IMPROVEMENT OF PLANNING SYSTEM IN SUPPLY CHAINS AND SOFTWARE SUPPORT

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Abstract: ***The topic*** *of this paper was born out of the* ***pratical need for improving collaboration also within planning,*** *and it deals with synchronising a) constant improvement of Planning Systems (principles, concepts, processes, structure, software sulutions etc.) of the Supply Chain members (SCPS) and b) limited ability of the SC members (especially if they are of the small and medium enterprise type – SMEs) to maintain the required software solutions needed to support such a dynamic planning system in SC. Bearing in mind: a) the different types of SC and their members (big business and/or SME), b) the complexity of planning per se, c) the different ways of organising for planning in LS and d) the difficulty in applying software changes within SCPS (stress, waiting, cost etc.),* ***the problem*** *is how to ensure adequate, but not overly expensive software support (new or improved) in a timely fashion for the new SCPS concept. The initial* ***hypothesis*** *is that there is at least one way in which it is possible to develop SCPS and, at the same time maintain the adequacy of the software solution supporting it. The paper is* ***intended*** *for those who design and construct SCPS, as well as all users of it, with the intention to increase awareness of the necessity for constant development of that particular system and about the need for its flexibility, as well as the awareness of the significance and possibilities of planning system engineering. At the same time it is also intended for those who create SCPS software – so that they bear in mind that their software should be functional even if significant changes within SCPS occur. In this paper we have shown a SC model followed by the relevant problem areas (and related works): planning in SC, with the need for SCPS improvement, and the standard software solutions in SC planning/management. In the section about research and results, we have defined seven research questions; we have then* ***pointed out*** *the significant elements of participant collaboration complexity within SC, as well as the possibility for maintaining the adequacy (relevancy) of the software solutions whilst constantly imporving SCPS.*

Keywords: System Planning, Supply Chain (SC), Collaboration in SC, Software Solutions adequacy, SC Planning System Improvement

1. INTRODUCTION

Management of organizational systems, both individual and those associated in supply chains (SC), begins with planning. Planning is the process of defining goals and their decomposition to the level of operational objectives, defining the necessary operations for transforming objects of work and defining the associated resource requirements, as well as determining the total demand for resources and ensuring their availability (Omerbegovic-Bijelovic, 2010). This large task becomes even more complicated when connecting companies in SC (Fig. 1), because the planning for one company becomes the planning for a number of companies - related by management (including planning), but also by business, technological, economic, and formal - legal issues.

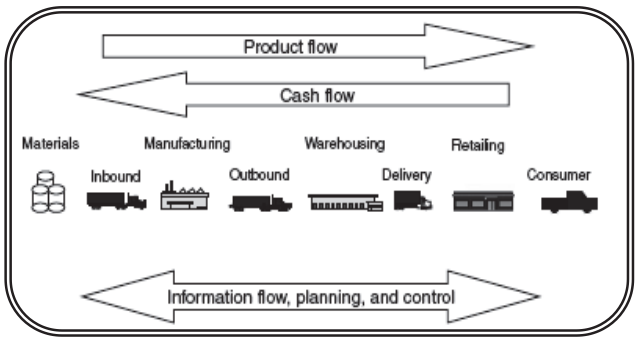

Figure 1: A classic view of the supply chain
Source: Schutt, 2004, p. 6.

Supply/value chain can be composed of two (buyer and seller, or resource supplier and manufacturers, or alike) or more consecutively positioned participants in the process of transformation of objects of work. Their predecessors and successors in the process (e.g. from those engaged in extracting ores, to those engaged in retail business of mixer bars) may also be members of SC. Carriers and others who provide various services to the other members (and thereby add value to the work of SC) are also SC participants/members, but are often omitted from consideration due to the simplicity of the model.

SC can be serial or divergent (Dominguez, 2014). As each participant in a SC may have more "input partners" and more "output partners," it is possible to generate more SCs (Fig. 2), and to plan for one or, more rarely, for more SCs, over the same set of partners.

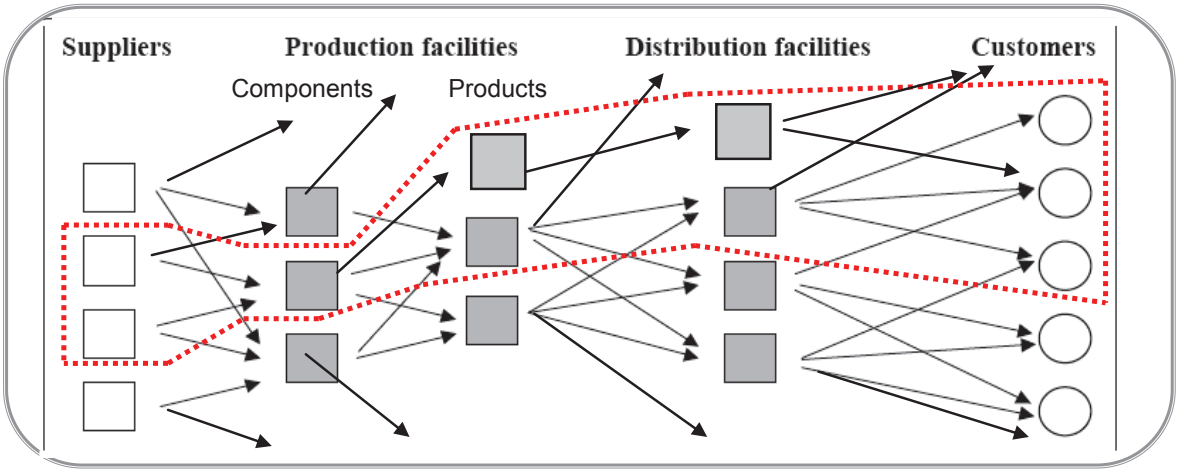

Figure 2. One possible supply chain in planning system network structure
Source: with adaptation from Dudek (2009), p. 26.

