SUPPLY CHAIN MANAGEMENT OF SMALL AND MEDIUM-SIZED ENTERPRISES

SORAK, M. & DRAGIC, M.

Abstract: *Supply chain management in small and medium-sized enterprises is aimed at ensuring both short- and long-term effectiveness and efficiency of these enterprises. Management practically ensures that small and medium-sized enterprises, as dynamic, self-controlled, controlled and open systems, adapt to the operating environment, which is inherently dynamic, open and stochastic. Traditional approach to management of small and medium-sized enterprises is associated with overstocking and providing excessive capacity as a means of protection against demand variability. Owing to the possibility of rapid and major changes in the marketplace, this approach presents a great risk with potential adverse effects. Contemporary approach to management of small and medium-sized enterprises implies that these enterprises operate following the "feel and react" principle, as opposed to the traditional "produce and then sell" principle. A fast response to the demand variability requires efficient solutions for all elements that constitute the supply chain: demand management, planning, procurement, warehousing, production, transport and distribution. For these very reasons, there is a need to address the issue of supply chain optimization, inasmuch since every organizational system wants to utilize the synergistic effect of a whole and be as efficient and effective as possible. As the synergistic effect depends heavily on both the strategy chosen and managerial decisions made by the managers at the operational level during adjustment of work processes, they are requested to make decision closely tailored to the entire organizational system. Taking the above mentioned problem into account, a growing number of researchers have recently been asking questions and searching for a solution on how chosen strategies and managerial decisions made by the managers at the operational level during adjustment of work processes may contribute to enhancement of effectiveness and efficiency of the entire enterprise.*

Key words: *Supply chain, SMEs, efficiency, effectiveness*

Authors´ data: Professor Dr **Milos** S[orak]*; Mr **Dragic** M[iroslav] , *University of Banja Luka, Vojvode Stepe Stepanovica 73, 78 000 Banja Luka, Bosnia and Herzegovina, **University of Banja Luka, Vojvode Stepe Stepanovica 73, 78 000 Banja Luka, Bosnia and Herzegovina, sorakmilos@yahoo.com; miroslav.dragic@gmail.com

This Publication has to be referred as: Sorak M[ilos] & Dragic M[iroslav] (2013) Supply Chain Management of Small and Medium-Sized Enterprises, Chapter 59 in DAAAM International Scientific Book 2013, pp. 951-968, B. Katalinic & Z. Tekic (Eds.), Published by DAAAM International, ISBN 978-3-901509-94-0, ISSN 1726-9687, Vienna, Austria
DOI: 10.2507/daaam.scibook.2013.59

1. Introduction

Every organizational system wishes to utilize the synergistic effect of a whole and be as efficient and effective as possible. That synergistic effect depends heavily on both the chosen strategy and managerial decisions made by the managers at the operational level during adjustment of work processes. Research has shown that managers, in most cases, make decisions that are most advantageous for a business entity in their charge. Of course, such decision-making is influenced by the objectives and politics of the organizational unit in their charge.

The reasons why managers, in most cases, make decisions closely tailored to the business entity in their charge, should be sought in the fact that, without a quality software solution and a quality training encompassing problems of the influence of partial (individual) managerial decisions on the overall optimum of the system, they are unable to perform their activities. Noting the above, a growing number of researchers have recently been asking questions and searching for a solution on how the chosen strategies and managerial decisions made by the managers at the operational level during adjustment of work processes may contribute to enhancement of effectiveness and efficiency of the entire enterprise (Sorak, 2005; Božičković, 2005; Kaluza, 2006; Marić, 2010).

This very chapter tries to provide answers to the questions on how the chosen strategies and managerial decisions made by the managers at the operational level during adjustment of work processes contribute to enhancement of effectiveness and efficiency of the entire enterprise. In that sense, this chapter puts an emphasis on the possible ways to improve supply chains using a modelling and simulation method. Its ultimate goal is a supply chain management model whose role is to track a timeline of the observed cause-and-effect phenomena.

A supply chain encompasses all participants and processes, from the raw material manufacturers to the end users. The classical view of the supply chain includes four basic components: procurement, warehousing, production and distribution. The contemporary approach requires precise forecasting and demand planning which link supply and demand in such a way as to ensure that the right product is to be found at the right place at the right time. If movement of raw materials, semi-finished and finished products through the supply chain is in better compliance with the demand, the enterprise will decrease its stock, enhance its customer service, and avoid unpleasant surprises (Gunasekarana et al., 2004; Sorak, 2005; Dragić, 2010).

Thus, the main objective of research on supply chain optimization of the production systems using the modelling and simulation method is to examine the possibility of boosting their flexibility during the process of managerial decision-making at the operational level. The ultimate goal is to define an integrated demand assessment model and integrate it with a dynamic model for production system estimation in order to improve effectiveness and efficiency of the entire enterprise. Some of the elements of such a model are:

- A long -term demand assessment model based on demand in the previous periods;
- Adjustment of a demand model in relation to time and demand disturbances;
- A dynamic model for change detection and condition monitoring of raw materials, semi-finished and finished products;
- Integration of a demand model and a dynamic model for production system estimation.

