



## The shaping of inventory systems in health services: A stakeholder analysis

Jan de Vries \*

Faculty of Economics and Business, University of Groningen, P.O. Box 800, 9700 AV Groningen, The Netherlands

### ARTICLE INFO

#### Article history:

Received 2 September 2008

Accepted 22 October 2009

Available online 1 February 2010

#### Keywords:

Inventory system

Exploratory case study

Health services

### ABSTRACT

Although many studies have addressed the diagnosing and redesign of inventory systems in an industrial setting, the field of operations management seems to lack a thorough understanding of the process of shaping inventory systems in a health care setting. In this article, a contribution is made to fill this gap by exploring the process of reshaping a hospital inventory system of medicines by means of an exploratory case study. In doing so, we concentrate on the question how the outcomes of this process are affected by the different stakeholders involved. Our case study indicates that decisions made during this reshaping process are heavily influenced by the dynamics of the relationships and interactions between the stakeholders involved in the project. Based on our case study there are also some strong indications especially in a health care setting, the existence of multiple stakeholders having a multi-goal focus regarding the inventory system can have a strong influence on the outcomes of inventory projects. For project managers it is important to be aware of these characteristics and circumstances in order to help health service organisations to develop and use inventory systems more effectively.

© 2010 Elsevier B.V. All rights reserved.

### 1. Introduction

Since the 90s, the health care sector has changed rapidly. Due to increased competition, a growing influence of patients and a stronger necessity to deliver health services in a more efficient and effective way, many health care organisations have started projects in the area of service quality, clinical pathways, information systems and patient logistics (e.g. Stock et al., 2007; Mahmoud and Rice, 1998). Not only in practice but also from a theoretical point of view the area of health care management has changed significantly. During the past 15 years an impressive number of studies performed in disciplines like Economics, Business Logistics, Operational Research and Business Administration have enlarged our knowledge regarding the health care sector considerably (e.g. Li and Benton, 1996; Jarett, 1998; McFadden et al., 2004; Ruiz, 2004).

Notwithstanding the fact that hospitals carry large amounts of a great variety of items, health care organisations have paid little attention to the management of inventories (Nicholson et al., 2004). Studies performed in the past as well as more recent research suggest that inventory costs in the health care sector are substantial and are estimated to be between 10% and 18% of net revenues (e.g. Jarett, 1998). At the same time, hospitals are forced to increase their internal service performance and it is also for this

reason why a strong focus on inventory management has become paramount in many hospitals nowadays. It will be of no surprise, therefore, that a large number of hospitals have started with projects in the area of inventory management in order to reduce costs and improve service levels.

Despite having some rather unique characteristics only few studies have addressed the question how the design and implementation of inventory systems in a health service setting takes place. Many different stakeholders are involved in the (re)shaping of inventory systems and together with the diverse and unique characteristics of hospital products, projects in the area of inventory management are far from a simple, straightforward design process in hospitals. Moreover, only a limited number of empirical studies are available regarding the question how conflicting interests and power relationships between stakeholders influence the shaping and implementation of inventory systems in health services. Undoubtedly, having a clear understanding of how inventory systems are affected by the specific characteristics of hospitals can be helpful to strategic and tactical decision-making processes on inventory systems. Additionally, this understanding can also be beneficial for the effectiveness of inventory projects.

In the next section, first the results of a literature study that guided the empirical part of our research are presented. In the second part of our paper, case data is analysed. In doing so we will concentrate on the question how the results of inventory projects in a health care setting are being affected by the different stakeholders involved. The cure and care context of the inventory project as well as some contingency factors that have influenced

\* Tel.: +31 50 363 7020; fax: +31 50 3632275.

E-mail address: [Jan.de.Vries@rug.nl](mailto:Jan.de.Vries@rug.nl)

the outcomes of the inventory project are explicitly taken into account when analysing the case data.

We view the contribution of this study from two perspectives. First, the paper aims to advocate the role of stakeholders during the process of shaping inventory systems. Noticeably, this role has not been fully explored in a health care setting and hardly any articles in the area of operations management have addressed this issue explicitly. Additionally, some tentative conclusions are drawn about how the hospital setting of the stakeholders might influence the design and performance of an inventory system. In this way, a contribution is made to identify various issues more profoundly regarding enablers and barriers to the shaping of inventory systems in hospitals.

## 2. The shaping of inventory systems: lessons from literature

### 2.1. Introduction

During the last decade numerous contributions have been made regarding the design of inventory systems. Traditionally, many of these contributions focus on the quantitative elements of inventory control. Both timing and quantity decisions are in the central core of the field of inventory management and a huge amount of literature is available on decisions how to determine economic order quantities and order intervals (e.g. Blinder and Maccini, 1991; Silver et al., 1998). Additionally, many researchers have studied the influence of Integrated Management systems like MRP-II and ERP on inventory decisions (e.g. Rabinovich and Evers, 2002; Razi and Michael Tarn, 2003) and it is well recognized nowadays that the design of inventory systems is closely related to management areas like Finance, Procurement, Production and Sales. Additionally, some researches have advocated more recently that it is highly important to take the organisational setting of inventories also into account during the process of designing inventory systems. Zomerdijk et al. for instance consider four organisational areas to be crucial when designing inventory systems (Zomerdijk and de Vries, 2003). The allocation of tasks, the decision-making processes, the behaviour of the parties involved in the inventory system as well as communication processes appear to be important contextual factors when analysing and redesigning inventory systems. Based on a longitudinal case study, De Vries (2005) elaborates further on the notion that a complex relationship exists between inventory control and its organisational design. The findings of this longitudinal case study suggest that organisations often try to neutralise shortcomings in the inventory planning and control system by applying organisational measures. However, negative forms of congruence also seem to exist implying that shortcomings in the inventory control system can be negatively re-enforced by its organisational setting as well (De Vries, 2005).

