Problems in the onward and upward phase of APS system implementation: Why do they occur?

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PROBLEMS IN THE ONWARD AND UPWARD PHASE OF APS SYSTEM IMPLEMENTATION: WHY DO THEY OCCUR?

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ABSTRACT

Purpose of this paper: Studies conducted on advanced planning and scheduling (APS) systems have found problems in the marginal or negative returns from APS systems when they are implemented in manufacturing planning and control processes. The purpose of this study is to examine what problems exist in the onward and upward phase of the APS system implementation and how the individual, technical and organisational (ITO) dimensions in the implementation phases influence the problems in the onward and upward phase.

Design/methodology/approach: Three different manufacturing companies using a supply chain (SCP) module to support their tactical manufacturing planning processes were chosen and their APS system implementation phases were studied. Interviews with the project members and the end-users, and on site visits, were conducted. Internal company data and presentations were collected and analyzed according to four implementation phases and the ITO dimensions.

Findings: Three types of problems were identified in the onward and upward phase: Process related problems concerning difficulties to move forward; dependency on a consultancy firm: and too much time spent in the system. System related problems include the usage of parallel systems and inadequate usage of the appropriate potential of the APS system. Plan related problems regard an incorrect production plan. Different relationships between the ITO dimensions in the implementation process and the problem type were proposed.

Practical implications (if applicable): The relationships identified in this paper are of important knowledge for companies who are implementing, or are in the process of implementing, APS systems.

What is the original/value of this paper: There has been little written about the implementation issues of APS systems. The practical use of APS systems in the tactical planning is also relatively low. We don't know what problems to expect and how the ITO-dimensions influence the problems during implementation. The findings this paper discusses fill some of these gaps.

Keywords: Supply chain planning, APS, Advanced planning and scheduling, implementation, problem

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1. INTRODUCTION

Advanced Planning and Scheduling (APS) systems are information systems suited for decisions where simple planning methods cannot adequately address complex trade-offs between competing priorities (Günter et al, 2005). A few examples of such decisions are found at the tactical planning level, where it should be decided which products to be produced at what plants and in what quantities; with what capacity requirements and which suppliers and subcontractors should be the source for raw materials and sub-components (Stadtler and Kilger, 2005). When APS systems are recognized in the planning processes, they may yield significant benefits, e.g. improved decision support, reduced overall planning time, cost savings, reduced inventory levels, and increased customer satisfaction (Jonsson et al, 2007). Since the potential benefits are massive, many companies are willing to invest in APS systems (Rudberg and Thulin, 2008). Still, everyone is not convinced that APS systems are "the solution" to superb planning (Stadtler and Kilger, 2005). Setia et al (2008), for example, stress that although companies with complex planning tasks may receive great benefits, companies with less complex products or narrower product lines may find negative returns from APS systems due to the additional effort required to manage them. Experiences with APS systems have also shown that many companies are not satisfied with their APS system investment (Günter et al, 2005).

In literature there has been little attention paid to the implementation aspects of APS systems (Wiers, 2009), with a few exceptions (Zoryk-Schalla, 2001; Wiers, 2002; Lin et al., 2007; Jonsson et al., 2007; Rudberg and Thulin, 2008). This does not mean that implementation aspects of information systems are new, rather the contrary – much research has been undertaken to develop a better understanding of how outcomes are created and which outcomes to expect from an information system installation (Zmud and Randolph, 1990). In broad terms the research approaches concerning information system implementation may be positioned as factor research or process research (Prescott and Conger, 1995). Factor research generally employs cross-sectional research design and is used for identifying variables related to particular outcomes (ibid). Those variables may be grouped into individual, organizational and technological dimensions (Zmud and Randolph, 1990). Factors found to have a significant impact on the outcome include top management support, appropriate user-designer interaction and understanding, and good IT- design, (ibid). Traditionally, the process research is an alternative to the factor research with the purpose of explaining how the implementation process unfolds over time and it is affected by changes in related variables (Prescott and Conger, 1995). During the years, a number of process models have been suggested in order to depict the different phases in the implementation process (Marcus and Tanis, 2000). Although the models differ in terms of the number of phases, they typically share the common underlying idea of the importance of all phases for understanding the outcomes of using the system.

Since APS systems are information systems, related studies on information systems similar to APS systems, such as ERP systems, would most likely be used in order to increase the understanding of which problems that might occur and how those problems are generated. Still, an APS system differs from its predecessor in several aspects, e.g. it comprises multi-plant planning, optimization, finite capacity planning, and what-if scenario analysis (Jonsson et al, 2007). An APS system are mainly used by a few persons in order to support the planning process. The ERP system, on the other hand, has several end users and compromises modules for numerous processes of the organization. Indeed, the differences between the APS systems and ERP systems and their usage also mean different implementation approaches. In an ERP system implementation, a "waterfall approach" is typically used. This is when requirements are specified before the system configuration starts, and where the project team consists of many members (Wiers, 2002). In an APS system implementation, an iterative and prototypical approach is typically used by a small number of consultants (ibid). This being so, we believe that the models and frameworks developed to explain how outcomes and their causes are related must be adopted to the specific situation of an APS system implementation in order to understand which typical APS system problems exist and why those problems occur.

In this paper we combine the factor and process research approaches on information system in order to contribute to the understanding of the problems in APS system usage. We structure the APS system implementation into four phases: (1) the project chartering phase where the company takes the decision to install an APS system, (2) the project phase where the module is designed and rolled out in the organization, (3) the shakedown phase during which the company makes the transition from "go live" to normal operations and (4) the onward and upward phase during which the company captures the majority of the outcomes. We propose that it is possible to identify relevant individual (I), technological (T), and organizational (O) related variables in each of those phases that influence the problems obtained when the system is used, i.e. in the onward and upward phase. The purpose of this paper is to examine the following research questions:

- What problems exist in the onward and upward phase of the APS system implementation?
- How do the individual, technological and organizational dimensions in the implementation phases influence the problems in the onward and upward phase?

