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Problems in buyer-supplier behaviours with emphasis on the ordering process in porportion to non-critical items. Can non-critical items become critical when they not function? - A case study of Hustadmarmor AS

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Abstract

Purchasing and supply chain management have received increasing attention the past couple of decades, and the interest for this topic seems higher than ever. The purchasing decisions directly affect the bottom line in the companies, and small changes could result in higher revenue. This paper will take a closer look at the supply chain with emphasis on the purchasing process and problems they experience according to purchasing and order processing for non-critical items. I will use one company, as a case study to illustrate the problems. Theories related to subjects concerning these problems and an analysis of today's situation will be explored. An evaluation of how to solve this problem concludes the paper.

Preface

This research paper is the final part of my education in Master of Science in Logistics at Molde University College. This thesis is a single case study of Hustadmarmor AS with a focus on the purchasing department in proportion to problems they experience in the ordering process of non-critical items. This paper will attach importance to the *behaviour* within relationships developed when companies are dealing with non-critical items, and look at the genuine *cost* related to them. Theories related to subject concerning these problems and an analysis of the today's situation will be explored. An evaluation of how to solve this problem concludes the paper.

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Summary

This paper principally attaches importance to the ordering process of non-critical items, and explores the involved costs of the non-critical items in a buyer-supplier relationship. Non-critical items have so far been offered little attention from researcher, although these are products that are causing at least 60% of all the invoices for a firm. Non-critical items are characterised as standardised products, of low value, and considered as not very important for the firm. However, even thought the non-critical items are not characterized as a critical product, it is still needed as a support for the production.

The firm Hustadmarmor AS will be used as a case study to examine problems related to non-critical items. Hustadmarmor often experience to receive confirmation on orders, but where the product or service still doesn't arrive. The labour connected with the follow up of orders especially for non-critical items is resource-draining and time consuming and also leads to extra costs for the firm. When a company experiences problems concerning the delivery from the supplier of non-critical items, it is reasonable to assume that this may affect the firm by a higher ordering- (related to the extra labour when following up orders) and holding cost.

The analysis developed in this research is measuring the underlying cause of why different suppliers deliver too late. The results from the analysis show that, long relationships, short distances, written contracts and large suppliers are variables that affect inaccuracy from a supplier. The behaviour inaccuracy may be one indicator to use when analysing if the supplier acts opportunistic. The inaccuracy from the supplier has been measured in costs, and accordingly three scenarios are calculated. The results of the calculations shows that purchase of non-critical items should be of more concern for firms, than what they are today. The accumulated costs related to the ordering process of non-critical items may be much larger than what the firm actually realize, and accordingly have a direct affect on the bottom line of the company.

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1. Introduction

Supply Chain Management is all about maximizing competitiveness and profitability for companies as well as partners in the supply chain networks. Because of the complexity involved in a network of organizations it is relevant for the management of each firm to understand their interrelated roles and perspectives (Lambert et. al. 1998). In the past couple decades marketing managers have focused increased attention on buyer- supplier relationships in business markets. Companies are often faced with the make-or-buy question, and it has to determine which products or activities that will be produced by the company itself, and which products or activities will be contracted out. When businesses are going to create relationships an important question arises. Is it beneficial to engage long-term collaborative relationships with other firms or is it more advantageous for firms to "keep their distance" and to interact with one another in a more market-like transactional way? (De Wit, et. al. 2004). This question doesn't have *one* simple answer; it all depends on the structure of the company's interaction with others, the market conditions, and the product type. The importance is that the relationships make strategic sense and bring value to the company.

Earlier, researchers have been focusing on buyer-supplier relations in accordance to different governance forms, which vary systematically in terms of how specific inter firm processes are carried out. The researchers have so far been focusing on relationship strategies in accordance to bottlenecks-, strategic-, and leverage products, and how to handle purchase of these products. In differ from previous research; this paper will attach importance to relationships developed when companies are dealing with non-critical items, which are not directly involved in the production, but in the secondary stream. Non-critical items have so far been offered little attention since this is products that are standardised, of low value, and considered as not very important for the companies. However, even though the non-critical items are not characterized as a critical product, it is still needed as a support for the production.

If a firm experiences problems concerning the purchase of non-critical items, this might affect the buying firm financially in the long run. The costs related to problems concerning orders of non-critical items might be significant higher than what the firm actually realize, since non-critical items are the product group that has the highest frequency according to purchase of products, and accordingly may take up almost all the storage space. These costs have earlier been looked at as immaterial, and it is therefore relevant to illuminate the costs related to the problems concerning ordering of non-critical items, since they may be critical in the long run. Based on this I find my research very relevant and will therefore investigate which impact problems concerning non-critical items can have on the total purchasing cost and the firm's financial results. Can it be that the non-critical items are much more important than what the actual applied science shows?