Not only the operating performance of inventory systems influenced by organisational factors. The process of re-shaping and designing inventory systems apparently is affected by organisational processes either. In general, it is well known that various groups of people in organisations may have different perceptions of management systems (e.g. Webster, 1995; Coakes and Elliman, 1999) and studies performed in the area of information systems show that the design of information systems can often be explained by the actions and attitudes of the stakeholders involved in the process of shaping these systems (e.g. Knights and Murray, 1992; Boonstra, 2006).

### 2.2. Inventory systems and health services

Notwithstanding the impressive body of knowledge regarding inventory management in an industrial setting, some gaps and

holes exist in our knowledge when trying to translate this knowledge to a health service setting. Clearly, a number of problems show up when transferring the techniques and approaches developed in industry directly to the management of inventories in hospitals. In a hospital, in many cases patient caregivers must be sure that particular products like drugs are always available. Additionally, in many hospitals it is not always clear what party is responsible for the money tied up in inventories. Moreover, decision-making processes in the area of inventory management within hospitals apparently are often heavily influenced by the many stakeholders involved. Some studies suggest that setting par levels for items in a health care setting tend to reflect the desired inventory levels of the patient caregivers and often seem to be more politically and experience-based driven rather than data-driven (Nicholson et al., 2004). Finally, inventory management projects in hospitals are often strongly linked to automation and to projects in the area of information, patient logistics and supply chain management. Manual dispensing of medications in hospitals in Canada, the United States and Europe for instance, is more and more replaced by automated medication distribution systems in order to help with distribution of medications to patient care areas and to improve inventory control (e.g. Novek, 2000).

One of the interesting differences between inventory systems in an industrial setting compared to inventory systems in a health care setting is the organisational context of the system. Obviously, many different stakeholders can be distinguished when studying inventory systems in health services among which nurses, pharmacists, doctors, care managers, financial managers and information specialists. Starting from the notion that different stakeholders may have different perceptions and interests with respect to the inventory system, the question arises how inventory projects are influenced by these stakeholders in a health care setting. There are indications for instance that the health service sector faces some specific inventory-related problems because a relative high percentage of their budgets is tied up in inventory and the required labour to manage it (Oliveira and Pinto, 2005). It can be hypothesized that one of the main reasons for this inefficiency is rooted in the existence of hidden stocks in order to avoid stock-outs. The shaping and operation of inventory systems in health services in other words, probably is heavily influenced by organisational processes as well. However, little to no understanding exists regarding the social and technical mechanisms underlying the process of (re)shaping inventory systems in a health care setting and it is for this reason why an exploratory case study was performed to deepen our understanding of this process.

In hospitals, often inventory systems for medicines are mix of centralized and decentralized stores in which medicines are kept in stock. Additionally, trade-off decisions between costs and the level of required service are probably more complex and difficult in hospitals in comparison to manufacturing companies. Understocking of medicines can result in increased dissatisfaction of physicians and/or surgeons and a lacking operational performance of the hospital, for instance delays in surgery. In a worst case scenario, a shortage of medicines ultimately can even cause the death of patients. Overstocking at the other hand, generally results in an increase of carrying costs. Costs due to obsolescence, depreciation and spoilage together with an increase of interest costs can be excessive in the case of high-priced pharmaceuticals. Finding a proper balance between quality metrics (timely treatment, adequate amount of services and meeting professional standards) and costs without doubt, is one of the main logistical challenges, hospitals are confronted with.

### *2.3. Elements of an inventory system*

In order to meet the required performance inventory systems in hospitals normally build around four main areas (e.g. De Vries, 2005):

- the physical system
- the planning and control system
- the information system
- the organisational system

The physical system relates to the way, organisations distribute and store products and goods within the company. In the case of hospitals many different products are distributed and stored e.g. office supplies, clothing and hotel supplies (uniforms, towels, etc.), medical-surgical supplies, medical devices, health aids (e.g. bandage) and pharmaceuticals. Without doubt, hospital supply chains are quite complex (e.g. Towill and Christopher, 2003) and products can be distributed and stored in many different ways. The physical shaping of inventory systems therefore, includes, amongst other issues, decisions on whether or not "stockless schemes" ought to be applied and the way the organisation is dealing with planned versus emergency sourcing of goods. Additionally, numerous decisions on a strategic, tactical and operational levels have to be made regarding the different products in order to co-ordinate the demand and supply of deliveries. It is for this reason why the planning and control system as well as the related information system highly dominate the performance of the inventory system in hospitals. Although some authors argue that a general transposition of planning and control methods and concepts from the industrial area into health care is possible (Young et al., 2004; Young, 2005; Kuljis et al., 2007) others feel that this is difficult to achieve due to the high stakes if goods are 'out of stock' and the combination of planned versus emergency care (Oliveira, 2005; Schneller and Smeltzer, 2006). The organisational embedding of the inventory system can be considered as a fourth main area which highly influences the performance of inventory systems in general and in a health care setting in particular. As stated before, organisational arrangements regarding stock levels as well as the allocation of responsibilities and authorities apparently is often quite dispersed within hospitals and seems to differ from industrial companies because of the existence of multiple stakeholders and less distinguishable parties like Sales and Production.

Each area addressed above can be subjected to changes; and projects in the area of inventory management, therefore, often are of a multidimensional character. Based on the arguments mentioned above, it is reasonable to assume that the outcomes of inventory projects within hospitals are shaped by the expectations and the perceptions different stakeholders have of these outcomes. Moreover, our study considers inventory projects as organisational change projects which are shaped by rational decision-making as well as by social mechanisms and political processes. Obviously, the outcomes of inventory projects can have far-reaching consequences for the stakeholders involved. A re-allocation of authorities and responsibilities regarding inventory costs for instance, may result in parties being held accountable for these costs which have not been so before.

