Wageningen University – Department of Social Sciences

Management Studies

Locating and Relocating Storage of General Hospitals:

A Literature Review

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Introduction

Hospitals have an important position in society when it comes to securing public health. Hospitals come in various forms, such as general, academic, and specialized (private) clinics. Basic principal of a hospital is to congregate care capacity and demand for care in a physical location. Medical practice in terms of diagnose, treat, and control are hereby core processes. A general hospitals' primary function is to offer diagnostic and therapeutic services for a broad variety of medical issues (Coles and Hesterly, 1998). An academic hospital is more oriented on the quality of healthcare services and educating future healthcare professionals by collaborating with medical schools and universities (Ford and Britting, 2010). In most cases an academic hospital offers treatment for a wide number of medical issues. Specialized clinics treat one care category (e.g. rehabilitation, pediatrics), where patient treatment time is commonly long-term (Farsi and Filippini, 2004).

To make medical practice of the different hospital types possible all kinds of support activities and means are necessary, each with an impact on the care process and its outcome (Menon *et al.*, 2009). Information Technology for example makes it possible to save and disclose information, and to exchange information quick and reliable. Human Resource departments have responsibility when it comes to inflow of qualitative personnel, staff development, and remuneration policy. Facility Management supports the primary process with building related services (e.g. maintenance, climate control, and interior) and work related services (e.g. cleaning, catering, and logistics)(Atkin and Brooks, 2009). Facility Management and its services are in literature associated with costs, but also with revenues (Okoroh *et al.,* 2001; Wauters, 2005). Some facility services have more direct linkage with the primary process than others (Shohet and Lavy, 2004). There is a tendency of increasingly outsourcing facility services to external organizations for a variety of reasons, e.g. increasing organizational efficiency and cost effectiveness (Ancarani and Capaldo, 2005) (outsourcing rate of facility services 63 % in 2010 (Twynstra en Gudde, 2011)). Also, the degree of outsourcing varies per service (e.g. cleaning service 90% outsourced, document management 23% outsourced (Twijnstra en gudde, 2011)) The degree of outsourced activities in hospitals (36, 1 %) is generally lower than in the industry sector (64,1%) (Bulcke, D., 2011).

With regard to outsourcing, a specific development (Bhakoo *et al,* 2012) noticeable in hospitals is reallocating warehouses outside the hospital. The large amount of goods (e.g. medicines, bandage, and surgical equipment) necessary for the care process and support of this process (e.g. beds, sheeting, and nutrition) generally results in an extensive need of storage. Not all of these goods are in the same amount at any moment necessarily present in the hospital environment (Rivard-Royer, 2002). Scarcity of space for storing goods, and limited financial resources are of significant role in the discussion of storing goods (Farahani *et al.,* 2010). Some hospitals decided to locate their warehouse outside the environment of the hospital, including management of the warehouse. Other hospitals decided to keep the warehouse close to the care process on own property and under own management. What are the drivers and motives for each of these decisions?

Answering this question may help decision makers in hospitals whether to (re)locate their storage to one of the possible storage locations. Clarifying motives and drivers for a storage location decision supports Decision Making Units of hospitals concerned with hospital logistics, by pinpointing variables which are decisive and present in making such a decision. Understanding the variables and their impact is a complex issue, because each situation has to deal with different situational (environmental) factors (Su *et al.,* 2011; VanVactor, J., 2012).

Reasons for rationalization of the storage (re) location of hospitals are the rising costs and increasing competition in healthcare (Poulin, 2003; Dacosta-Claro, 2002; De Vries and Huijsman, 2011) which challenges the healthcare provider to work in a cost efficient way and by a demand based responsive manner (Meijboom *et al,* 2011). Next to those reasons, storage is an element of logistic processes, which encompasses approximately 30 per cent of hospitals' costs (Dacosta-Claro, 2002; Bhakoo *et al.*, 2012; Pan and Pokharel, 2007). Beside costs the increasing quality expectations of patients are a challenge for hospital's management. The risks involved in meeting quality requirements and cost reductions needs to be taken into account, e.g. physical risks involved in product logistics. All those and other involved variables make a decision towards hospital's logistics a complex issue (Su *et al.,* 2011; VanVactor, J., 2012). With respect to supply chain and facility management practices healthcare is behind in developments concerned with logistics processes (Bhakoo *et al,* 2012) in comparison with the industry sector (De Vries and Huijsman, 2011).To establish if there is a possibility to cut costs, while meeting quality expectations and minimizing risks, the decision and impact of (re)locating storage of hospitals is investigated.

There are several types of hospitals distinguished. The offer of services and medical treatment differ per hospital. Therefor it is assumed that content and quantity of supply varies by hospital type. General hospitals have to deal with approximately 76 per cent of total hospital demand, what implies an excessive product flow (Pan and Pokharel, 2007). Since general hospitals have to deal with highest demand quantity and most likely the most comprehensive supply stream, this study will focus on general hospitals.

To come up with appropriate outcomes we first have to define a main research question and acquainted research questions.

Main research question:

Which variables have to be considered in the decision making process of where to (re) locate the storage of general hospitals in order to come up with the most knowledgeable choice of storage location?

Research questions:

1 *What alternative storage locations for general hospitals can be distinguished?*

2 *What stakeholders are involved in decision making with regard to (re) allocation of storage in general hospitals?*

3 *What are motives and drivers for (re)locating storage of general hospitals?*

4 *What is the expected impact of motives and drivers of (re) allocating storage on the decision for (re) allocating storage of general hospitals?*

Afore the research questions are answered is in the research delineation described what is included in this study.

Research delineation

Storage is an element of logistic processes. Logistics is divided into internal and external logistics (Filip and Klein, 2010; Pan and Pokharel, 2007). Coordination and management of internal logistics is part of Facility Management responsibilities (Atkin and Brooks, 2009). Management and coordination of external logistics refers to Supply Chain Management (Meijboom *et al*, 2011; Chopra and Meindl, 2010). Literature from both management perspectives as well as Healthcare Management literature are consulted and interpreted to answer the research questions.

The decision making unit (chapter 2) in this study is concerned with the question what the optimal storage location is for storing products of general hospitals. Out of literature from inter alia Dacosta-Claro (2002), Nicholson (2004), Pan and Pokharel (2007) it appears that based on various characteristics there is a distinction made between critical and non- critical products in hospitals. Distinctive for critical products is that those products need to be available within hospitals at all time (Nicholson, 2004; Pan and Pokharel, 2007). This is necessary to be able to execute emergency care (e.g. surgery supplies, injectable medical supplies, blood). Next to emergency care products, products with a high level of perishability are also stated as critical (Nicholson, 2004; Shen *et al.*, 2011). Perishable products need regular (re)stocking, because there expiration date is relatively short-term (e.g. food-items, medicines with a short shelf life). Products with a replenishment lead time that is not acceptable for hospital processes are also considered as critical products (Pan and Pokharel, 2007; Chopra and Meindl, 2010). Replenishment time refers to time between the appearance of a stock-out and the moment it is restocked (Chopra and Meindl, 2010).

Non-critical products have a replenishment lead time that is acceptable when stock-outs appear or when the order-level is reached. Non-critical products usually have multiple available suppliers and a relatively low cost price (Nicholson, 2004; Pan and Pokharel, 2007). Examples of non- critical products are suture sets, disposable sheeting, latex examination gloves, gauze pads, soap, and medicines with a long shelf life (Nicholson, 2004; Pan and Pokharel, 2007). With critical products there is no possibility to locate them outside the hospital, regarding that critical products deemed to be available (stock-outs are not acceptable) at all time because they have a direct influence on patients' health (Kumar *et al.,*2008). Non-critical products, in terms of storage, can be flexible located. The non-critical products bring no (direct) harm to the patients when stock-outs appear (Bhakoo *et al.,* 2012). It does not have to be present in bulk but only to a limited extent. This allows the decision making unit to determine the optimal storage location for these non-critical products (in terms of quality, risks and costs).