This paper has carried out a survey with a focus on objective observations of a supplier's behaviour by measuring the supplier's inaccuracy in costs. The behaviour inaccuracy may be one indicator to use when analysing if the supplier acts opportunistic. According to Williamson (1985) opportunism is "self interest seeking with guile". Opportunism builds upon the usual behavioural assumption that individuals act to maximize their utility (Waldman et.al. 2007).

The firm Hustadmarmor AS will be used as a case study to examine problems related to non-critical items. For Hustadmarmor it is important that products and services are delivered to them at the right time. The problem is that they often experience to receive confirmation on orders, but where the product or service still doesn't arrive. The labour connected with the follow up of orders especially for non-critical items is resource-draining and time consuming and also leads to extra costs for the firm. When a company experiences problems concerning the delivery from the supplier of non-critical items, it is reasonable to believe that this can affect the firm by a higher ordering- (related to the extra labour when following up orders) and holding cost.

The main purpose of this paper is to put additional insight into the purchase process of non-critical items, and explore the involved cost of the non-critical items in a buyer-supplier relationship.

Problem to be addressed: This thesis explores problems in buyer-supplier behaviour with emphasize on the ordering process (from ordering to receiving the product) in proportion to non-critical items. Can non-critical items become critical when they not function? – A case study of Hustadmarmor AS.

The rest of the paper is organized as follows: Section 2 goes into the aspect of Supply Chain Management. Section 3 describes the purchasing function and theories related to purchase of non-critical items, the hypothesis is derived in this section. Section 4 describes the case company used when examine problems related to non-critical items. In section 5 the research methodology is elucidated. Section 6 describes the variables used in the analysis. Section 7 defines the regression models, and the results obtained, a discussion of those results is found in section 8. Section 9 concludes the paper, while study limitations are found in section 10.

2. Supply Chain Management

The development of modern business the last couple of years has been witnessing a change in the organizational structure. An individual business is no longer complete as a solely autonomous entity, but is now rather as a supply chain (a network of multiple businesses and relationships) (Lambert et. al. 1998). Since time to market is getting crucial and the competition is increasing, organizations need to become more efficient and flexible (Weele, 2005). By developing business relationships across organizations many firms get the opportunity to focus on their own core values, where as they outsource other operations to their business partners.

Supply chain management was originally introduced by consultants in the early 1980s and has subsequently received much attention. During the 1980s; the original supply chain management was looked at as the "work of consultants", with a main focus on understanding the system integration of business processes throughout the supply chain (Gundlach, et.al. 2006). The main focus was to reengineering the chain in order to improve the customer service and to be better suited to meet customer demands.

A review of the literature concerning supply chain management shows that this impression has changed, and literature from the early 1990s place emphasis on supply chain management as; logistics management, network sourcing, supplier-base reduction, and inter-organizational integration (Gundlach, et.al. 2006). *"As the field involved in the late 1990s, firms increasingly recognized their role as part of number of supply chains, having multiple customers and multiple as well as alternative suppliers"* (Gundlach, et.al. 2006).

Mills, et.al. (2004) claims that supply chain management research is developing into two distinct streams: First, there are descriptive research on industrial networks conducted by research from industrial marketing and purchasing, and second there are prescriptive researches on supply chain management, based in the fields of strategic management, operations management and logistics.

To compete successfully in the global market today, companies need to manage the effectiveness and efficiency of the operations that manufacture and distribute their products or services to their customers (Tang, 1997). In order to get their services and end products to their customers a manufacturer has to procure raw materials from suppliers, transform these raw materials into finished goods, and deliver these goods to the end customers through a distribution system (Joshi, 1998). Supply chain management can therefore be stated as the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders (The Global Supply Chain Forum). Supply chain management coordinate activities and goals between different entities in the supply chain with a goal of reducing waste and creating value.

Lambert, Cooper and Pagh (1998) describes the supply chain management as a combination of three closely inter-related elements: the structure of the supply chain, the supply chain business processes, and the supply chain management components. The three elements are presented in figure 1.