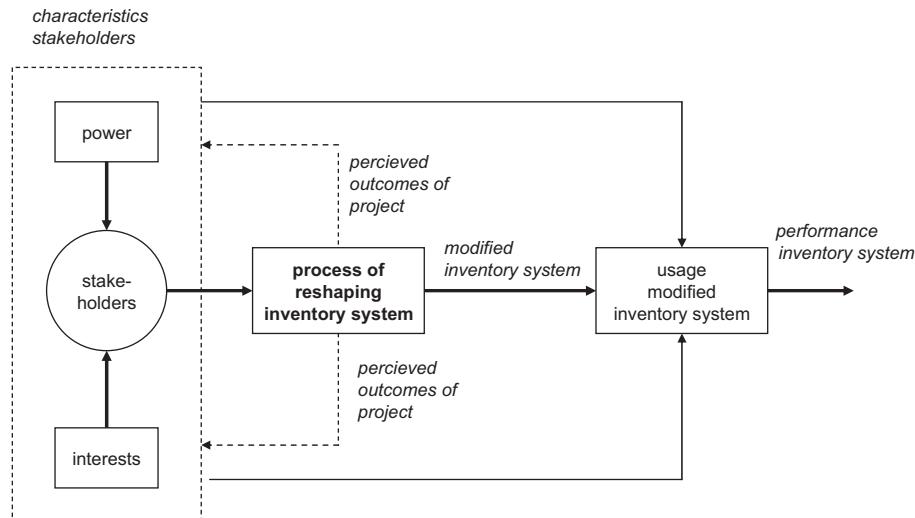
Starting from the notions mentioned above, the question arises how the results of inventory projects in a health care setting are being affected by the different stakeholders involved. In the next Sections the results of an exploratory empirical study aimed at answering this question are reported.

### **3. Methodological backgrounds**

In this research, a qualitative exploratory case study was employed. The case study took place during the period February 2006–December 2008 and concentrated on following an inventory project in a medium-sized hospital. The hospital employs 1500 employees and has 400 beds. Furthermore, the hospital covers more than 80 medical specialisations and each year about 20,000 patients are admitted to the hospital. Additionally, more than 180,000 treatments in an outpatients' department take place. The initial aim of the project was to analyse and improve the performance of the inventory system of pharmaceuticals in the hospital. During the early process of (re)shaping the inventory system though, it appeared that a complex set of processes based on social and technical arguments played an important role and during the course of the project different events took place which ultimately lead to only partly adopting a new inventory system. For this reason, the research focus shifted towards establishing the complex processes and mechanisms during the shaping of inventory systems taking care of the delivery system of hospitals into account. Additionally, the aim of the research was to establish the impact of the different perceptions of the stakeholders on the ultimate usage of the inventory system. In doing so, the four elements outlined in the previous section were taken as a starting point.

Revealing the social and technical mechanisms during the process of shaping inventories as well as assessing their impact on the ultimate usage of the inventory systems is a 'how' question about a contemporary set of events over which the researcher has no control. For this reason, a case study seemed to be the most appropriate choice. A case study approach enables the researcher to collect more insightful data where explanation is required rather than statistical measurement (e.g. Bryman and Bell, 2003) and we therefore conducted an exploratory case study. Moreover, aiming at establishing the specific care context of the study also justified the employment of a qualitative case study methodology. Because little to no research has been performed on establishing the influence of stakeholders on shaping inventory systems in a hospital setting, a case study approach enabled us to gather rich knowledge of a specific context (Yin, 1991). Additionally, four mini cases were conducted aimed at making repeated observations. These mini cases were also performed in regional hospitals having the same size and characteristics of our main case study. All the hospitals studied struggled with the shaping of their pharmaceutical inventory system and initiated projects in this area. One hospital for instance, considered to eliminate some of the existing stock points of pharmaceuticals and to implement a Vendor Managed Inventory system. Two hospitals focused on adopting advanced software packages to improve the performance of the inventory system while one hospital concentrated on rearranging the authorities and responsibilities regarding the inventory costs of pharmaceuticals. The logic underlying the mini cases was to produce similar results compared to our main case study in order to develop a rich, theoretical framework (Yin, 1991).

Although exploratory of nature, our main case study was based on the assumption that in hospitals the reshaping of inventory systems is heavily influenced by the perception of the stakeholders regarding the (potential) impact of the changed inventory system on care and cure processes. Moreover, it was assumed that in case changes are perceived as not being in the interest of a party or countervailing the power of a stakeholder, this will heavily influence the chain of events during the course of the project. Additionally, this will probably also affect the way subsystems of the inventory system ultimately are reshaped and used (e.g. the information and planning system). Fig. 1 captures the basic idea behind our research.

**Fig. 1.** Research model.

Primary data collection was undertaken through semi-structured interviews. Anonymity and confidentiality were guaranteed to the interviewees because of the sometimes political nature of the subject. Our main case study encompassed more than 35 interviews ranging from 1 to 3 h. In all cases, stakeholders involved in the project were interviewed more than once during the course of the project. Ultimately, 14 different stakeholders were interviewed among which a care manager, two information specialists, two pharmacists, three specialist doctors and one member of the board of directors. Furthermore, access was gained to project archives, memos and formal reports. Additionally some important project meetings were attended. In doing so, multiple sources of data were used and for this reason, it is reasonable to assume that no systematic distortion has taken place in our study. The research team did not directly interfere in the decision-making processes concerning the inventory project and was solely restricted to making observations and gathering data.

The process of data-gathering with respect to the four mini cases was more condensed and limited. On an average, in each of the four hospitals, six interviews were held with relevant stakeholders participating in the inventory projects. Additionally, some important project documents were studied and in one hospital a short survey was conducted. A total of 15 questionnaires were distributed among the project members and other persons closely linked to the project team. The mini cases were performed during the period of July–December 2007 and followed the replication logic as addressed by Yin (1991).