When conducting research on supply chain optimization of the production systems using the modelling and simulation method, work processes in production systems of small and medium-sized enterprises present a specific problem. Compared to large business systems, these enterprises have the ability to quickly adapt to constant changes and thus meet the changing demands of the market. However, small and medium-sized enterprises have a chronic problem that makes their management specific. This problem is a lack of resources. This is primarily related to financial resources, as well as all other resources - knowledge, human resources, and capacities. From this perspective, management of small and medium-sized enterprises takes the form of enterprise management in conditions of limited resources.

2. Defining the Supply Chain and Supply Chain Management

In the literature, it is possible to find a large number of papers dealing with supply chains, which are treated from different aspects. Supply chain is thus described as a system, a network of organizations, a series of activities, an integration of processes, etc. through which the material, information, and financial flows pass.
Different approaches in defining basic elements, characteristics and an objective of the supply chain are due to the fact that different conceptions of the activities, processes and flows in the supply chain exist. Therefore, modelling, design and analysis of the supply chain primarily depends on providing the answers to the following questions (Lambert et al., 1998; Vlajić et al., 2005; Dragić, 2010):

- What constitutes the chain (who are the participants, what are their resources, where is their location, which processes take place in the chain, in what manner the material, information and financial flows are being realized, etc.),
- what procedure is used to manage the chain (who makes the decisions, which managerial strategies are being used, to what degree some of the chain members can be influenced, etc.), and

- how to determine successful functioning of the chain (what performances are to be monitored, how and where to make their quantification, how to set the target performances, how to conduct benchmarking, etc.).

2.1 Supply Chain

To better understand the issues surrounding supply chains, this paper gives a chronological overview of the most cited definitions concerning the concepts of a supply chain.

According to Beamon (1998), a supply chain may be defined as an integrated process wherein a number of various business entities (i.e., suppliers, manufacturers, distributors, and retailers) work together in an effort to: (1) acquire raw materials, (2) convert these raw materials into specified final products, and (3) deliver these final products to retailers. This chain is traditionally characterized by a forward flow of materials and a backward flow of information. Mentzer et al. (2001) have defined the supply chain as a series of three or more entities (organizational or individual) that are directly involved in two-way flows of products, services, finances and/or information, from source location to consumer. Min & Zhou (2002) have observed the supply chain as an integrated system that synchronizes a series of interdependent business processes in order to: (1) supply raw materials and parts; (2) transform these raw materials and parts into finished products; (3) add value to these products; (4) distribute and promote these products either to retailers or consumers; (5) ease information exchange between different business entities (such as suppliers, manufacturers, distributors, logistics service providers, and retailers). Pienaar (2009) defines Supply Chain as “a general description of the process integration involving organizations to transform raw materials into finished goods and to transport them to the end-user”. Chan at al., (2006): A supply chain can be viewed as a network of participating corporations working together to achieve global objectives, which are generally minimizing total cost, or reducing inventory level, etc, through which material and products are acquired, transformed and delivered to consumers in markets. Supply chain management is the act of optimizing all activities through the supply chain, so that products and services are supplied in the right quantity, at the right time and at an optimal cost.

According to Wallace (2007), a supply chain is a goal-oriented network of processes and stock points used to deliver goods and services to customers. In this definition, processes represent the individual activities involved in producing and distributing goods and services. They could be manufacturing operations, service operations, engineering design functions or even legal proceedings.

2.2 Supply Chain Management

The question of how supply chain management can be used to permanently boost effectiveness and efficiency of the organizational systems has become one of the key questions in today’s era of globalization. In order to provide answers to this question, many researchers tackling the issue of supply chain management have offered their definitions or explications of the above mentioned problem.

According to Simchi-Levi at al. (2003), Supply Chain Management (SCM) refers to 'a set of methods used to effectively coordinate suppliers, producers, depots, and retailers, so that commodity is produced and distributed at the correct quantities, to the correct locations, and at the correct time, in order to reduce system costs while satisfying service level requirements'. Hensher & Brewer (2004) think that supply chain management comprises all business and management activities that are used for transforming input resources in products and services. According to Grant at al. (2006), Supply Chain Management refers to corporate business processes integration from end-users through suppliers that provides information, goods, and services that add value for customers.

The Supply Chain Management Professionals' Council (2009) asserts that Supply Chain Management (SCM) includes the designing and management of all activities involved in sourcing and purchasing, transformation, and all logistics management activities. Principally, it also includes coordination and partnership with network partners, which can be suppliers, mediators, third party service providers and customers. Fundamentally, Supply Chain Management (SCM) coordinates supply and demand management within and across companies.