Planning in SC (as a system, SCPS) implies a shift from "individual" planning (successive and segregate) to collaborative planning in SC, wherein the collaborative planning approaches can be:
a) *Hierarchical planning approach* - with centralized guidance in planning in SC, with the inevitable use of modern software solutions, including using APS (*Advanced Planning and Scheduling*), models and methods of operations research and others.
b) *Non-hierarchical approach to planning* - essentially collaborative planning based on coordination between the selected areas of business planning ("*planning domain*") of participants in SC (Fig. 3). Thus it is possible to arrange that a supplier/manufacturer plans to supply a customer independently (VMI - *Vendor Managed Inventory*), to cooperate in the supply planning (CMI, Co-Managed Inventory) or to work together on planning, forecasting and supply (CPFR, Collaborative Planning, Forecasting and Replenishment).

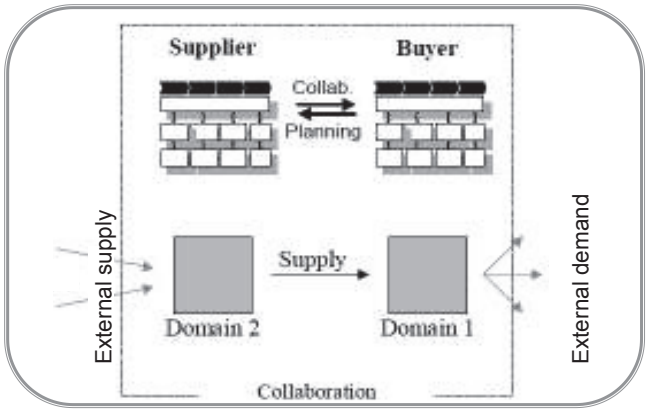

Figure 3: Two party collaborative planning
Source: Dudek, 2009, p. 58.

Due to the possibility of different interpretations of the term "collaborative planning", here it refers to: planning operations in SC, through the planning of operations of selected, contracted "*planning domain*". SC is planned according to time horizon (*far shorter than before*), and within a longer time horizon (in the corresponding number of iterations) it is planned for shorter periods. A long-term, medium-term and short-term plans still exist, and companies make "major" (master) plans for 12 (and/or 18) months - on a "rolling planning" principle. The principle implies also that plans relating to the shorter period give more reliable data. Typically, a master plan does not leave out the most important data (Table 1).

Table 1: Basic decisions of master planning, Source: Rohde / Wagner (2005), p.159.

N°	Decision type	Description
1	Procurement	Quantities of input materials purchased from external suppliers
2	Production / Material handling	Production and handling quantities, or output levels of other relevant operational processes
3	Inventories	Inventory levels at the end of planning periods
4	Customer shipments	Quantities supplied to customers and their origins
5	Transports	Transport quantities on all transport links considered

Besides on negotiation and contracts, the collaboration between members of a SC is based on the fulfillment of the contracted issues and on building the trust among SC participants. Therefore, collaboration is

established in multiple phases (Kilger and Reuter, 2005, p. 271): Domain planning, Data exchange, Negotiation&Exception handling, Execution, Performance measurement.

When it comes to the realization of the planning process, it is done by a pull principle: first the outputs from SC are determined, then predecessors' operations, upstream. At each stage (for each participant in SC) firstly the type and quantity of its output are determined, and then - based on consumption norms - the necessary amount of resources (which should be obtained from the predecessor in SC). The neighbours in SC cooperate on the level of "planning domain" (Fig. 4).

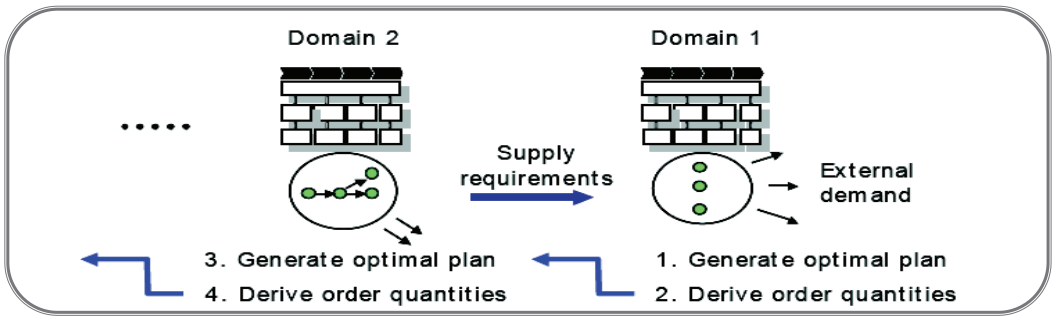

Figure 4: Upstream planning scheme
Source: Dudek (2009), p. 47.

The above suggests the complexity of the problems of planning systems in SC (SCPS). The complexity increases when we take into consideration the development of SCPS. As the system implies a process (processes) and structure, here the "organization to plan," as well as appropriate meta-managerial tools (Omerbegovic - Bijelovic, 1998) such as concepts / models, methods, technical means and organizational tools (including software), their development even more/ further multiplies the complexity of SCPS.
This paper is written based on the following structure: Section 2 explains the conceptual framework and gives the problem description; in Section 3 survey results are presented, and Section 4 summarizes some concluding remarks and suggestions for further studies.

