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Implementing web-based delivery planning systems; the case of LogNet

Master of Science Thesis in the Master's Programme Design and Construction Project Management

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Abstract

In an ever changing economic climate, organizations around the world are required to develop new business strategies and methods to increase efficiency and productivity. The Swedish construction industry is no exception; companies are becoming more and more aware that there exists a need to progress in order to stay on top on a highly competitive market. Addressing the importance of establishing efficient logistics is one example of this development.

This study will focus on the logistical issues associated with on-site deliveries of construction material and, more specifically, the implementation effects of the LogNet delivery planning software developed by Svensk Bygglogistik AB. The software implementation effects will be discussed in relation to four criteria: Usability, Cost, Efficiency, and Communication. Moreover, this report will to a large extent be based upon the findings made from two case studies located in central Gothenburg operated by one of the major construction companies on the Nordic market. In addition, case 1 uses the LogNet software to manage the daily delivery activities whilst case 2 does not use LogNet, serving mainly as a reference object.

The results of the study indicate that the LogNet software has potential of reducing the overall cost of the project through standardized procedures, more efficient material handling, and establishing uniform channels of communication. However, there exist some reluctance of adapting new systems among users and the software carries expenses including acquisition costs, educational costs, and some obligations of conformation i.e. all actors must use the software correctly in order to achieve the desired result. Furthermore, in order to make the system work as efficient as possible, the system needs to be tailored in accordance with the requirements and prerequisites of the client and the intended users.

Key words: Delivery planning, LogNet software, Logistics, SCM, Software implementation

Preface

We would like to extend our gratitude to the companies which showed interest and took the time to answer our questions on-site between October 2011 and February 2012. Additionally, they supplied us with information and enabled us to see how the construction process and delivery planning is conducted on a daily basis. This study would not have been possible without their participation.

Moreover, we would like to thank our supervisor Per-Erik Josephson at Chalmers University of Technology and Samuel Lindén at Svensk Bygglogistik AB for their continuous support throughout the course of this study.

Gothenburg March 2012
Niclas Hultberg and Kristoffer Kull

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1 Introduction

1.1 Background

In order to illustrate the impact the Swedish construction industry has on the national economy it can be mentioned that the investments made into the sector represent over eight percent of the annual gross domestic product (GDP), or approximately 266 billion SEK (Swedish Construction Federation, 2011). In addition, construction industry is one of the largest employers providing 305,000 job opportunities and much more if external actors such as architects, technical consultants, facilities management etc. are included (Swedish Construction Federation, 2011). The amount of waste activities in a typical construction project is estimated to represent approximately 30 to 35 percent of the project's total production cost (Josephson and Saukkoriipi, 2005). There are large financial gains to be made by increasing efficiency in the construction process and addressing the importance of logistics management plays a central part of this development.

Logistics management is by the Council of Supply Chain Management Professionals (CSCMP, 2011) defined as: *"…that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements".*

In order for a construction project to be considered successful it needs to be delivered to the end user on schedule, within the budget and quality according to specifications (Jonsson, 2008). According to the Logistics manager at case 1, on-site deliveries is the most important risk factor to causing delays and disruptions in the operations. Therefore, applying logistics management on the on-site deliveries is essential and one solution is implementing a delivery planning system (Choy, 2006). Delivery planning systems are tools developed to manage the delivery activities with focus on increasing overall efficiency and productivity. There are a variety of such systems available on the market, all with different features and design. Furthermore, it is important to study and evaluate the actual effects when implementing new systems (Operations manager, 2011).

1.2 Purpose and scope

The purpose of this study is to assess the positive and negative effects of implementing the LogNet delivery planning software for on-site deliveries. Moreover, the implementation effects are discussed in respect to four criteria; Usability, Cost, Efficiency, and Communication.

The study presents the findings from two construction projects located in central Gothenburg operated by a major construction company on the Nordic market. Furthermore, the main part of the information presented in this study has been collected through interviews of LogNet users with different responsibilities within the projects. In addition, due to unavailability and complexity of applying numerical measurements on the evaluation criteria of the LogNet software, the implementation effects are presented in a generalized form.

1.3 The LogNet software

The LogNet software is a web-based delivery planning system developed by Svensk Bygglogistik AB in order to facilitate delivery activities on construction sites. When using LogNet all parties involved in the project have access to the delivery information at any given time via computers, smart phones or screens placed throughout the building site. The most important functionalities of LogNet are:

Booking of deliveries and resources
Viewing the current schedule of deliveries
Viewing the current outline plan
Receiving important project specific information
Viewing contact information to other actors in the project

Using LogNet within a project often results in the appointment of a number of persons directly responsible for implementing the proper system procedures on-site. These are ordinarily, and preferably, associated with functions such as logistics manager, supply planner and reception controller (Svensk Bygglogistik AB, 2011b). All have different responsibilities assuring that LogNet functions as efficiently as possible. The logistics manager is generally responsible that deliveries are scheduled into LogNet. Keeping the logistical analysis up to date and assisting in the production planning are examples of important tasks for the logistics manager. The supply planner is appointed primarily on major projects to relieve the workload of the logistics manager. Possible functions for the supply planner are delivery planning, manage the communication between different actors and identify possible problems and bottlenecks in advance. Within a project, there are usually one or more reception controllers appointed, depending on the size of the project. The reception controllers monitor the flow of material to the site. Moreover, this involves conducting a number of inspections when the material arrives, for example, delivery time, quantity, quality, and moisture measurement. When using LogNet it is important to establish a detailed outline plan (Svensk Bygglogistik AB, 2011a) containing information regarding storage, traffic routes, unloading sites, entrances, resource availability etc. (see Figure 1.1).

Figure 1.1 Example of an outline plan (LogNet, 2012)

There are three access levels in LogNet; administrator, user, and guard, all in order to make it possible to use the system in a structured and effective way. Furthermore, there exists a light version of the software named "simplified user", which make it easier for people with less computer experience to use LogNet. The LogNet login takes the user to the project homepage which provides general information about the project and project specific news. For example, this information can include a crane that is inoperative or important information about an upcoming delivery. It is of great importance that all parties involved in the project keep themselves updated in order for LogNet to have the desired effect. In addition, when a delivery or resource is planned to the construction site a form is filed by the user, this form contains an extensive amount of information about the delivery. This form then needs to be authorized by the administrator in order for it to be scheduled into LogNet. After accessing the schedule, the user can easily navigate between different deliveries using the different colour schemes and patterns, all indicating specific activities. Moreover, it is possible to obtain detailed information about the activity, for example, recipient, arrival time, unloading area, resources required (truck, crane), and to which building and floor the delivery is intended.

Another functionality of LogNet is the possibility to send a message to the recipient when the delivery has arrived at the site. Furthermore, in the LogNet schedule, the user can choose to view only a certain time period (day, week) or choose only to view certain resources or unloading areas of interest to them, see Figure 1.2.

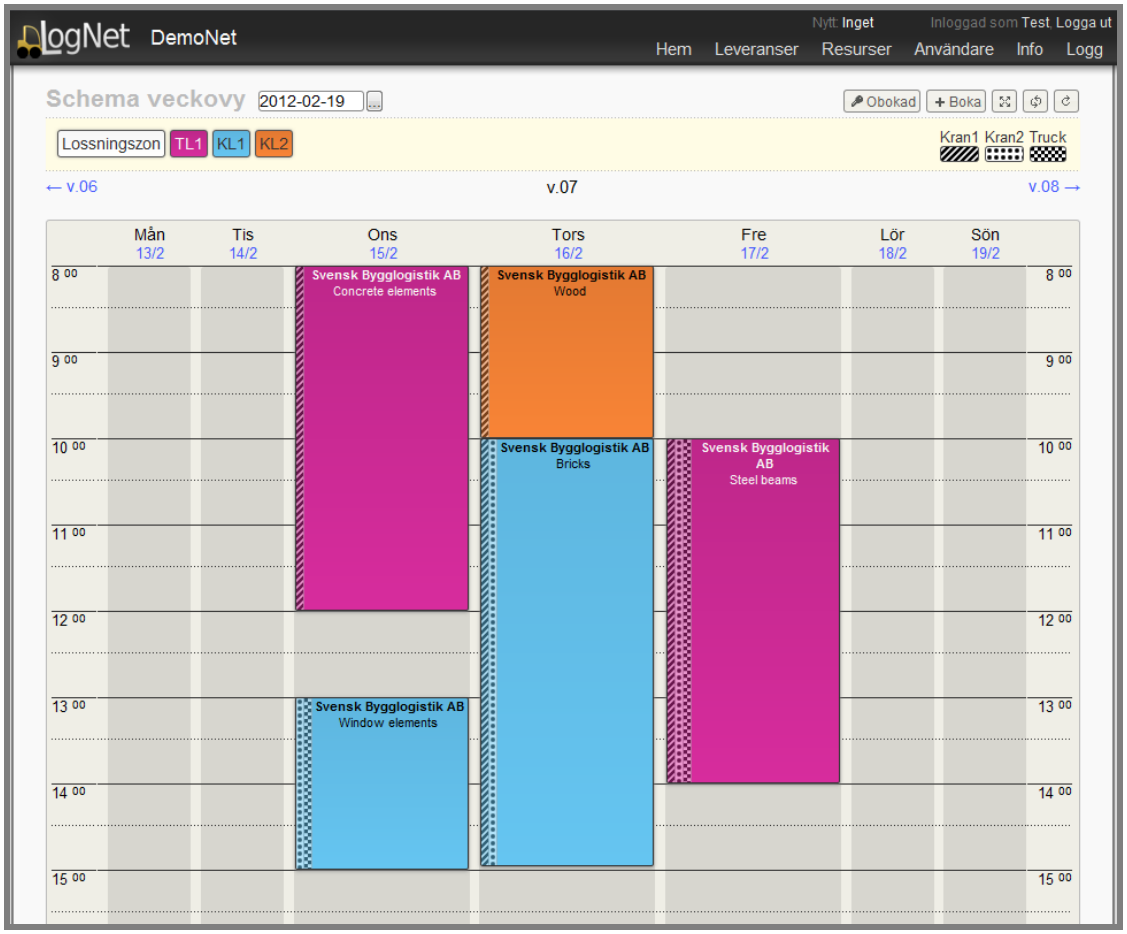


Figure 1.2 Example of a weekly schedule in LogNet (LogNet, 2012)

Deliveries are generally made to an unloading area at the construction site or to the mounting place within the project in question, the scheduling in LogNet and procedures associated with these delivery options are illustrated in Figure 1.3 and Figure 1.4. As can be seen, the procedures vary depending on the intended destination of delivery. A typical delivery process when using LogNet starts when the recipient makes the booking in the software. The delivery is then processed by an administrator and when the delivery is confirmed an e-mail is sent to the recipient confirming the delivery. The workset, containing information regarding the mounting place of the delivery, has to be received by the delivery planner at least one day before the delivery. Furthermore, the truck driver is to alert the reception controller at least 30 minutes before arrival and the reception controller then inspects the material and transports it to the mounting area according to the workset. After these activities are completed, a delivery status report is sent to the involved parties.