In summary, this study focusses on storage location decisions concerning non-critical products of general hospitals. Literature from facility management, supply chain management, and healthcare management perspective will be consulted and interpreted.

Chapter 1: Storage locations for general hospitals

The storage of general hospitals can be (re) located in several ways. This section distinguishes the possible storage locations.

The storage locations are distinguished by ownership and distance to the hospital. Literature distinguishes three main storage locations (Aptel and Pourjalali, 2001; Bijvank and Vis, 2012; Meijboom *et al.,* 2011; Dror *et al.,* 2012; Rivard-Royer, 2002). The possible storage locations are in this section separately dealt with. The three possibilities are consecutive described:

1 Storing products at hospital facility
2 Storing products at storage facility located between hospital and supplier
    - Storage facility property of hospital
    - Storage facility property of supplier
3 Storing products at supplier facility

Deciding to locate storage at one of previous mentioned locations will influence the supply chain configuration. A supply chain configuration illustrates the allocation of resources/products, and the involved supply chain actors (Chopra and Meindl, 2010). The configuration of each storage location is illustrated in Figure 1.

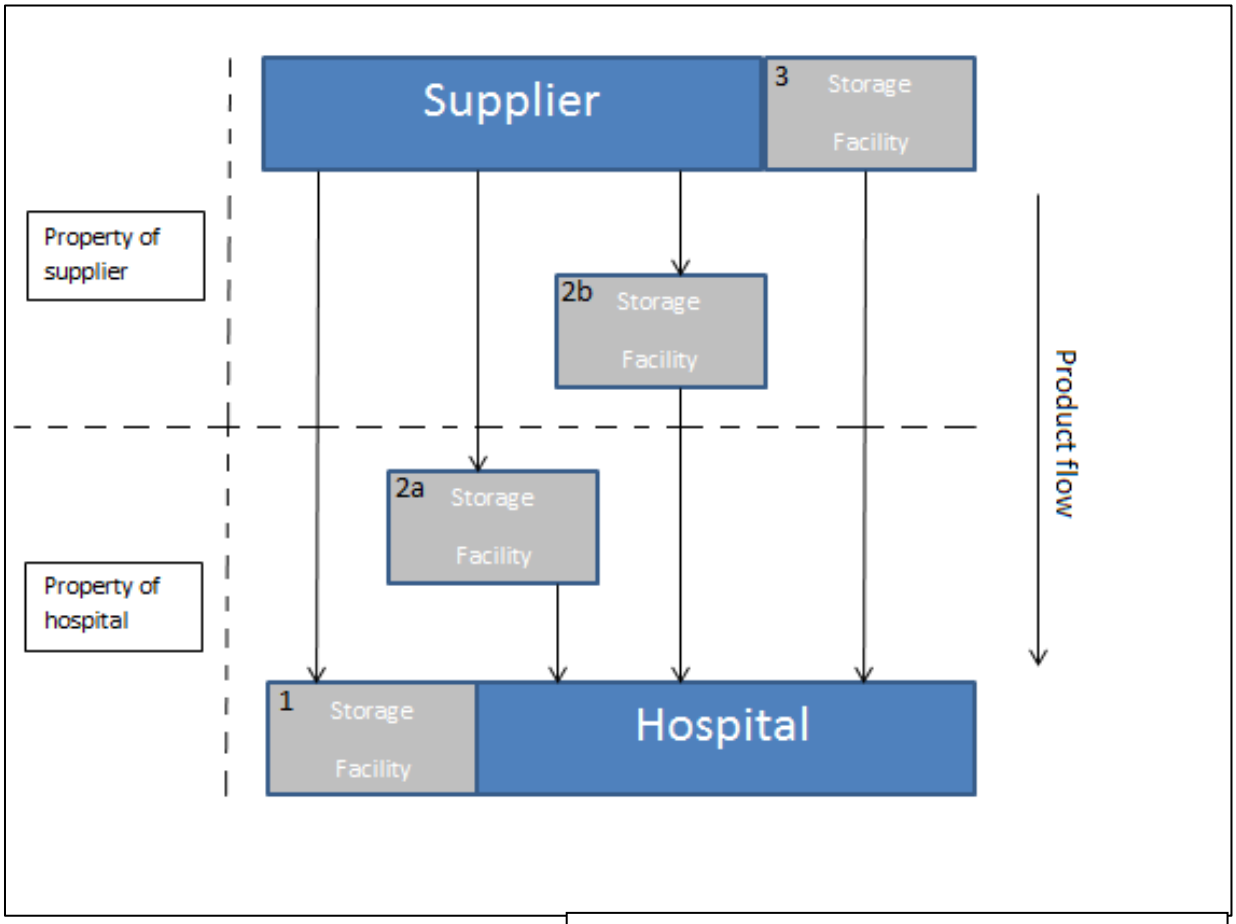


Figure 1: Storage facility supply chain configuration

§ 1.1 Storing products at hospital facility

Storing products at hospital facility is identified by a warehouse located at a hospital facility keeping a multitude of products (Bijvank and Vis, 2012). Literature refers to this method as the traditional method (Aptel and Pourjalali, 2001; Bijvank and Vis; 2012, Rivard-Royer *et al.*, 2002; Chopra and Meindl, 2010). Locating a warehouse at hospital's facility enables the hospital to store products close to the care units. Hospital warehouse personnel prepare and deliver products in order of care units' demand or based on forecasting models. The procurement department of a hospital in their turn orders products from suppliers for (re)stocking the warehouse to be able to fulfil orders of care units (Aptel and Pourjalali, 2001; Lapierre and Ruiz, 2007). This storage method is illustrated in figure 1 by storage facility 1.

To be able to distinguish storing products at the hospital facility from storing products at the storage facility located between hospital and supplier, and storing products at the supplier facility, distinctive components are described. Storing a multitude of products at hospital's facility is associated with high inventory costs due to; capacity restrictions for storing the multitude of products (Bijvank and Vis, 2012); high level of waste due to the high amount of (safety) stock (Aptel and Pourjalali, 2001). The transportation costs of this storage method are according to Chopra and Meindl (2010) lower than storing products at a supplier facility or storing products between supplier and hospital, because of a lower delivery frequency from supplier to hospital storage is required since the lot sizes of a delivery are higher. A higher lot size most likely means lower transportation costs per product (Van Norden and Van de Velde, 2005).

Since storage is located close to the care units responsiveness of product delivery (to care units demand) is probably high (Chopra and Meindl, 2010). A high amount of (safety) stock at the warehouse may represent a high product availability of products for the care units (Liao and Chang, 2011).

§1.2 Storing products at storage facility located between hospital and supplier

Storing products at a storage facility located between hospital and supplier is identified by a storage facility located outside the immediate vicinity of the hospital and the supplier. Suppliers deliver products to the centrally located storage facility in response to the warehouse's order(s). In their turn the centrally located storage facility transports products in response to demand of hospital's staff to the hospital facility (Meijboom *et al.*, 2011) (Figure 1, storage facility 2a and 2b). To be able to compare this storing method with storing products at hospital facility and storing products at supplier facility, a number of characteristics will be described.

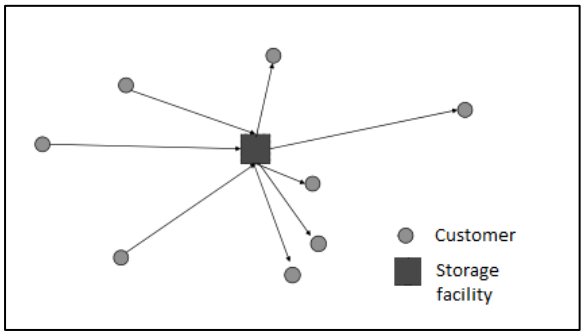
Storing products at a facility between the hospital and supplier enables a hospital to decrease the frequency of replenishment orders to suppliers (Lapierre and Ruiz, 2007). Storing at a central storage facility allows care units to decrease their inventory level to the extent that lead-time permits (Lapierre and Ruiz, 2007).