Essential notion of the above definitions is that the supply chain must be controlled in order to be fast, reliable, cost-effective, and flexible enough to meet customer demands. The goal of supply chain management is to improve its competitiveness by raising the level of customer services on the one hand, and lowering the total cost of the chain itself on the other. Therefore, to achieve this ultimate objective it is necessary to integrate and synchronize the activities and processes of all participants in the supply chain at all levels, from strategic to operational. Although all chain members are united in order to increase the overall performance of the supply chain, each of them expresses a specific interest in some of the processes within the supply chain. Different areas of interest and different personal goals set barriers to the supply chain implementation. The main benefits, barriers as well as challenges set before the supply chains are given in Tab. 1 (Andreas, 2006).

3. Supply Chain Structure

The supply chain in production systems is an integrated set of business processes that guide all activities of the enterprise, from forecasting, planning, and inventory management to the delivery of finished products to the end user.
The main objectives of an effective and efficient supply chain are included in the JIT (Just in Time) concept, i.e. the demand to deliver the right product at the right time, in the right amount and in the right place. To meet these demands, goal-oriented activities must be taken in order to ensure that all processes of the supply chain function efficiently.

Benefits	Obstacles	Intermediaries
Enhanced reaction to customer demands	Inadequate information exchange	Higher management support
More stable on-time delivery	Poor/ambiguous performance measurements	Open and fair information sharing
Shorter order fill	Inconsistent operations goals	Correct and understandable measures
Reduction in inventory costs	Organizational culture and structure	Alliance based on trust Guidance and rationalization of the supply chain
Better utilization of assets	Resistance to changes – lack of trust	Exchange of managerial experience
Lower prices of purchased items	Lack of cooperation in business practice	Process documentation and ownership
Higher product quality	Lack of vision – misconception of the supply chain	Education and training
Ability to react to unexpected events	Lack of managerial decisions	Supervisory authorities
Faster implementation of product and process innovations	Limited resources	Usage of pilot projects
Desirable and appropriate relations		

Tab. 1. Benefits, obstacles and challenges in the supply chain

Accordingly, supply chain management of small and medium-sized enterprises and production activities should include management of the following processes (Fig.1):

- Forecasting, often defined as a survey of the future in order to obtain trustworthy information on factors in external and internal environment vital for business activities of the enterprise in the future. The main goal of forecasting procedures is to minimize the uncertainty of actions in the future.
- Planning, often defined as a systematic design of events in the future. The task of production planning is to fulfil customer orders on time, reduce inventory and interoperation time with optimum utilization of material, labour and machinery.
- Stock management, usually defined as a problem-solving setting and maintaining the necessary amount of raw material, semi-finished and finished products in order to ensure production and sales continuity. Therefore, the goal of inventory management of materials in the supply chain should not be just ensuring process continuity, but also providing the minimum requirements needed for the reproduction process, in order to increase effectiveness and efficiency of the production systems.

- Production and assemblage, encompassing all activities taking place from the moment raw materials enter the production process to the finished product release. Here, on the basis of elaborate technological procedures and production plans, accompanied by a provision of the necessary production elements, changes in status (transformations) of the raw materials into products occur, i.e. inputs of the enterprise are converted into its outputs.
- Sales and delivery of finished products, with a task to carry out packaging, transport, invoicing and charging for delivered products, depending on a production program, type of production, and environment within which the enterprise operates (Dragić, 2010).