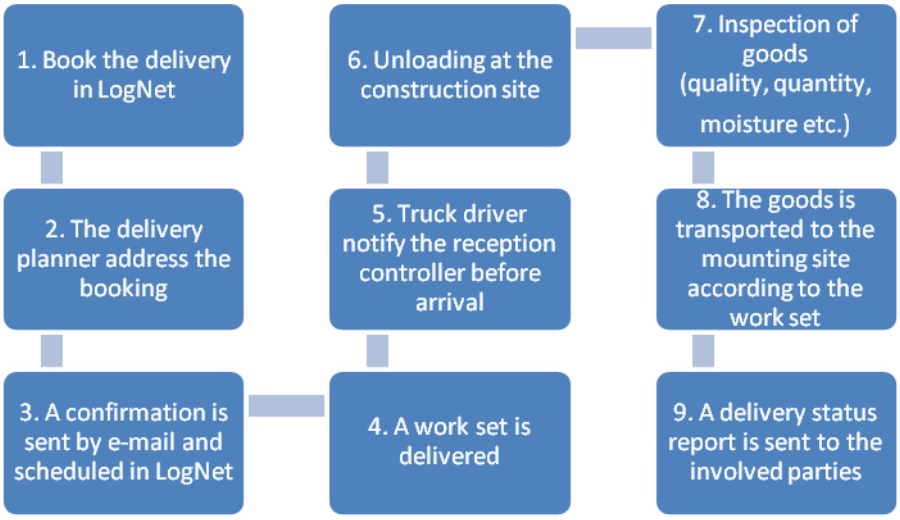


Figure 1.3 Procedures for deliveries to the mounting place

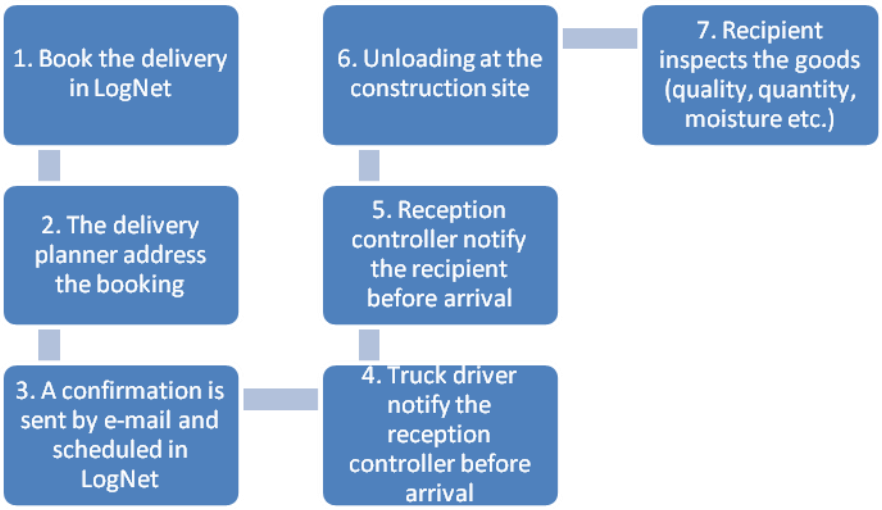


Figure 1.4 Procedures for deliveries to the unloading area

Moreover, it is possible to view the specifications and the statistics concerning past deliveries in the software directly. For example, it is possible view the number of deliveries made on time and deliveries that were delayed. In other words, LogNet create a basis for evaluating the performance of specific suppliers and subcontractors.

2 Literature review

2.1 Efficiency in the construction industry

The inefficiency in the construction industry is a major challenge and according to a study on housing projects made by Josephson and Saukoriipi, (2005), waste activities represent in the region of 30 to 35 percent of the total production cost. The waste activities are activities that consume resources without adding value to the construction project. In addition, the waste activities can be divided into two categories necessary waste and unnecessary waste. According to Strandberg and Josephson (2005) necessary waste represents 45.4 percent of the work time for an average construction worker and involves activities such as planning, material handling and resource preparation. Unnecessary waste represents 33.4 percent of the work time and consists of activities that could have been avoided with better planning. Examples of such activities are multiple handling, stockholding, product defects, unused time, and disruptions in operations (Josephson and Saukoriipi, 2005). These unnecessary waste concepts are explained in further detail below:

Multiple handling *– This concept involves excessive movement of material and resources that increase the risk of damages and wear and tear to the product.*

Stockholding *– This concept involves the storage of material at the construction site or warehouses. This creates additional costs due to increased risk of damages and theft.*

Product defects *– This concept involves product that are not delivered according to specifications. This creates additional work having to return the products to the supplier and worst case scenario, a standstill in operation.*

Unused time *– This concept involves waiting for another activity to be completed before being able to proceed with intended work.*

Disruptions in operations *– This concept involves interruptions in the construction process due to a lack of necessary resources.*

In addition, the direct value-adding activities represent 17.5 percent of the work time; see Figure 2.1 (Strandberg and Josephson, 2005). The general approach in order to increase efficiency is to optimize these activities; however, there exist higher potential of improvement when addressing the waste activities. Focus should be on eliminating the unnecessary waste activities and reduce the necessary waste activities (Josephson & Saukkoriipi, 2005). LogNet can be used to manage delivery planning and thus

eliminating, or reducing, activities such as stockholding, multiple handling, unused time etc.

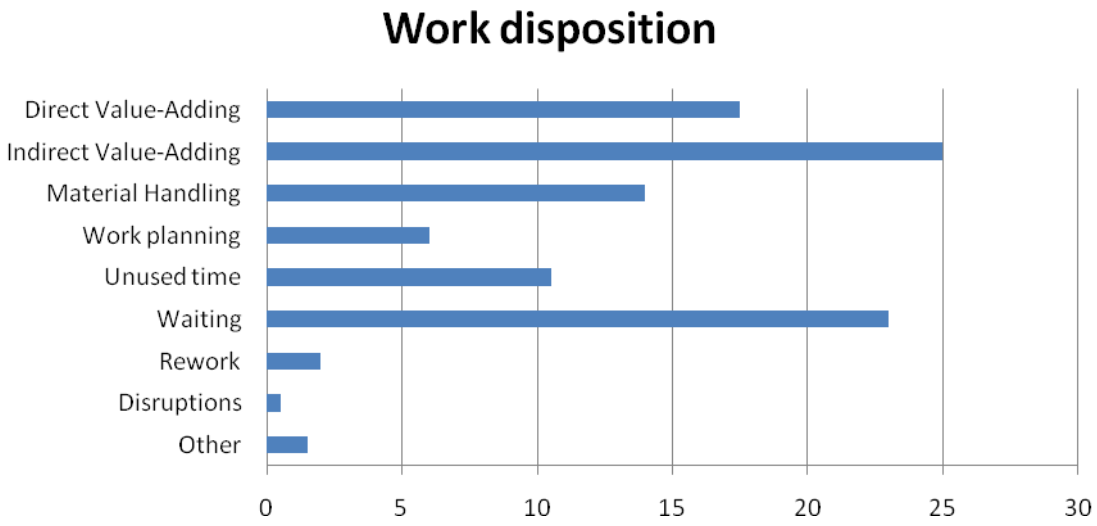


Figure 2.1 Work disposition of a typical construction worker (Strandberg &Josephson, 2005)

Furthermore, the study made by Josephson and Saukoriipi (2005) addresses additional waste activities as well, for example; heavy machinery waste corresponds to approximately two and five percent of the production cost, and unused material between one and three percent. In addition, when using Design-Bid-Build contracts Swedish contractors estimate that the bidding process represent in the region of four to seven percent of their annual turnover (Josephson and Saukkoriipi, 2005). This number can be reduced by limiting the number of actors involved in the process, e.g. only enquire actors with known references or previous collaborations.

Delivery activities on a construction site incorporate many of the previously mentioned waste activities and thus being an important area to address. According to a study made by Nicander (2009) approximately 25 percent, of the deliveries are not received according to specifications. This includes issues such as incorrect products, wrong quantity, and damaged goods etc. In addition, the deliveries are often not received according to schedule and thus creating confusion and frustration as a result and further down the line increased costs. Moreover, many of the projects suffered from disruptions in the operations as a direct result of the problems associated with on-site deliveries.

2.2 Logistics and Supply Chain Management

Logistics and Supply Chain Management (SCM) are concepts that play important roles in most companies. The main purpose of logistics and SCM is to increase efficiency and effectiveness and thus increasing the profitability. This is made possible through creating high customer service, low costs, high flexibility, low tied-up capital and short lead time (Jonsson, 2008). This chapter presents how logistics and SCM will be interpreted throughout the course of this study.

The construction industry is a complex industry where most projects are unique and go through several phases involving a large variety of actors from different lines of work. These include contractors, architects, engineers, clients, agents, suppliers, managers, logistics providers etc. The challenge is to control and manage all the recourses in order to make them work as effective as possible and govern them towards a common goal. According to Jonsson (2008), logistics may be described as the science of the efficient flow of materials which include production and distribution as well. The purpose is to make sure that the materials and recourses (personnel, machinery etc.) are at the right place at the right time. SCM is easily confused with logistics with the difference that SCM suggests an actual action made to increase efficiency and effectiveness. In addition, SCM cover a larger part of the activities involved in a products lifespan. In other words, SCM specifically emphasize on the integration between resource flows of the individual company and the resource flows of other companies within the same supply chain. This is illustrated in the definition of SCM according to the Council of Supply Chain Management Professionals (CSCMP, 2011);

> *"Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies".*

However, according to Jonsson (2008) the term "supply chain" is confusing since it would indicate a linear correlation between activities, which is usually not the case, the term "supply network" is probably a more suitable expression. In order to illustrate this further one can look at Figure 2.2, which illustrates a logistics system as part of a larger supply chain i.e. not confined to a single organization. The supply chain stretches from the supplier to the customer, which could cover the entire lifespan of a product. This figure significantly simplifies the complexity of the supply chain but delivers an understanding of the differentiation of a logistical system and a supply chain (Jonsson, 2008). In this figure the internal processes and activities of the

logistics systems have been divided up into three subsystems; material supply, production and distribution i.e. not a typical construction company.

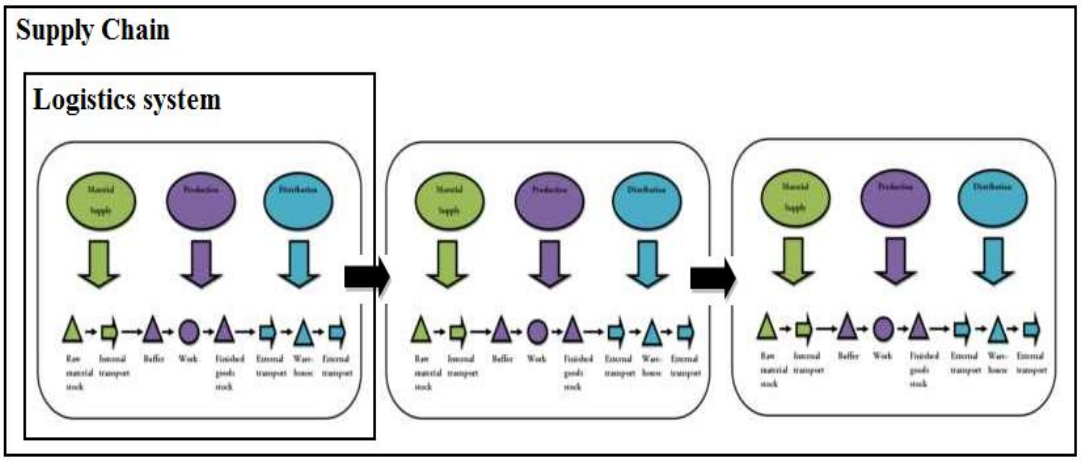


Figure 2.2 Example of logistics systems as part of a supply chain (Jonsson, 2008)

Logistics in construction correlates to a large variety of activities and the focus of this study involves evaluating in what way a delivery planning system can help managing these activities in order to achieve a higher efficiency and effectiveness across the project including its subcontractors, i.e. implementing SCM.