#### 4. Case description

##### 4.1. Backgrounds

The inventory project of the hospital that was studied was initiated in 2006 by a sector manager and aimed at reducing both the inventory costs of medicines as well as improving the service delivery of pharmaceuticals in the hospital. The background of this initiative was threefold. At a broader level, inventory costs of pharmaceuticals in hospitals in general are increasing due to the growing volumes and variety of medicines. Consequently, individual hospitals are confronted with an increase in stock keeping items. Not surprisingly, the hospital studied was also confronted with this development. During 2006, the costs of pharmaceuticals used in the hospital were increased by 6.5%

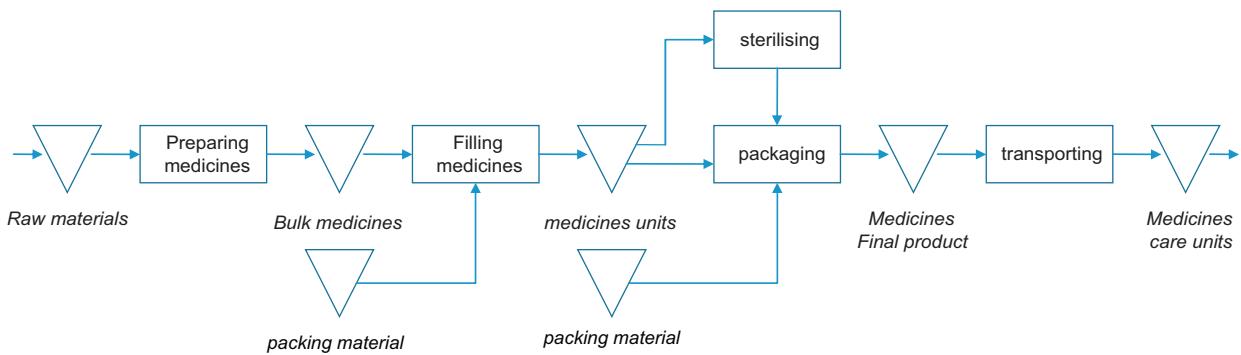
compared to 2005. Although no reliable data were available regarding inventory cost, it was estimated that during the same period, inventory costs had increased by 7% approximately.

Secondly, European regulations with respect to the production and preparation of medicines have become more stringent. As a consequence, a centralisation of preparing medicines takes place in Dutch hospitals resulting in only a restricted number of hospitals producing medicines for own usage as well as for other hospitals. The hospital that was studied has the ambition to become a main supplier of medicines for other hospitals in the region and it is also for this reason why a project in the area of inventory management was considered to be of strategic importance. Moreover, the hospital aims at becoming a Good Manufacturing Practice (GMP) certified production facility of pharmaceuticals and considered a reassessment of the inventory system as a necessity to comply with GMP standards.

Finally, the overall performance of the inventory system was considered as too low by the Board of Directors of the Hospital. An internal study performed during the period April 2006–August 2006 showed that during the last six months stock levels of 43% of the products were on an average below the minimum safety stock level for 20 days. The study also revealed that during this period 16% of the products were facing the risk of running out of stock which resulted in rush orders and a necessity to take additional measures to prevent from potential dangerous situations. Although many different reasons were considered to be accountable for the lacking performance it was generally agreed upon that the effectiveness as well as the efficiency of the inventory system could be improved by:

- implementing new software packages and integrating the hospital information system with existing inventory management software;
- implementing a more sophisticated decision support system for releasing production orders of medicines by the central hospital pharmacy;
- eliminating some of the stock points of medicines at patient care units;
- integrating the information system of the hospital pharmacy and the systems used by suppliers of pharmaceuticals;
- reallocating authorities and responsibilities regarding the production, storage and distribution of medicines.

**Fig. 2** summarizes the main good flows and stock points for medicines in the hospital at the start of the project. As can be



**Fig. 2.** Physical system of producing and distributing medicines.

derived from the figure, the inventory system included seven different stock points ranging from raw materials to final products which are stored at different locations. It is noticed here that the inventory project included both the pharmaceuticals produced by the hospital pharmacy and medicines which are directly delivered by pharmaceutical companies.

#### 4.2. Overview of the inventory project

The inventory project was designed in three phases. During the first phase an analysis was made of the major strengths and weakness of the inventory system. In doing so, four areas were covered including the physical infrastructure of the inventory system, the planning and control systems being used, the information infrastructure and the organisational embedding of the inventory system. Starting from these four areas an assessment was made of the performance of the inventory system. During this stage, it appeared that different stakeholders had different perceptions of the performance. For instance the director of the hospital pharmacy considered the planning and control structure to be adequate but criticized the lack of integration between the hospital information system and the way stock levels were recorded. The Head of the laboratory at the other hand, strongly opposed against this and considered the planning process regarding the making of medicines as being the main reason for a lacking performance of the inventory system. After an extensive period of discussions, it was therefore decided to perform some quantitative analyses. These analyses showed an excessive number of products running (almost) out of stock (16%) resulting in an emergency procedure to replenish stock levels for 8% of all production orders. The study further revealed the existence of many different spreadsheets and isolated software packages. Examples of this could be found in the area of procurement, the amount of packaging being available and the number of obsolete products. Furthermore, on an average each year financial analyses showed an increase of inventory costs during 2004–2006 of 5.5%.

During the second phase of the project, an extensive discussion took place regarding the reshaping of the inventory system. In a period of seven months three proposals were formulated which aimed at overcoming the shortcomings of the inventory system. Each proposal emphasised different aspects of the inventory system and was putting the process of reshaping the inventory system in a different perspective. Proposal one for instance, recommended a major overhaul of the number of stock points as well as the way medicines in the hospital were distributed. It was suggested that a decentralised system focusing on a direct delivery of medicines from the pharmacy wholesaler to nurse care units should be implemented. A reduction of handling costs, preventing nurse care units to stock up on medicines and a

reduction of storage space at the central hospital pharmacy were considered to be some of the major benefits of this redesign. It will be clear however, that this proposal was grounded on a rather internal focus of the inventory system and more or less neglected the ambition of the hospital to become a major supplier of medicines for other hospitals. Ultimately, this proposal was rejected by the board of directors and some other plans to adjust the inventory system were proposed by the project team. It is noticed here that each draft version of the different proposals was heavily discussed and that decision-making processes apparently were embedded in a complex social and organisational setting. Eventually, a mix of measures was proposed by the project group which was partly implemented during the third phase of the reshaping process. In summary, these measures included:

- the replacement of existing spreadsheets by implementing a software tool in order to record and monitor the amount of raw materials and packaging. Additionally, a planning tool was implemented to support the decision-making processes of the central hospital pharmacy regarding the production of medicines;
- the building of software linkages between the hospital information system and the inventory management system. It was decided that these linkages should be programmed by the hospital information and technology (ICT) department in order to safeguard a customer-oriented focus of the applications;
- the streamlining of procedures and communication channels in case of rush orders and medicines running the risk of going out of stock;
- the elaboration of a feasibility study to create a separate facility for producing medicines from which hospitals as well as other health care organisations in the region could be delivered;
- a re-definition of minimal stock-levels, replenishment levels and necessary amounts of safety stock. The underlying rationale of this measure was rooted in the observation that a more precise and differentiated set of decision-making rules were needed to be implemented in order to optimise the high variety and amounts of stock keeping products.