The empirical analysis is based on three case companies who all use an APS module to support their tactical planning. The remainder of the paper begins with a theoretical discussion of APS systems in tactical planning, and definitions and descriptions of the APS system implementation phases and the ITO dimensions are also discussed. Thereafter the methodology is described. In Section 4 the case companies and their individual APS system implementation journeys are presented and analyzed. A cross-case analysis and discussion are carried out in Section 5. The paper ends with concluding remarks.

2. THEORY

2.1. APS systems in tactical planning

APS systems are defined as: "Any computer program that uses advanced mathematical algorithms or logic to perform optimization and/or simulation on finite capacity scheduling, sourcing, capital planning, resource planning, forecasting, demand management and others…" (APICS, 2010). Existing commercial APS systems from e.g. SAP, Oracle, and JDA generally consist of various modules supporting different planning processes (procurement, production, distribution, sales) at different horizons (strategic, tactical, operational) (Stadtler and Kilger, 2005). The core module supporting the tactical planning is the supply chain-planning module (Günter et al, 2005), which is the focus of this paper. The SCP module aims at synchronizing the flow of materials along the supply chain, thereby balancing demand and capacity (Günter et al, 2005). It supports the mid-term decisions concerning efficient utilization of production, distribution and supply capabilities (Stadtler and Kilger, 2005). The SCP module not only balances demands with available capacities but also assigns demands (production and distribution amounts) to sites in order to avoid bottlenecks. Owning to the complexity and detail required in the model, only constrained (or near-constrained) resources are modeled in detail. To increase the solvability of the model, most vendors distinguish between hard and soft constraints in the linear programming (LP) or mixed integer programming (MIP) model that is used (Entrup, 2005). While hard constraints have to be fulfilled, the violation of soft constraints only renders a penalty in the objective function.

2.2. The APS system implementation phases

This section describes the four phases of an APS system implementation and the typical problems in the later phase.

The Chartering Phase: This phase comprise decisions leading to funding an APS system. Typical activities in this phase are current state analysis, ideas of adopting the system, definition of key performance indicators, conducting business case for investment development, identifying project manager, approving a budget and schedule, and the selection of a software package (Marcus and Tanis, 2000). Stadtler and Kilger (2005) highlight the importance of a thorough understanding of the current situation, the goals, needs, and priorities of the process under investigation prior the decision of investing in an APS system. Based on the current state analysis, the improvement areas and required functions are identified and the organization can decide whether to invest in an APS system or not. This decision is not only a based on how well the functionality in the APS system matches the goal and needs of the process under investigation, it is also a matter of the organization's maturity and assets in the form of skills, people, and money (Clause and Simchi-Levi, 2005). Logistical and financial key performance indicators are used to describe and quantify related benefits (Stadtler and Kilger, 2005). Ross and Vitale (2000) stress that companies that have not established metrics can count on a discouraging period later on when everyone sees problems and only a few people sees benefits. Benefits and implementation costs are time-phased based on the implementation plan, resulting in a business case. Budget and schedule are approved and project manager or/and project team is chosen. During this phase, or the next Project Phase, the APS system is selected (Marcus and Tanis, 2000). Several different APS systems exist, thus a systematic selection approach is normally required (Stadtler and Kilger, 2005).

The Project Phase: This is the phase where activities are comprised in order to get the system up and running (Marcus and Tanis, 2000). Typical activities include model building, setup of internal data structures and databases, validation/testing, training, and go-live. The SCP model is described as a linear programming or a mixed integer programming model (Günter et al, 2005). The mathematical models are not rebuilt to every organizations needs, instead parameters (i.e. costs, BOMs, routings, and regular capacities) are used to adjust the mathematical model to the specific situation (Stadtler and Kilger, 2005). In the first step a general network of supply chain entities are modeled (i.e. key-suppliers, key-customers, transport links, distribution and production sites). In the second step each entity is modeled in more detail and a planning-profile is defined including resource calendars, planning strategies for heuristics approaches and profiles for optimizers. It is often overlooked that the SCP optimization model can grow quite large, requiring long computational time (Günter et al, 2005). The SCP module collects data kept in ERP systems and data warehouses, thus a strong integration between the systems, and the correct and updated data, are considered critical steps to obtain accurate plans (Wiers, 2002). Validation of the system is done to fine-tune system parameters and validate planning results. One reason why problems arise later on in the implementation process is inadequate validation (Wenrich, 2009). The importance of education and training, and for companies to actively manage the educational process, has especially been shown in several ERP studies (Yu, 2005). It is important not only to offer training to project members and end users on computer/system operation but also training in the process the system will support, and the APS concept (Wenrich, 2009). Carrying out modeling, configuration, validation and training lead to a go-live date. Experiences from ERP system implementations have shown that go-live many times is linked to new processes, i.e. major organizational change (Ross and Vitale, 2000). Also an SCP module requests a standardized way of performing tactical planning (Stadtler and Kilger, 2005), resulting in organizational change.

The Shakedown Phase: is where organizations are coming to grips with the information system. It is the period from “going live” until “normal operations” have been achieved (Marcus and Tanis, 2000). Typical activities in this phase include cleaning up data and parameters, providing additional training to users, particularly on business processes, and working with vendors and consultants to resolve bugs in the software (Ross and Vitale, 2000). To a large extent, this is the phase in which the errors of prior phases are felt in the form of reduced productivity or business disruption. It is also possible for new error to arise in this phase (ibid). Many times, operational personnel adopt manual bridges to cope with early problems; this might result in the personnel continuing to use the manual bridges even when the problem is resolved (Marcus and Tanis, 2000). Another problem might be that the organization relies extensively on knowledgeable project team members rather than building the APS knowledge and skills in all relevant operational personnel (ibid).