2. PROBLEM DESCRIPTION AND LITERATURE REVIEW

Working within SC demands serious activities and resources for synchronising the varied interests and operations of its members. Synchronising the SC functioning starts with planning (SCPS), which, in time, changes (as a rule: improves). Planning in SC has, for decades, been impossible without software support. That support needs to change together with the changes within SCPS. SC members, not only within the SME category – which have “evidently of limited capacity” (Sitompul, 2012), and can therefore seem like a serious if not insurpountable problem – especially if the changes are very frequent. This is why some members of SC, unable to follow developments, decide on ceasing to be in SC altogether or find other solutions for keeping the relevancy of their software planning solutions.

2.1. Planning in supply chains

Schut (2004, p. 219) states that planning (including SC) covers the following areas: Sales Forecasting, Quantitative support for Sales & Operations Planning, Integrated Supply Chain Tactical Planning, Production requirements calculation from distribution network requirements, Master Scheduling of production, Detailed scheduling of production, Inventory deployment planning in a distribution network and Short-range transportation planning and load building. By Zamarripa et al. (2012), “the typical scope of the **SC planning problem** is to determine the optimal production levels, inventories and product distribution in an organized network of production sites, distribution centers, consumers, etc., taking care of the constraints associated to products and raw materials availability, storage limits, etc. in such network nodes.”

All of these areas (and others relevant to SCPS) are based on mathematical modelling and programming, which is an argument in favour of claims that there is no modern planning without software support. (*Of course, sometimes, in special circumstances and only for the limited scope of issues / narrow fields, even today it is possible to obtain an acceptable solution without software support.*) But the business system is so complex that it is impossible (and certainly not profitable) to operate without adequate software support in the conditions of contemporary competition.

2.1.1. Planning of one participant in a supply chain

Participants in SC can retain a tendency to "individualistic" or "disconnected" planning in SC (DSC), reffering to planning without involving other parties and without "spreading" the scope of the information based on which the planning is done. Moreover, within a single company so called "Functional silos" may appear

where there is a lack of cooperation between different functions within a company. In the same way we can define the ”planners' silos” in SC, where the planning is done without taking into consideration the attitudes/knowledge of other participants in SC who are also involved in the planning (planning "within the closed box"). This planning approach implies that a company plans only internal activities (procurement, production, sales) that are directly related to the supply/demand of the first predecessor/successor in SC. Companies that aim to integrate the entire supply chain tend to eliminate "functional-" and "planning silos" and create inter-functional processes.

2.1.2. Cooperation between neighbouring participants in SC in production and inventory planning

Cooperation between neighbouring participants in SC in the area of production and inventory planning in different participants in SC has been studied by many authors. Prominent authors in this area (Lee, Padmanabhan and Whang, 1997; Barratt and Oliveira, 2001) agree that the presentation of sales data from retail outlets is useful information for manufacturing companies that are planning the production in line with demand forecasts. Raghunathan (1999) claims that a manufacturer reduces its costs to a different extent, depending on the number (percentage share) of retailers who share their sales forecasts with a manufacturer, as well as that the cooperation in forecasting helps to reduce the cost of the retail chain which shares its forecasts with a manufacturer.
Paiva et al. (2014) suggest that supply planning and trust-based relationship within buyers and suppliers are positively related and both influence supply integration and operational performance. They claim that “integration with suppliers is the means by which companies work with suppliers seeking mutual objectives, sharing ideas, information, knowledge, risks, rewards and solutions to common problems”.

2.1.3. The cooperation of the entire supply chain in production and inventory planning

It is assumed that some of the members of SC (e.g. retail) have limited interest in participating in the exchange of information and cooperation in SCPS . The key reason for cooperation can be identified by the fact that SCPS is a prerequisite for the efficient supply of all the members of SC.
Cao and Zhang (2011) consider collaborative relationships and find that they “can help firms share risks, access complementary resources, reduce transaction costs and enhance productivity, and enhance profit performance and competitive advantage over time”. Collaboration concerns with the alignment of decisions and actions amongst SC members - in their planning and inventory management. This alignment is enabled by the exchange of information in the SC (Stadtler 2009).

The availability of relevant information provides a manufacturer with better production planning, especially for products with a high variation in demand. As production plans are developed under the direct influence of identified demand, this means the possibility of creating a detailed and reliable delivery and supply schedule, using simulations in defining future orders, for example. A manufacturer is enabled to create its own delivery plan that is probably different from that of the customer's orders, with the adjustment of production plans to the real market needs. Considering research studies, according to Småros (2007), it is possible to draw a general conclusion that the availability of sales data from customers' facilities to the end user is a very significant potential for improving business of manufacturing enterprises. Studies show that by a combination of reports on orders of retail outlets and reports on the flow of goods in distribution centers of retail chains (which are governed by the concept of VMI), a production company can benefit even when only a handful of the total number of customers and retailers is involved in the collaboration system. The greater part (%) of its sales is "covered" by including into the VMI system, the better for all participants in SC.