#### 4.3. Results of the project

At the beginning of 2008, the above mentioned measures were only partly implemented and only some small improvements have been made. After extensive discussions a software tool has been implemented aiming at giving support to the hospital pharmacy during the process of releasing production orders and to record inventory levels of stock keeping product. However, only a small part of the modules are applied and existing spreadsheets

are still used to register the stock levels of some products. Furthermore, a start has been made with respect to the implementation of software linkages between the hospital information system and the inventory management system. A dispute about the associated costs and as result of a conflict between the management of the pharmacy department, the ICT department and the central Board of Directors of the Hospital, further implementation of the applications is postponed and it is generally expected that on the short term no overall implementation will take place.

However, despite these somewhat disappointing results of the inventory project, several improvements have been achieved by rearranging the allocation of authorities and responsibilities in the case of rush orders, reorganizing communication channels and formalising co-ordination procedures. Additionally, the role of pharmacists, medical staff and care managers in the context of the inventory system was made more explicit. An internal survey conducted at the beginning of 2008 showed that all respondents believed that due to these organisational changes a significant improvement was established regarding medication-safety (4,6<sup>1</sup>) a reduction of inventory costs (3,7) and a more efficient way of working (4,0).

## 5. Discussion of the case findings

The process of reshaping the inventory system described in the previous section encompasses many different aspects and can be analysed from various perspectives. It is tempting, therefore, to analyse the flow of events described in our exploratory case study from a multidisciplinary point of view. However, in this paper we will restrict ourselves to the question how the outcomes of the inventory project can be explained by the dynamics of relationships and interactions between the stakeholders involved in the project. In doing so, we will focus on the specific situation, hospitals find themselves in.

### 5.1. Dynamics of the relationships and interactions between stakeholders

The exploratory case study clearly supports the idea that within hospitals, many different stakeholders may affect the shaping of inventory systems in a complex and dynamic way. Table 1 presents an overview of some of the main stakeholders involved in the inventory project. As can be concluded from this table, these parties and stakeholders apparently are more diverse and in some cases more indirectly related to the inventory system than in an industrial setting. For instance medical staff employees and the unit manager of the intensive care department are stakeholders who only have an indirect link with the inventory system. During the course of the project however, many of these indirect stakeholders showed to have an important impact on the decision-making processes regarding the (re)shaping of the inventory system. In many cases, both the legitimacy as well as the power of these stakeholders were based on their medical profession. Working with opiates for instance, is regulated by legislation and in some cases medical oriented stakeholders blocked the decision-making process regarding the reshaping of the distribution and storage of medicines because they had the opinion that the proposal did not comply with their medical responsibilities. It is interesting to notice that the outcome of the inventory project is not only influenced by individual

stakeholders but also by coalitions of stakeholders. For instance, the investment committee advises the Board of Directors of the Hospital in case of major investment decisions. During the interviews all respondents were very clear in their opinion about who they believed had a significant decision-making power regarding the reshaping of the inventory system. According to almost all interviewees, the decision-making power of the investment committee could be considered as very high and half of the interviewees ranked the investment committee as the second to most important group of stakeholders regarding the inventory project. Additionally, the pharmaceutical committee also played an important role during the course of the project. Although being responsible for the prescription policy of the hospital as well as for the monitoring of pharma-therapeutical treatment guidelines, the committee also had some clear opinions about the way medicines ought to be distributed and stored in the hospital.

In Table 1 also an overview of the goals and interests of the stakeholders involved is presented. As can be concluded from Table 1, only a minority of the stakeholders aimed at reducing costs and improving the efficiency of the inventory system. This was confirmed during the interviews. Almost all interviewees emphasized the necessity to increase the speed and flexibility of delivering medicines and to improve the quality of prescribing medicines by means of a more advanced inventory system. Medical oriented objectives in other words seemed to prevail above logistical and materials management goals and the focus of the stakeholders apparently was more health care rather than materials and goods flow driven. It will be of no surprise that only the Procurement and Logistical manager emphasized a goods flow perspective during the project meetings. Because of the high number of stakeholders involved in the project and the different scopes and backgrounds of these stakeholders, a substantial amount of negotiation took place during the course of the project. Different stakeholders had different perceptions of the outcomes of the inventory project and each proposal for reshaping the inventory system of medicines resulted in different coalitions opposing the proposal. In all cases, the medical specialists ultimately played a dominant role in the decision-making process regarding these proposals. However, the arguments used by the medical specialists were not based on an in-depth logistical analysis of the pros and contras of alternative inventory systems but on a strong belief whether the proposed adjustments served the interests of the patients. In many cases the medical specialists succeeded in convincing the other members of the project group and they had both the power and the legitimacy to do so. The dynamics of the relationships between the stakeholders involved in the project is also illustrated by the interaction between the ICT representatives and the medical staff members of the project. Ultimately, it was agreed upon that the implementation of advanced software tools and integrating the inventory information system with the hospital information system would improve the performance of the inventory system significantly. However, because of a conflict between the ICT department and some clinical heads, the ICT project was prioritised rather low by the investment committee which resulted in a severe delay of the programming activities.

Without any doubt, the dynamics of the relationships and interactions between the stakeholders described above and the way this has affected the outcomes of the inventory project was strongly reinforced by the organisational structure of the hospital and the structural limitations placed on the partnership of the stakeholders involved in the project. As can be concluded from Table 1 different stakeholders had different interests with respect to the required performance of the inventory system which were to a great extend reflected by the authorities and responsibilities

<sup>1</sup> Assessment based on a Likert scale ranging from 1 (no improvement) to 5 (strong improvement).