The Onward and Upward Phase: This is the phase that continues from normal operation until the system has been replaced with an upgrade or a different system (Marcus and Tanis, 2000). Typical activities in this phase are post implementation audit, continuous business improvement, technical upgrading, additional end-user skill building. According to Weston (2001) many companies fail to take the time and effort required to establish a post implementation audit, meaning that there is no way to compare results before and after the implementation. Problems arising during the onward and upward phase often have much earlier roots (Marcus and Tanis, 2000). Example of problems that occur in this phase are that adopters might not know whether the implementation has resulted in improvements or not, therefore they may be unable to recover gracefully from future problems, and they may not be able to make future technology upgrades without outside help (ibid).

2.3. The individual, technological and organizational dimensions

This section defines and describes the individual, technological, and organizational dimensions.

The individual dimension (I) stands for the issues that are individual and at the same time important when performing a task or a change (Berglund and Karltun, 2007). The I-dimension is similar to the term organizational function, capturing the human activities in the organization. The functional dimensions are primarily described by verbs, i.e., what people are doing at work. Empowerment, commitment, knowledge, group dynamics and leadership are examples of functional factors. No consensus, however, is found and Richardson et al

(2002) point out that researchers have used an almost infinite variety of organizational factors. No clear set of factors is derivable from theory. From an APS system implementation perspective, the knowledge of APS and planning, experiences of the processes under investigation and implementation projects, and commitment to the project should be important individual factors. Several studies on ERP implementation conclude that the top management's support is of vital importance for successful implementation of an ERP system, and for running the system after implementation. These findings are also relevant for APS system implementation. The management role is to invest in education, spend time with people and assume a long-term perspective for successfully using the system. Different organizations consist of several cultures and each function/department operates with separate procedures and has its own way of performing tasks (Gargeya and Brady, 2005). Cultural resistance to change is often times mentioned as a factor hindering system use and acceptance (Gargeya and Brady, 2005). In general, when an APS system is implemented, planning and scheduling decisions are transferred from the planner to the APS system (Lin et al, 2007). When there is disagreement or resistance to such a change, the APS system implementation is likely to suffer (Wiers, 2009).

The technological dimension (T) is the term representing the technical systems (Berglund and Karltun, 2005). In this study, the APS system is used as a decision support in tactical planning processes. The technical dimension concerns the planning functionality and the user friendliness of the APS system, i.e. how easy it is to set and update parameters, generate reports and use the available functionality. It also concerns the input data to the APS system, i.e. the data quality, and the technical interface with other software systems such as ERP systems, data warehouses and legacy systems storing the basic data and using the APS system output. An SCP module consists of functionalities such as multi-plant planning, optimization, finite capacity planning, and what-if scenarios (Jonsson et al, 2007). Although APS systems are configured to the special characteristics of each company, the functionality flexibility is limited (Wiers, 2009). APS systems are strong when presenting information graphically to personnel (Wiers, 2002) and include user friendly planning tools, such as interactive scorecards and drag-and-drop functionalities (APICS, 2010). Usability of interfaces may be seen as one of the key factors influencing the end-user satisfaction (Calisir and Calisir, 2004). Users will become less willing to put up with difficult interfaces of information systems and search for alternatives when these systems fail to meet user needs (ibid). Wiers (2002) concludes that it is important that the APS system is well integrated in the existing IT infrastructure in order for it to be used successfully. This is also supported by Stadtler and Kilger (2005) who identify a strong coordination of APS modules and a strong integration of APS systems and ERP systems as a prerequisite to achieve consistent plans.

The organizational dimension (O) is said to represent the I-component in an aggregated sense and comprises how activities are organized and structured (Berglund and Karltun, 2007). We then talk about organizational structure – a term referring to the division of work and to the division of authority in organizations (Andersen and Jonsson, 2007). Here, the O dimension focuses on the divisions of work and authority of different project organizations during the implementation processes. In the first phases of the APS system implementation process the organization structure consists of the project team responsible for carrying out the work according to the budget, whereas in the later phases the responsibility is handed over to the planning organization. In many cases the personnel involved in the project team are the same as the ones that will be responsible for the APS supported planning process.

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2.4. An APS system implementation framework

Figure 2.1 illustrates an APS system implementation framework. The four implementation phases with their different activities make up the APS system implementation, which in turn are permeated with the ITO dimensions. The ITO dimensions in the different phases are suggested to influence the problems obtained in the last APS system implementation phase, i.e. in the onward and upward phase.

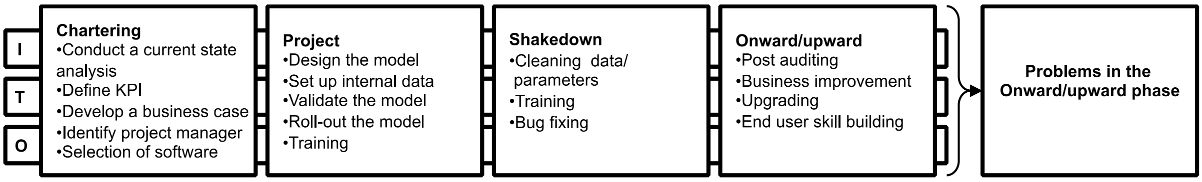

Figure 2.1: The APS system implementation phases and the ITO perspective

3. METHODOLOGY

The research method used for data collection and analysis in this study was a case study research. Case study is a research method which focuses on understanding the dynamics present within single settings and is particularly useful when there is little known about a phenomenon, when current perspectives seem inadequate, or when there is a need for a new perspective (Eisenhardt, 1989). Although there has not been much written about APS system implementations, our studied phenomenon is not completely new or unknown. There has been a lot of research conducted on implementations of other types of information systems, therefore there are experiences and theories to build upon. Still, APS systems differ from other types of information systems in several aspects, which create a need to understand the unique APS system implementation situation in order to develop knowledge about the overall APS system implementation. Thus a case study is appropriate. One aim of this study is to generate better understanding of how the ITO dimensions in the implementation process are related to the problems arising when the system is used.