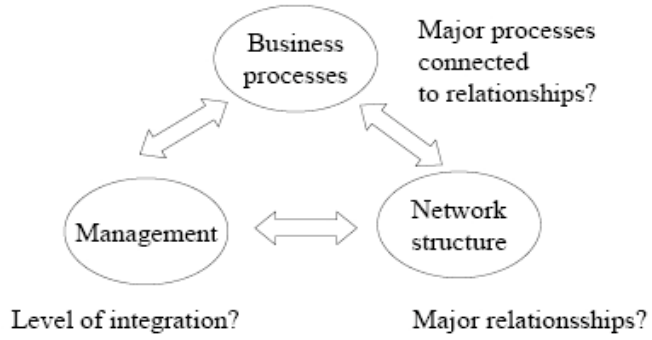

Figure 1 – The Supply Chain Management Framework: Elements and Key Decisions (Lambert, et.al. 1998).

These three elements are connected to each other and are when analyzed answering what level of integration the supply chain has, if it has major relationships and which major processes that are connected with the different relationships. The supply chain structure is the network of members and the links between members of the supply chain. Business processes are the activities that produce a specific output of value to the customer and the management components are the managerial variables by which the business processes are integrated and managed across the supply chain (Lambert, et.al. 1998).

Supply chain management has historically had a number of different definitions, and it seems like researchers are struggling to find a definition that they all can agree upon which includes all the aspects concerning supply chain management. In a paper of Mentzer, et.al. (2001) they have examined the existing research done of supply chain management to understand the concept and to come up with a single, encompassing definition of supply chain management. By reviewing the literature of supply chain management they found that supply chain management consists of multiple firms, multiple business activities, and the coordination of those activities across the functions and across the firms in the supply chain (Mentzer et.al. 2001). When pulling all these disparate aspects of the supply chain management they defined the supply chain management as; *"the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purpose of improving the long-term performance of the individual companies and supply chain as a whole."*

Their definition implies much about the management of supply chain, and has further led to the development of a conceptual model.

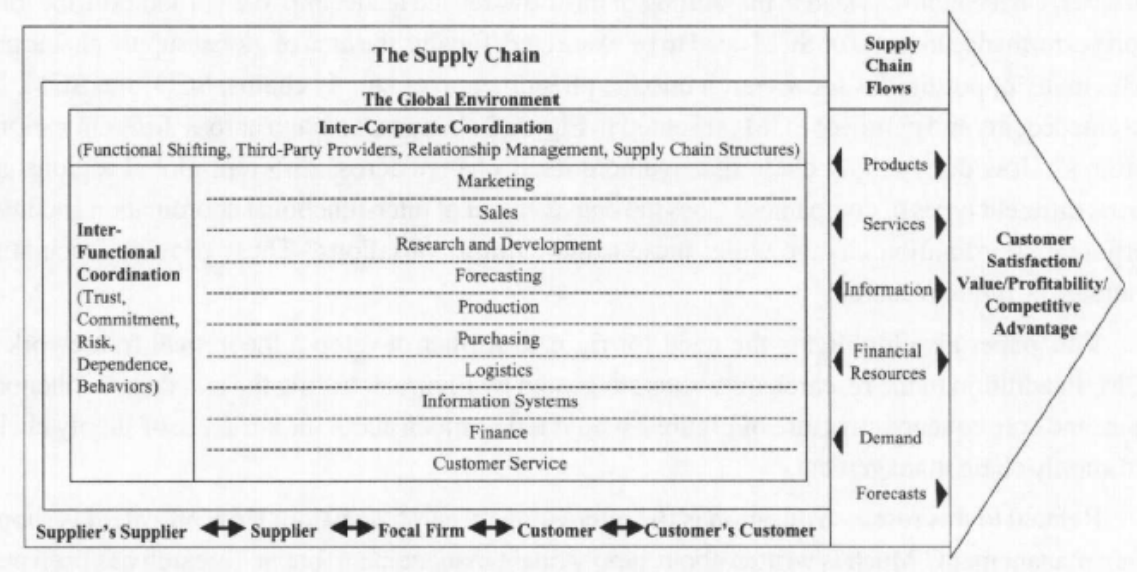

Figure 2 – A model of Supply Chain Management (Mentzer, et.al. 2001).

The model is based on the definition and illustrates the supply chain as a pipeline from one side, showing directional supply chain flows. The figure includes all the typical business functions in the supply chain management as planning, organization, and processing, and should serve as a guide to practitioners so that the supply chain management can achieve its full potential. The figure also focuses on the ultimate goals of supply chain management, as lower costs, increased customer value and satisfaction, and ultimately competitive advantage (Mentzer, et.al. 2001).