**Table 1**  
Overview of main stakeholders.

Department	Stakeholder	Interests
<b>Preparing medicines</b>	Head department	<ul style="list-style-type: none"> <li>• Fast introduction of new medicines</li> <li>• Keeping medicines in stock</li> <li>• Avoiding rush orders</li> <li>• Having aggregated inventory management information</li> </ul>
	Unit manager	<ul style="list-style-type: none"> <li>• Having accurate data about costs and service delivery</li> </ul>
	Planner	<ul style="list-style-type: none"> <li>• Reliable production forecast</li> <li>• Avoiding rush orders</li> <li>• Accurate and reliable inventory data</li> </ul>
	Pharmacist	<ul style="list-style-type: none"> <li>• Being able to fulfil customer demand</li> <li>• Flexible production</li> <li>• Error free production process</li> <li>• Producing high quality medicines</li> </ul>
<b>Distribution</b>	Head department	<ul style="list-style-type: none"> <li>• Preventing medicines running out of stock</li> <li>• Fast delivery of medicines</li> <li>• Avoiding recalls of medicines</li> <li>• Having management information on service delivery process</li> </ul>
	Unit manager	<ul style="list-style-type: none"> <li>• Fast delivery</li> <li>• Optimising storage space</li> <li>• Accurate and reliable inventory data</li> </ul>
	Pharmacist	<ul style="list-style-type: none"> <li>• Preventing medicines running out of stock</li> <li>• Fast delivery of medicines</li> </ul>
<b>Laboratory</b>	Head department	<ul style="list-style-type: none"> <li>• Avoiding rush orders</li> </ul>
	Unit manager	<ul style="list-style-type: none"> <li>• Avoiding rush orders</li> </ul>
	Pharmacist	<ul style="list-style-type: none"> <li>• Avoiding uncertainties about producing medicines</li> </ul>
<b>Logistical department</b>	Manager	<ul style="list-style-type: none"> <li>• Minimizing stock inventory costs</li> <li>• Optimizing trade off between service delivery and efficiency</li> <li>• Avoiding obsolete medicines</li> <li>• Having logistical oriented management information on key performance indicators</li> </ul>
	Employee procurement	<ul style="list-style-type: none"> <li>• Long term relationships with preferred suppliers</li> <li>• Avoiding rush orders</li> </ul>
<b>Board of directors</b>		<ul style="list-style-type: none"> <li>• Minimizing costs</li> <li>• Becoming supplier of medicines for other regional health organizations</li> <li>• Having aggregated management information system</li> </ul>
<b>Medical staff employees</b>	Medical specialists	<ul style="list-style-type: none"> <li>• Flexible delivery of medicines</li> <li>• Fast and reliable delivery of special medicines</li> <li>• No out of stock</li> <li>• High quality medicines</li> </ul>
	Head care unit	<ul style="list-style-type: none"> <li>• Having medicines locally stored at the care unit</li> <li>• Fast delivery of special medicines</li> <li>• Avoiding running out of stock</li> </ul>

of the stakeholders. The logistical manager for instance was considered to be formal accountable for inventory costs. Medical staff employees at the other hand are by law accountable for patient care which is formalised by means of structural arrangements within the hospital. In many cases medical specialists are represented by an independent board which has the authority to overrule the Board of Directors of the Hospital in case they consider patient care is in severe danger. Additionally, medical staff employees often have no direct responsibilities whatsoever regarding inventory costs. Performance indicators linked to financial criteria therefore, do not belong to the mindset of

professional qualified employees like surgeons and physicians which clearly was the case in the hospital that was studied. Undoubtedly, this situation impeded the optimisation of the inventory system and resulted in different realities regarding the inventory system.

### 5.2. Multidimensional character of inventory systems

Although it can be argued that no fundamental differences exist between the shaping of inventory systems in a health care setting and in an industrial setting, our exploratory case study

suggests that in hospitals the multidimensional character of inventory systems shows to have some specific characteristics. During the course of the project it became clear that the process of reshaping the inventory system of medicines could not be isolated from the process of distributing the medicines within the hospital. Moreover, both processes are closely intertwined with the process of cure and care of patients. It is probably also for this reason why discussions during the project meetings about the four areas addressed in the Section 2 frequently shifted away towards a strong focus on the health care process itself. Our analysis of the decision making processes regarding the reshaping of the inventory system reveals that the strong interrelationship between cure and care processes on the one hand and the process of storing and distributing medicines on the other hand, have significantly influenced the outcomes of the inventory project. When assessing the proposals for adjusting the inventory system, each stakeholder involved in the project reviewed the pros and contras of the proposal by discussing the potential consequences of the proposal for the health care process. In doing so, each stakeholder applied a patient-oriented perspective taking his or her role and responsibility regarding the usage of medicines as a starting point for the review. Without doubt, this severely hampered discussions about replenishment levels, the amount of safety stock and the procedures to be applied in case of rush orders. A proposal made by the Procurement and Logistical manager to re-evaluate the amount of safety stock for medicines with a high turnover rate for instance, was immediately blocked by representatives of the medical profession.

The influence of the health care setting on the process of reshaping the inventory system also became manifest in the final stage of the project when some software tools were implemented in order to optimise the planning and control of stock-keeping items. Ultimately, these advanced software tools are only partly used and existing spreadsheets are still the backbone of the inventory management system although showing many shortcoming. Interviews with the Head of the pharmacy department, laboratory employees and as well as employees of the distribution department after studying the working procedures confirmed the idea that from a logistical planning point of view the implemented software is superior compared to the existing tools being used. However, from a medical perspective, the application of this software was considered as time consuming, not being relevant and not directly serving the interests of patients.

### 5.3. Contingency factors

Finally, analysing the process of reshaping the inventory system of the hospital as well as the outcomes of the project indicates that at least three contingency factors strongly contributed to the results of the project:

- top management support and policy;
- project management;
- health delivery setting.