2.3 Delivery planning

Delivery planning includes the planning, coordination and management of the material flow from supplier to the construction site with focus on achieving the lowest cost possible. Since all construction sites are unique the availability of resources, e.g. cranes, forklifts, and storage facilities need to be taken into consideration. Generally, the construction site provides poor conditions for on-site storage of material such as wood and prefabricated elements due to being exposed to external risk factors such as weather conditions and general shortage of available space (Svenskt trä, 2010). In addition, all forms of multiple handling should be avoided to reduce costs since it is both time-consuming and puts the quality of the material at risk. In the initial stages in the delivery planning process, a delivery schedule is produced in which details regarding type of product, quantity, time of call-off, and time of delivery should be clearly stated (Svenskt trä, 2010). In addition to preparing the construction site for the delivery it is important to conduct a material control on the arrival. This control should involve checking the quantity, quality and measure the moisture content of the material (Svenskt trä, 2010).

In general, the procurement agreement regarding purchase of material includes transportation to the construction site which lead to that the material often delivered in large quantities (Friblick, 2005). According to Bertelsen and Nielsen (1997) another

problem is that deliveries to the construction site are rarely scheduled and that a large proportion of the deliveries are handled by the use of express delivery, resulting in high cost.

Logistics by planning and logistics by consumption are the two main principles regarding the material delivery process (Bertelsen and Nielsen, 1997). Logistics by planning involves calculating the future consumption and as a result of this the material are ordered and delivered according to the prognosis.Logistics by consumption concerns ordering material when the material reaches a certain minimum stock level. More recently a combination of the two principles has become the preferred option, a logistics by planning method on general level and logistics by consumption in the daily routine (Bertelsen and Nielsen, 1997). According to Bertelsen and Nielsen (1997) Just-In-Time (JIT) is an advanced and developed form of logistics by consumption where the inventory is reduced and thus the carrying cost. Furthermore, when conducting JIT deliveries, the material is delivered in very small batches whereas the minimum level of inventory decreases to almost nothing before restocking (Bertelsen and Nielsen, 1997). In addition, the JIT methodology requires effective overall planning from the company management and communication throughout all involved actors (Friblick, 2005).

Communicating information to all involved parties and keeping them updated throughout the course of the project is one of the most important factors in order to be efficient and productive. According to the study by Svensk Byggtjänst (2009), the average project costs could be reduced by approximately 13 percent, or 35 billion SEK, annually by establishing proper channels of communication. This includes schematics, deliveries, timetables, daily reports etc.

2.4 The procurement process and contract relationships

The building process typically begins with an idea or a need which the construction project is intended to satisfy or fulfill. This can be a completely unique project or a reproduction of a previous project i.e. a paint-by-numbers project (Jonsson, 2008). The need usually arises from the client and is followed up by acquiring resources needed to continue with the planning and construction. This can include the purchase of external contractors unless the client has the required competence internally in the organization. Furthermore, choosing a suitable contractual form is important since the financial and logistical impact on the project can be significant (Jonsson, 2008). In addition, this choice determines at which point the client becomes involved and also the specific logistical responsibilities of all parties, which affect the use of a delivery planning system. The contract can take a great number of shapes, however, three general forms can be distinguished; Design-Bid-Build (DBB, most commonly used), Design and Build (DB) and Management Contracting (MC). However, contracts such

as PPP's or Public Private Partnerships are becoming more and more common (Jonsson, 2008).

The Design-Bid-Build contract involves the client contracting an architect or engineer to act as a project coordinator, see Figure 2.3. The design and construction contracts are separated and the only evaluation criteria of the bids are the lowest total cost (LAO, 2005).

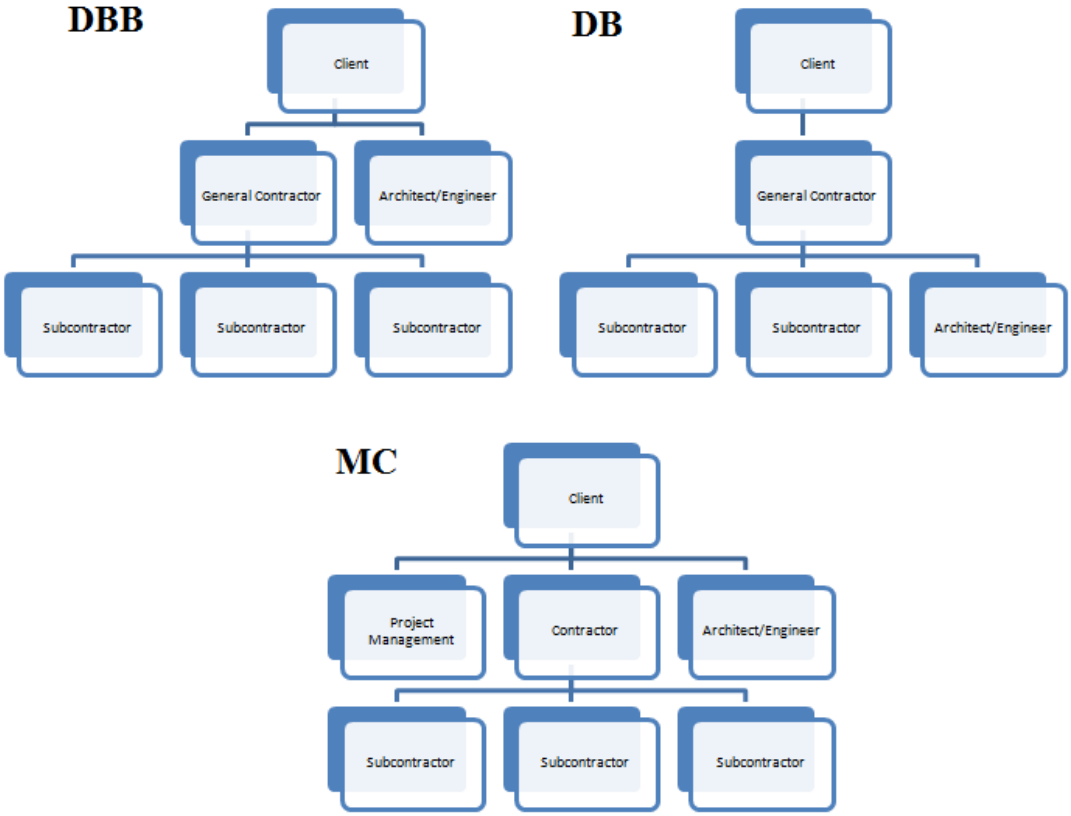


Figure 2.3 Examples of the hieratical structure of Design-Bid-Build, Design Build, and Management Contracting contracts (LAO, 2005)

Design and Build contracts include fewer actors within the project management whereas the client purchases a complete package from the general contractor or service provider, see Figure 2.3. The design and construction contracts in this scenario are combined into a single document (LAO, 2005). Management Contracting has the benefit of empowering the client to a great extent and thus creating a higher flexibility, control and transparency. The client establishes separate contracts with each actor e.g. architects, engineers, project management, and contractors being liable for the commitments regulated through the signed contracts (Constructing Excellence, 2004).

Supplier contracts need to be written in sufficient detail in order to be reliable and not creating disputes between involved parties. These contracts can take many shapes but

usually include agreements regarding price, quantity, flexibility, buyback/return policies, responsibilities, incentive rewards, revenue sharing, penalties etc. (Jonsson, 2008). Furthermore, it is important to cover as many aspects as possible when designing the contract since when a contract has been set up and signed by all involved parties it is difficult, time consuming and costly to implement any changes (Maylor, 2005). When there exist a lack experience with designing the contracts or there are some uncertainties, it is usually strongly advised to outsource these responsibilities to a legal office and use experienced lawyers to assist communicating every aspect of the written document to each of the actors involved in the project (Jonsson, 2008).

According to Maylor (2005), there are five important factors that should be considered when purchasing a service: Quantity, Quality, Price, Time, and Supplier. Moreover, if these five "rules" are taken into account, and not only the lowest bid, there is a high chance that the overall success of the project will benefit by reduced overall financial costs and increased fluidity in the operations. In addition, by using long-term contracts and relationships with trustworthy contractors and suppliers, many uncertainties and start-up issues can be eradicated increasing efficiency and effectiveness both in a monetary and a lead-time perspective (Maylor, 2005). Furthermore, long-term contracts have better chance of successfully implementing a delivery planning system, since it is a learning process and experience gained can be transferred between projects.

2.5 Third party logistics

The use of third party logistics (3PL) services has become an important logistics strategy for many companies. The principal of 3PL logistics concern the outsourcing of logistics activities to an external company specializing in this area of work (Langley, 2007). According to Schubert (2012), *"A third party logistics (3PL) company provides multiple logistic services. These services are integrated thus multimodal in nature. A 3PL would include transportation, warehousing, cross-docking, inventory management, packaging and freight forwarding".* A 3PL company can provide services relating to all, or parts, of a company's SCM functions. In order to be as effective as possible the services are needed to be customized according to the requirements of the client (Langley, 2007). According to surveys conducted by Langley (2007), the implementation of 3PL usually has a positive effect on both customer services and business process efficiency. Furthermore, the surveys showed that price and quality were the two main reasons for contracting a certain 3PL company.

The collaboration between the 3PL company and the customer is essential in order to achieve a good result. According to Langley (2007) "*Supply chain collaboration between a 3PL and a customer occurs when both organizations work toward a*

common set of goals and objectives, and when there is a meaningful exchange of information relating to planning, management, execution, and performance measurement". To allow for this, three cornerstones regarding collaboration has been developed; people, processes and technology (Langley, 2007). Considering these three cornerstones while customizing the service provides the prerequisites forachieving the intended objectives.

In 3PL companies, Information Communication Technology (ICT) systems are vital to generate a good service and there are many such systems available on the market. According to Langley (2007) the two single most popular technologies that 3PL companies supply their customers with are Warehouse Management Systems and Transportation Management Systems. Moreover, there is a large demand for visibility tools and web-based communication tools.

2.6 Delivery monitoring systems

Delivery monitoring systems can decrease the time for collecting and sharing information on a construction site and significantly reduce the response time in an unexpected situation (Mohammed, 2003). For example, these systems can improve localization of material, enable the identification of material, and reduce waste activities. Examples of such systems are RFID Technology, GPS Technology and GSM Technology (Suhong and Visich, 2006).

According to Langley (2007), Radio Frequency Identification system (RFID) is one of the IT systems with the greatest potential. RFID is a system with the purpose of detecting and monitoring various items using radio waves. These systems use transponders/transceivers that communicate with host terminals. The transponder is a chip that contains information regarding the item in question. This chip is in turn read by the transceiver, which forwards the information to the terminal, consisting of computers (Suhong and Visich, 2006). According to Sardroud and Limbachiya (2003), RFID system has some advantages over traditional barcodes. For example, barcodes are damaged relatively easily and thus being difficult to read; however, RFID chips can endure harsh conditions and does not require line-of sight for reading.