Transportation costs are most likely lowest in the central storage method in comparison to storing at hospital or supplier facility, because this method allows an economic mode of transportation (Chopra and Meindl, 2010) (e.g. adapted truckload sizes) for delivering products from central warehouse to

the hospital (Chopra and Meindl, 2010; Chopra, 2003). Handling and processing costs are probably higher since using a centrally located storage facility is labor intensive and requires continuous review of inventory at the hospital (Bijvank and Vis, 2012), because the risk of stock-outs is much higher when available storage (space) at hospital is low.

If a hospital decides to make use of a storage facility located between the hospital and supplier(s) it has to make a trade-off between a supplier owned (Figure 1, 2b) and hospital owned(Figure 1, 2a) storage facility. At certain points there is a clear difference between these two storage methods.

A hospital owned storage facility is located relatively close to the hospital to limit lead-time. A supplier selects a location for the storage facility which is central of their customers to limit the overall lead-time and transportation costs (Dror *et al.*, 2012). Figure 2a (Bloemhof, 2010) displays a Minsum model (equal weights) where storage facility is located central to the customers by minimizing the distance to every single customer (Klose and Drexl, 2005). Figure 2b displays a weighted Minsum model where storage is located closest to the customer who purchases most and further away from the smaller customers (Klose and Drexl, 2005). The thickness of lines represents the usage rate (e.g. thicker means more often use of distribution line).



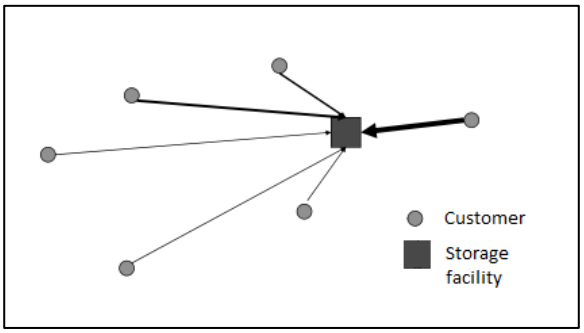


Figure 2a: Adapted from Bloemhof (2010)

Figure 2b: Adapted from Bloemhof (2010)

Next to differences in lead-time and transportation costs other differences between supplier and hospital storage facility ownership are; facility costs are lower when the storage facility is owned by the supplier since the supplier has to pay for the facility and has to deal with the risks involved; inventory cost decline when the storage location is owned by the supplier because holding cost (Kunnumkal and Topaloglu, 2011) and facility costs are on account of the supplier (Klose and Drexl, 2005); information risks increases when a storage facility is property of a supplier since storage is under management of a supplier and not under management of the hospital (Rivard-Royer *et al.,* 2002).

§ 1.3 Storing products at supplier facility

In the 1970s and 1980s researchers noticed a trend of decreasing storage at hospital facilities (Rivard-Royer, 2002). The storage was increasingly located at suppliers' facilities (Figure 1, storage facility 3). By placing the storage outside the hospital at the supplier, the availability of products inside the hospital depended on logistics processes, making it more labor intensive and very

expensive. The trend of storing products at supplier facility ran out of steam in the mid-1990s (Rivard-Royer, 2002).

Due to the progression of developments the reasons for not storing products at supplier's facility, labor intensity and costs, are not applicable to date. Especially developments in the field of transportation and information technology make it reasonable to take another look at storing the products at supplier facility. Information technology improves information infrastructure between supplier and customer, and developments in transportation decreases the relative distance between parties by the ability to deliver products more promptly (De Vries and Huijsman, 2011).

Storing products at the supplier's facility reduces the in-house storage of a hospitals' facility. A supplier may deliver products to the hospital in response to hospital's staff demand (points of care or procurement department).

Locating the storage at supplier's facility could seem equal to storing products at a storage facility located between the hospital and supplier (and owned by the supplier). However, there is a difference. Products stored at supplier's facility are delivered directly to the hospital, whereas a storage facility located between the hospital and supplier enforces the supplier to deliver products in two phases. First the supplier has to deliver to the centrally located storage facility, second the supplier most likely has to deliver the products from the centrally located storage facility to the hospital. Therefor the volume of inventory deliveries with a storage facility located at a supplier is higher than a delivery from a storage facility located between the hospital and supplier (Mustaffa and Potter, 2009). It may be assumed that, since the lead time is probably longer a higher level of safety stock is required when storage is located at the supplier.

Handling costs are most likely low by storing at the supplier(s), but unit costs will be higher since the supplier has to deal with storing and (frequent) delivering products to the hospital (Butler *et al.,*1996).

Chapter 2: Decision making unit for storage (re)location decisions

There is a diversity of stakeholders involved in the decision making process for locating storage (Baghbanian *et al.,* 2012). A decision making unit (DMU) is imposed with such a decision (Cheun and Palan, 2012). The composition of the DMU consists of cross functional members from each business level (strategic, tactical and operational business level) of the hospital (Van Vactor, 2012). The diversity of the decision making unit provides a variety of perspectives and interests which makes the decision process more complex. A schematic representation of the decision making unit concerned with a logistics innovation or change decision is displayed in the figure below adapted from Su *et al.* (2011).

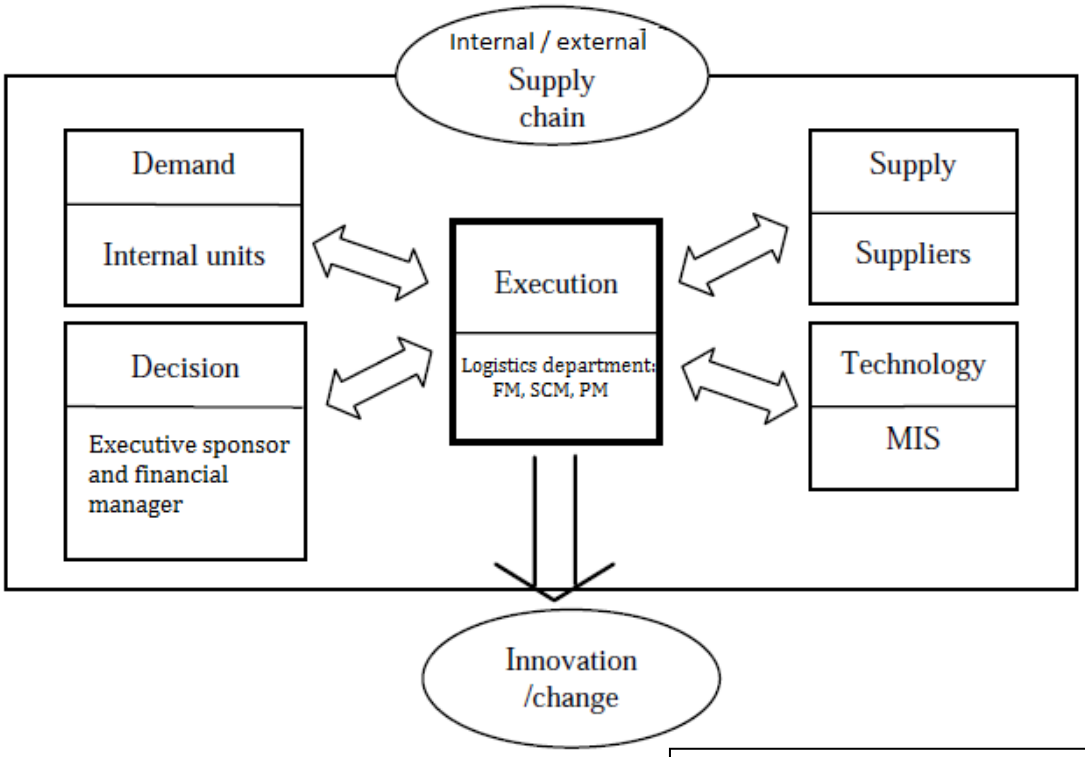


Figure 3 Adapted from Su *et al.,*2011.