Initially, top management support for the inventory project was rather high but during the course of the project this support slowly decreased. Although having a clear policy to reduce costs and to operate in a more efficient and effective way, the Board of Directors had no clear long term inventory policy regarding medicines and pharmaceuticals. Moreover, the Board on the one hand aimed at being the main supplier of medicines for regional hospitals and care providers. However, at the other hand the top management of the hospital made no attempt to reconcile long term strategic objectives with an integrated and systemised

approach of the inventory problems of medicines. In this context it is interesting to notice that within hospitals, major investment decisions made by the Board of Directors are frequently based on the advice of internal investment committees. In our case study, this process showed to have its own dynamic character resulting in a somewhat fuzzy and less transparent decision-making process regarding the reshaping of the inventory system.

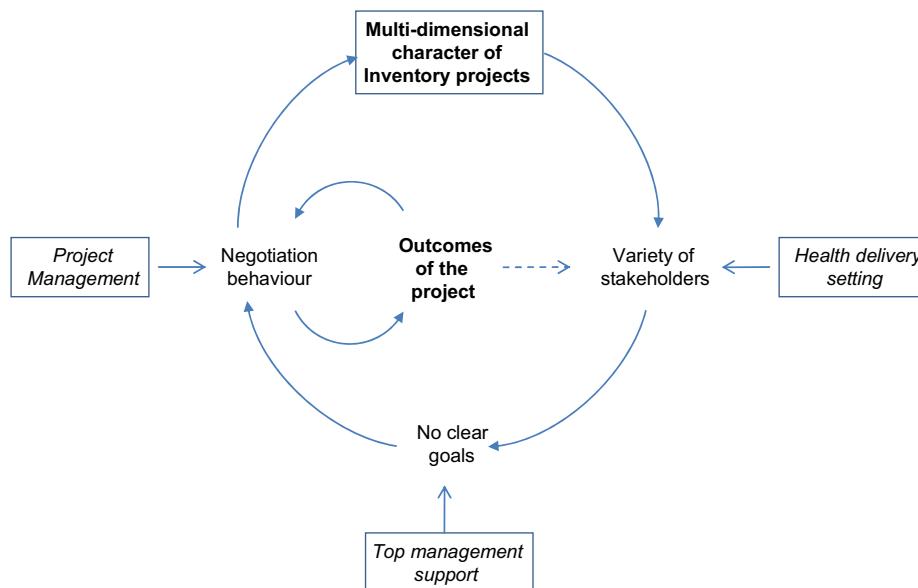
The project team consisted mainly of delegated stakeholders who had a clear interest in the way medicines were stored and distributed in the hospital. However, in general the project members did not have an in-depth knowledge of inventory systems and issues related to the planning and control of inventories. On an overall level, the project members had a strong focus on the medical consequences of the project and only the manager of Procurement and Logistics as well as the manager of the distribution department emphasized to apply a more logistical focus. Additionally, no clear methodology was applied regarding the way, inventory problems can be solved and it is probably also for this reason why the project has only been partly successful. A lack of operations management focus probably also explains why the final results of the project are restricted to the organisational embedding of the inventory system.

Hospitals are often characterized as a professional bureaucracy being not as much an integrated organisation as well as a collection of experts hired by the organisation where they can practice their professions as individuals (e.g. Mintzberg, 1983). Moreover, to a certain extent medical professionals often retain control of the administrative structure because this structure is largely composed of representatives of the experts themselves. In doing so, they serve their own needs, reconcile the conflicts among the experts and deal with external influences (e.g. Mintzberg, 1983, p. 393). Noticeably, the inventory project our research reports about, should be put in the context of this setting and the outcomes of the project without doubt have been influenced by the federated-type meritocracy which characterizes the hospital that was studied. It is interesting to notice for instance, that during the course of the project none of the medical professionals being a member of the project team was really worried about the disappointing outcomes of the project in terms of costs and efficiency.

Fig. 3 captures the central core of our analysis by showing some of the main cause–effect relationships which can be derived from our case analysis. The inventory project studied suggests that at least three groups of contingency factors have influenced the process of (re)shaping the inventory system (cf. top management support and policy, project management and the health delivery setting). Because of the multidimensional character of the inventory project as well as because of the health care setting of the inventory project, many different stakeholders were involved in the project which ultimately resulted in a complex set of interactions and negotiation behaviour of the stakeholders involved. This dynamic character of the relationships and interactions between the stakeholders was re-enforced by the multiple-goal focus of the project which in itself resulted in different perceptions and expectations of the outcomes of the project by the stakeholders. Ultimately, this has lead to a rather ‘political neutral direction’ of the project and a redesign of the inventory process in a direction none of the stakeholders could oppose against.

## 6. Conclusions and further research

Although the issue of inventory management often is associated with industrial companies, nowadays a strong focus on



**Fig. 3.** Cause–effect relationships related to the inventory project.

inventory management has also become paramount in many hospitals. Due to an increase of inventory costs and a strong necessity to improve service levels many hospitals have been forced to start up projects in the area of inventory management in order to improve their performance. In general, the (re)shaping of inventory systems includes many different stakeholders and together with the diverse and unique characteristics of a great variety of hospital products, projects in the area of inventory management are far from a simple, straightforward design process in hospitals. In spite of this, only few studies have addressed the question how the design and implementation of inventory systems in a health service setting takes place. In this paper, we tried to fill this void by exploring the process of reshaping an inventory system by means of an exploratory case study.

Several conclusions can be drawn from our research. Most importantly, our case study clearly indicates that decisions made during the process of reshaping an inventory system are heavily influenced by the dynamics of the relationships and interactions between the stakeholders involved in the project. Especially in a health care setting, the existence of multiple stakeholders having a multi-goal focus regarding the project may easily result in different perceptions and expectations on the outcomes of the project. Based on our case study, there are many indications that the specific situation hospitals find themselves in can have a strong influence on the events taking place during inventory projects. A strong focus of the stakeholders on patient oriented care and cure processes, the federated-type meritocracy character of hospitals and the multidimensional character of inventory systems easily lead to a fragmented process of reshaping the inventory system which is more based on negotiation than on a logistical-oriented design rationale.