Global Position System (GPS) is a three-dimensional positioning system that requires four satellites to work, three for location and one for the receiver time. Furthermore, additional benefits of the GPS are that there are no geographical barriers and works regardless of weather and time (Sardroud & Limbachiya, 2003). Global System for Mobile Communications (GSM) is a wireless communication system used for cellular technology. According to Sardroud & Limbachiya (2003), there are typically two services that can be utilized to improve the delivery planning; Short Messaging Service (SMS) and General Packet Radio Services (GPRS). SMS is a system for sending and receiving information in the form of text where the main advantage is the

simplicity and the main disadvantage is the text length limitation. GPRS allows one to send, in addition to text, video and audio. Furthermore, GPRS can send more data and at higher speed than SMS (Sardroud & Limbachiya, 2003).

2.7 Software implementation

Implementing new procedures and technology in order to increase efficiency and productivity is often associated with a great number of challenges. New routines involve a time-consuming learning process for the intended users, a process that is proportionate to the complexity of the software (Intelera, 2003). In addition, implementation of new software usually slows down productivity momentarily decreasing direct value adding activities. Furthermore, it is important to understand that implementing a delivery planning system involves transforming the company's work processes and methodology in accordance with the system and vice versa. In other words, the emphasis has been shifted from pure technological development and programming into work process design (Al-Mudimigh et al., 2001). This transformation process needs to be addressed by all involved parties throughout the company including strategic, tactical, and operational levels. Furthermore, it is vital that these processes are transferred and adapted by all involved parties throughout the entire supply chain as well.

Communicating the applications and effects of the system to the intended users is of great importance and this can be a challenge since personnel can be resistant to learn new procedures. This scenario is quite common and needs to be addressed by the company at an early stage of the software implementation process (Intelera, 2003). It is up to the company management, or 3PL Company, to create training programs to remove barriers when implementing new software. These training programs should be developed to include necessary aids and be accessible anywhere and anytime. This enables the employees to practice and refine their skills until they can manage the applications of the software. This in contrast to having a single workshop in the initial phases of the implementation process which may lead to that the employees forget what they learned prior to actually using their skills. In addition, in order to create a smooth transition to the new system it is necessary to use a feedback system in the training program especially in combination with exercises (Intelera, 2003). Furthermore, the method the information concerning the new software system is conveyed is of great importance since our minds interprets information differently depending on the media in question (Intelera, 2003). For example, practice-by-doing have a 15 times higher retention rate than lectures meaning that the knowledge gained is 15 times higher and discussion groups have a five times higher retention rate than reading (Intelera, 2003).

Moreover, focusing on the right aspects is important since it is likely that less than 20 percent of the total amount of barriers will represent over 80 percent of the problems

in the end, this according to the Pareto principle (De Jager, 2011). These aspects can be identified through observations, discussions and general experience within the subject. Administrative theory also comes into account when discussing implementation effects of a delivery planning system and collaborating with different subcontractors and suppliers. This approach to management emphasizes the importance of the fact that accountability shouldbe linked to the authority in an organization where each employee should have one manager and each manager an area where the manager has sufficient authority in order to provide a uniform issuing of orders (Mintzberg, 1979). The concept of "span of control" suggests the number of people that a manager can efficiently control and monitor (Meier & Bothe, 1998), whereas the control decreases with an increased number of actors involved. According to studies more standardized tasks could increase the control span. In other words, standardizing activities by, for example, creating a more uniform approach to delivery planning through using a delivery planning system increases the span of control (Mintzberg, 1979).

In order to illustrate the potential benefits and savings with implementing a delivery planning system one can look at the study made by Favilla and Fearne (2005). This study chooses to present a case concerning a steel production company that implemented a logistical planning system to increase efficiency and profitability. The result was reduced procurement cost, reduced transportation cost, reduced lead times, and reduced stockholding. Moreover, the planning cycle time was reduced from 60 to 15 days and demand forecast accuracy increased from 40 to 60 percent. Additional result from the study was that delivery information and confirmation could be received almost instantly and orders delivered according to time specifications increased to 97 percent.

In addition, throughout the literature review a number of key Critical Success Factors (CSF) for system implementation were identified. These are important to assess in order to provide the best possible prerequisites for the implementation process. The CSF's presented were selected from studies chosen through a sampling process (see Figure 2.4). A brief description regarding each article is presented in the following section.

The Al-Mudimigh et al. (2001) article concerns implementation of Enterprise Resource Planning (ERP) software. ERP software is an instrument to develop the decision-making processes within an organization. The article presents several factors and key elements, which contribute to a successful implementation of ERP software. Choy (2006) describes the implementation of 11 Knowledge Management (KM) CFS's on Information and Communication Technology (ICT) companies in Malaysia. In the study made by Favilla and Fearne (2005) the aim is to find CFS's when implementing SCM with special emphasis on IT solutions. Moreover, the article written by Suhong and Visich (2006) focuses on the challenges and impact on the supply chain when implementing RFID technology. Furthermore, the study is based

on an online survey with over 350 participating IT executives. The article made by Alshawi and Faraj (2002) discusses how to successfully implement integrated construction environments on organizations within the construction industry. Finally, the article written by Fatina (2006) describes how to conduct successful software implementation in an organization with the least amount of resistance possible.

Critical Success Factor	Source	Critical Success Factor	Source
System training	1,2,3,5	Reward and recognition	2
Project management	1,3,4,5,6	Cost	3,4
Change management	1,5,6	Standardization	2,4,5
Top management	1,2,3,5,6	Security	4
Communication	1,2,4,5	Environment	4,5
Efficiency	2,4	Integration	4,5
Usability	2,4,5	Interface/design	2,4,5
Benchmarking	2	Stockholding	3,4
Accessibility	2,4	Waste	2
Reliability	3,4	Organizational culture	2,3

Figure 2.4 Identified Critical Success Factors, Source: 1. Al-Mudimigh et al. (2001), 2. Choy (2006), 3. Favilla and Fearne (2005), 4. Suhong and Visich (2006), 5. Alshawi and Faraj (2002), 6. Fatina (2006)

In addition, out of these CSF's four factors, or criteria, were chosen in order create an applicable scope for this study. Moreover, these criteria were chosen since they address the questions in the interview questionnaire and were frequently referred to throughout the studies. The chosen criteria were Usability, Cost, Efficiency, and Communication. Moreover, the factors are explained in further detail below, for references see Figure 2.4.

Usability concerns the interaction and operation of the system itself in order to create a more user-friendly work environment. This factor also includes system design, accessibility, and reliability. In addition, increasing the usability of a delivery planning system has the potential benefits of; for example, raising productivity and reducing the learning curve when implementing a new system.

Cost concerns the direct and indirect financial costs associated with the implementation of a new delivery planning system. Costs associated with this factor include system acquisition cost, employee and management training costs, waste costs, and stockholding. Reducing cost increase the overall profitability of the project.

Efficiency concerns how well the system fulfils the desired objective with minimal use of resources. This factor specifically involves reducing the number of non-value adding processes associated with the delivery planning system.

Communication concerns conveying project and delivery specific information to all involved parties in an effective way. This factor also correlates to the vertical and horizontal information flow throughout the company. Communication can established through a variety of different media such as, e-mail, telephone, face-to-face, and additional ICT systems.

3 Methodology

The purpose of this study is assessing positive and negative implementation effects of LogNet, a web-based delivery planning system for on-site deliveries. The study has been produced in cooperation with Svensk Bygglogistik AB. Moreover, this report is to a large extent based upon the findings made from two case studies in Gothenburg.

3.1 Case studies

This study is conducted as a multiple case study involving two similar construction projects in order to achieve a result of high credibility (Yin, 2003). A list containing potential projects to study was compiled through the recommendations of Svensk Bygglogistik AB. However, this list had restrictions due to the fact that there are only a handful of projects currently using LogNet to manage their delivery planning. After an evaluation of the potential projects presented two projects in Gothenburg were deemed applicable for this study. The projects chosen are similar in regard to size, budget, geographical location, construction phase, organizational structure, and purpose of use. These similarities reduce the impact of external factors possibly undermining an objective comparison due to different prerequisites.

The study is of a qualitative nature (Merriam, 2009), based on primary and secondary data. Qualitative studies refers to presenting how people, in this case the interviewees, perceive and interpret their experiences. This in contrast to quantitative research, which aim to present numerical values concerning the studied subject (Merriam, 2009). Primary data concerns information gathered through direct observations and interviews while secondary data consist of information available by previous research in form of journals, books etc. (Rabianski, 2003). The methodology of these meetings is explained more in detail in next section. In addition, if the population studied i.e. two projects would have been increased and thus creating a more extensive base of information, the results could have been different. The main reason of not doing this was due to the time limitations of this study.

3.2 Data collection

The information base used in order to conduct this case study is gathered through interviews with actors having different responsibilities within the projects. This methodology was decided upon on an early stage of the study and included one logistics manager, one logistics coordinator, one production manager, and one subcontractor, from each project. Contact with the logistics managers at the projects were established trough consultation with Svensk Bygglogistik AB. However, the methodology of receiving contact information from a possibly biased party could affect the result and decrease validity. The study aims to present results with both high

validity and reliability. Validity refers to how well the measurements and results fit the intended purpose of the study. Another concept connected to validity is reliability, which concern how trustworthy the measurements are. For example, the reliability is high if the interviewees have similar responses (Roberts et al, 2006). The correlation between the concepts of validity and reliability is explained further in Figure 3.1.

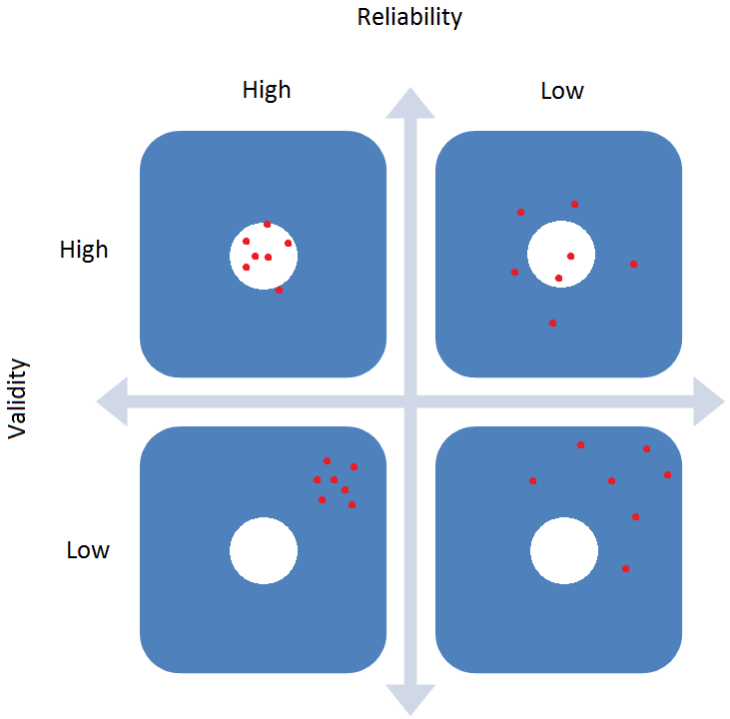


Figure 3.1 Correlation between Reliability and Validity (Roberts et al, 2006)

This methodology involving interviews with actors of similar responsibilities within the projects increases the reliability of the results. By contacting the logistics manager through e-mail, contact information regarding additional sources of information was supplied. This was followed up by approaching the selected actors through e-mail and telephone conversations concerning possible participation in the study. In addition, interviews with an operations manager from Svensk Bygglogistik AB were conducted on several occasions at Svensk Bygglogistik AB's main office in Mölnlycke.