The header of figure 3 (internal/ external supply chain) describes the sector in which the decision find its origin. A supply chain consists out of an internal and an external supply chain (Lee *et al,* 2011; Rivard-Royer *et al.*, 2002; Pan and Pokharel, 2007).The internal supply chain concerns in-house product processes (e.g. storage, internal logistics), and the external supply chain concerns processes that involve product handling outside the hospital (e.g. logistics, storing) (Lee *et al,* 2011; Rivard-Royer *et al.*, 2002; Pan and Pokharel, 2007).

It can be assumed that the executive sponsor and financial manager eventually decide what storage location will be used. To come up with information about the storage locations the executive sponsor most likely assigns the logistic department to come up with the appropriate information. The logistic department in this case most likely includes personal with the expertise of facility management (FM), supply chain management (SCM), and/or project management (PM) regarding storage locations of hospitals.

The assigned (logistics) department coordinates and communicates with the other members, by providing and receiving information related to the storage location decision. The facility manager contributes to this information flow by providing knowledge about supportive processes like; storing the product; and product distribution inside the hospital, (Su *et al.*, 2011) aiming to make the internal supply chain more effective, efficient and flexible (Maas en Pleunis, 2001). A supply chain manager contributes to the information flow by giving information about the possible storage locations; storing methods; logistics; and ordering policies (Su *et al.*, 2011). Aim of the supply chain manager is to maximize profits and quality by optimizing product, information, and fund flows (Chopra and Meindl, 2010). Day to day business of facility managers and supply chain managers includes product logistic processes, what states their interest and responsibility in this decision. So, we expect the logistics department when providing information on the (re) location of storage, to focus on the product flow through the internal and external supply chain.

Internal units (Demand) of a hospital also have a certain interest in supply chain decisions. They expect that logistic processes support them to provide the required quality and quantity of products and at the right time (Su et al., 2011). The internal units are represented in the DMU by a delegation of physicians (Su et al., 2011). The physicians translate the demand and expectations of patients, combined with their own expertise, into demand (quantity and quality) of products to satisfy hospital staff's needs, to be able to cure and care patients (Kumar *et al.,* 2008; Lim and Tang, 2000). So, when providing information on the (re) location of storage, we expect the internal units to focus on the quality and availability of the products.

Suppliers are organizations that are responsible for delivering qualitative and the right quantity of products in response to hospitals' order (Lee *et al.,* 2011). Including supplier information in the decision making unit enables to clarify capabilities of suppliers; give insights in the upcoming developments (products, logistics, storing); and defining service quality and prices (Su et al, 2011; Gadde and Snehota, 2000; Lee *et al*., 2011). Interpreted out of literature from the industrial segment supplier relationships are significant because they are important for the future of the hospital (business) since they deliver products (quality) that respond to the needs and expectations of hospital staff (customer relationship) (Gadde and Snehota, 2000). Therefore, when providing information on the (re) location of storage, we expect the supplier information to focus on options for building (long term) relationships with the hospital, and information on the developments in suppliers market.

Hardware and software requirements have to correspond with data and information flows. Therefor information of the Management Information System (MIS) staff is included in the decision making unit. The MIS staff has to deal with the information flow in-house (between care units, and in-house storage facility (or procurement department)) (Awaya *et al.,* 2005) and with information flow between hospital and other members of the external supply chain (Su et al, 2011). It is important that the information flow runs fluently to avoid a bullwhip effect, where a discrepancy between product demand and product supply is the case (Lee *et al.*, 1997). So, in providing information on where to (re) locate storage, we expect the MIS-staff information to focus on the information flow and supportive information systems.

The financial manager and executive sponsor are for financial support and overall approval included in the decision making unit (Su et al, 2011). The (financial) executives are the deciders in this process

and consider approving plans provided by the logistics department. So, in a riskier, heavy regulated environment and an increasing competition it is important that all the relevant information (estimated by the logistics department) is transferred to the executives (Kovner, A.R., 2001). So, when deciding on the (re) location of storage, we expect the (financial) executives to focus on financial constraints (budgets) and organization wide impact (in particular risks) of a storage location decision (is it in line with vision, mission, and strategic objectives).

It appears that there are multiple actors involved with a decision on the (re) location of storage. They all have different interests and specialisms. We therefore expect a decision process concerning storage facility (re)location to be complex and time consuming.

Chapter 3: Decision variables for (re) locating storage of general hospitals

A decision regarding the (re)location of storage, is associated with several motives and drivers. Those associated motives and drivers are translated into decision variables. This section describes the decision variables that are mentioned in literature. Decision variables are variables which characterize the different possible scenarios and are useful for making estimates to support decision making (Colin *et al.,* 2011). The decision variables are a mixture of numerous technical, strategic and operational variables (Ling *et al.,* 2008).

It seems that authors value the variables costs (Dacosta- Claro, 2002; Lodree *et al.,*2004; Nicholson *et al.,* 2002; Rego and De Sousa, 2009; Rivard- Royer, 2002; Tancrez *et al.*, 2012) and quality (Ling *et al.,* 2008; Dacosta- Claro, 2002; Lodree *et al.,* 2004; Aguilar Chinea, 2009; Meijboom *et al.*, 2011; Lim and Tang, 2000) of the hospital services as most related to a decision for (re) locating storage. For example, Tancrez *et al.*(2012) states that locating a storage facility is all about satisfying customer demand while minimizing costs. Dacosta-Claro (2002) writes that resource utilization is about increasing product and service quality to out run competition and at the same time reduce costs. Costs and quality are the main decision variables. Literature related to the topic numerous times mentioned the importance (as shown in the examples) of both factors in making this kind of decision.

Another variable which has an impact on the decision besides costs and quality is risk, according to Cagliano *et al* (2011). However, in topic related literature the variable risk is not mentioned that explicit, where other literature stated that the risk variable is highly important in (almost) every decision (Verbano and Venturini, 2010). Therefor in this section the variable risk is taken into account and rated as main variable.

Next to the three main variables there are a number of so-called situational factors (Jaros *et al.*, 1994). The situational factors are hospital size, logistical staff, infrastructure, strategies, and government regulations (Demirel *et al.,* 2010; Farahani *et al.,* 2010).

§ 3.1 Costs

Similar to the industry sector the healthcare sector has to deal with the harsh economic conditions and so needs to minimize costs (Lodree *et al,* 2004). It appears that a decision regarding (re) locating storage of general hospitals concerns a variety of cost components (Liao, 2010; Norris, 1998). In table 1 Norris (1998) distinguishes several operational cost components for locating storage.

Components	Definition and key cost drivers
Unit costs	The cost or price of the items purchased.
Acquisition costs	The cost associated with acquiring the product (e.g. clerical time spent sourcing, preparing purchase orders, receiving, and accounts payable); also included is a portion of overhead, equipment, and supplies used in the process.
Possession costs	The cost associated with holding, managing, and controlling inventory in the warehouse and other areas where supplies are stored (e.g. inventory carrying costs).
Transaction costs	The cost of preparing and managing the documentation used to account for the entire procurement process (e.g. creating, filing, retrieving, and matching requisitions, purchase orders, and receiving documents).
Distribution costs	The cost of moving supplies throughout the hospital (e.g. from the warehouse to the user).
Operation costs	The cost of assembling and preparing material for use (e.g. sterilizing, packing, loading carts).
Utilization costs	The cost of actually using the product in its intended clinical application.