2.2. Application software in supply chain planning

The general trend of the software manufacturers is the integration of supply chain components into existing software packages (ERP) in order to offer customers a complete solution designed for the overall needs of companies in SC. According to (Yen, Chou and Chang, 2002), in most cases, softwares for SC management (SCM software) are software solutions specifically developed for the needs of companies of a certain type (production, storage, distribution, trade). Some of the major software vendors have tried to combine different and specific software solutions for SC in a single software solution. According to (Yen, Chou and Chang, 2002), the best solution for the success of SC is the development of SCM software in two ways: a) The solutions that support the planning of participants in SC (Supply Chain Planning Software), and b) Software solutions that support the operational functioning of SC (Supply Chain Execution Software). *Softwares used for planning in SCs* are based on mathematical algorithms whose implementation optimize the flow of information and goods, enhance the efficiency of the SCs and optimize inventories. These software solutions are completely dependent on the available information and its reliability (precision). Software for planning in SC provides the support for these most important functions of SC; the greatest contribution is realized in the demand planning, which is the initial plan for all other activities in the chain - based on which further plans are created. *Software intended to support the operational functioning of SC* is designed for automation of SC

specific needs (e.g. vehicle route optimization in distribution or automatic ordering in accordance with predefined signal inventories/re-order point).

2.2.1. Software packages for production and inventory planning of one participant in SC

Software used for planning in SC allows SC members to manage inventory in line with sales and demand forecasts. As part of the SCM in general, a software solution for SC planning (S&OP - Sales and Operations Planning) plays an important role in reducing costs and improving the profitability of a company. Using software for SC planning (such as Modules for demand planning or S&OP modules), based on historical data and along with the expected activities to improve sales, companies can simulate the potential demand and, in line with expectations, harmonize inventories of finished goods and raw materials.

In some cases the software components required to manage SC represent solutions that are fully integrated into the standard ERP, while in the others they represent separate modules or fully independent software solutions for the management of SC. According to (Kumar, 2001), software solutions for the SCM have a very large impact on the performance of the entire company, which has been recognized by leading software manufacturers. Major producers of software (SAP and Oracle) are dedicated to the further development of software for SCSP; this resulted in the creation of advanced software modules aimed at "complex" planning in SC (Chang and Makatsoris, 2001).

Current software solutions for planning in SC enable cooperation between a manufacturer and buyer through the exchange of information on the available stock and realized sales, in order to perform mutual optimization of inventories. According to the recommendation made by Software AdviceTM (www.softwaradvice.com), in accordance with the cost of software, the number of implementation and success in optimizing inventory, the following software packages are recommended: JD Edwards, WISERoyal, SCP 4.0, SAP-SCM, PackManagerNulogy's, iTracker Hosted 3PL, MachSix, IBS Enterprise Manufacturers, POOL4TOOL and Quintiq's Supply Chain Planning & Optimization.

SC aims to integrate all the key business processes. In practice, it happens that the key processes in SC individually do not have uniformed adequacy of software support, which implies a reduction of compatibility and causes missed business results.

Standard business softwares (ERP) are primarily focused on providing software support to internal operations (production planning, inventory records of raw materials and finished goods, material and financial records - accounting, etc.). In contrast to standard ERP solutions, software solutions designed for SC are focused both on internal business activities and on external processes among participants in SC. According to (Buxmann, von Ahsen, Díaz and Wolf, 2004), the largest number of Supply Chain Management Software packages support SCPS (all SC members who cooperate in planning), while standard ERP solutions provide automation and support in the implementation of operational plans.

The most common system of advanced planning, APS, provides immediate response to customer requirements providing timely and reliable information from the business system of a production company. APS system is a concept on which the software for SCM is based. The basic structure of APS concept ensures the creation of software that consists of the following planning modules and sub-modules: Strategic Network Planning, Demand Fulfilment & ATP, Production Planning and Scheduling, Transportation Planning and Distribution Planning.

2.2.2. Software support to production and inventory planning with the cooperation of neighboring participants in SC

From the perspective of the cooperation in the SC planning, one of the most important goals is to achieve harmonized interpretation of: 1) the problems that exist in all participants, 2) the functioning system of observed supply chain, and 3) the approach to decision making. The key to success is the adoption of comprehensive optimal decisions based on the collective knowledge of participants in SCPS.

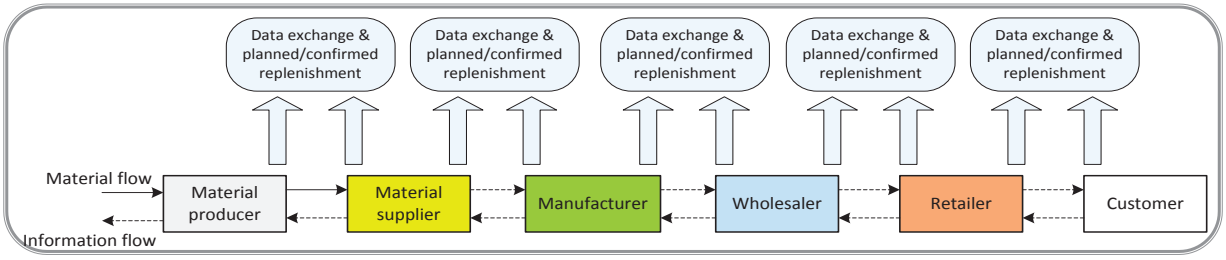

Figure 5. Model of cooperation of neighbouring participants in SC planning

The model of cooperation of neighboring participants in planning in SC is shown in Figure 5. Software tools that provide cooperation in planning in supply chains should be clear and "user friendly" for all members of

SC, transparent (and to show valid and accurate information), provide monitoring of performance indicators of all participants in the SC planning, as well as enable compatibility with different software (ERP solutions) used by participants in the SC.