APS system implementation phases were studied in three different manufacturing companies (a food company, a chemical company, and a brewery company) using an SCP module for supporting their tactical manufacturing planning. Several criteria were used in the selection of the companies. First, we selected companies that had entered the onward and upward phase. The project leaders of the APS system implementation were still working in the company since we wanted to derive experiences from the previous implementation phases to the problems perceived in the onward and upward phase. This is usually a problem when studying and collecting data about something that took place in the past, because people have a tendency to only remember certain parts of history. We interviewed a number of people involved in the projects and complemented the interviews with internal documents, therefore, we believe that we received a correct view of each phase of the processes. Second, we looked for specific cases that had experienced problems. Few companies are using APS systems for tactical planning which made the optimal selection difficult. We do believe, however, that we identified the "typical" APS system user who corresponded well to our criteria.

The food company: had been in the onward and upward phase for one year, and the project leader was about to hand over responsibility of the tactical SCP planning to the production scheduler and to a newly employed supply chain planner. The company was an interesting case since it had recent experiences of the APS system implementation phases. Besides, the

SCP was implemented to support an already settled process and an ERP system had been in place for many years. The key players in the APS system implementation were a consultancy firm, the production manager (likewise the project manager), two purchasing managers, and the soon to be retired production manager. The end users were the newly employed supply chain planner, the production manager, the production scheduler and the purchasing manager. We interviewed the production manager (project manager), the consultant involved in the project and the supply chain planner.

The chemical company: introduced the first APS system implementation nine years ago and the second implementation six years later. This meant that the company had a vast array of experience of APS system implementation. The first SCP module was implemented before an ERP system was introduced and a settled planning process existed. The second SCP module was implemented after an ERP system and a planning process were in place. The key players in the two implementations were the central planning organization (the supply chain manager and the two supply planners), the operation managers, people from the system vendor, and consultants. The end users were the centralized planning organization, the production managers, and the site schedulers. We interviewed the centralized planning organization, the operations managers, the CEO, the production managers, the site schedulers, and the consultants from the second implementation.

The brewery company: had been in the onward and upward phase for five years. The implementation team consisted of the production manager and one consultant. It was the production manager who used the SCP. The company was interesting since the SCP project consisted of a much smaller implementation than the other two companies, considering the amount of people that had been involved in the implementation and the usage. Besides, the motive behind the implementation was to “use the opportunity when an ERP system implementation was conducted because the ERP system vendor was also able to offer an SCP module” rather than solve a specific planning problem or support a specific process. We interviewed the production manager, who also was the main user of the system, and the consultant who was involved in the project.

Various methods were used to collect data from the case companies: interviews, on-site visits, company internal data and presentations. The interviews were semi-structured and questions were sent to the interviewees beforehand. In general, an interview took 3 hours and multiple investigations were used. Interviews were followed up by telephone and e-mail to verify and clarify data, if needed. A research protocol containing not only the questions to be asked but also the procedures and the general rules to be followed, was used. Data from the chemical company was collected during a three-year period (2008-2010), and for the food and brewery companies data was collected during the first quarter of 2010. The data was first analyzed case by case. Each case study was written up as a case story where the implementation phases were described in detail by the help of the interviews from the different actors. Thereafter the problems and factors identified in each phase were highlighted and the possible reasons for the respective problems were derived. Finally, we categorized the factors that influenced the implementation phases in the ITO dimensions, and conducted a cross-case comparison by looking for similarities and differences between the phases and the ITO dimensions according to Figure 2.1.

4. THE CASE STUDY

In this section, the case companies and the APS system implementation process are shortly presented. A within-case analysis is also conducted where the phase related issues influencing the received problems are identified.

4.1. The food company

The food company manufactures and sells soft cheese, dairy products, and salad dressings. It employs 600 people and consists of five different production sites. At the Swedish site the 140 food items are produced according to forecast, still the items cannot be kept in stock for a long time because of their short durability times. The tactical manufacturing planning is a weekly process which aims to generate a production plan suggesting the number of tons to be produced at each line every day in order to minimize total cost. Since the forecast usually changes during the week a new production plan is generated about three times each week. The production scheduler verifies the production plan before it is sent back to the ERP system where it is used for detailed production and purchase planning.

The APS system implementation: The implementation of the SCP module started in September 2008 and in March 2009 it was used in the weekly planning. The motive behind the implementation was that the company needed more transparency in the planning process. A consultancy firm, well known to the company, carried out the activities during the chartering phase. No business case or targets for key performance indicators were created. The production manager and two purchasing managers were selected for the project team. In the project phase the consultancy firm was responsible for the model building, system integration, and education of the project team. The food company was responsible for deciding how the module should support the process, the collection of data, validation/testing, and education of end users. The project phase took longer time than presumed and the production manager stressed that it was difficult to use the data and to validate the model. According to the consultant the low knowledge of how data was structured in the ERP system and what optimization can and cannot do obstructed data collection and validation. During the shakedown phase a lot of time had been given to bug-fixing and additional training of users, which also is something that the company has continued doing lately. A couple of technical upgrades have been accomplished in the onward and upward phase and the consultancy firm stay in close contact with the food company to answer questions and solve problems.

The phase related issues: The SCP users identified a number of problems when using the SCP module in their weekly process. These problems were derived from how the activities had been performed in the earlier phases and from the ITO dimensions (see Table 4.1). From the very start the consultancy firm took the major responsibility for the activities and knowledge was not successfully transferred to the project members who had become dependent on the consultancy firm also in the onward and upward phase. The knowledge transmission in the other direction was also insufficient leading to difficulties when designing the model. The model was, among other issues, not designed to consider setup dependent sequences important in the usage. This, in turn, had resulted in unrealistic suggestions. Another reason for why the plans many times were unrealistic is because data was not accurate. There were great difficulties in collecting data during the project phase and enough time was not given to this activity. The end users did not always update data figures and there was some resistance to this activity due to the lack of motivation and understanding, and the fact that there had been some transferring of the decision-making in the production department.