Table 1 Norris (1988): Operational costs

Norris (1988) investigated the total costs for hospitals involved in delivering, storing and using a product. In table one (Norris, 1988) are the operational cost components of delivering products to the hospital care units enumerated and defined.

The operational cost components in Table 1 (Norris, 1998) are in great extent variable in case of hospital products. Variable cost components mean that the costs component most likely differ for every single hospital and fluctuates regularly. This is due to a variety of reasons: the fluctuating demand in healthcare industry, technological and scientific developments in medicines and treatment equipment (Teng and Yang, 2004), the storage method (and location) of the products, the developments in the competitors' environment, the suppliers (e.g. prices of products increases), and the resources availability (Chopra and Meindl, 2010).

In addition to the operational cost components of Norris (1998), Kuprenas (2010) describes the costs involved in building a storage facility. The total costs of realizing a storage facility are built out of construction costs and design costs (Kuprenas, 2010). Construction costs and design costs are applicable if the hospital decides to build a new storage facility at hospital location or at a central storage location.

Another additional cost component appears when a hospital decides to use an existing storage facility, known as facility costs (Tancrez, 2012). This includes maintenance costs, taxes, and/or rental in case the facility is owned by another actor (e.g. real estate agent).

So, all costs of building, maintaining, operationalize, and/or renting the storage facility have to be taken into account when a hospital has to make a decision concerning (re) locating a storage facility.

§ 3.2 Quality

The perceived quality of hospital storage is determined by two factors; product quality and service quality (Babakus and Mangold, 1991). The level of quality is determined by the level of satisfying needs and expectations of clients (Aguilar Chinea, 2009; Lim and Tang, 2000; Choi *et al.,* 2004).

The level of service quality is according to Lim (2000) and Buyukozkan (2011) determined by a number of aspects. Service quality is difficult to measure, because of its intangibility and the different perceptions of the people (e.g. physicians and patients) who have to deal with the service (Buyukozkan, 2011). However, a survey research instrument called Servqual developed by Parasuraman *et al.* (1985) made it possible to measure the level of service quality. Parasuraman *et al.* (1985) distinguishes the following aspects of service quality: tangibility, reliability, responsiveness, assurance, and empathy. Other authors (Buyukozkan, 2011; Lim and Tang, 2000; Babakus and Mangold, 1991; Sower *et al.*, 2001; Choi *et al.*, 2004) have added accessibility and affordability to the Servqual model with respect to logistics. Not all of the aspects of the Servqual model are applicable to this case of a storage facility location decision. The tangibility aspect, concerning the design, lay-out and equipment of a hospital (Babakus and Mangold, 1991), is not applicable since this case focuses on storage locations and not on the design of a storage facility. Empathy (the ability of personnel to understand individual customer needs (Parasuraman *et al.* 1985)) is also not applicable since, in perceiving hospital storage quality and the related logistics processes are not concerned with empathy but only with the ability of delivering the products. We also did not include affordability, because affordability concerns costs and is dealt with in paragraph 3.1. The aspects that could be applied are separated and defined in Table 2 (Buyukozkan et al., 2011; Vandamme and Leunis, 1992; Litman, 2012).

The weighting factors of the aspects in table two are difficult to determine. For each situation the aspects have another impact on the service quality. There is also a part of subjective judgment in determining weighting factors of aspects, what makes it difficult to precisely evaluate service quality (Buyukoznan, 2011; Lim and Tang, 2000).

Aspect	Definition
Reliability	The ability to perform the promised service dependably and accurately
Responsiveness	The willingness to help in fulfilling demand and to provide prompt service
Accessibility	The easiness of reaching facilities, products and destinations
Assurance	The ability to provide trust, confidence, and guaranty provision

Table 2 Adapted from: Buyukozkan, 2011, Vandamme and Leunis, 1992, and Litman, 2012.

Reliability in logistics is about performing the right product delivery at the appointed time and place (Lim and Tang, 2000). The storage should be located in such a way, with the right capacity and distance from the hospital, that those quality requirements could be met (Liao and Chang, 2010).

Responsiveness is concerned with the ability of hospital logistics to react on hospital staffs' demand (Buyukozkan, 2011). If storage is located at further distance from the care units the responsiveness will decline, since lead-time increases. Availability of products at the storage facility also impacts responsiveness, since more available products most likely increases the ability of the hospital to respond (Babakus and Mangold, 1991).

Accessibility in this logistic matter refers to the physical access to products in storage locations (Litman, 2012). Storing products at a hospital facility therefore has probably a high accessibility because its destination is nearby and the storage facility is owned by the hospital and therefor accessible for hospital's staff.

Assurance in this matter refers to the ability of providing trust and confidence to the hospitals' staff (Vandamme and Leunis, 1993). In case a discrepancy appears between demand and supply assurance is also referred to as the guaranty of compensating or ability of solving the problem (Buyukozkan *et al*., 2011). The physical appearance of a storage facility (located at hospital facility) could increase the level of trust and confidence, since hospital staff knows storage is located nearby and so probably has a short lead time and high availability.

§ 3.3 Risks

Decision making in healthcare logistics is a comprehensive issue accompanied by most likely a high level of risk (Verbano and Venturini, 2011). This is due to; diversity of product portfolio of the hospital makes it complicated to correspond logistics processes with demand of hospital's staff (Lee *et al.* 2011); many cross-functional activities are involved in product- and material management in hospital logistics (Cagliano, 2011); and hospitals are directly linked to the quality of life of the patients (Buyukoznan, 2011). A decision regarding the location of storage of hospitals distinguishes six basic groups of risk (Cavinato, 2004; Spekman and Davis, 2004).

1. Physical risks: Related to the distribution and storage of the products between supplier and hospital locations.
2. Financial risks: Associated with the money flow between the hospital and supplier, the care authority (e.g. Nederlandse Zorgautoriteit ,2011) and the hospital, and the patients and the hospital.
3. Information risks: Associated with the information systems of the hospital, used for information gathering, information storage, and information transferring to the supplier, patients, care authority, and other stakeholders and/or shareholders. Information flow is all about synchronizing replenishment with hospital's staff and patient's needs. (Rivard-Royer *et al.,* 2002)
4. Relational risks: Related to the relationships with suppliers, patients, and care authority, that makes it possible for the hospital to maximize profits.
5. Innovation risks: Related to the cooperation between the hospital and other actors of the supply chain in order to find options to improve processes, products and services.

6. Quality risks: Is associated with the factors that may have an impact on the quality of hospital services/products, and which may influence the performance of products/services (Gray *et al.,* 2011).

Bose (2003) states that effective risk managing is a process of minimizing risk by continuously information gathering and interpreting that information to organizational performances. This information gathering and interpreting helps the hospital to define what probably will happen and what could happen, also known as scenarios (VanVactor, 2012). Scenarios support the hospital to anticipate what could happen and decreases hereby risks.

§ 3.4 Situational variables

Every decision making process towards storage (re)location of hospitals is unique (Jaros *et al.*, 1994). In this section we describe the situational factors, in context with the case, that make a situation.

Hospitals differ in their strategy in order to align with stakeholders' expectations (e.g patients, government, physicians, competitors (Johnson *et al.,* 2012)). Strategies are translated in a mission, vision, and objectives of a hospital (Jaros et al., 1994; Johnson et al., 2012). A decision concerning a storage location needs to be in line with the strategy. Chaudry and Dacin (1997) distinguish three main strategies. The first strategy focused on reducing costs by optimizing the logistic processes. The second, so called political strategy, focusses on nurturing the regulatory agency in the region by providing information that supports research of governmental organizations. The third so called social strategy focusses on pleasing the stakeholders of the hospital and will lead to a decision which is as much as possible in line with (all) the stakeholders' needs and expectations.