In their studies (Stadler and Kilger, 2005) presented (by APS matrix) the list of software manufacturers that base their software solutions on the APS. The survey by the SCM Competence & Transfer, published in (Laakmann et al., 2003) included 23 APS software solutions. Stadler and Kilger (2005) summarized the results of the survey and presented the complemented results by APS matrix (**Table 2**). Some of the most important comprehensive software solutions for SCM, based on the APS, are i2 Technologies, PeopleSoft and SAP (with *Advanced Planner and Optimizer* (APO)). In these comprehensive solutions it is possible to use only a specific module, in case of limited need.

i2 Technologies offers the solution from i2 software modules, mostly directly connected with the planning in SC: SC Strategist, Demand Manager, Supply Chain Planner, Factory Planner, Production Scheduler, Demand Fulfilment, Enterprise Project Planner and Transportation Modeler, Optimizer and Manager.

	Strategic Network Planning	Demand Planning	Master Planning	Demand Fulfillment / ATP	Production Planning & Scheduling	Distribution & Transport Planning	Collaborative Planning	Alert Management
Adexa	●	●	●	●	●		●	●
Agilisys	●	●	●	●	●	o	●	●
Aspen Tech	●	●	●	●	●	●	●	●
Axxom	●	●	●	●	●	●	●	●
Baan	●	●	●	●	●	●	●	●
DynaSys		●	●	o	●	o		
Flexis			●	●	●			●
GEAC		o	o	o	●			●
i2 Technologies	●	●	●	●	●	●	●	●
ICON		●	●	●	●	o	●	●
Intentia	●	o	●	●	●	o	●	o
Manunistics	●	●	●	●	●	●	●	●
Mapics	●	●	●	●	●	●	●	●
Oracle		●	●	●	●		●	●
Peoplesoft	●	●	●	●	●	●	●	●
SAP	o	●	●	●	●	●	●	●
TXT e-solutions		●	●	●	●	o		●
Viewlocity	●		o	●	●	●	●	●
Wassermann	o	o	●	●	●		●	o

Table 2. The planning process in SC and APS

PeopleSoft as part of Oracle's Advanced Supply Chain Planning (ASCP) provides companies with the ability to plan in the entire supply chain through a "holistic planning, scheduling and optimization". ASCP is a simultaneous approach to planning for all members of the SC - suppliers, manufacturers and distribution centres, both in short and in long terms. The concept of APS in this software is implemented through the following modules: Strategic Network Optimization, Production & Distribution Planning (PDP) and Vehicle Loading, Demand Management (Demand Forecasting and Demand Consensus, Production Scheduling Process (PSP), Production Scheduling and Discrete Order Promising.

SAP AG offers the SAP APO (based on APS). APO is a fully integrated APS solution, which is accessed through the application of Supply Chain Cockpit. It contains the modules: Demand Planning, Supply Network Planning, Global ATP, Production Planning and Detailed Scheduling, Deployment and Transport Load Builder, Transportation Plan-ning and Vehicle Scheduling, Purchasing, Workbench.

2.2.3. Software support to production and inventory planning with the cooperation of all participants in SC

Software solutions for cooperation in planning in supply chains are a combination of ERP solutions, software for project management and software on whose concept different social networks are functioning. The main advantage of this software is that it allows decentralization of control and responsibility in the planning of activities in the whole SC. All participants in the SCPS have access to the software in accordance with the position in which they work and the relevant responsibilities. The concept of the functioning of the software is based on the regular exchange of information between participants, so it is imperative that all stakeholders are aware of the responsibilities of regular updates of progress and change in the status of the activities for which they are responsible. Unlike the traditional software designed for planning in SC which optimize plans and simplify the planning process, these software solutions allow "discussion" i.e. the exchange of information between participants on a particular topic.

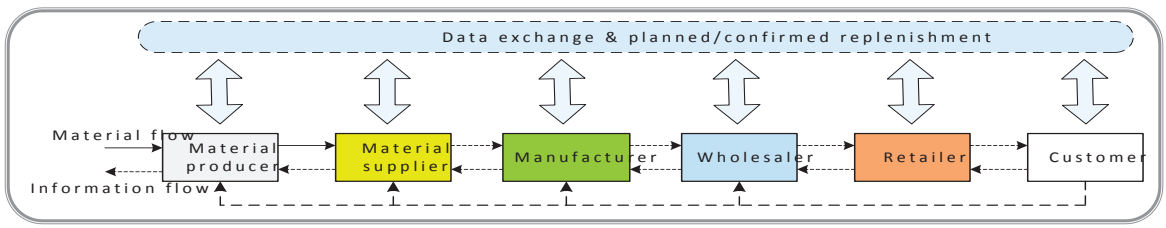

Figure 6. Model of a full cooperation in planning in SC

The cooperation of the participants in planning in SC can be full or limited. Full co-operation (Fig. 6) is achieved if all participants in SC cooperate fully (transparent) and use the appropriate software for collaboration in planning in SC. The basic concept of cooperation is presented in Lecic-Cvetkovic et al. (2012).

Limited co-operation (Fig. 7) is a modification of the full cooperation model; it occurs when the cooperation of the participants in SC is limited, where each participant cooperates with the first predecessor and successor in the SC, whilst concurrently cooperating with the final buyer. It is believed that the cooperation with the buyer is most easily attainable, because the buyer i.e. retail store, aims to ensure the availability of products to consumers and thus "retain" them, while the other SC members have the opportunity to find alternative channels of product placement.