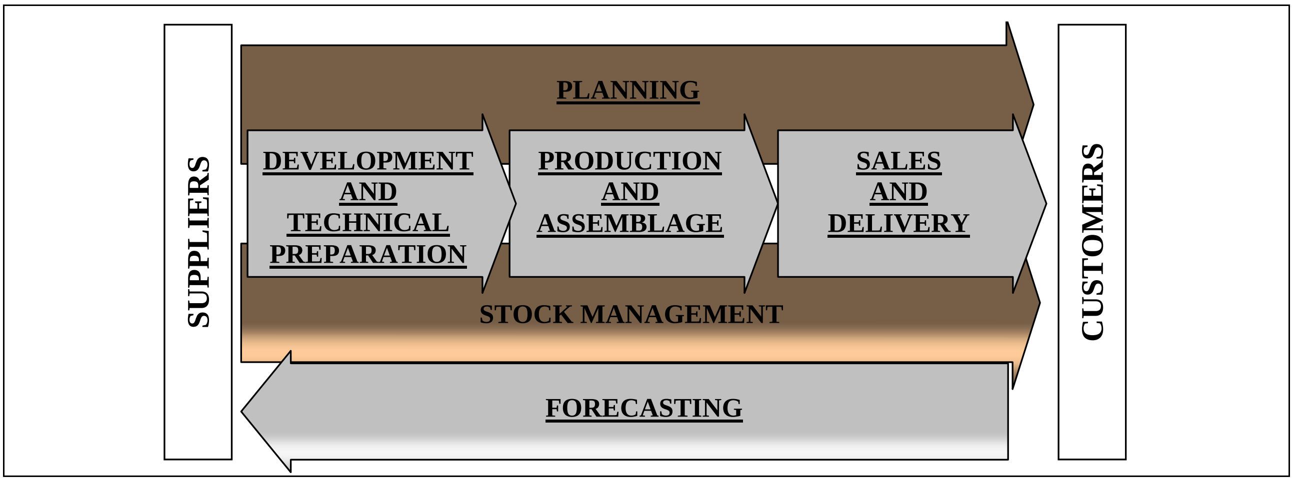

Fig. 1. Supply chain processes

4. Supply Chain Performance Measurement

Supply chain performance measurement is used to determine effectiveness and/or efficiency of the supply chain, as well as to compare different alternatives through a value determination of the supply chain variables, which provide the most desirable level of performance. According to Kotler (1984), from a marketing standpoint, enterprises can accomplish their goals by meeting customer demands more effectively and efficiently than their competitors. Accordingly, they can derive multiple benefits from an assessment of the level of effectiveness and efficiency along the entire length of their supply chain. According to Lambert & Pohlen (2001), absence of a widely accepted definition of supply chain management and vaguely defined supply chain structure complicate the assessment of the supply chain effectiveness. In addition, somewhat difficult information exchange between different supply chain elements, accompanied by rejection of information exchange between different entities, make this procedure even more complicated.

However, in accordance with different approaches for defining the supply chain, different approaches for defining the supply chain performance exist. According to Rolstad (1995), when developing a system for supply chain performance measurement one should keep in mind the following:

- System needs to support a decision-making process, showing where and how to act, and the type of consequences arising from implemented action plans.
- System has to control the impact of strategic plans, so that amendments can be made to guarantee the achievement of long-term goals.
- Measurement is necessary for tracking the realization of internal corporate goals, as well as for meeting the demands of different external participants.
- System needs to have analytical properties, so that it supports the alarm system prior to business performance decline.
- Measurement should be an integral part of the continuous improvement process.

Although every supply chain is unique, in most cases, the following four categories can be applied to group performance and performance measures (Stadler & Kilger, 2002; Gunasekarana et al., 2004; Goknur & Turan, 2010):

1. Delivery performance – It has an impact on the customer sales, and therefore on the supply chain competitiveness. This performance is typically measured in terms of deviation between the actual delivery date and the customer requested delivery date. Different measurements for this performance can be found in the literature, the most common being: service level, order fill rate, on time delivery, forecast accuracy, etc.
2. Supply chain flexibility – It is the ability of the supply chain to adapt to changes, and represents one of the most important conditions for the survival of supply chains in a business environment. Flexibility can be expressed in terms of different variants (alternatives) through which a system can adapt to changes. Alternatives can refer to the possibility of changes in the system elements, as well as in the planning and management domain. In addition, taking into account the aspect of service reply, flexibility can be measured in terms of speed through which an adaptation of the system to new conditions can be reached. It can be expressed as a reaction time or reaction costs.
3. Working capital - Working capital of the supply chain encompasses receivables, inventory, facilities, and equipment owned by the chain. The most important performance measures of the working capital management typically include:
   - Flow of working capital, which is defined as the ratio between total revenue and total working capital, and
   - Cash flow coefficient, which represents a derived measurement used to describe the average number of days needed for the cash flow to be carried out, from the money investment in raw materials to the payment made by the end user.
4. Stock – It represent a constituent of the working capital of the supply chain, which significantly affects effectiveness and efficiency of the chain itself. To determine the optimal level of stock in the supply chain, an adequate stock analysis covering the aspects of its place in supply chain, its function, structure, value, management strategies and parameters, costs etc. must be carried out.

From the physical aspect, common performance measures in the stock domain include:

- Stock flow, which is defined as the ratio of total material consumption over a time interval and the average level of stock in the same time interval.
- Stock life cycle, which is defined as the average time the products are being kept in stock.
- Average stock level, which represents an adequate performance measure when comparing supply chain performance in different scenarios.

5. Simulation Model Development

Simulation is one of the operations research techniques. The concept of simulation, in a broader sense, is seen as a set of activities associated with experimental determination of the effects that occur in a system, process or model which imitates them. Therefore, simulation is a basis for the analysis of acquired results, and a place where the validity (validation) testing (verification) of the model, based on developed criteria, is being performed. Since experimentation on real-life objects is not always possible, experimenting on a simulation model provides information on behaviour of the elements in a real-world system. As numerous observed systems are becoming more complex, classical mathematical findings are no longer sufficient enough to determine their dynamics (Letić, 2001; Dragić, 2010).