The location of storage influences the infrastructure of a hospital. The available transportation modes, reachability and telecommunication systems constitute this influence (Demirel *et al.,* 2010; Farahani *et al.,* 2010). Demirel (2010) and Farahani (2010) also mention political matters, government regulations and laws as situational factors. They state that regulation and law differ per region. One can think of taxes, pollution regulation, and policies for waste management (Demirel *et al.,* 2010; Farahani *et al.,* 2010). The hospitals are obliged to adapt to these laws and regulations, what may lead to additional costs. So, when a hospital has to make a storage (re) location decision, the previous mentioned variables of the (potential) facility location has to be taken into account.

Next to previous variables the size of a hospital (bed capacity and demand capacity) impacts a decision concerning storage location (Demirel et al., 2010). To be able to deal with hospital demand the storage facility capacity (amount of (safety) stock) needs to be in line with demand capacity. For completion of logistical support functions of hospital demand, skilled logistical staff is required (Farahani, 2010). The inability or ability of logistics staff to meet hospital requirements may influence the storage capacity (Demirel et al., 2010). Inability of logistical staff could be reason to outsource the logistical activities.

Chapter 4: Expected impact of the decision variables on storage location of general hospitals

In previous chapter a number of decision variables were distinguished. This section describes the expected impact of a storage location on those variables.

§ 4.1 Impact on Costs variables

The cost we enumerated earlier (§ 3.1) are in this section related to the storage location. The hospital is central in this study therefor we focus on the impact of the storage locations on the hospital costs.

§ 4.1.1 Unit costs

Amount of *unit costs* depends on the price negotiation between suppliers and hospital (Liao and Chang, 2010). Therefor it is hard to determine what storage location has highest unit costs involved and which has lowest unit costs. When we speculate about the influence of storage locations on unit costs one can think of the lot sizes of a delivery. Looking at lot sizes the amount of unit costs decreases when the lot sizes are higher (Chopra and Meindl, 2010). Since storing at hospital facility is associated with a higher storage capacity, in comparison to the other storage methods, a higher delivery quantity is possible and so unit costs decreases. However, as we stated before, the unit costs are determined by price negotiations between the supplier(s) and hospital. Literature is not clear about the impact of a storage facility location on unit costs, therefor we can only speculate.

§ 4.1.2 Acquisition costs

Acquisition costs increases when the number of deliveries increases. The number of deliveries will most likely be reduced when economies of scale increases (Monczka *et al.*, 2009). An increase in storage capacity allows the supplier to increase economies of scale (Chopra and Meindl, 2010). If a supplier increases the economy of scale the number of deliveries probably decreases. This most likely decreases the acquisition costs. The same as for unit costs we can only speculate what the impact of a storage location is on acquisition costs. Therefore the impact of hospital storage locations on acquisition costs is also considered as a blind spot in literature.

§ 4.1.3 Possession costs

A reduction of inventory for the hospital appears when storage is located at suppliers' facility or central storage location owned by the supplier (Kumar *et al.*, 2008). This reduces *possession costs* of the hospital. Storing products at hospital facility or central storage facility owned by the hospital increases possession costs, because the costs associated with storing products is on account of the hospital (Rivard-Royer, 2002). This increase in cost for the hospital is due to a probable increase in depreciation, spoilage and obsolescence of products (De Vries, 2011).

§ 4.1.4 Transaction costs

Locating the storage facility at a supplier or central storage facility most likely requires a more frequent delivery of products to the hospital. In this situation the *transaction costs* are higher (e.g. more administration costs) (Rego and Sousa,2009). A storage facility located at hospitals' facility and owned by the hospital probably increases the lot sizes (delivery

quantity) and decreases delivery frequency, and so decreases the transaction costs (Rego and Sousa, 2009). The difference in transaction costs between a central storage facility owned by the hospital and a central storage facility that is owned by the supplier is not explicitly dealt with in literature. It is most likely and we assume that the transaction costs are higher if the central storage facility is owned by the hospital, since the transaction consist out of two stages (supplier to hospitals' central storage facility and hospitals' central storage facility to hospital) and most likely has to deal with more documentation activities. The amount of transaction costs for central storage facilities of hospitals is however, as stated before, not explicitly dealt with in literature. Therefore we can only make assumptions on the impact of central storage locations on acquisition costs.

§ 4.1.5 Distribution costs

The *distribution cost* of hospital products consist out of product movement from the warehouse to the points of care (Andersen, 1990). Storing the products at a central storage facility owned by the supplier(s) or at suppliers' facility will most likely have the lowest distribution costs, because the distribution costs in this case most likely only exist of product distribution from hospital door to the points of care. It is even possible that the products are directly delivered to the points of care by the supplier what decreases the distribution cost even more (Nicholson *et al*. 2004). Storing products at the hospital facility increases the distribution costs, since more distribution related activities are needed to deliver the products to the point of care. Storing products at a central storage facility owned by the hospital also has higher distribution costs, because the delivery of products in this case most likely consists out of two stages (central storage facility to hospital facility and hospital facility to points of care) (Chopra and Meindl, 2010). The ranking of the level of distribution costs for the different storage facility locations is not dealt with in literature. However, it may be assumed that storage facilities owned by the hospital involve higher distribution costs in comparison to storage facilities owned by the suppliers.

§ 4.1.6 Operation costs

Van Weele (2010) describes *operations costs* as the costs associated with preparing inventory for actual use (e.g. packaging, assembling, and sterilization). The definitions of Van Weele (2010) and Norris (1988) (Table 1) are interpreted and based on those definitions we will describe the most likely impact of the storage facility locations on operating costs. Based on the definitions one can say that storing products outside the hospital at a central storage facility owned by a supplier or at suppliers' facility decreases the operation costs, since products are most likely directly delivered to the care-units with no or limited hospital operations activities involved. However, due to developments and expertise of suppliers in packaging, assembling and sterilizing, operations activities are also limited when storage is held at the hospital facility or at central storage facility owned by the hospital. Therefore we can assume that the operation costs are approximately equal for the different storage locations.

§ 4.1.7 Utilization costs

Each possible storage location has the same *utilization costs* if the products are used at the clinical application. A storage location does not impact the costs involved in actual using the product.

§ 4.1.8 Construction and design costs

Construction costs and acquainted *design costs* of a storage facility are only applicable for a hospital when a storage facility is newly build and owned by the hospital. This principle could appear when a storage facility is located at a hospital's facility or at a central storage facility location (in ownership of hospital). Building a storage facility at a central location is in most cases (ratio is approximately 4:1 (O'neil and Purkanto, 2009)) associated with lower construction and design costs in comparison to constructing and designing a storage facility at a hospital facility location or supplier location (O'neil and Purkanto, 2009). This is because of the excessive space constraints and higher space price at hospital facility.

§ 4.1.9 Facility costs

Facility costs appear to be higher when a storage facility is owned by the hospital. Owning a central storage facility is in general more expensive than a storage facility at hospital's location, since it is most likely located at a secluded location (e.g. stand-alone rent, maintenance). Storing the products at a central storage facility which is owned by the supplier and storing the products at supplier's facility does not involve facility costs for the hospital.

Table three indicates the ratio of costs between the different storage locations (*1, 2a, 2b, and 3)*. The number 4 indicates the lowest costs, where number 1 indicates highest costs.