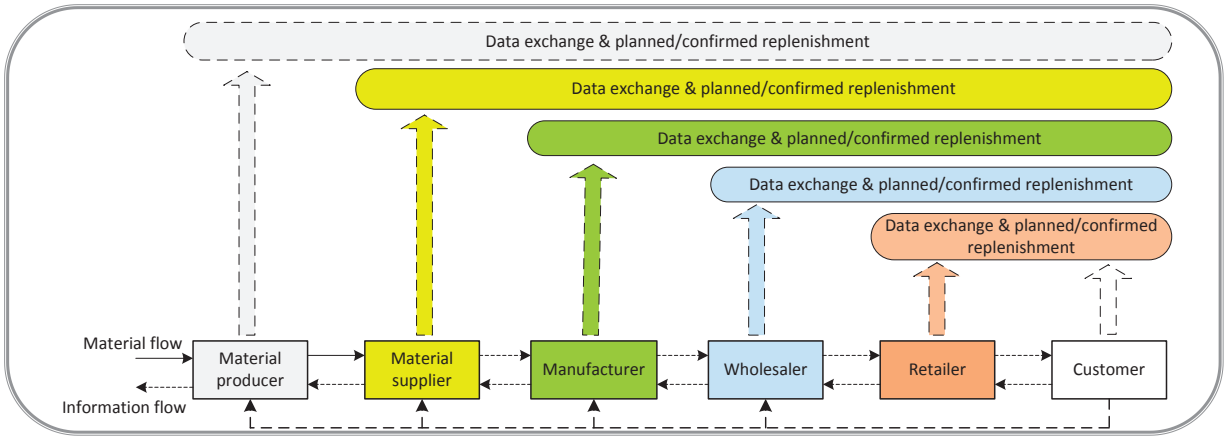

Figure 7. Model of limited cooperation between the participants in SC planning

Collaborative planning, forecasting and replenishment (CPFR) software from „Demand Solutions“ which is "cloud-based" concept, provides reliable information on the demand and the need for replenishment of the stock through the coordination of material and informational flow between multiple participants in the SC, between different locations and different companies. *Demand Solution software* allows defining priorities in meeting the demand (through *Demand Solutions Dashboards*), as well as different levels of aggregate considerations of demand and the available stock. Cooperation is achieved through the following additional features: Exchange calendar event (production, delivery, receipt), Support for XML and EDI in order to facilitate the exchange of information, full access to the entire SC from the perspective of each member. Cooperation in planning in SC is also provided by software „Voyager Collaborate“, whose main advantage is Module Logility Voyager Collaborate with providing effective communication in decision-making, contributes to the identification of potential problems and preventive action. JDA CPFR, created by JDA Software Group, is a direct upgrade by creators of VICS CPFR ® standard, through the module that allows planning by the application "alerts" and the work with flexible planning horizon. NeoGrid CPFR is a software solution for collaboration in planning in SC which is derived from the solutions intended for aligning inventory levels between the SC members, i.e. between multiple storage positions.

3. RESEARCH AND RESULTS

By Paiva et al. (2014), “Some studies about supply chain planning have focussed on mathematical models to reduce losses due to mismatches, while other studies have focussed on antecedents that lead to improvements in supply chain planning, for example, the use of electronic marketplaces, advanced planning systems, information technologies use and supply chain flexibility. Here we draw attention to the improvement of planning in LS and the need to maintain the software support for such, new planning.

Contemporary SC cannot operate without adequate software support (which effectively and efficiently serve SCPS, i.e. which can be applied, and, at the same time, provides the benefit for SCPS), and the adequacy of software support reduces with the accumulation of changes in the concept of SCPS (because every change of SCPS requires appropriate, new or updated software). Hence the need to replace the software with a new, more adequate one. But the downsides of the replacement are: replacement costs, changing time, and stress (training for new software for planning in SC, adjustments of experts in planning in SC etc.).

Hence SCPS must be improved, and the adequacy of its software support must be maintained, i.e. must not be reduced. Therefore, this paper seeks answers to questions (RQ1-RQ7):
RQ1: What is the "chosen problem" in SCPS?
RQ2: Why is it necessary to have a software support for SCPS?

RQ3: What changes with the improvement of SCPS?
RQ4: What is happening with the SC planning software with the improvement of SCPS?
RQ5: Is it possible to "keep" the adequacy of the software for SCPS?
RQ6: Who can "keep" the adequacy of the software for SCPS?
RQ7: How to "keep" the adequacy of the software for SCPS?

"Selected problem" (RQ1) refers to maintaining the adequacy (or at least the usability and usefulness) of not too expensive, new or improved, software solutions to support the SC planning system (SCPS), in circumstances when SCPS maintains its topicality, i.e. it improves in accordance with the progress of the environment. "*The adequacy of software support for SCPS*" (Software Support Adequacy for Supply Chain Planning System, SSA4SCPS) as one of the key performance indicators of "quality software solutions for SCPS", means that software solutions suit all the needs of SCPS, that this support is effective and efficient, is on the same "level of modernity" as the SCPS, is usable (accomplishes its goals well enough) and is useful. Indicator SSA4SCPS, similarly to other quality indicators of any product/service, must be measurable/comparable, its functional dependence on certain variables should be described, standards for measures of their changes should be defined for the measurement system and the maintenance of the desired values, etc. The question is what happens when the SCPS software support loses its function, i.e. is it possible to do business without this support? Examples from the past show that it is (was) possible, but the contemporary practice says that it is not possible. Modern business involves a significant level of availability and reliability of data, accessibility, and the use of software tools for decision making, quick decision making, and dislocation of the participants in the decision-making system and in the complete management, etc. The cooperation of the participants in SC without software support for SCPS is now virtually impossible. Therefore, it is necessary to maintain the highest possible (or at least acceptable) indicator levels of SSA4SCPS.