The interviews were of a semi-structured nature using open-ended questions. This methodology was chosen in order to receive a more comprehensive understanding of the answers and to enable discussions stretching outside the framework of the study. Moreover, the interviewees were decided to be kept anonymous in order to circumvent any bias and achieve an objective result. All interviews, except for the subcontractors, were conducted on-site with respective actor with duration of 60 to 120 minutes. The interviews with the subcontractors were conducted at the subcontractors' regional office. Furthermore, having a studied population of adequate size reduces the risk of a specific actor having an extensive influence on the results.

The interview questionnaire can be found in the Appendix. During the interviews the answers were noted continuously and compiled after the session. In addition, these notes were later followed up through email and telephone contact in order to clarify and complement any misunderstandings.

Moreover, this study has been written with the aim of presenting the results from a holistic and inductive perspective even if atomistic and deductive approaches are considered as well. The concept of holism revolves around observing the overall picture or the macro perspective of the studied subject. In addition, this approach concerns the interrelation between processes and activities (Karakostas, 2008). In contrast to holism, atomism focuses on the individual processes and activities without addressing the correlation, or interrelation of such (Karakostas, 2008). Inductive conclusions are conclusions made from observations or other empiric studies without using existing literature as basis for information (Bilica, 2009). Deductive conclusions concerns conclusions and problem formulation made solely from existing literature (Bilica, 2009). The inductive methodology used in this study correlates to presenting conclusions made through empiric studies in the form of interviews at the construction sites. The holistic approach correlates to interviewing a variety of actors involved in the project enabling the possibility of understanding how the processes and activities interrelate. To illustrate how this study relates to these concepts in further detail one can look at Figure 3.2.

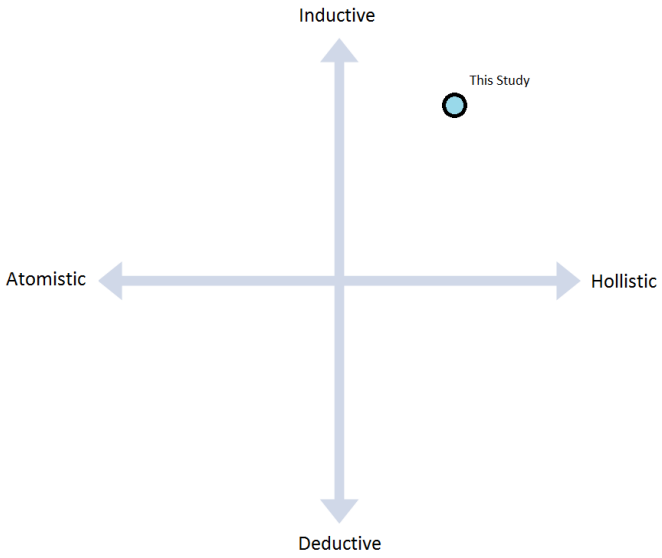


Figure 3.2 the relation of this study to the concepts of holism, atomism, inductive, and deductive conclusions

In order to gather required information regarding LogNet an account was setup by Svensk Bygglogistik AB. This account was used throughout the course of this study

to provide the possibility of assessing the functionality and becoming familiar with the procedures incorporated with the delivery planning methodology.

3.3 Data analysis

The implementation effects are discussed and analysed in relation to four criteria; cost, usability, efficiency, and communication. This methodology is used in order to be able to evaluate and present the findings with a structured approach. The four criteria were chosen since they cover a wide range of implementation effects and represent the basis of the interview questionnaire. In addition, a literature study concerning Critical Success Factors for software implementation was conducted in order to verify that the four selected criteria were applicable and relevant for this study (see 2.7 Software implementation).

Furthermore, within each criterion the data is divided into positive and negative feedback. The information gathered during the interviews was compiled into a single text document. At this stage the data was interpreted in order to create an understanding of the interrelation of activities and processes and being able to analyse the cases more thoroughly. In order to enable the possibility of presenting the results in a comprehendible manner this study has chosen to assess the cases separately. Moreover, the gathered information is presented in two parts, implementation and feedback in order to separate the actual implementation procedures and personal reflections made by the interviewees. This was done in order to create a structured approach to the results and provide a basis for the analysis.

The analysis part of the study assesses the collected data from both case studies combined. This analysis is conducted in correlation to each evaluation criteria individually. Finally, the information is presented in a more general form (see Figure 5.1) in order to provide an outline of the results of this study. This is followed by the conclusion chapter presenting the main findings of this study and recommendations of further research.

4 Results

In order to be capable of assessing the positive and negative effects when implementing the LogNet delivery planning software, two case studies were performed. Both projects are operated by a major construction company on the Nordic market.

Figure 4.1 Geographical location of the projects

These two projects are located at Hjalmar Brantningsplatsen in central Gothenburg, see Figure 4.1. The area has previously served as the grounds for housing the pottery factory Rörstrand. The company relocated in 1939 and throughout the years up until the 1980's the premises housed a number of small companies (GP, 2009). During the 1980's the premises were closed off for the public due to poor building conditions and were ultimately demolished in 2003 (GP, 2009). The property was then sold in 2008 to the construction company that had the intension of transforming it to condominium housing (GP, 2009). This transformation is now in the final stages and is scheduled for completion in the winter of 2012 (Case 1, 2011).

4.1 Case 1

Case 1 concerns a 17-storey building (see Figure 4.2) consisting of 53 condominiums with individual area ranging between 55 and 154 square meters. Furthermore, the project is a design-bid-build contract using the LogNet delivery planning software as a tool to manage the delivery activities on the construction site.

Figure 4.2 Cross-section of case 1

Implementation of LogNet

The delivery planning process revolves around LogNet.The software is used on a daily basis in order to help the users plan and book deliveries along with available equipment and resources necessary forthe unloading of delivered goods.The software is used to ensure a harmonious flow of deliveries without excessive workload or delays. At the project, a logistics manager has been appointed to hold the main responsibility regarding the logistical issues within the project. However, each subcontractor is responsible for their own logistics activities including deliveries, personnel and machinery.

The deliveries are checked in relation to the information logged by LogNet at the gate and delivery quantity, quality, and moisture content are measured. Furthermore, this responsibility of control has been delegated to worker with limited physical ability since the physical requirements are low. To convey the information from LogNet to the workforce, the logistics manager uses various media. The main source of information is computer screens placed in the work quarters; these screens present a continuous rotation of slides stemming from LogNet. These slides include information regarding daily and weekly delivery schedule, resource schedule, weather forecast and project specific news. Other media used to share information from the system are printouts and verbal communication. Moreover, an important issue that was highlighted during the site visits was that the logistics manager received a much higher workload than originally intended. This was due to the fact that delivery recipients contacted the logistics manager and asked him to do their bookings in LogNet directly, in contrast to them making their own bookings followed by the

logistics manager approving them. There exist difficulties in learning new tools and procedures. However, these tendencies are a part of a transition phase when implementing a new system.

Feedback from LogNet users

The general consensus made from the site visit was an overall positive attitude towards LogNet. The positive aspects included higher utilization of recourses, less unnecessary delays, easy access to delivery information, and significantly reduced lead-time. The negative aspects revolved around implementation issues, and more specifically, resilient attitudes towards new systems among the users.

According to the logistics manager, the lead-time effects occurred as a result of several factors. For example, the visualization of the weekly schedule increases the overall awareness of the operations leading to better forward planning and more structured flows in the deliveries. In addition, the risk of delivery collisions was significantly reduced along with unnecessary delays and general confusion stemming from unscheduled deliveries or deliveries with unspecified content/recipient. On-site storage was optimized as well since the material was delivered directly to the desired location and thus reducing multiple handling and temporary storage. Moreover, the increased utilization of recourses was important since machinery and personal represents one of the major cost factors associated with construction projects thus being one of the main areas to address when trying to increase effectiveness and lowering costs. In other words, machinery not in use still generates a running cost and it is essential to create a manageable workload while keeping the machinery in continuous operation. Furthermore, the logistics manager illustrated how LogNet can contribute to a more cost effective construction process by explaining the outlines of situations that occurred during the construction phase of the project.

> *The first situation concerned sabotage of material stored at the construction site. Apparently, the material had been stored at various locations on the construction site awaiting transportation to the intended place of mounting. However, this solution left the material vulnerable to sabotage during the night time when the construction site was not under supervision. The result was that somebody or some ones had breached the perimeter thus gaining access to the material and sabotaging the project. The sabotage consisted of theft and damaging the material, rendering it unfit for use. In one case the material was even lit on fire damaging a high amount of material. However, the result of this incident could have been much worse if the fire had spread to other adjacent material or housing which could have proved devastating not only to the project but also to the surrounding community. According to the logistics manager optimized use of LogNet can reduce the risk of these incidents occurring by implementing more efficient just-in-time deliveries and thus*

decrease the need for temporary storage at the construction site. LogNet cannot eliminate the risk of sabotage; however, it can minimize the time the material is left open to external influence that also includes weather conditions such as rain and snow.

Another situation illustrated by the logistics manager involves the storage and delivery of concrete elements to the construction site. This scenario shows to prove how important continuous communication and feedback with the suppliers throughout the project is. Moreover, how LogNet can help the user to visualize and understand the information given regarding the deliveries of a specific actor within the project. Shipments of concrete elements take place throughout the majority of the project's duration. These concrete elements are essential since they serve as the very foundation of the structure and need to be mounted in order for any other succeeding construction work to proceed. In other words, failure to deliver the concrete elements on schedule and according to specifications can result in a domino effect where other actors and activities are affected negatively. This creates a gap in productivity where the resources are not utilized to an optimal degree and thus creating unwanted costs. When the concrete elements were delivered to the construction site they were inspected and photographed at arrival in order to ensure that the delivery was up to specifications. The gathered information was used as a reference sheet for establishing a communication channel and feedback system with the supplier in order to optimize future deliveries. This proved beneficial for both the construction company and the supplier since both organizations could adapt their respective supply chains to fit the prerequisites of the other party. Establishing a good communication and feedback system is particularly important when it comes to working with subcontractors with the intention of creating long-term relationships or cooperation. Properly implemented, LogNet can provide statistics containing information regarding the deliveries by a specific actor made on schedule, bookings made on schedule; this can then be used as a reference sheet to pinpoint areas improvement or serve as a basis of supplier evaluation. Further updates to LogNet could be made to include issues such as shipment contents, damages to the shipment, shipment quantity etc. in the statistics. This methodology of evaluation regarding the deliveries and handling of the material made by the respective parties is of interest especially when attempting to establish a long-term relationship with a supplier. However, using a feedback system is nearly just as important when it comes to temporary supplier relationships since the objective is to increase productivity and profitability by making the deliveries run as smooth as possible.

