeling Supply Chains" in *Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS'05).* Vol. 3. 2005, pp. 87.
[6] C. N. Verdouw, A. J.M. Beulens, J.H. Trienekens, and S. Wolfert, *Business Process Modelling in Demand- Driven Agri- Food Supply Chains*. [Online]. Available: http://centmapress.ilb.uni-bonn.de/ojs/index.php/proceedings/article/viewFile/58/56 [Accessed: Sept. 10, 2011].
[7] O. Soshko, Y. Merkuryev, and H. Van Landeghem, “Application of stochastic programming for supply chain inventory optimization under uncertain demand and lead time” in *Proceedings of the 6th EUROSIM Congress on Modelling and Simulation*. EUROSIM, 2007. pp. 9-13.
[8] O. Soshko, J. Goetgeluk, H. Van Landeghem, and Y. Merkuryev, “Optimisation of Beer Game inventory model under uncertain demand” in *Scientific Journal of Riga Technical University*, Series *5*, Computer Science, vol. 28, Information Technology and Management Science, 2006, pp. 57.-66.
[9] O. Soshko, N. Pluksne, “Inventory Management in Multi Echelon Supply Chain Using Sample Average Approximation” in *Scientific Journal of Riga Technical University*, Series 5, Computer Science, vol. 40, Information Technology and Management Science ,2009, pp. 45-52.
[10] O. Soshko, V. Vjakse and Y. Merkuryev, “Modelling Inventory Management System at Distribution Company: Case Study” in *Scientific Journal of Riga Technical University*, Series 5, Computer Science, vol. 44, Information Technology and Management Science, 2010, pp. 87-93.

Oksana Soshko graduated from Riga Technical University (Latvia) in 2003. She has a Master Degree in Information Technology.
Since 2003, she has been working at the Department of Modelling and Simulation of RTU. Currently she holds a position of Lecturer. She is the co-author of a textbook on Logistics Information Systems. Her professional interests are related to information technology applications in supply chain management, as well as application of active learning methods in teaching. Oksana Soshko is Information Coordinator of the Latvian Simulation Society.
E-mail: oksana@itl.rtu.lv.

Oksana Soško. Modeļos sakņotā piegādes ķēdes vadīšana
Pasaules loģistikas eksperti izsaka viedokli, ka, neskatoties uz zinātniskiem sasniegumiem piegādes ķēžu vadīšanas jomā, loģistikas uzņēmumiem trūkst kvalificētu darbinieku un ir jāpieaicina ārpakalpojumu sniedzēji piegādes ķēžu darbības uzlabošanai. Tāpēc aktuāls uzdevums ir tādas metodoloģijas izstrāde, kas varētu atbalstīt lēmumu pieņemšanu piegādes ķēžu vadīšanā, sniedzot gan līdzekļus, gar arī to izmantošanas piemērus saprotamā valodā un plaši pieejamā vidē. Šajā rakstā ir izskatītas modelēšanas pieeju izmantošanas iespējas piegādes ķēžu vadīšanas uzdevumos. Raksta sākumā ir sniegts mūsdienu daudzešelonu piegādes ķēdes apraksts. Piegādes ķēde ir sarežģīta struktūra ar nelineārām saitēm starp ešeloniem, kas darbojas globālā mērogā, pie augstām klientu prasībām dažādu informācijas tehnoloģiju standartu platformā. Uzņēmumu nespēja izvēlēties sev piemērotāko informācijas sistēmu padara neefektīvu piegādes ķēžu vadīšanu. Bieži vien jaunas informācijas sistēmas ieviešana prasa uzņēmuma biznesa procesu pārprojektēšanu. Vairākiem uzņēmumiem, it īpaši Eiropā un Latvijā, kur ir mazo vai mikrouzņēmumu pārsvars, informācijas sistēmu ieviešanu bremzē tādi faktori kā izmaksas un kompetenču trūkums. Tāpēc metodoloģijas izstrāde, kura piedāvātu līdzekļus un metodes matemātiski pamatotai lēmumu pieņemšanai piegādes ķēžu vadīšanā, ir ļoti aktuāla. Modelēšanas izmantošana var būtiski pilnveidot lēmumu pieņemšanu piegādes ķēžu vadīšanā. Rakstā ir aprakstītas modelēšanas pieejas, kuras izmantojot uzņēmums varēs novērtēt pieņemtā lēmuma efektivitāti kādā laikā intervālā. Šie modeļi var būt aprakstoši un matemātiski. Rakstā ir paskaidrots, kādā veidā šie modeļi var būt izmantoti piegādes ķēžu vadīšanā. Raksta nobeigumā ir aprakstīti divi piemēri, kuros ir izmantoti krājumu vadības analītiskie modeļi, kā arī imitācijas un optimizācijas modelēšanas pieeja.

Оксана Сошко. Использование моделей в управлении цепями поставок
Мировые эксперты логистики все чаще отмечают, что, несмотря на научные достижения в области управления цепями поставок, логистические компании испытывают трудности из-за нехватки квалифицированных работников и необходимости использования услуг консалтинговых специалистов для улучшения работы цепи поставок. В связи с этим становится актуальной задача разработки методологии, которая могла бы обеспечить компании доступными методами и средствами принятия решений в процессе управления цепями поставок. В данной статье для создания такой методологии рассматриваются функциональные возможности различных подходов моделирования. В статье дается описание многоуровневых цепей поставок, которые представлены в виде сложной структуры с нелинейными связями между уровнями. Работа такой системы осуществляется в глобальном пространстве при высоких требованиях к уровню обслуживания. К тому же, для поддержки операций в управлении цепочками поставок используются информационные платформы с различными стандартами. Все это, а также трудности выбора подходящей информационной системы, приводит к тому, что процесс управления цепями поставок становится неэффективным. Чаще всего внедрение новой информационной системы приводит к необходимости перепроектирования бизнес процессов компании. Более того, внедрение информационных систем на малых предприятиях, число которых преобладает на Латвийском и Европейском рынках, осложнено высокими издержками на приобретение и внедрение системы, а также недостаточной компетентностью работников. Поэтому разработка методологии для поддержки математически обоснованного принятия решений в управлении цепями поставок является важной задачей для компаний. В данной статье основной составляющей такой методологии называется совокупность различных подходов моделирования, которые могут существенно улучшить процесс управления цепями поставок. В статье рассмотрены различные подходы моделирования, включая описательные и математические модели, а также возможности их использования в задачах управления цепями поставок. В заключение представлены два примера, которые демонстрируют возможности использования аналитического и имитационного моделирования, а также оптимизационных моделей.