When considering the SC planning system, it is interesting to investigate what is the function of software support (RQ2), i.e. which business activities in SC cannot be planned if there is no adequate software support. It is already said (Tab. 1) what "basic decisions of master planning" are. But that is only part of the function of a complex planning system in general as well as in SC. Practically, there is no area or object of planning where the software support does not facilitate obtaining a solution of a higher quality (more reliable, more accurate, faster, etc.).

When asked why the SCPS is complex, the best response is to remember at least some of the dimensions of the business system (Omerbegović-Bijelović, 2005): processes, resources, organizational components/parts, inputs and outputs, the relationship between inputs and outputs, changes, property, environment, expectations and goals, constraints, and so on. When this is viewed as an object of development in SC, exponential growth in a number of potential problems can be identified. For managers (owners and managers), this complexity would be insurmountable without a software support - for planning and for all other managerial activities.

Enhancement/improvement of the SC planning system (RQ3) can be symbolic and "painless", but a radical change (concepts, principles, data supply and software support, together with function and location of parts of the planning system in the SC organizational structure) is an important, complex, and unavoidable task. The cause of these changes is the need to maintain the competitiveness of SC and its members while the motives may be different - depending on the perceived problems and the capacity to address them, but always with setting a certain priority/objective: maximizing the satisfaction of customer requirements (Lecic - Cvetkovic et al., 2010). Often the Bullwhip Effect phenomenon (BWE) is used as an excuse to change the SC planning system. For example, instead of founding their plans on communicating with their immediate neighbours, the SC members may decide that each member of the SC should plans it output according to the last member in SC (usually a retail), using the same reasoning mechanism and taking into account its own historical data (Lecic - Cvetkovic et al., 2012).

The often cause of SCPS changes is the necessity to improve the SCM system (in order to improve the quality of plans, eliminate conflicts, increase the level of communication within the SC and with the environment), or the application or changes of meta-managerial tools, reducing costs, reducing the duration of production and business cycles, improving decision-making (by introducing higher mathematics and related disciplines), introduction of APS and the like. Along with the improvement of SCPS, it is necessary to adapt its software support (RQ4). Only together they perform their function in the SCM.

If the software is not flexible, if there is no automatism in its adaptation to changes in SC and in its planning system, the question of the adequacy of such software support arises. SSA4SCPS indicator should signal the need for software updates. Maintenance of the adequacy of the software is important for all participants in the SC; in several ways: as a sign that SC is uniformly developed and remains competitive, but also as an incentive to occasionally check whether at least one element from the set {"*Planning system in SC*" * "*Software support to SCPS*"} has been improved (and caused the improvement of the other one) in the given period. Practice shows that the improvement of the planning system in the SC is inevitable, even desirable,

but that it is also necessary to keep the adequacy of the planning software in SC (RQ5). It is not difficult to keep SSA4SCPS within the limits of admissibility - if there are necessary resources (e.g., money, time, staff readiness for change).

Given the importance and the task of SCPS imrovement, including the importance, and the task of maintaining the adequacy of the software (SSA4SCPS), the question is who has a role in fulfilling these tasks (RQ6). Among the resposabile and interested are: a) Those who conceived, designed, devised the SCPS, b) Those who "produce" software support to SC planning, and c) Companies - participants in SC.

Some of the ways to keep the adequacy of the software for SCPS within the limits of acceptability (RQ7) are proposed: application of planning system engineering (processes and organizational structures) and the design of a flexible planning system for SC; the use of flexible, adaptable software solutions for planning in SC (modules and the possibility of accepting the "upgrade" - tailored to the changes in the SCPS); replacement of SCPS software (especially if it is possible to substitute it on the "old to new" principle with software provider); automatic updating of software solutions; timely defining principles for the change of software and allocation of related costs; that, from the moment of establishing SC, all participans define and agree on not only SCPS, but also the principles of its development; timely creation of a body for improving SC planning/management; the fund for improvement of SC planning/management settings; miscellaneous.

4. CONCLUSION

The paper points at the necessity of improving the planning system in supply chains (SCPS), and the need and ability to maintain the adequacy of the software to support the SC planning even when the planning improves and promotes/develops. Today, a complex planning system (planning, organizational structure in which the process takes place and the cooperation among the participants in SC) cannot function without a software support. Given the variety ranges of SC in which modern businesses operate, the complexity of planning is still growing. The competition between enterprises and their association's increases, and therefore SCs need to increase their competitiveness, i.e. to develop. Consequently, it urges the planning systems in enterprises in SC to improve, innovate, change, including the whole SC.

Due to the development of the principles and concepts of organization and functioning of SCPS, a reduction of the adequacy of existing software support occurs, and this leads to the need to provide the software that is not too expensive, which is (new or improved) adequate for the new SCPS. Therefore, the problem of maintaining the adequacy (usability, usefulness) of software packages that need to support the operation and development of the SCPS is noticed.

In addition to identifying the needs for maintaining the adequacy (or at least usability) of software support to SCPS, this paper also pointed at some possibilities to extend the duration, usefulness and/or appropriateness of software for planning in supply chains. Different aspects of cooperation/collaboration in planning in SC are presented by authors (as shown on Fig.5, Fig.6 and Fig.7) clearly showing the respective information flows between one or more participants in SC planning, with extension of closed loop for feedback/backward data collection. Some ways of keeping the SCPS software support adequacy within acceptable boundaries are also suggested.