Table 4.1: ITO and phases influence on received problems at the food company

	Chartering	**Project**	**Shakedown**	**Onward /upward**	**Problems**
I		*Knowledge:* The project team lacked knowledge in the ERP/SCP and cannot convey the message of what it want to accomplish with the SCP module. *Motivation:* Team members dropped out.	*Understanding:* It was difficult to understand the output from the SCP module when it was suggesting an infeasible production plan. *Motivation:* The SCP required discipline by its users, who had to update data and parameters in the ERP system.		-The system was not used to its full potential. -The production plan gave sometimes unrealistic suggestions. - The firm was dependent on the consultancy firm.
T		*Data quality:* It was difficult to collect data. *Planning functionality:* The model did not consider setup dependent sequences.			
O	*Responsibility:* The consultancy firm was responsible for all activities.		*Authority:* Power was transferred from purchasing to production, leading to resistance.		

4.2. The chemical company

The chemical company manufactures, sells, and distributes chemicals. The case company employs 1,100 people divided into three regional organizations. The European division consists of three production sites that each year produce 110,000 tons. Many of the products are manufactured in more than one process step, often involving several production sites, which means that there is a large flow of intermediate products between the three sites. The European division also does contract manufacturing at fifteen other production sites. The tactical planning process is a monthly process which aims to generate a final production plan made at stock keeping level suggesting how much of which volume each site should produce so that every demand and target level is fulfilled at the highest contribution margin. Every month a preliminary production plan is generated from the SCP module. This plan is discussed during a capacity planning meeting. Thereafter the SCP module is updated with actual stock balances and the final production plan is generated and sent back to the ERP system where it is used in the detailed planning at the sites, and by the contract manufacturers and raw material suppliers.

The APS system implementation: considers two implementations from different APS system vendors, the first implementation in 2001 and the second in 2007. The motive of the first implementation was the new CEO’s vision of a supply chain focus where capacity would be shared among the sites. A consultancy firm was employed to support the company with a current state analysis and different APS system vendors were evaluated. The project team consisted of two people from the company, one consultant, and two people from the APS system vendor. The model building and customization of the optimization algorithms were mainly the responsibility of the consultant firm and the APS system vendor. The company also participated actively in the design of the model. The consultancy firm and the APS system vendor had the major responsibility for the system integration, the set up of internal data structures and the responsibility of databases and validations. The consultancy firm educated the project members, whom thereafter educated the end users. There were many problems with the first SCP implementation and the module was not used as expected. After a few years the decision stood between making an extensive upgrade or replacing the SCP module. The company chose to replace the module and a throughout evaluation of APS system vendors was conducted. According to the supply chain manager the second implementation went smoother than the first and for the moment the central planning organisation is working hard with the next step of the SCP module – to synchronize the production plan tightly with the detailed scheduling.

The phase related issues: One of the main reasons for why the first SCP installation was not used to its full potential was that the organization did not agree upon what the SCP module was supposed to solve. Thus, in parallel with the SCP supported process, a manual planning process where “one preferred site” was used limited the progress and the potential of the SCP module. Besides, the first SCP module was not user friendly and the integration between the SCP and the many legacy systems was not properly integrated. The project team lacked knowledge of the planning process, which led to a very complex model that was difficult to use. The roles in the project team were not clear and many times decisions were based on estimates instead of facts. During the first APS system implementation no ERP system existed and it was difficult to produce the data needed. Even though the user has perceived the second SCP module positively they still felt that they did not use the module to its full potential. One reason for this is the lack of planning data, e.g. contract manufacturers were not willing to share their data. Although the model is more accurate this time, problems with the data quality still exist since users do not update figures as they should. This leads to unrealistic suggestions. The organization also lacks knowledge to move forward with the SCP module.

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Table 4.2: ITO and phases influence on the received problems at the chemical company

	Chartering	**Project**	**Shakedown**	**Onward/ Upward**	**Problems**
I		*Understanding:* One did not think through which data that should be used, and how to design the model. This resulted in a too complex model. *Knowledge:* The organization did not know where the bottlenecks in production existed.	*Resistance:* The user did not use the system and did not update data figures. *Understanding:* The users did not see the value of using the system.	*Knowledge :* There was a lack of knowledge of the APS system potential.	- The system was not used to its full potential. -The production plan gave sometimes unrealistic suggestions. -It was difficult to know how to move forward.
T		*Integration:* There were difficulties to integrate the APS and ERP systems. *Data:* It was difficult to receive data.	*Planning functionality:* The system was not user friendly.		
O	*Priorities:* The organization had different expectations on the system.	*Authority:* The project team's roles were not clear and many times the top management over-ruled the team.			

4.3. The brewery company

The brewery company produces and sells beer and soft drinks and it employs 1,100 people. There are four breweries geographically dispersed, each supplying its own market. In the Swedish brewery, the 400 items are made to stock and have a durability time between 16 and 52 weeks. The tactical production planning is a weekly process which aims to generate, 1) an unlimited production plan suggesting the number of articles to be produced at the lines each day, and 2) a limited capacity plan. The unlimited production plan is used by the production planners in the material planning to set due dates for manufacturing orders whereas the limited capacity plan is used to generate proposals for purchasing orders and to identify capacity shortage.

The APS system implementation: started in 2003 and the SCP module was used in the operation in 2005. The motive behind the implementation was to take the opportunity to replace the system for production planning at the same time as an ERP system implementation was in place. Unfortunately there was no incentive to improvement and the SCP project became very much technically driven. A consultancy firm made a current state analysis of the ERP system implementation project of which the SCP project became a part. The SCP installation took longer than expected and the reason for this was a jointly intermediate aim of all ERP modules. During the project phase, activities were phased over to the production manager, who was the only person included in the project team from the company's side. The production manager was also the only user of the module. A number of upgrades have been done since the first version was installed.