Simulation on models enables the industrial systems to explore and improve their conditions through application of the appropriate methods and techniques, but primarily through monitoring a time course of the changes associated with the effects of work processes in the system. To better understand the appropriateness of applying this approach, it should be noted that the material and information flows are often highly stochastic, which causes unpredictable system behaviour. For this reason, analytical methods cannot always provide an adequate quantification of the system behaviour through which an overall functionality of the system could be observed.
The aforementioned changes of environmental conditions and disturbances in the business processes of small and medium enterprises require development of a flexible model for supply chain simulation. Such a model has to meet specific requirements, and these are reflected in:

- necessity to follow different trends in demand for finished products,
- need for simulation of planning procedures and adjustment of work processes,
- requirements for continuous monitoring of materials in stock, work in process and finished products, and
- need for continuous harmonization of the finished products distribution in accordance with customer demands.

It is also necessary to meet the specificity of small and medium-sized enterprises and production activities, which is reflected in (Dragić, 2010):

1. a wide range of products,
2. usage of a wide range of different materials,
3. preparation and execution of the production process, usually in small batches,
4. need for the development of technical documentation, mostly for the modified products, because, in many cases, it is necessary to modify technical documentation, and
5. continuous requests to reduce the elapsed time between receiving a customer order, placing a bid and manufacturing a product.

General process of simulation basically involves procedures in simulation model development, planning and execution of simulation experiments, result analysis and drawing conclusions. Taking this into account, simulation model development can be represented as a series of activities which include (Radenković 1999, Stadler & Kilger 2002):

6. Problem definition - This step defines a desired objective and purpose of the simulation, system boundaries and level of detail, constraints and assumptions to be applied, etc.
7. Verbal description of the model - It is a representation of the model in spoken language, and is commonly presented in a written form.
8. Model development - This step defines controlled and uncontrolled elements of the model, their behaviour, decision rules and performance measures.
9. Making a flowchart of the model - This step facilitates computer programming and helps to clarify logic of the model.
10. Model programming – At this stage, a user program is being written using some of the programming languages (C, Visual Basic, Java ...) or ready-made solutions.

For the purpose of performing a simulation of the supply chain processes in small and medium-sized enterprises, a modular approach to simulation model development is a preferred option. This approach involves development of a model out of discrete units (modules), with each unit having its own objective, decision rules and performance measures. The advantages of this approach in simulation model development are reflected in:

- easier definition of the purpose of each module,
- simplified verbal, mathematical and logical description of the model,
- adjustment of the level of details of the modules to the simulation process requirements,
- possibility to improve certain modules without the need to make changes in other modules,
- ability to engage professional staff for individual modules,
- easier error detection in a model,

- easy monitoring of the simulation process results, and
- possibility of a modular approach to simulation program development.

The intensity and frequency of changes in the business environment have imposed the need for integration of a demand estimation model with a dynamic system behaviour model. As such, this integrated model might serve the industrial systems as the basis for conducting simulation experiments and analysis of obtained results. Modules of a proposed model for the supply chain simulation in small and medium-sized enterprises, with its allotted performance measures, are given in Tab. 2.

MODULES		PERFORMANCE MEASURES		
No.	**Name**	**Trend**	**Name**	**Definition**
M.1.	**FORECASING AND INITIATION OF CUSTOMER DEMANDS**			
M.2.	**PREPARATION AND EXECUTION OF PRODUCTION PROCESSES**	↑	***Capacity utilization***	*The relationship between the required and available capacity*
		↓	***The flow coefficient***	*Dimensionless number that shows the actual production cycle is greater than the theoretical production cycle in ordinal terms switch series from one operation to the other*
		↓	***The average level of work in progress***	*The average value of work in progress*
M.3.	**INVENTORY MANAGEMENT**	↓	***The average level of materials in stock***	*The average value of finished goods over a period*
		↑	***Inventory turnover***	*The ratio of total material consumption in a certain period and intermediate levels of inventories in the same time interval*
M.4.	**SALES AND DELIVERY**	↑	***Fulfillment of orders from the existing stock***	*Percentage of the amount of goods that customers require and that can be filled with existing supplies*
		↑	***Timeliness of delivery***	*The percentage of orders that are filled before or as scheduled/promised delivery date.*
		↑	***The value of realized orders***	*The total value of orders received in the relevant period.*
		↓	***The average level of finished goods inventory***	*The average value finished goods inventory over a time*

Tab. 2. Modules of a basic simulation model with its allotted performance measures

6. Case Study

This chapter describes a case study concerning the application of simulation in supply chain optimization of a small enterprise manufacturing metal products. The developed model helps the enterprise managers to make decisions at the operational level by enabling them to recognize the impact of their decisions on the performance of other processes, and thus on the overall performance of the enterprise business operations.

6.1. Planning the Experiment

To conduct the supply chain simulation of an enterprise as efficiently and effectively as possible, the experiment planning stage needs to be carried out first. The experiment plan will be primarily used to determine temporal parameters of the simulation execution. A period of one hour (1 hour) was adopted as a basic defining unit. Simulated period corresponds to the period of one quarter. Assuming that the enterprise works 5 days a week, the total time covered by the simulation experiment will be 65 working days, or 520 defining units.