Moreover, an issue in focus regarding the implementation of LogNet is that the resilience to use the software did not stem from the complexity of the software itself, but rather the challenge to introduce new routines in the daily work. This since the

software requires the users to submit information about each delivery in a more extensive way compared to previous work routines. According to the logistics manager, the prerequisites from the construction company's perspective when choosing a delivery planning system was that the system should be user friendly, i.e. not requiring a long time to understand and have high accessibility. Accessibility in this case means that it should be possible to use the software through a variety of media, e.g. computers, mobile phones and tablets. According to the interviewees, LogNet fulfils these requirements and has proved to be an effective aid in managing and structuring the daily operations. However, there is a desire to use the light version of LogNet to enable a smoother transition process and attract more users. In addition to this, wishes were expressed for having computer terminals located at the construction site to be used solely by the construction workers and subcontractors to make delivery and resource bookings in LogNet.

During the site visit the logistics manager and logistics coordinator expressed their desire to develop a delivery planning system in-house enabling a higher degree of customization according to the organization's and project's requirements. One advantage when developing such a system in-house is cost reduction over the long-term even if the initial costs of development are higher than purchasing an existing system. Another advantage concerns standardization, since the organization has the possibility to make the use of such a system into a standardized tool for managing logistical issues throughout the organizations different projects. This system could then be adapted to fit all sizes of projects even projects where a system such as LogNet normally would not be financially justified. Customization also enables the possibility of adding additional functions in the software along with integration of other systems used by the organization thus extending the area of application; such systems could include Radio Frequency Identification (RFID) and Global Positioning System (GPS). These systems can be used separately but also combined with each other through a portal to be as effective and accessible as possible. RFID could be used at the construction site to minimize the time spent on searching for a specific machine or material. In addition, checking the inventory is made less time consuming and thus reducing the cost. RFID can identify specific machinery and materials equipped with a RFID chip and through this determine whether the inventory needs to be restocked or not. GPS has many areas of application, it could be used to locate a delivery in transit, provide information regarding drop-off point etc.

As mentioned, LogNet is intended to be used as a tool for managing just-in-time deliveries in order to reduce the lead-time and thus costs. However, this requires that all parties involved in the project implements LogNet in their daily routines. According to the subcontractor, additional modifications to the typical supply chain structure were made in order to being able to follow the contract clauses regarding time requirements for the deliveries. The result was that the subcontractor was forced to order large quantities of material at an early stage to stock internally at the company's warehouse enabling easy and fast access to material and the possibility of

shipping out material to the construction site whenever the demand arises. However, this is not the intention of LogNet since it creates longer supply chains and additional costs. However, the subcontractor was very positive to systems such as LogNet, being able to see all the potential advantages it involves and seeing it more as an issue of adaptation rather than problems with the software itself. Moreover, this requires charters and clauses in the contract regulating all parties involved through financial reprisals etc.

Another consensus made from the interviews was that feedback system regarding the deliveries needs more focus in order to create a well functioning structure of daily operations. The feedback generally used is informal i.e. not planned in advance and highly spontaneous. Furthermore, it is usually of a negative nature meaning complaints when something is not working rather than complementing on a job well done. According to the logistics manager, some suppliers receive a deviation report including information in the form of pictures and an explanation of the issues at hand. The reason of this is to enable the supplier to improve their future deliveries and reimburse any damaged or lost goods. Feedback systems are important for LogNet to function properly in the sense of having the desired effect, i.e. creating a structured work environment regarding deliveries.

A situation, which came up to discussion with the logistics coordinator during the site visit revolved around the delivery of specific window elements. These window elements were ordered to be delivered according to certain specifications, which included arranging the window elements in a specific order to enable easy mounting and eliminating the need of temporary storage at ground level. Moreover, the specifications also included that the window elements with dimensions greater than a predetermined number were placed lying down instead of standing up and thus avoiding any risk of damage to the window elements. However, this proved to be information that was difficult to communicate to the supplier in question. When the window elements arrived at the site, they were arranged in a completely different order, which eliminated the possibility of transporting the elements as a package to the desired location for direct mounting. Instead this resulted in additional activities since the window elements needed to be stored at ground level and rearranged to fit the intended model of application. To avoid a repetition of this procedural problem a feedback channel was implemented in order to ensure deliveries according to specifications in the future. The information was properly conveyed and both parties were on the same page regarding the next shipment. The following shipment of window elements was up to specifications regarding the order of the elements; however, the window elements that were supposed to be delivered lying down arrived to the site standing up. These conditions once again resulted in additional work through having to shift the larger window elements from a standing up to a lying down position in order to avoid any damages occurring when handling them. The issue in this situation is communicating with all parties

and at an early stage since the complexity of the supply chain increases with number of activities and actors.

Furthermore, there always exist external factors that cannot be accounted or planned for in advance. Examples of this can be weather conditions, traffic accidents, traffic jams, machinery failure, system malfunction, internet connection issues, and user errors. Even if these factors cannot be accounted for this proves that even while using a delivery planning system such as LogNet, a reasonable safety margin should be applied on incoming deliveries and vital activities in each project.

4.2 Case 2

Case 2 includes eight buildings (see Figure 4.3) containing 345 condominiums (Logistics manager, 2011). In addition, the construction includes a parking garage located under one of the buildings. The project is a design-big-build contract similar to case 1; however, at case 2 LogNet is not used to manage the delivery activities at the construction site.

Figure 4.3 Case 2 overview

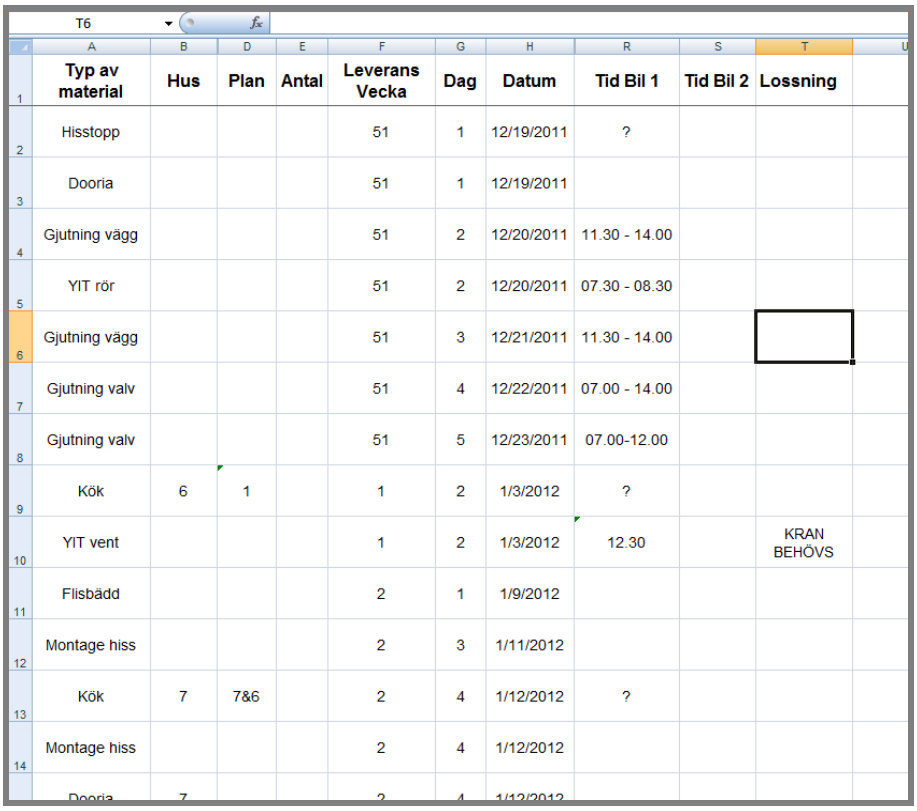
Implementation of delivery planning systems

In contrast to case 1, LogNet is not used at this project to manage the daily delivery planning routines; instead the delivery planning is handled through using Microsoft Excel to list and schedule upcoming deliveries and information regarding destination, quantity, person responsible etc. This methodology of delivery planning has both positive and negative aspects, on one hand it is less costly and time consuming to

acquire and implement, in addition, most of the people is familiar with the software. On the other hand, using Microsoft Excel as a delivery planning system creates a higher workload through not being accessible by a web portal and thus having to convey the information via personal contact and printouts solely. Furthermore, the risk of human errors plays a more significant role when it comes to this type of methodology since all bookings and verifications of these are made manually without additional safety measures increasing the risk of delivery collisions.

Similar to case 1, a logistics manager has been appointed to be responsible for the logistical issues within the project. In addition, each subcontractor at case 2 is responsible for his or her own logistics, which include deliveries, personnel and machinery and the delivery quantity, quality and moisture content are checked at the gate. As mentioned, the methodology of collecting and distributing the information regarding the deliveries at project is highly different than at case 1 being of a much more conventional nature, i.e. personal contact through meetings, e-mail, phone, and fax. The logistics manager collects the necessary delivery information from his chief operation officers and verifies this information with the respective subcontractors in order to minimize the risk of double-bookings. The gathered information is then compiled into a single Microsoft Excel sheet (see Figure 4.4) in order to visualize the data making it more comprehendible and accessible.

Furthermore, regarding the collection of delivery information, it is important that this procedure is conducted with good forward planning preferably several days, if not weeks, in advance. This creates a continuous flow of material that in turn decreases the risk for unintentional stockpiling of goods and rash decision-making (leading to unwanted logistical problems). Moreover, the responsibilities of the logistics manager when using this methodology for delivery planning is highly time-consuming and subsequently demands a high safety margin in order to work in practice.



	Typ av material	Hus	Plan	Antal	Leverans Vecka	Dag	Datum	Tid Bil 1	Tid Bil 2	Lossning
2	Hisstopp				51	1	12/19/2011	?		
3	Dooria				51	1	12/19/2011			
4	Gjutning vägg				51	2	12/20/2011	11.30 - 14.00		
5	YIT rör				51	2	12/20/2011	07.30 - 08.30		
6	Gjutning vägg				51	3	12/21/2011	11.30 - 14.00		
7	Gjutning valv				51	4	12/22/2011	07.00 - 14.00		
8	Gjutning valv				51	5	12/23/2011	07.00-12.00		
9	Kök	6	1		1	2	1/3/2012	?		
10	YIT vent				1	2	1/3/2012	12.30		KRAN BEHÖVS
11	Flisbädd				2	1	1/9/2012			
12	Montage hiss				2	3	1/11/2012			
13	Kök	7	7&6		2	4	1/12/2012	?		
14	Montage hiss				2	4	1/12/2012			

Figure 4.4 Example of the Excel schedule used by the logistics manager

This Microsoft Excel sheet (see Figure 4.4) is an example of the printouts used by the logistics manager. As can be seen, the sheet contains high amounts of information regarding the deliveries in question, e.g. contents, destination (building, level), quantity, time of arrival (week, day of the week, date), duration, resources required and place of unloading. Additionally, information provided could include personnel that needs to be informed about the delivery and which security measures that are needed, e.g. setting up blockades or safety barriers.