The phase related issues: The production manager perceives that he does not use the system to its full potential. This is also something that the consultant agrees upon. The production manager thinks that it should be possible to utilize more of the optimization engine whereas the consultant thinks that the latter does not have a strong connection to the tactical plan. One reason for this problem is that the SCP was not a prioritized project and no analysis was made to investigate what an SCP module would be able to accomplish and how to receive potential of the SCP module. Besides, because the SCP implementation was not prioritized, the old production system, that the SCP module was supposed to replace, is still in use during the tactical planning phase. Another problem perceived by the production manager is that the system is time-consuming. The SCP module is not connected to the ERP system but instead to several different databases. This leads to the performance of several manual tasks before each SCP is implemented. The production manager is dissatisfied with the reporting functionality and instead has to use Excel for generating reports.

Table 4.3: ITO and phases influence on the received problems at the brewery company

<table>
<tr><th></th><th>Char-tering</th><th>Project</th><th>Shake-down</th><th>Onward/ Upward</th><th>Problems</th></tr>
<tr><td>I</td><td></td><td></td><td></td><td></td><td rowspan="3">- The system was not used to its full potential.
- The users spent too much time in the system.
- Other planning systems were used in parallel with SCP.</td></tr>
<tr><td>T</td><td></td><td>Integration: The SCP module was put outside the ERP system.
Data: It was difficult to collect data.</td><td colspan="2">Functionality: The SCP module could not generate reports.</td></tr>
<tr><td>O</td><td colspan="2">Prioritization: The SCP implementation was part of the ERP implementation project and not prioritized by the management.</td><td></td><td></td></tr>
</table>

5. CROSS-CASE ANALYSIS AND DISCUSSION

This section identifies problems in the onward and upward phase and explains how the ITO-dimensions occurring during the implementation phases influence the problems in the case companies. Based on the case company analysis and previous literature we propose a number of relationships between the ITO-dimensions and these problems.

5.1. Problems in the onward and upward phase

Six major problems were identified in the case companies. They were categorized in to three separate groups: *Process related problems* concern difficulties to move forward, dependency on the consultancy firm, and too much time spent in the system. All three companies experienced one process related problem each because of case unique conditions. The food company, for example, did not have vast knowledge about the process since the production manager was replaced just before the implementation. The chemical company implemented an SCP module without having any settled processes and no ERP system in place. The brewery company implemented an SCP module in order to replace their old system. Similar problems are discussed in previous literature on software implementation. Marcus et al (2000) identifies that it is often times difficult for ERP system users to be able to make future technology upgrades without outside help and that much time is spent making the system work. An APS system relies on an optimization model, therefore, the dependency on outside experts may become even stronger. *System related problems* concern using other planning systems in parallel with the APS system (e.g. Excel for reports) and not using the appropriate potential of the APS system. In the case companies, one company reported using other systems parallel with the APS system. None of the companies thought they used the full potential of the APS system. Marcus and Tanis (2000) stress that it is possible that operational personnel will adopt workarounds to cope with early ERP system related problems and that these workarounds might remain even in the late phases of the implementation. In previous APS system studies it has been identified that users do not think that they use the APS system's full potential (e.g. Günter et al, 2005). None of the companies in our study made use of the APS system functionality that integrates several production sites in the model, and only the chemical company made use of what-if analysis. Still, it is well known that APS models easily grow quite large and that there is a tradeoff between the time of solving the problem and the feasibility of the plan (Stadtler and Kilger, 2005). Another reason for not including too much complexity in the model is that the more complex the model becomes the more difficult it is to interpret the results and errors (Günter et al, 2005), which, for example, was experienced by the chemical company in its first SCP installation. *Plan related problems* occur when the plan generated from the APS system contains errors or is not considered feasible. Two of the case companies experienced this problem. Günter et al (2005) have found that there often is a discrepancy between the expectations of the companies and the capabilities of the software, which is one of the reasons why the plans are not considered feasible.

5.2. The influence of ITO dimensions on the problems

The ITO-dimensions in the different phases influenced the problems that arose in the case companies. The I-dimension was especially prominent and influenced all problems. In the case companies, lack of understanding of which data and parameters that were of importance, how to design the model, and knowledge of the planning process were some of the I-dimensions causing consultancy dependency and unused potential in the *project phase*. During the *shakedown phase,* users did not see any value in using the system and found it difficult to understand how to interpret the output. This resulted in that users did not use system to its full potential, they instead used parallel systems, or they spent too much time in the system. In the *onward and upward phase,* users lacked knowledge and understanding of what the SCP could or could not do. Lack of motivation was another factor causing problems. This resulted in incorrect plans, unused potential, and difficulties to move forward with the implementation. The importance of knowledge and training in the usage of the planning system and the planning process, have been emphasized in previous ERP system studies (e.g. Yu, 2005). We consequently verify these findings and show that these issues should be of greatest importance also in APS system implementations. The organizational culture and resistance to change has also been identified to cause problems in ERP system studies (Ross and Vitale, 2000) as well as previous APS system studies (Wiers, 2002). Other influences identified were related to how many people were involved in the implementations as well as how many APS users there were. Only one of the companies employed a single APS system user. This user was also involved in the project team from the start of the implementation. Compared to the cases with several users, the I-dimension was much less critical in the single user case. It was obvious that this user had better knowledge, understanding and motivation as well as less resistance to change compared to the average user in the other cases. It is still important to emphasize that the problems influenced by the I-dimension may be more difficult to overcome in an implementation involving several people. One interesting fact is that the I-dimension was not evident in the chartering phase in the case companies. The reason for this is probably that many of the activities identified in theory were not carried out in the case companies during this phase. Some of these activities include current state analysis, vendor selection and determining key performance indicators. In accordance with previous ERP studies that emphasized the importance of early implementation phases (Ross and Vitale, 2000), we believe that problems related to limited improvement of work and failure in using appropriate APS functionalities may have been eliminated if these early activities had received a stronger focus.