The results of the simulation experiment are expressed through the supply chain performance measures of the simulated system. The goal is to define the system parameters which will lead to a satisfactory level of supply chain performance. As the dependency of the supply chain performance measures and the model parameters of the system is not uniformly defined, it is necessary to conduct the experiment several times (varying the model parameters).

The basic version of the experiment was conducted using the model parameters adopted from the actual data of the simulated production system. It should be noted that not all system parameters are liable to change or that their change will not be the subject of this research. This primarily applies to the normative of materials and time, the product development time and the time required for the procurement of materials.

Different variants of the experiment are obtained by changing (more or less) the model parameters. In that sense, there are many possible variants of the experiment. However, the number of its variants can be reduced by a target-oriented variation of the model parameters, i.e. by a variation aimed at direct improvement of one or more performance measures of the supply chain. The experiment needs to show how such changes affect other performance measures.

The adopted plan for conducting multiple experiments with the plan of model parameter variations is given in Tab. 3.

Experiment mark	Description of an experiment variant		Model parameters: Signal quantity of finished products	Max. quantity of finished products	Capacity of work	Signal quantity of raw materials	Max. quantity of raw materials
E.0.	*Basic variant of the experiment* *Model parameters are set in accordance with data collected from the enterprise database. Obtained results will be used as a basis for the result comparison of other experiment variants.*	*indicating a change of the model parameters*	**0**	**0**	**0**	**0**	**0**
E.1.	*Variant with an increased level of finished products in stock* *Increased level of finished product in stock aims to increase the level of customer service.*		+	+	**0**	**0**	**0**
E.2.	*Variant with increased available capacity* *Increase of available capacity (introduction of new machines) is primarily aimed at affecting reduction of the production cycle and the level of work in process. Changes should be made to job groups that have the highest capacity utilization.*		**0**	**0**	+	**0**	**0**
E.3.	*Variant with reduced level of raw materials in stock* *The aim is to examine to what extent the reduction of stock levels influences other system parameters. Stock reduction should be performed on raw materials which have the largest financial stake in the total stock value.*		**0**	**0**	**0**	-	-

Key : **0** - Without a change of model parameters +/- - Increase / decrease of model parameters

Tab. 3. Simulation experiment plan

6.2. Result Analysis

By varying the model parameters, different behaviour of the simulated system was obtained. Such behaviour was observed by tracking the performance measures, i.e. by tracking the dependency of supply chain performance measures to the model parameter values. The obtained values of performance measures are shown in Tab.4. By analyzing the obtained results, it can be concluded that:

1. Increase in stock level of finished products leads to an increase in the total level of customer services, with an undesirable increase in the level of work in process.
2. Increase in available production capacity entails a number of positive effects on performance measures (better customer service, lower levels of work in process and a lower flow coefficient), with a poorer capacity utilization.
3. Decrease in raw materials stock increases their flow in a warehouse with no significant effect on other performance measures. However, it should be noted that the reduction in the inventory level was carried out only to the extent where no disturbances occurred in the supply of raw materials needed for production. If the stock level fell below this limit, other performance measures of the supply chain would certainly be affected by these disturbances.

4. Variations of the model parameters do not have to be directed in only one of the three above mentioned directions. The optimal choice of the model parameters is obtained by combining the aforementioned effects and a constant monitoring of the supply chain performance measures.

Supply chain performance measure		**Values**			
		E.0.	**E.1.**	**E.2.**	**E.3.**
↑	*Fulfilment of orders from existing stock*	*4.82%*	*8.62%*	*5.21%*	*4.82%*
↑	*Timeliness of delivery*	*49.43%*	*74.79%*	*53.44%*	*49.43%*
↑	*The value of realized orders*	*331350.00€*	*352238.00€*	*337250.00€*	*331350.00€*
↓	*The average level of finished goods inventory*	*14208.81€*	*15108.67€*	*14189.90€*	*142208.81€*
↑	*Capacity utilization*	*39.90%*	*42.52%*	*34.92%*	*39.90%*
↓	*The flow coefficient*	*1.83*	*1.81*	*1.47*	*1.83*
↓	*The average level of work in progress*	*32323.12€*	*36092.98€*	*28634.54€*	*32323.12€*
↓	*The average level of materials in stock*	*45977.67€*	*46564.81€*	*46092.20€*	*36217.14€*
↑	*Inventory turnover*	*3.89*	*3.96*	*3.88*	*4.81*

Tab. 4. A comparative overview of the experiment results

It is clear that finding a set of model parameter variants, which would result in the simultaneous improvement of all performance measures, is not possible. Therefore, it is only possible to find one set of variants that would direct the performance of the supply chain towards a desired (target) level. The optimal variant of the supply chain parameters needs to be observant of the enterprise capacity (for example, to expand the capacity), as well as of its financial, human resources and marketing policies. Therefore, Table 3. provides only guidelines for improvement of the performance measures, in order to level them off, if not perfectly, then at least acceptably.