The fundamental criteria for using this methodology of delivery planning is that the logistics manager needs to actively make sure the information reaches all involved parties in the project. As mentioned, this is made using several different medias, i.e. the Microsoft Excel sheets which are e-mailed to everyone involved, printouts for handing out to people of interest, weekly meetings where the information of upcoming events is presented, and on computer screens located at the community areas on-site in order to reach out to everyone at the ground of operations and quickly convey information regarding any updates to the delivery schedule.

Feedback from users

As previously mentioned, the construction site did not use any software specifically designed to aid in the delivery planning process for construction projects. However,

the logistics manager had developed his own procedures for handling this process by using software such as Microsoft Excel to list scheduled activities and keeping track of involved actors. According to the logistics manager, this is a rather blunt instrument with limited ability to create an overall understanding of the deliveries and the performance of specific actors. In addition, it was emphasized that this methodology requires much more manual work in order to convey all the necessary information to the correct actor. This is a methodology that is commonly used in various forms at construction sites nationwide and usually fulfils its purpose; however, the intention of specifically designed delivery planning systems is to increase the effectiveness of these processes. In order to exemplify the possible benefits of an implementation a few scenarios, which occurred during the construction will be presented in the following section.

The first situation involves facade panels and presents an example of how major problems and costs that can arise when logistical management decisions are not followed throughout the communication lines from the supplier to the end user. In this project the facade system was made up of different facade panels. The facade system can briefly be described as a big puzzle you put on the wall where all exterior sides are unique due to the window placement, balconies etc. The facade panels are delivered to the project prefabricated in packages and are intended to be packaged in the order they should be mounted. For example, this means that the package containing facade panels marked and intended for the north third floor can delivered and mounted directly without multiple handling or temporary storage. On one occasion a shipment arrived containing 32 packages consisting of facade panels belonging to four house sides and seven floors in total. However, at delivery arrival, it became clear that there were major shortcomings in the delivery. For example, facade panels associated with north and west, and various floors were mixed together in the same package. Furthermore, because of poor labelling the packages had to be opened at ground level checking the dimensions manually and comparing the facade panels against what was originally specified in the manifest. By doing so, it could be determined where the package was intended to be mounted and thus where it should be delivered. The sorting of the facade panels had to be made by forklift, this since the packages weigh approximately 700 kg each. Having a truck standing unused for a long time is inefficient and very expensive; in addition, it also affects subsequent deliveries, which cannot be unloaded due to unavailability of space. If the packages are opened the facade panels are more exposed and vulnerable to unnecessary damages. In addition, the risk of damages also is increased when multiple handling is required. On top of all that has been mentioned, the delivery was five weeks late.

All these events occurred despite the fact that the supplier had received clear instructions of how the goods should be delivered. If the packages had been delivered pre-sorted with clear labelling, a forklift could have unloaded the

truck and transported the facade panels directly to the mounting site. Instead, this rendered large amounts of additional costs and delays for both the supplier and for us. When one looks back on this scenario, it probably would have been a correct move to return the initial shipment in the beginning of the process. This could have been avoided with better communication and logistics management.

This illustrates an example of logistics management gone wrong especially in the supplier end of the supply chain. Even if it is difficult to weigh in every single factor into the equation these events could have been dealt with through better communication and the effects could have been reduced significantly by addressing the issues on an early stage. Moreover, this example clearly shows the effects of the lack of forward planning, which is rather typical for the industry in general. New tools for delivery planning can be used to increase the forward planning and communication between actors and in return create a more structured approach to construction. According to the logistics manager, systems such as RFID could have been used to locate and identify specific panels directly without having to perform manual measuring or opening the packages. This could have saved considerable amounts of time and resources in addition to not exposing the material to dangerous weather conditions etc.

Another situation illustrated by the logistics manager that can create major problems in logistics management includes subcontractors and their use of the foreign transportation providers. Some of the subcontractors use foreign transportation providers to transport materials to the construction site, creating language and cultural barriers. When foreign companies are used, it is difficult if not impossible to establish contact with drivers in an early stage and if contact is established with the driver he or she is most unlikely to speak Swedish or English. This results in that when the driver shows up, usually not according to schedule, they park at the unloading site and refuses to move the truck until it has been unloaded. This creates interference in the everyday traffic and delays other scheduled deliveries.

This illustrates the importance of establishing good communication channels and the necessity to create a solid contract clearly making every actor liable for their actions. Including the proper clauses into the contract can have positive effects on situations like these since the parties involved are usually more likely to act according to the contract, and thus schedule, if financial penalties are implemented. In order for this to work, it is important to make all the actors subordinated the contract and possibly also the delivery planning methodology, e.g. a delivery planning software.

A prime example that shows how much there are to gain from good logistics management involves one of the window suppliers. In advance an order was sent to the window supplier containing a specification regarding how the windows should placed on the pallets and exactly how the windows should be delivered to

the site. The result was that the windows were at the mounting site on the morning enabling the carpenters to immediately start the assembly process without any delays. This means that the windows have direct transportation from factory to mounting site causing minimal stockpiling and exposure.

This situation is easily comparable with the facade panel scenario with the difference that this approach was conducted in accordance with the original plan and executed perfectly. This demonstrates that it is possible to plan and execute logistics management with basic logistical tools such as Microsoft Excel. However, again this requires much more manual work to communicate the necessary information. When using delivery planning software the human error factor is significantly reduced leading to less last minute problem solving and delays.

5 Analysis

Throughout the course of this study there have been clear indicators that there exists a need for standardization of the methodology concerning the delivery planning process for on-site deliveries and implementing Supply Chain Management (SCM). Examples of tools that can be used to aid in this process are delivery planning software such as LogNet and other information communication technology systems such as Radio Frequency Identification System (RFID), and Global Positioning System (GPS). In addition, in order to efficiently coordinate resources and implement SCM the client, or the contractor, can outsource this responsibility to a third party logistics provider. Regardless, it is important that logistical planning should be considered as a vital part of the construction process. According to the interviewees, there exists a negative attitude towards logistics in the construction sector in general.

In addition, the belief is that there is a need for conducting thorough studies and investigations demonstrating the financial benefits of implementing efficient logistical solutions. However, the opinion made during this study is that there already exists adequate information providing hard evidence of the possible financial gains made from implementing SCM. It is only a question of conveying this particular fact to the correct individuals within the administration. In addition, in order to circumvent this cultural barrier it is essential to illustrate the advantages of SCM in a structured and comprehendible fashion. The following sections discuss the implementation effects in regards to the respective evaluation criteria, i.e. usability, cost, efficiency, and communication. Finally, the positive and negative implementation effects are compiled into a table, see Figure 5.1.

5.1 Usability

The general consensus attracted from the sites was that most construction projects lack emphasis on logistics regarding on-site deliveries. In addition, the interviewees perceived LogNet as step in the right direction creating a structured approach to delivery scheduling and supplier evaluation utilizing the available resources. When developing and implementing new systems there is room for improvement, this since the software needs to be customized according to the requirements of each customer. Approached with questions about possible improvement areas regarding the software the interviewees expressed satisfaction regarding the simplicity and availability of LogNet, however, one feature interpreted as missing was an integrated channel of communication in the form of a chat function or similar. Due to the fact that each user need to sign in using a personal username and password in order to be able to access the software there is the possibility of implementing such a function without modifying the software extensively. Such a feature could be designed to include individual actors and sub grouping of actors in order to convey information to specific

parties through the web portal. These messages should be sent and received with the option of selecting the preferred media, e.g. SMS, LogNet integrated chat or e-mail. According to Langley (2007) web-based communication tools are of high interest thus supporting this statement. The main benefits of implementing a chat function into LogNet is that it provides easy access to all involved actors and making the software serve as a direct media between parties without intermediary processes. In order to benefit the most from RFID, GPS and GSM technology these three systems can be combined with each other into a single system. In the combined system the GPS technology locates the items and helps to observe the transports, the RFID technology collect item information. Then the information and location of the item is distributed to the parties involved through GPRS and SMS technology. Using this system could improve the delivery process significantly and increasing the visibility.

Furthermore, when the implementation of the delivery planning system is complete and the system is up and running it is important to evaluate the performance of the system. This study is an example of such an evaluation; however, this can be extended to include more specific data or measurements. For example, areas of interest can be measuring time spent to complete a certain task in the software and the number of steps required in order to do so. Other evaluation criteria could include simplicity of the software e.g. measuring the number of mistakes committed by users and the impact degree of these mistakes. Moreover, transition of knowledge between projects is important and the degree of system recollection after periods of non-use could be measured to serve as a performance indicator of the system as well. Finally, a key performance indicator of importance is the user response; this indicator can include evaluating how the user feels about the software. The evaluation of these impressions could cover questions such as: Does the users feel confident about their ability to use the software? Possible areas of improvement? Stress level when using the software? Is the system stable? Would the user recommend this software to others?

5.2 Cost

The direct acquisition cost may be considered to be small in correlation to the potential savings. However, one must look at the entire picture and take all economical factors into account. Apart from the initial acquisition cost there will be costs in form of direct educational costs (instructors, wages etc.), costs for additional personnel if necessary, higher contract rates due to higher workload and responsibility for subcontractors etc. However, the simplicity of the software in question contributes to a smoother transition when implementing a new delivery planning methodology since the learning curve is proportionate to the complexity of the software.

As mentioned, implementing delivery planning software or new procedures in general usually leads to additional expenditures and higher acquisition costs of services required from subcontractors. This is an issue since the mindset within the

construction industry is to acquire the specific service at the lowest cost possible (see chapter 2.4) instead of evaluating the bids during the procurement process according to additional criteria such as the five factors presented by Maylor (2005); quantity, quality, price, time and supplier. This may result in additional cost in form of not achieving the intended degree of quality within the timeframe. The contractual form plays an important role during the procurement process since it determines which actor who has the responsibility of coordinating the project as well as the financial liability, this actor stands to gain the most by implementing a functioning and efficient delivery planning system such as LogNet. Furthermore, implementing SCM and JIT deliveries reduces the need for temporary storage and material waste. The material waste is reduced due to the fact that monitoring of material and material consumption is increased when implementing a functioning delivery planning software.

In addition, implementing a delivery planning methodology such as seen in case 2, i.e. using the Microsoft Excel software for scheduling deliveries, create less direct acquisition costs. However, one has to consider the cost throughout the entire course of the project. In addition, there exist several advantages with this methodology such as a familiarity with the software available to most. However, this methodology is associated with higher degree of workload conveying the information to all parties as well as being much more sensitive to human errors. This is an example of how logistics managers try to make the best of the situation by using the means available.
To address the potential risks associated with the implementation of a web-based delivery planning system one must consider the impact of a system failure. The likelihood of this happening is possibly not that high; however, the consequences can be catastrophic when the delivery planning system is completely dependent on the software itself. One scenario can be that the server controlling the software goes down due to computer viruses, electrical failure, hardware, and malfunctions etc. This would result in great costs since one would not be able to see upcoming deliveries, plan new deliveries without the risk of double-bookings. These facts suggest that creating backups of the schedule should be performed continuously in order to decrease the possible impact. There already exist a backup server for LogNet to prevent this from happening but no system is totally impervious to malfunctions. Furthermore, system failure is a potential risk when using other computer software such as Microsoft Excel as well; however, having the schedule stored locally and not on a server enables a higher extent of data backup and printouts.