The T-dimension was most evident in the *project phase* and the companies reported on difficulties to receive data, to integrate the APS system with the ERP system, and shortage in the planning functionality, which support the study by Lin et al (2007) that also identifies activities concerning the technical system connected to the project phase as being problematic. The T-dimension caused problems in the form of too much time spent in the system, the use of parallel systems, and incorrect plans. Previous studies on APS systems have emphasized the importance of collection and validation of data and a strong integration with ERP systems and data warehouse systems in order to reach the goal of feasible plans (Wiers, 2002; Stadtler and Kilger, 2005; Jonsson et al, 2007). This was confirmed by our study. T-dimensions were also identified in the *shakedown and onward/upward* phase as a lack in functionality. The system was not considered user-friendly and did not generate reports, which lead to the use of parallel systems or/and non-use of any system. This is something that Calisir and Calisir (2004) also discover in their study on ERP systems. Even though it is not surprising that the T-dimensions are especially emphasized during the project phase since it includes such activities as model building, set up of data structures and data bases, validation, and training, a stronger T focus is probably needed in the earlier chartering phase. It is during the chartering phase where the necessary APS functionality is identified and the appropriate system is chosen. If some more work were done during this phase, several problems regarding functionality problems would probably be minimized. Previous literature highlights the importance of the task-technology fit and systematical selection of APS vendors (Stadtler and Kilger, 2005).

In the case companies, the O-dimension was apparent in all phases except the last one. In the *chartering phase*, the companies reported on responsibility and prioritization issues. The consultancy firm was in charge of the largest part of the activities during the chartering phase, which was one of the reasons for consultancy dependency in the onward and upward phase. Management and operational personnel also had different expectations on the SCP module, which limited the progress and potential of the module. During the *project phase*, the companies had assigned unclear project roles and they experienced difficulties giving priority to the SCP implementation. Management involvement and commitment are often mentioned as key issues for succeeding with ERP system implementations (Finney and Corbett, 2007) as well as in APS system implementations (Stadtler and Kilger, 2005). An APS system implementation usually becomes the supply chain manager's or the responsible planner's main priority. Therefore, a wider management commitment is important in order to get users involved and committed, and to get the implementation in focus during the first phase. There was also an indirect relationship between the O-, and the I-dimensions, because the management involvement most likely affected the knowledge, motivation and commitment of the project members and the APS system users. In the shakedown phase, power was redirected, which resulted in resistance and un-used potential. As reported by Lin et al (2007), implementing an APS system usually means that roles and decisions are changed and when there is disagreement about such a change the implementation is likely to suffer (Wiers, 2009). The O-dimension was not apparent in the last phase, indicating that the delivery from the project team to the operational personnel had gone smoothly. In an ERP implementation this might be a quite challenging issue (Marcus and Tanis, 2000) and responsibility, priority and authority might be central. In the case companies most project team members were operational personnel who made the O-dimension less important and gave the I-dimension priority in the late phase.

5.3. The revised APS system implementation framework

Figure 5.3 conclude the identified problems and the ITO dimensions in the different phases that influence the problems in the onward and upward phase of an APS system implementation.

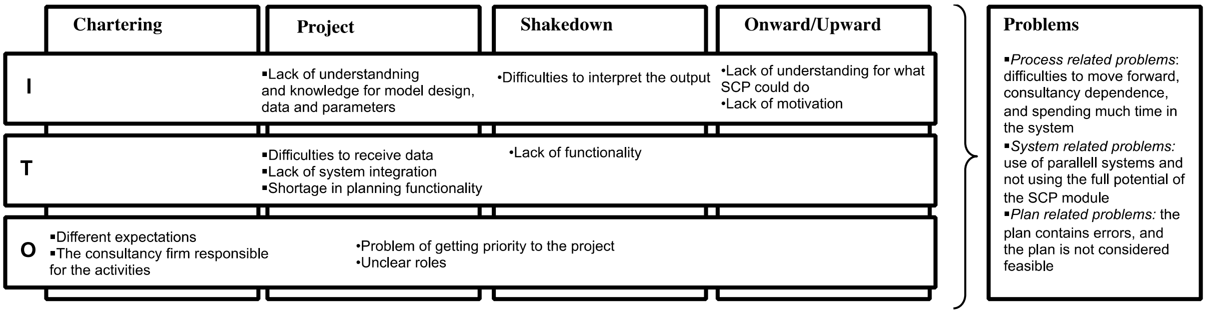

Figure 5.3 The ITO dimensions influencing the identified problems in the APS system implementation phases.

5.4. Discussion and proposed relationships

The analysis presented in the previous section identified relationships between ITO-dimensions and problems. The discussion presented in this section elaborates on the most important findings and generates propositions.

From the analysis it is clear that one may expect all three types of problems to arise and it is not possible to identify one problem type as more important than another. It should be possible to reduce all problem types, but still we believe that some problems are very difficult, almost impossible, to eliminate. For example, a plan may hardly become perfect, there will always exist some deviations between planned and actual figures. The ambition when implementing an APS system is usually to receive feasible and sometimes even optimal plans – so the expectations are high from the start making it difficult to become satisfied with the plan.

When identifying connections between the ITO dimensions and the problems we observed that two out-standing issues in the I-dimension were knowledge and understanding. These I-issues probably go hand in hand since one requires knowledge in order to understand. In the case companies it was found that there is a great need for a general understanding of what optimization can do and what it cannot do. Sometimes the APS model is compared with a car engine where the user does not need to understand the details behind the engine to be able to drive the car. It is not necessary to understand the details behind the APS model, but we do believe it is important to have an overall understanding of what optimization is about in order to utilize the system to its full potential. If this is not the case, it is possible to, in the best scenario, end up with a long implementation time since it is during the implementation that it is observed if the solution designed corresponds to the problem or not. This was, for example, experienced in the food company where much time was spent on validation since this was the first stage where the project team started to understand what the model was able to achieve. In the worst scenario, no understanding for optimization will lead to disappointments in the later phases when the system already is in place. This in turn may lead to all three problem types arising. In accordance with the above discussion, we state the following proposition:

Proposition 1: Understanding of optimization reduces the problems in the onward and upward phase of an APS system implementation.