	Storage location			
Cost category	*1*	*2a*	*2b*	*3*
Unit costs				
Acquisition costs				
Possession costs	2	1	3	3
Transaction costs	4			1
Distribution costs	1	1	4	4
Operation costs	1	1	1	1
Utilization costs	1	1	1	1
Construction costs	1	2	-	-
Design costs	1	2	-	-
Facility costs	2	1	-	-

Table 3: Cost ratios different storage locations

§ 4.2 Impact on Quality variables

§ 4.2.1 Reliability

Products should be provided to the patients at the appointed time and at the right condition to become a reliable hospital (Lim and Tang, 2000). This is most likely to happen if storage is located near to the care unit(s) (Babakus and Mangold, 1991). *Reliability* is also dependent

on the supplier. The supplier needs to deliver what is ordered. If a supply chain is build out of many supply chain actors the chance of a bullwhip- effect increases and a decrease of reliability (and so quality) is the result (Lee *et al.* 1997; Liao and Chang, 2010). Therefore, storing products at hospitals' facility is most reliable. It is difficult to determine the least reliable storage location, because storing the products at supplier location increases the distance but decreases the supply chain actors (in comparison to a central storage facility owned by the supplier). Therefore storing products at a suppliers' facility and storing products at a central storage facility owned by supplier(s) are assumed to be equally reliable. A central storage facility owned by a hospital is often located closer to a hospital in comparison to a storage facility owned by the supplier (§1.2). This reason and the fact that the hospital owns the storage facility make it most likely more reliable in comparison to the supplier owned storage facilities. However, the ranking of the reliability of storage locations cannot be applied in every situation since reliability is highly dependent on personnel. So, if a storage facility at hospital location is managed by poor personnel the reliability will most likely decrease. Therefore the reliability aspect in table 4 is valued by the assumption that the different storage locations personnel have the same level of expertise.

§ 4.2.2 Responsiveness

The lead time increases when a storage facility is located at greater distance from the hospital. If transportation modes remains the same but the distance between storage and care units increases, than the responsiveness to care units demand and the hospitals' ability to deliver prompt service decreases (Buyukozkan *et al*, 2011). So, *responsiveness* is highest by storing products at hospitals' facility and lowest when storage is located at suppliers' facility. If storage is located at a central storage facility owned by the supplier is most likely located further from the hospital than a central storage facility owned by the hospital, therefore a central storage facility owned by the supplier has a lower responsiveness. A low response time in order to patient demand increases waiting times and decreases the quality of service provided (Babakus and Mangold, 1991). The assumptions we made for responsiveness are only applicable if the different storage locations have the same expertise personnel, the same transportation methods, the same information technology, etc. Therefor it is difficult to say if previous ranking of storage locations impact on responsiveness is applicable in practice.

§ 4.2.3 Accessibility

When storage is located at a hospitals' facility the *accessibility* is highest. The lead time is lowest and the storage could relative quickly be acquired (Lim and Tang, 2000). Storing at a central storage facility is further away and less accessible. Probably even more when the central storage facility is property of the supplier, because of the longer distance and it's harder to get access to the facility's storage (Liao and Chang, 2010). Accessibility is therefore probably even lower when storage is located at a suppliers' facility.

§ 4.2.4 Assurance

The level of *assurance* for a hospital storage location is hard to determine. Assurance has to deal with feelings (trust and confidence) which are difficult to assess (Vandamme and Leunis, 1993). Another part of assurance has to deal with guaranty, e.g. compensation in case a problem appears (Buyukozkan *et al.,* 2011). This concerns agreements between hospital and

supplier. These underlying variables make it practically impossible to rank the assurance level of the different storage locations.

Table four indicates the ratios of quality aspects between the different storage locations (*1, 2a, 2b, and 3)*. The number 1 indicates the lowest quality, where number 4 indicates highest quality.

	Storage location			
Quality aspect	*1*	*2a*	*2b*	*3*
Reliability	4	3	2	2
Responsiveness	4	3	2	1
Accessibility	4	3	2	1
Assurance				

Table 4: Quality aspect ratios of different storage locations

§ 4.3 Impact on Risk variables

§ 4.3.1 Physical risk

Physical risk is only applicable if products are in possession of the hospital. In case of storing products at a suppliers' facility the physical risk is for the supplier (Verbano and Venturini, 2011). When storage is located at a central storage facility owned by the hospital the physical risk is most likely high, because in this way product has to go through multiple phases before it is at its final destination (care units of the hospital) (Lapierre and Ruiz, 2007). Storing products at hospital facility has probably also a high amount of physical risk, since the storage facility is owned by the hospital and product distribution is conducted by hospital staff. Next to previous statement the level of physical risk could be affected by several other variables. It depends on transportation modes, storage facility conditions and abilities, expertise of personnel considering product handling, etc. Therefore the level of physical risk for hospital owned storage facilities is difficult to determine and so assumed to be equal for every storage location(table 5).

§ 4.3.2 Financial risk

The financial flow between hospital and supplier is associated with *financial risk*. Since all the storage locations have to deal with the supplier-hospital money flow they all have to deal with financial risk. Next to the supplier-hospital money flow the hospital has to deal with financial flow from the care authority (Nederlandse Zorgautoriteit, 2011). This authority provides the hospital funding. The level of financial risk per hospital storage facility location is not described in literature and therefore not ranked in table 5.

§ 4.3.3 Information risk

In a hospital, errors may be related to communication between the supply chain actors. The more supply chain actors, the higher the probability that a discrepancy in information appears (bullwhip effect (Lee *et al.,* 1997))(Liao and Chang, 2010). Therefore locating storage at a hospital location, whereby eliminating a central storage facility, reduces the probability of *information risks* (Cagliano *et al.* 2011). The number of supply chain actors is equal to storing products at supplier facility, but the probability of information risk is assumed to be higher since the hospital is more dependent on the supplier (frequency of delivery is higher). Storing products at a central storage facility is most likely concerned with a high level of information risk, especially when the storage facility is owned by a supplier (more dependable on supplier). Previous ranking of information risk on the different storage facility locations is speculative. In literature is not explicitly described what the impact is of a storage location of the level of information risk. Because of this lack of information about information risk concerning storage facility locations we will not include the ranking in table 5.

§ 4.3.4 Relational risk

Relational risks are related to trust, collaboration and atmosphere of a relationship (De Vries and Huijsman, 2011). In locating storage of hospitals relational risks may appear in the relationship between hospital and supplier(s). Since every storage location has to deal with this relationship we will assume that the level of relational risk is equal for the different

storage locations. To reduce the relational risk it is important for the hospital to evaluate the reputation of the supplier(s).

§ 4.3.5 Innovation risk

Keeping up with developments is what *innovation risk* is all about. A lack of flexibility to adapt to changes in the environment and a lack in capability to pinpoint important developments increases innovation risks (Goes and Park, 1997). An increase in number of supply chain actors increases the interdependency. According to Goes and Park (1997) this will lead to a higher innovation risk. Since each storage location has to deal with the hospital supplier relationship and literature does not write about the difference in innovation risk between the different storage locations, it is not valued in table 5.

§ 4.3.6 Quality risk

Quality risk is influenced by all the processes involved in delivering a product from the supplier to the end user (care units). Every supply chain actor is of influence on the quality of products or hospital services (Gray *et al.,* 2011). A delay in delivering a product to a hospital for example, impacts the availability of products and so the responsiveness of the hospital on patient demands. The storage facility locations all have their own involved quality risks. The level of those risks are not weighted in literature and therefore not ranked. However, literature (Gray *et al.,* 2011; Berbeé *et al.*, 2008) states that quality could be affected in many different ways and therefor seen as highly rated risk.

Table five indicates the ratios of risk aspects between the different storage locations (*1, 2a, 2b, and 3)*. The number 4 indicates the lowest risk, where number 1 indicates highest risk.

	Storage location			
Risk aspect	*1*	*2a*	*2b*	*3*
Physical risk	1	1	-	-
Financial risk				
Information risk				
Relational risk	1	1	1	1
Innovation risk				
Quality risk	1	1	1	1

Table 5: Risk aspects ratios of different storage locations

Conclusion/Discussion

We have studied the storage location of non-critical products of general hospitals. It appeared that non-critical products of general hospitals could be stored at four different locations. Each storage location has its own characteristics in terms of ownership and distance from the hospital.