For project managers it seems important to be aware of the influence these factors can have on the shaping of inventory systems. Our study clearly indicates that besides the technical aspects of inventory management, good project management needs to include a thorough understanding of the dynamics of the relationships and interactions between stakeholders as well. In doing so, one of the main challenges of top management is to balance the different interests of the stakeholders involved in inventory projects. Compared to manufacturing companies,

hospitals more heavily rely on different coalitions of stakeholders with different interests and responsibilities, each of them having different mindsets and realities. In many cases, these coalitions are reflected in the organisational structure of hospitals and integrated performance management systems are for this reason often frequently limited by organisational arrangements. Inventory projects therefore, without any doubt need to be fully supported by top management teams. This support not only relates to facilitating the project and allocating sufficient budgets to the project; it also requires a full integration of all the different interests into a proper set of overall goals regarding the inventory system.

The above mentioned conclusions are only a first step towards a design methodology for inventory systems in a health care setting and further research is required for getting an in-depth understanding of the process of reshaping inventory management system in hospitals. In particular it seems to be worthwhile to explore the differences between inventory systems in an industrial setting and inventory systems in a health care setting. Additionally, we feel more in-depth case studies of inventory projects executed in hospitals need to be performed in order to unravel the mechanisms that influence the outcomes of these projects. Hopefully, a more profound understanding of these mechanisms ultimately may help organisations to develop and use inventory systems more effectively.

## References

- Blinder, A.S., Maccini, L.J., 1991. Taking stock: a critical assessment of recent research on inventories. *Journal of Economic Perspectives* 5 (1), 73–96.
- Boonstra, A., 2006. Interpreting an ERP-implementation project from a stakeholder perspective. *International Journal of Project Management* 24, 38–52.
- Bryman, A., Bell, E., 2003. *Business Research Methods*. Oxford University Press, Oxford.
- Coakes, E., Elliman, T., 1999. The role of stakeholders in managing change. CAIS: Focus Issue on Legacy Information Systems and Business Process Change. *Communications of the Association Information Systems* 2 (4), 2–30.
- Jarett, P.G., 1998. Logistics in the health care industry. *International Journal of Physical Distribution and Logistics Management* 28 (9/10), 741–742.
- Knights, D., Murray, F., 1992. Politics and pain in managing information technology: a case study from insurance. *Organization studies* 13 (2), 211–228.
- Kuljis, J., Paul, R., Lampros, P., Stergioulas, K., 2007. Can health care benefit from modeling and simulation methods as business and manufacturing has? In:

- Henderson, S.G., Biller, B., Hisch, M.H., Shortle, J., Tew, J.D., Barton, R.R. (Eds.), Proceedings of the 2007 Winter Simulation Conference.
- Li, L.X., Benton, W.C., 1996. Performance measurement criteria in health care organizations: review and future research directions. *European Journal of Operational Research* 93 (3), 449–468.
- Mahmoud, E., Rice, G., 1998. Information systems technology and healthcare quality improvement. *Review of Business* 19 (3), 8–13.
- Mintzberg, H., 1983. Power in and Around Organizations. Englewood Cliffs NJ, Prentice-Hall.
- McFadden, K.L., Towell, E.R., Stock, G.N., 2004. Critical success factors for controlling and managing hospital errors. *Quality Management Journal* 11, 61–74.
- Nicholson, L., Vakharia, A.J., Erenguc, S.S., 2004. Outsourcing inventory management decisions in healthcare: models and applications. *European Journal of Operational research* 154, 271–290.
- Novek, J., 2000. Hospital pharmacy automation: collective mobility or collective control? *Social Science & Medicine* 51 (4), 491–503.
- Oliveira, M.D., Pinto, C.G., 2005. Health care reform in Portugal: an evaluation of the NHS experience. *Health Economics* 14, 203–220.
- Oliveira, F.J., 2005. Enabling long term value added partnership in the healthcare industry. MSc Thesis, MIT Center for Transportation and Logistics.
- Rabinovich, E., Evers, Ph.T., 2002. Enterprise-wide adoption patterns of inventory management practices and information systems. *Transportation Research Part E, Logistics and Transportation Review*, 389–404.
- Razi, Muhammad A., Michael Tarn, J., 2003. An applied model for improving inventory management in ERP systems. *Logistics Information Management* 16 (2), 114–124.
- Ruiz, U., 2004. Quality Management in health care: a 20-year journey. *International Journal of Health Care Quality Assurance* 17 (6), 323–333.
- Schneller, E.S., Smeltzer, L.R., 2006. Strategic management of the health care supply chain. Jossey-Bass.
- Stock, G.N., McFadden, K.L., Gowen III, C.R., 2007. Organizational culture, critical success factors, and the reduction of hospital errors. *International Journal of Production Economics* 106, 368–392.
- Silver, E.A., Pyke, D.F., Peterson, R., 1998. Inventory Management and Production Planning and Scheduling. John Wiley & Sons, Inc, New York.
- Towill, D., Christopher, M., 2003. An evolutionary approach to the architecture of effective Healthcare Delivery Systems. *Journal of Health Organisation and Management* 19 (2), 130–147.
- de Vries, J., 2005. The complex relationship between inventory control and organisational setting: theory and practice. *International Journal of Production Economics* 93–94, 273–284.
- Webster, J., 1995. Networks of collaboration or conflict? EDI and power in the supply chain. *Journal of Strategic Information Systems* 4 (1), 31–42.
- Yin, R.K., 1991. Case Study Research. Design and Methods. Sage, London.
- Young, T., Brailsford, S., Connell, C., Davies, R., Harper, P., Klein, J.H., 2004. Using Industrial processes to improve patient care. *British Medical Journal* 328, 162–164.
- Young, T., 2005. An agenda for healthcare and information simulation. *Management Science* 8 (3), 189–196.
- Zomerdijk, L.G., de Vries, J., 2003. An organizational perspective on inventory control: theory and practice. *International Journal of Production Economics* 81–82, 173–183.