In the cross case analysis it was observed that the influence of the I-dimension of the problem types decreased with the number of people involved in the implementation project. This might seem obvious, as it is often times easier to stay focused and transfer understanding, knowledge and motivation with fewer people in the project. In general, APS system implementation projects are much smaller than, for example, ERP system implementation projects. This is not surprising since the APS system is a “low-user system” and from this perspective not many people need to know how to actually use the system. Still, the implementation of an APS system will affect many people at different divisions since it usually changes the way the planning process is being run. If the APS system should have a chance to be used in an efficient way, people must change their approach and opinions about the system. In order to do this the system has to be accepted by its users. Although we believe that APS system implementation projects should be kept small-scaled and focused on a specific target, the study shows that there is a risk that the project is not given enough priority by the top management. It is important that the project leader is given mandate from the top management and that effort is made to gain acceptance of the APS system supported planning processes in the organization. We consequently state the following propositions:

Proposition 2: Small and focused project teams reduce the negative influence of the I-dimension on the problems in the onward and upward phase of an APS system implementation.

Proposition 3: Top management priority to the APS project reduces the problems in the onward and upward phase of an APS system implementation.

An APS system is an advanced technical system requiring a small project team, therefore it is possible to expect the I and O dimensions to be less important than the T dimension. However, the case study analysis and previous literature suggest the opposite. There were other issues in the T –dimension that caused problems in the onward and upward phase, but they were not as important as the I-, and O-dimensions. The T issues causing the most problems were the planning functionality. The users did not have any problem utilizing the planning functionality, instead problems were encountered when extracting and generating reports. Low data quality did not seem as important as one would expect, it was rather the lack of understanding of which data to make use of and how data was structured in the ERP system that caused problems in the later phases. We argue accordingly that it is not a must to have perfect data quality from the start of the project – what creates problems in the onward and upward phase is incorrect assumptions of how the ERP system works, because an SCP module requires that the basic data is registered correctly in the ERP system. In fact, an APS system implementation project many times works as a catalyst for increased data focus and higher data quality. We state the following propositions accordingly:

Proposition 4: The I-, and O-dimensions are more important than the T dimension in order to reduce the problems in the onward and upward phase of an APS system implementation.

Proposition 5: Understanding of how data is structured in the ERP system reduces the incorrectness of APS plans.

The personnel in the case companies did not become involved in the project until the project phase. Even though the design of the model and the system integration require experts we believe that the company staff should be involved much earlier and a larger focus should be emphasized on the activities in the chartering phase. A few examples of involvement are, to conduct a current state analysis, define key performance indicators and compare different APS vendors. The following proposition is supported and motivated:

Proposition 6: Focus on the ITO dimensions in the chartering phase reduces the problems in the onward and upward phase of an APS system implementation.

6. CONCLUSIONS

Three types of problems were identified during the onward and upward phase of an APS system implementation. *Process related problems* concern difficulties to move forward, dependency of the consultancy firm, and too much time spent in the system. *System related problems* concern using other planning systems parallel to the APS system, and not using the appropriate potential of the APS system. *Plan related problems* occur when the plan generated from the APS system contains errors or is not considered feasible. We discovered how individual, technological and organizational issues influence the problems. The *I-dimension* was especially prominent and influenced all identified problems. During the I-dimension the *understanding issue* was outstanding and of special importance, and it was suggested that problems could be reduced if the team members had a general understanding of optimization and how data was structured. The *T-dimension* influenced the time spent in the system, the use of parallel systems and incorrect plans and the T-dimension was evident in all phases but the chartering phase although the *project phase* stood out as especially important. The T-dimension was not as important as the I-,and O dimensions. This suggests that top management should not view the APS system implementation solely as a technical project aimed for a few users, but instead give priority to the project since an installation of an APS system will affect a large number of people. The O-dimension influenced the dependency on consultants, the use of parallel systems, un-used potential and incorrect plans and was evident in the *chartering and the project phases*. The study suggests that the O-dimension in the later phases is not as important for an APS system implementation as it is for an ERP system implementation project because the pass over from the project team to the operational personnel are not a big issue in an APS system implementation.

Our study does, however, have a few limitations. Only three case companies are included in the study, which could possibly be considered a small number in a multiple case study. However, it was important to study each respective case in detail and to understand the full context of each case, which therefore motivated a smaller number of cases. In the analysis of the three cases, we also arrived at a certain degree of saturation. Originally, two more cases were involved in the study but they were not included in this paper because they didn't add any new insight to the study and the findings wouldn't have been different if they had been included. Another possible limitation is that we studied the chemical company in more detail than the other companies. However, since this company was studied in depth we arrived at broader understanding of the phenomenon, which in turn simplified the data collection in the other cases.

Another limitation of the study is rooted in the fact that we have not been a part of the APS system implementation process at any company. Instead, we have interviewed the users and project team members about their experiences with the implementation. It is always problematic to observe a phenomenon from a historical perspective. We believe that by using different types of data collected from different sources, including several people with different roles in the implementation process, we have indeed obtained a realistic view of what was taking place.

This study has taken a quite wide focus in order to identify different types of problems and derive types of causes from different implementation phases. The approach has partly been inductive with the ambition to identify and explore problems and ITO related causes and to generate a framework of problems, causes and implementation phases. The study opens up for several more detailed studies, focusing on the different dimensions in the APS system implementation framework. One stream of further research relates to more detailed exploratory studies. It would, for example, be interesting to conduct deeper studies of implementation project management. Such studies could focus on the dependency issue between the consultant and the APS system buyer or on the cultural issues of APS system implementation. The chartering phase was identified as a critical implementation phase. It would, therefore, be interesting to study cases were a lot of focus was given to the activities in the chartering phase, and explore the effects achieved. Conducting longitudinal studies of APS system implementation projects could also add more insight about the process and would therefore be relevant in future detailed studies. Another obvious stream of further research would be to empirically test the generated propositions. This would be a first step of deductively oriented research striving to develop a more general framework and more general conclusions. A fourth stream of further research relates to the knowledge transfer between ERP system and APS system implementations. This study has used ERP system implementation knowledge to learn about APS system implementation, but it should also be interesting to study what ERP system implementations could learn from APS system implementations.

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