7. Conclusion and Recommendations for Future Research

Conducted research and available publications indicate that competitiveness of small and medium-sized enterprises on both domestic and international market can be enhanced through development of the supply chain concept. Special emphasis is given to the possible directions for improvement of the supply chains in small and medium-sized enterprises using the modelling and simulation method.

The shown procedure of the simulation model development and the simulation process run has great applicability in real systems. Therefore, basic characteristics of the developed and applied models for simulation of the supply chains in small and medium enterprises can be specified as:

5. Efficiency - Simulation can be used for cases in which it is too expensive or too difficult to conduct a true experiment. In these cases, the decision effects can be tested on the simulation model, prior to the decision implementation.
6. Flexibility - It was achieved through an ability of the model to adapt to the environment and disturbances within the supply chain processes.
7. Modularity - This approach to simulation model development provides numerous benefits in the development and application of the simulation model, which are reflected in the simplified purpose definition of each module, simplified verbal, mathematical and logical description of the model, level of detail adjustment of the modules to the simulation process requirements, possibility to improve certain modules without the need to make changes in other modules, possibility of engaging professional staff for the individual modules, facilitated monitoring of the simulation process results, and possibility to use a modular approach in the simulation program development.
8. Scope - The presented model was developed as a dynamic and tight unit with clearly defined relations to the environment. In addition to the basic supply chain elements, this model contains behaviour and decision-making rules and clearly defined performance measures.
9. Applicability - Depending on the time scale, applied methodology can be used to find solutions to the supply chain problems, and thus equally affect:

- long-term decisions, which lead to an increased competitiveness and a greater market share, mergers and reduction in cost of the physical assets (such as making decisions on the opening of factories and distribution centres, as well as on their shutting down, etc.),
- medium-term decisions, which affect stocks and costs of the supply chain (here, simulation can help in the procurement, production and transportation planning, in order to minimize the supply chain costs),
- short-term decisions, where costs of keeping the level of finished products in stock and capacity utilization have a primary impact (simulation can help enterprises to modify the existing scheduling of tasks and inventory, and thus to depreciate unplanned events), and
- current decisions, which are mainly related to a timely fulfilment of the customers' order (for example, following the customer demand for immediate delivery of goods, the enterprise can use simulation applications aimed at determining the effects of rescheduling production tasks in order to fulfil an order and provide a quick customer response).

Supply chain definition and management is undoubtedly an approach that leads to the improvement of a business process in small and medium-sized enterprises. Having in mind that supply chain management needs to increase effectiveness and efficiency of small and medium-sized enterprises, it is necessary to understand not only the constituent elements of the chain, but also the role each of them plays in the overall supply chain efficiency. It is also worth noting that a successful application of the supply chain management concept essentially depends on a clearly defined link between a business strategy and values provided to the customer.

In the above sense, today's models are developed to adequately show possibilities of an application of the modelling and simulation method in small and medium-sized enterprises. However, the solutions developed indicate the need for further research which will be steered in two directions:

- enhancement of the supply chain flexibility, and
- development of the coordination mechanisms between entities when making managerial decisions in the supply chain.

It should be noted that, over the last fifty years, enterprise management has adopted different concepts and recommendations, such as JIT, lean manufacturing, strategic outsourcing, effective production systems, computer integrated manufacturing, etc. However, reliance on these concepts might, nowadays, carry some new risks. Specifically, global financial crisis, increase in labour costs, volatility of energy prices and other more important factors may disturb the entire supply chain of an enterprise and jeopardize its ability.

These reasons indicate that the issue of supply chain flexibility is becoming an important feature that enables enterprises to adapt their business processes to a new situation. Flexibility can be a powerful means for gaining competitive advantage, reducing costs and improving response in emergency situations. Therefore, researchers who have addressed the supply chain issue suggest different strategies that are applicable for achieving flexibility. These are usually classified into three categories: system design, process design and product design.

Lately, there has been a trend to view the supply chain as a single entity composed of several sequential chains. Thus, the supply chain can be established between different organizations (manufacturing, trade and financial organizations, service industry), as well as between different functions or different activities within the organization. Due to their complex interactions, supply chain members can increase their profit by sharing information and working together, i.e. by establishing coordination with each other in order to fulfil the objectives of the observed individual systems. Specifically, lack of information sharing is generally considered to be one of the most significant factors contributing to an unexpected system performance, even in the cases when some system elements achieve good results.

For these reasons, the coordination under precarious conditions and the supply chain flexibility have become a key issue in business practice. Therefore, the management in many organizational systems, and particularly in small and medium-sized enterprises, is faced with an uncertainty in demand and, in most cases, with delayed orders, because they need time to gather as much information as possible, which is clearly useful as it enables them to reduce the demand forecasting error. This leads to insufficient time for a timely production/product delivery to the customers, resulting in an increase of costs in the supply chain. Therefore, development of a coordinated mechanism for managing the processes within the supply chain, along with increased flexibility, presents a challenge set before contemporary supply chains of small and medium-sized enterprises.