5.3 Efficiency

Using delivery planning systems such as LogNet is a form of standardization and by analyzing the theories stated by Meier and Bothe (1998) one can deduce that the span of control is increased when implementing this kind of tools to aid in the delivery planning process. This meaning that when the implementation is complete, the logistics manager can manage and control a greater number of actors, including

subcontractors, without an increased workload. Furthermore, this leads to a higher efficiency through fewer individuals handling a greater responsibility and thus also reducing costs.

Moreover, the issue of the logistics manager receiving a higher workload than originally intended was due to the fact that the actors contacted the logistics manager and asked him to do their bookings in LogNet instead, this in contrast to the actors making their own bookings and the logistics manager approving them. Results of this are higher costs mainly due to inefficiency and increased information lead-time. This problem can be resolved by introducing comprehensive contracts in the procurement process clearly stating the responsibilities of each actor and making them liable for their own actions. Financial liability act as a deterrent against breaking the agreements made between the different parties, e.g. client and contractor. One should bear in mind that the users of the system are actors with various amount of technical expertise and knowledge of information communication technology systems. Implementing "easy to use" software for delivery planning is important to include all parties in the planning process and thus creating a more productive construction process. In this sense the interviewees deem that LogNet fulfils its intended purpose well, however, there are issues regarding the system application when it comes to some subcontractors at case 1. These issues can be related to the resilience to commit to the software and instead calling the logistics manager or other contact to book the delivery. This methodology creates more intermediaries and counteracts the intention of the LogNet implementation.

One of the main benefits when implementing a delivery planning system is that the production mangers can focus on the production itself, adding value to the project, instead of dealing with delivery issues having to make rash decisions, often with inadequate information. This responsibility should be transferred to the logistics manager who usually has greater experience of dealing with the delivery activities and having the advantage of being able to see the larger picture over a certain time period. During the site visits, the question of integrating new features and systems such as RFID, GPS and GPRS into LogNet arose. However, this could compromise the very idea with the system by making it more complex to use and thus creating additional implementation difficulties. Furthermore, by integrating additional systems into the software the scope of application would be broader; on the other hand this would transfer the software into competing on a completely different market. This since there already exist systems that provides these kinds of services. This study suggests that it is more important to make efforts towards increasing function quality instead of quantity i.e. increasing the usability and accessibility of the software instead of adding new features.

An important feature that has been integrated into LogNet is a feedback system listing information regarding frequency of deliveries received on schedule thus creating the possibility of evaluating each actor's individual performance. However, this feature

could be extended to cover more aspects of the actor's performance and thus serving as a broader base for decision-making regarding contractual performance evaluation and future collaboration. These aspects could include how well the delivery matches the order in regards to quantity, quality etc. In addition, one could also measure the frequency of LogNet bookings made by each individual actor and their degree of forward planning in order to visualize the utilization of the software itself. This is important since being able to deliver according to schedule is only one part of establishing an effective supply chain, i.e. being on schedule is not as beneficial if the order needs to be returned due to incorrect or damaged products. Moreover, it is important to choose an appropriate contractual form during the start-up face of the project in order to optimize the conditions for the implementation of a delivery planning system. Since choosing a suitable contractual form influence the responsibilities of each actor it is important that there exist a central decision-making entity having sufficient authority to enforce the use of such a system e.g. design and build contracts.

Another approach to manage the daily delivery planning is to develop a delivery planning system internally at the company in question. An advantage with this approach is that the software can be tailor-made to fit each unique project even smaller ones whereas purchasing external software normally would not be financially viable. Another advantage is that it could be standardized as a tool to manage the on-site delivery planning within the company and over time making all users familiar and comfortable with the software. However, developing delivery planning software could be a very costly and complex undertaking demanding knowledge and available recourses. One solution to this problem is to develop the software in cooperation with a third party logistics company having sufficient expertise within the area. Another option is to purchase already existing delivery planning software and customize it to fit the intended purpose.

5.4 Communication

Delivery planning systems such as LogNet can be used in order to reduce the scale of the supply chain through enabling just-in-time deliveries and thus limiting the number of actors the information has to be conveyed to. In short, this reduces lead-time and makes up for a more effective channel of communication, minimizing the risk of misunderstandings. An example of this problem is when subcontractors contact the wrong person at the site or in the administration who in turn is supposed to contact the logistics manager on their behalf.

Moreover, communicating and designing the contents of the contract appropriately is vital for the implementation of the LogNet software. For example, the contracts can be made to include clauses stating that LogNet should be used for scheduling all deliveries, and if not done so, what the consequences will be. In addition, the

formulation of the contract is important since a statement can mean something for one person but another person will interpret the same text in a completely different way. A common problem during the procurement phase is that companies only use the lowest price or bid as an evaluation criterion for the service needed. This methodology can cause problems further on in the project, this since the lowest bid usually does not include anything else than the minimum effort in order to accomplish the required service. Communicating the benefits of addressing logistics and SCM through e.g. implementing and utilizing a delivery planning software is important in order to create a more efficient construction process.

Moreover, there are also issues regarding the media used to communicate the information this since it often has a limited life-span, growing out of date quickly and creating an information gap between different actors within the project. These situations often occur when participants within the project use different media to access information, i.e. some participants use written documents and some online material etc. This is a scenario that occurs more often at case 2 using Microsoft Excel sheets. Creating a uniform approach by implementing standardized procedures to handle the flow of information regarding deliveries, e.g. using LogNet, reduces confusion at the construction site. In addition, cultural barriers produce communication problems and possibly interfere with the possibility to use the software efficiently. These problems can be avoided through carefully selecting subcontractors and possibly modifying the design of LogNet to involve a higher degree of visual aids, e.g. figures instead of text.

5.5 Summing up

In order to present the central results of this study concerning the implementation effects of the LogNet delivery planning software, a table containing the most important positive and negative aspects is displayed below (see table 5.1).

Assessment Criteria	Positive Effects	Negative Effects
Usability	*Standardized procedures for delivery planning* *Software simplicity* *Software accessibility* *Available "Light" version* *Activity visualization* *Possibility to integrate additional functions*	*Lacking computer experience among users* *Requires Internet connection* *Requires training* *Requires continuous access in order to stay up-to-date*
Cost	*High potential overall cost reduction due to;* *Reduced stockholding* *Reduced multiple-handling* *Reduced material waste* *Reduced material deficiencies* *Reduced sabotage*	*Acquisition costs* *User educational costs* *Possible increase in contract rates* *Risk of system malfunctions* *Risk of user errors*
Efficiency	*Reduced number of human errors* *Reduced workload associated with delivery planning* *Increased value-adding activities* *Increased forward planning* *Increased span of control* *Increased utilization of resources* *Increased awareness of operations*	*Requires commitment of all parties involved* *Requires contractual liability* *Increased workload for subcontractors* *Increased workload for logistics management during implementation phase* *Requires correct input data* *Possible lack of system functionality*
Communication	*Uniform communication channel* *Increased ability to access contact information* *Provides statistics regarding individual performance* *The delivery planning process is transferred from the head office to the construction site enabling faster communication*	*Limited contact information* *Cultural barriers*

Figure 5.1 Positive and negative implementation effects of LogNet

6 Conclusions

Throughout the course of this study it has become clear that there is much room for improvement concerning the delivery planning process. In a market where all actors strive to maximize profit margins it could be considered irresponsible not to address the logistical issues on an early stage in a project. When evaluating the implementation effects of the software, a number of positive and negative effects can be distinguished. For example, according to the interviewees the software creates standardized procedures for delivery planning and thus increasing efficiency by making users familiar and comfortable with the planning process. Moreover, the software has a high potential of reducing the overall cost of the project through more efficient material handling. In addition, the software produces a uniform channel of communication transferring the delivery planning process from the head offices to the construction site enabling faster information sharing.

According to the interviewees the negative implementation effects are mainly the costs associated with the implementation of the software including acquisition costs, educational costs etc. Moreover, the efficiency of the software is highly dependent on continuous commitment of its users since all deliveries and required resources need to be logged in the system. There also exist difficulties when implementing new systems on a sector with a relatively low degree of computer knowledge.

In conclusion, LogNet is a tool part of a process aiming at steering the development of construction logistics and SCM in the right direction. In order to make the implementation of a delivery planning system as efficient as possible it is important to tailor the system in accordance with the requirements and prerequisites of the client and the intended users. The development of such a system can be done internally or externally; however, it is important to consult a company specializing in logistics management since there are a large variety of factors to consider.
Finally, changing a company's logistical structure is a difficult process; however, the expectation is that studies such as this will contribute to shine light on the possible advantages of implementing new systems to improve the delivery planning process and overall logistics management. In addition, developing and implementing standardized delivery planning software applicable for the construction industry in general would most likely provide the best prerequisites for increasing efficiency and reducing costs. Further research within the subject would preferably include expanding the scope to cover a broader spectrum of implementation effects within the strategic, administrative, and operational levels of the organizations on the market and especially weighing the financial benefits more in detail.

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Appendix

Project information

Name?
Company?
Type of project?
Budget? (SEK)
Contractual form? (DB, DBB, or MC)
Client?
Location?

Logistical planning

If a logistical planning system is used in what way has it effected your daily operations?

- Lead-time effects?
- Risk of double-bookings?

Who has the responsibility of the delivery/logistical planning in the project?

- Does this include subcontractor deliveries?
- Has this person received any relevant education/training?
- In what way has this role effected the on-site operations?

What kind of delivery planning/information is easily accessible for all parties involved in the project?

- Detailed time-plan
- Inventory list
- Delivery schedule
- Outline plan
- Risk assessment
- Resource availability

Does any common information portal regarding the delivery planning exist?

- If not, could such a system increase efficiency?
- If so, how is this system designed?
- Who has access to the system?
- Additional experiences of the delivery planning system?
- Effects?

To what extent are the deliveries unloaded to the mounting place?

- What kind of deliveries does this involve?
- Experiences?

How often do double-bookings occur?

- What are the main reasons of this?

On-site material handling

What kinds of activities/tools are available or associated with the delivery reception process?

- Quantity, quality, moisture measurements etc.?
- Contact information of transporter, controller etc.?
- Resources used?

How often do the following events occur?

- Wrong products?
- Wrong quantity?
- Bad quality?
- Delivery unloading exceeded time expectations?
- Delivery was delayed?

When the deliveries are delayed, what are the main reasons?

If a delivery cannot be received what action is usually taken?

- Reschedule the delivery without an extra fee?
- Reschedule the delivery with an extra fee?
- Store the material at the construction site?
- Store the material at a company terminal/storage facility?
- Store the material at other terminal/storage facility?
- Receive the material and adjust operations accordingly?

Regarding subcontractor deliveries, what information is communicated?

- Time of delivery?
- Quantity?
- Resources needed?
- Unloading area?

Has the cost disposition of material, transportation, and inventory been evaluated?

Does the degree of forward planning applicable in the construction industry cause any problems?

Has a risk assessment been made for the project?

What is considered to be the main logistical issues regarding deliveries? (For example, safety, delays, lack of space/resources, double-bookings etc.)

Additional

Is any supplier performance evaluation made?

- If so, how does this work?

What are the main areas of improvement regarding delivery planning?

Have there been any attempts made to increase efficiency at the site regarding delivery planning?

In what way has/would the implantation of a delivery planning system, such as LogNet, effect the daily operations?