Regarding further study on this subject, authors would like to suggest examining the scale of the software support adequacy and/or measuring its influence on business results.

REFERENCES

Barratt, M., Oliveira A., 2001. Exploring the experiences of collaborative planning initiatives, *International Journal of Physical Distribution & Logistics Management*, Vol. 31, No. 4.

Bozarth, C.C., Handfield R.B., 2006. Introduction to Operations and Supply Chain Management. Pearson Education, Inc.

Buxmann, P., von Ahsen A., Díaz L.M., Wolf K., 2004. Usage and evaluation of Supply Chain Management Software – results of an empirical study in the European automotive industry, *Info Systems Journal*, Vol. 14, pp. 295–309.

Cao, M., Zhang Q., 2011. Supply chain collaboration: impact on collaborative advantage and firm performance. *Journal of Operations Management*, *29*(3), 163-180.

Chang, Y., Makatsoris H., 2001. Supply chain modelling using simulation. *International Journal of Simulation*, Vol. 2, No. 1, 24-30.

Christopher, M., 2005. Logistics and Supply Chain Management. 3rd ed. Pearson Education Limited, Great Britain

Domínguez, R., Cannella S., Framiñán J. M., 2014. On bullwhip-limiting strategies in divergent supply chain networks (accepted for publishing). *Computers & Industrial Engineering*.

Dudek, G., 2009. Collaborative Planning in Supply Chains – A Negotiation Based Approach (2nd ed.), Springer, Berlin.

Kilger, C., Reuter B., 2005. Collaborative Planning, in: Stadtler, H., Kilger, C. (2005). Supply Chain management and Advanced Planning – Concepts, Models, Software and Case Studies, 3rd ed., Springer-Verlag, Berlin et al. 2005. pp. 259-278.

Kumar, K., 2001. Technology for supporting supply chain management: Introduction. *Communications of the ACM*, Vol. 44, No. 6, pp. 58 – 61.

Laakmann, F., Nayabi K., Hieber R., 2003. Market Survey 2003: Supply Chain Management Software – Detailed investigation of supply chain planning systems, Fraunhofer IPA Stuttgart, Fraunhofer IML Dortmund, ETH Zürich BWI

Lecic-Cvetkovic, D., Atanasov N., Babarogic S., 2010. An Algorithm for Customer Order Fulfilment in a Make-to-Stock Manufacturing System. *International Journal of Computer, Communications and Control*, 5(5), 783-791.

Lecic-Cvetkovic, D., Atanasov N., Omerbegovic-Bijelovic J., 2012. Improvement of Supply Chain Management by Bullwhip Effect Reduction. Proceedings of the XIII International Symposium SymOrg 2012, Serbia, 226-234.

Lee, H., Padmanabhan V., Whang S., 1997. The Bullwhip Effect in Supply Chains, *Sloan Management Rev*. 38, 93-102.

Omerbegovic-Bijelovic, J., 1998. Meta-management and quality of management (monograph, in Serbian), Zaduzbina Andrejevic, Belgrade.

Omerbegovic-Bijelovic, J., 2005. Planning and preparing of production and services delivering (in Serbian), Faculty of organisational sciences – Belgrade University, Belgrade.

Omerbegovic-Bijelovic, J. (editor and one of authors) et al., 2010. Basics of Operations management (in Serbian), Faculty of organisational sciences – Belgrade University, Belgrade.

Paiva, E. L., Teixeira R., Vieira L. M., Finger A. B., 2014. Supply chain planning and trust: two sides of the same coin. *Industrial Management & Data Systems*, 114(3), 405-420.

Raghunathan, S., 1999. Inter-organizational collaborative forecasting and replenishment systems and supply chain implications, *Decision Sciences*, Vol. 30, No 4.

Rohde, J., Wagner M., 2005. Master Planning, in: Stadtler H., Kilger C. (Eds.), Supply Chain Management and Advanced Planning – Concepts, Models, Software and Case Studies, 3rd ed., Springer-Verlag, Berlin et al., 2005, pp. 159-177.

Schutt, J. H., 2004. Directing the flow of product: a guide to improving supply chain planning, J.Ross Publishing&APICS, Boca Raton, Florida

Sitompul, C., 2012. A Supply Chain Planning for Small and Medium Enterprises. *Procedia Economics and Finance*, 4, 384-389.

Småros, J., 2007. Forecasting Collaboration in the European Grocery Sector: Observations from a case study, *Journal of Operations Management*, Vol. 25, No 3.

Stadtler, H., Kilger C. (Eds.), 2005. Supply Chain Management and Advanced Planning – Concepts, Models, Software and Case Studies, 3rd ed., Springer-Verlag, Berlin et al.

Stadtler, H., 2009. A framework for collaborative planning and state-of-the-art, in: Günther, H.O. and Meyr, H. (authors and editors) et al., Supply Chain Planning - Quantitative Decision Support and Advanced Planning Solutions, Springer, Berlin, 2009, pp. 3-28.

Yen, D.C., Chou D.C., Chang J., 2002. A synergic analysis for Web-based enterprise resources planning systems. *Computer Standards & Interfaces*, 24, 337–346.

Web source: http://www.softwareadvice.com/scm/supply-chain-planning-software-comparison/ (accessed: 24.04.2014)

Zamarripa, M.A., Aguirre A.M., Méndez C.A., Espuña A., 2012. Improving supply chain planning in a competitive environment. *Computers & Chemical Engineering*, 42, 178-188.