8. References

Andreas, H. (2006). *Enabling Successful Supply Chain Management: Coordination, Collaboration, and Integration for Competitive Advantage* (doctoral thesis), University of Mannheim

Beamon, M. B. (1998). Supply chain design and analysis: Models and methods. *International Journal of Production Economics*, 55, 281 – 294

Božičković, R. (2005). *LEAN koncept u efektivnim proizvodnim sistemima* (doctoral thesis), Faculty of technical sciences,(LEAN concept in effective production systems (doctoral thesis), Faculty of Technical Sciences), Novi Sad, Serbia

Chan, F. T. S., & Chan, H. K. (2006). A simulation study with quantity flexibility in a supply chain subjected to uncertainties, *International Journal of Computer Integrated Manufacturing*, Vol. 19, No. 2, 148 – 160

Council of Supply Chain Management Professionals (2013). *CSCMP's Definition of Supply Chain Management* . Retrieved from https://cscmp.org/about-us/supply-chain-management-definitions

Dragić M. (2010), *Optimizacija lanaca snabdijevanja primjenom metoda simulacije, (Optimization of supply chains using simulation method),* (master's thesis). University of Banja Luka Faculty of Mechanical Engineering, Banja Luka, Bosnia and Herzegovina

Goknur, A.A., & Turan, E. E. (2010). Supply chain performance measurement: a literature review, *International Journal of Production Research*, 48:17, 5137-5155. http://dx.doi.org/10.1080/00207540903089536

Grant, D., Lambert, D., Stock, J., & Ellram, L. (2006). *Fundamentals of Logistics Management*, European Edn. Berkshire: McGraw-Hill Book Co

Gunasekarana A., Patelb C., & Ronald E. M.(2004). A framework for supply chain performance measurement, *Int. J. Production Economics* 87, 333–347

Hensher, D. A., & Brewer, A. M.(2004). *Transport and economics and management perspective*. Oxford University Press

Kaluza B., Bliem, H., & Winkler H. (2006), Strategies and Metrics for Complexity Management in Supply Chains. In Thorsten Blecker & Wolfang Kersten (Eds.), *Complexity Management in Supply Chains: Concepts, Tools and Methods* (pp 3-20). Berlin, Germany

Kotler, P. (1984). *Marketing Management Analysis, Planning and Control*, Englewood Cliffs. NJ: Prentice-Hall

Lambert, D. M., Stock, R. J., Ellram, M. L.(1998). *Fundamentals of Logistic Management*. McGraw – HillInternational Editions

Lambert, D. & Pohlen, T. (2001). Supply chain metrics. *International Journal of Logistics Management*, 12(1), 1–19. http://dx.doi.org/10.1108/09574090110806190

Letić D. (2001). *Operaciona istraživanja*, Tehnički fakultet Mihajlo Pupin, Zrenjanin, Serbia

Marić. B. (2010), *Model upravljanja proizvodnim procesom u remontno-proizvodnim sistemima na bazi Lean koncepta, (Model process control in dry-production systems based on the concept of Lean)* (doctoral thesis). University of East Sarajevo, Bosnia and Herzegovina

Mentzer, J.T., DeWitt, W., Keebler, J. S., & Min, S. (2001). Defining supply chain management. *Journal of Business Logistics*, Vol. 22, No. 2, 1 – 26

Min, H., & Zhou, G. (2002).Supply chain modelling: past, present and future. *Computers & Industrial Engineering*, 43, 231-249

Pienaar, W. (2009). *Introduction to Business Logistics*. Oxford University, Southern Africa

Rolstad, A. (1995). *Performance management: A business process benchmarking approach*. London: Chapman and Hall

Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2003). *Designing and Managing the supply chain Concepts, Strategies and Case studies*. New York: McGraw-Hill Publishing

Sorak, M. (2005). Izbor metode optimalnog redosleda poslova u upravljanju proizvodnjom u jednakim vremenskim intervalima.(Selection of the optimal order methods in managing production at equal time intervals), *Tehnika*, 4/2005, 1-4

Sorak M., & Dragić M. (2005). Istraživanje problema procjene trenda prodaje u industrijskim sistemima, *Lider*, 1-2.2005

Stadler, H., & Kilger, C. (2002). *Supply Chain Management and Advanced Planning: Concepts, Models, Software and Case Studies*. Springer-Verlag, Berlin Heidelberg

Vlajić, J., Vidović, M., & Miljuš, M. (2005), Supply chains –defining and performances, *The International Journal of TRANSPORT &LOGISTICS*, 09/05, 85-112

Wallace J.H. (2007). *Supply Chain Science*, McGraw-Hill Education