A decision concerning storage facility (re) locating of general hospitals is based on a variety of variables and multiple actors are involved in this decision. On a high level of abstraction the three main variables are costs, quality and risks. An executive sponsor is concerned with deciding which storage location to use. The logistics department with expertise of facility management, supply chain management, or a project manager knowledgeable of storage location decision will be appointed for gathering information. Information will be gathered from, the logistics department; internal units; suppliers; management information system staff; financial manager and executive sponsor. Next to these actors and variables there are a number of situational factors that influence the decision of (re) locating storage of general hospitals. The involved factors in a decision concerning storage facility (re)locating are displayed in a decision framework (figure 4).

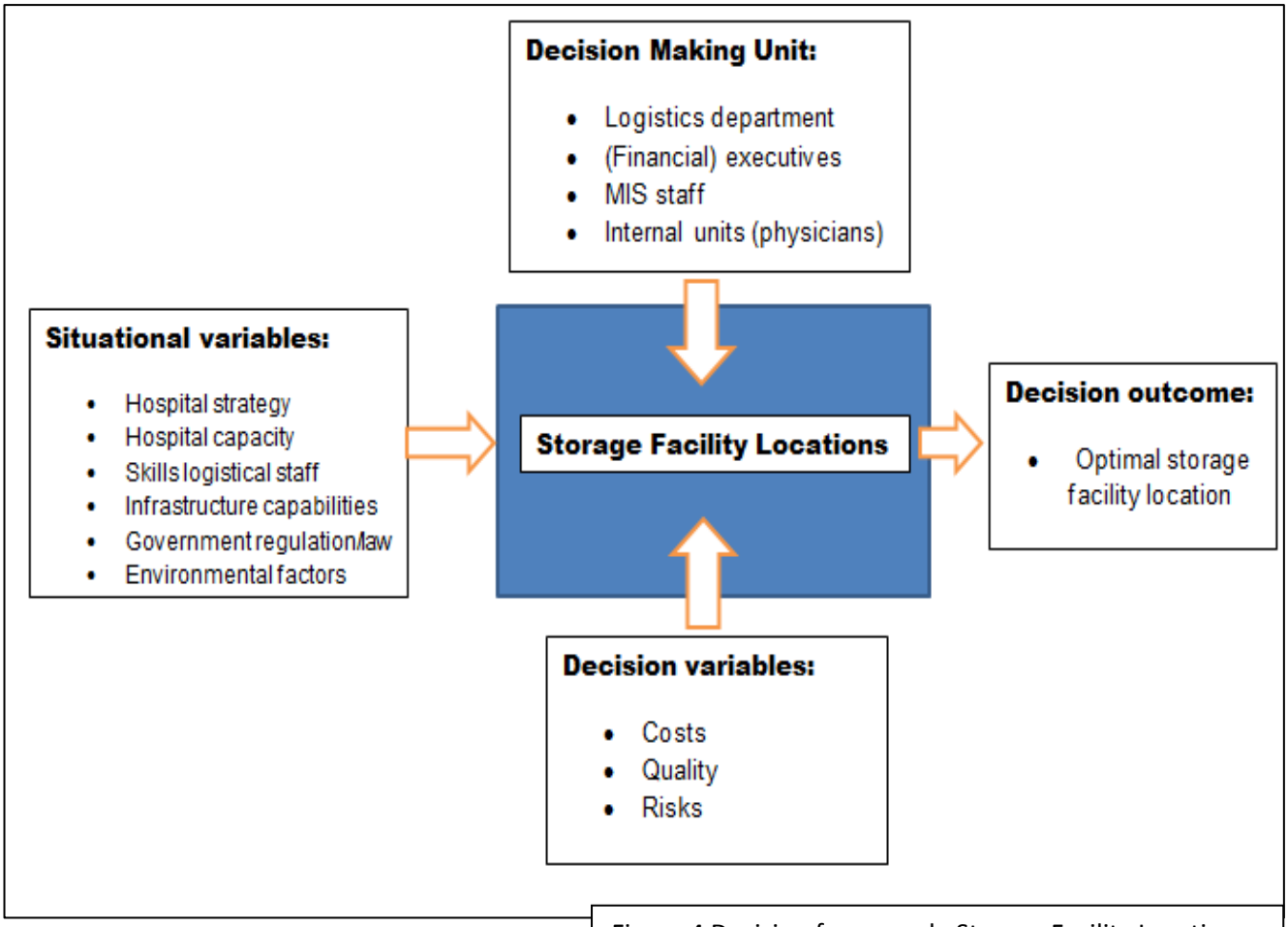


Figure 4 Decision framework: Storage Facility Location

A decision making unit concerning a storage facility location decision is a cross- functional team with a diversity of perspectives and interests. Interaction between the different DMU members is therefore required.

Based on the diversity of the DMU and the excessive number of decision variables one can say that a decision regarding storage facility location of general hospitals is very complex. The lack of literature about a storage facility location of general hospitals makes it even more difficult for an executive sponsor to come up with a knowledgeable decision.

The lack of literature becomes clear when we look at the tables three till five. In those tables the white boxes, represent the “blind spots” in literature. The decision variables of costs show in particular a lack in literature about unit costs and acquisition costs. Decision variables concerning quality show a lack of information about assurance. The decision variables financial risk, innovation risk, and information risk are not yet explicitly dealt with in literature.

It is concerning to see that those variables, in particular risk, are not covered by literature. This implies a lack of awareness in healthcare about the decision variables involved in making a decision concerning healthcare logistics.

Next to the lack in literature about the impact of the decision variables we can also conclude, based on the excessive number of assumptions in this literature study, that literature related to decision making concerning healthcare storage (re) locating is limited.

If we now try to answer the main research question of this literature study:

Which variables have to be considered in the decision making process of where to (re) locate the storage of general hospitals in order to come up with the most knowledgeable choice of storage location?

In this literature study it became clear that there is a number of decision variables involved in making a decision concerning a storage facility location of general hospitals (chapter 3). This enumeration of variables helps the decision making unit in gathering information. To come up with the most knowledgeable choice of storage location further research is required. The impacts of all the variables are not yet clear, and the weighting factors of the variables are not yet investigated. However, this literature study provides a clear basis for future research.

This literature study can be used as a support tool in making a storage facility location decision of general hospitals. It enumerates the different DMU members; the optional storage locations; the situational variables; the main variables; and the impact of a storage facility location on those variables (aspects).

Concluding, in order to successfully make a decision on a storage facility location of general hospital, information from a cross-functional decision making team is required and the variables cost, quality, risk, and situational variables must be taken into account.

Limitations/Future research

The impact of the situational variables was difficult to determine. In literature there is also not that explicit mentioned what the impact of situational factors is on the storage location decision of general hospitals.

Another limitation of this literature study is that we did not include a storage facility configuration, which uses multiple storage facility locations (e.g. storing a part of the non-critical products at the hospital, and storing a part of the non-critical products at a suppliers' facility).

To be able to determine the impact of situational factors on the storage location decision of general hospitals additional research is required. Future research also needs to determine what the weighting factors are of the variables involved in making a storage location decision. It is advisable to conduct this in an empirical research.

It appeared that a decision concerned with a storage facility location of a general hospital is a complex decision based on a number of variables. The impact of the multiple decision variables on the decision of (re) locating a storage facility is hard to determine. As previous mentioned, therefor an empirical study on the involved decision variables and their weighting factors needs to be conducted. Starting point of this additional research might be:

Which variables have to be considered in the decision making process of where to (re) locate the storage of general hospitals and what are their weighting factors in order to come up with the optimal storage location?

Outcome of this research should be a decision model that is applicable on all general hospitals that have to make a decision concerning storage facility (re)location.

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