As the figure above shows, one of the main business processes within an organization is the purchasing function. This function is of importance within an organization because it takes part both within and between the firms (Lambert et. al. 1998). The focus of this research will be on how to handle purchase of non-critical items, and the purchasing function will therefore be important.

3. Purchasing

In the last 20 years we have noted a change in the costs related to purchasing. The total share of the purchasing costs in relations to the firm's total costs has been increasing, and in proportion this development has led to a higher signification of the supply area (Bjørnland, et.al. 2001). The purchasing decision directly affects the bottom line in the companies, and small changes could result in higher profit. The importance of this area therefore is of high relevance for the financial results.

In this paper the main focus of the supply chain will be the purchasing area with emphasis on the strategic aspects related to the costs concerning non-critical items. An analysis of the cost structure of manufacturing companies shows the importance of purchasing to organizations since most companies today spend more than half of their sales turnover on purchased parts and services (Weele, 2005). According to Weele (2005) the purchasing function can contribute to improving a company's return of net assets in two ways. First by reducing all direct material costs by, introducing new suppliers, competitive tendering, looking for substitute materials, etc. Second, by reducing the net capital employed by the company by for example longer payment terms, reduction of inventories of based materials through just-in-time agreements and supplier quality improvements (lead to less buffer stock required) (Weele, 2005). Purchasing directly affects the bottom line in the companies, a dollar saved in purchasing is a dollar added to the bottom line. By developing better quality and logistics arrangements with suppliers, purchasing can contribute to a higher capital turnover ratio. The conclusion is that as the purchasing sales ratio for a company increases, the purchasing decision will have more thorough impact on the company's net result (Weele, 2005).

Apart from immediate savings on purchasing prices, the purchasing department may also contribute to the improvement of the company's competitive position in more indirect ways as, reduction of quality costs (by selecting suppliers who have their production under control resulting in no need for quality control), product standardization, stock reduction (by imposing a solid discipline on suppliers and enforcing them to deliver on time) and by investing in ERP systems (Weele, 2005).

It is obvious that companies can benefit significantly from effective purchasing and supply strategies in several ways, both quantitative and qualitative to improve the company's bottom line, but the indirect contributions in practice often save more money than the indirect savings in purchasing prices (Weele, 2005).

The purchasing function traditionally involves the process of buying, with the responsibilities as determining the need, selecting the supplier, negotiating a proper price, specifying terms and conditions, issuing the contractor and order, and follow up to ensure proper delivery (Weele, 2005). Weele (2005) defines purchasing as; *"The management of the company's external resources in such a way that the supply of all goods, services, capabilities and knowledge which are necessary for running, maintaining and managing the company's primary and supported activities is secured at the most favourable conditions"*.

Figure 3 illustrates the main activities within the purchasing function. The activities are closely connected.

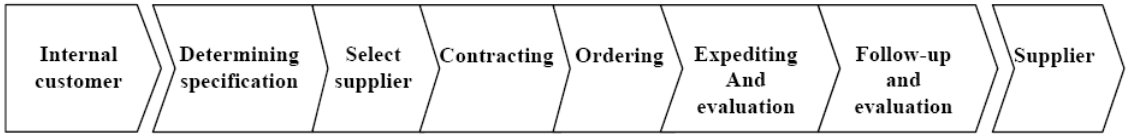

Figure 3 – A purchasing process model (Weele, 2005)

In the 1980s, purchasing was viewed as a non-strategic function. A literature research done by Stanley and Wisner (2001) shows that purchasing has the past couple of years changed from purchasing as a function that only focus on purchasing at lower price within shorter delivery times (transaction oriented), to purchasing as a more strategic function by adding value for customers and meeting the firms long-term goals. Purchasing and supplier management is important to the supply chain efficiency because it directly affects the bottom line in the companies, and small changes could result in higher revenue. Additionally good supplier relations can contribute to innovative product development, which the buying firm might not be able to do on their own. Today's development shows that the firm and its purchasing department often enter into partnership relations with its suppliers. Research shows that supplier-buyer relations often give benefits and competitive advantages for the buying firm, since the buying firm no can concentrate on their own core

values. To gain this advantage, companies presuppose an effective way of managing the purchasing activities and partnership relations (Zhang, 2008).

Obviously, not all buyer-supplier relationships are to be managed in the same way. Research findings indicate that successful supply chain management requires the effective and efficient management of a portfolio of relationships (Gelderman, et.al. 2002).

Another distinctive feature is that some suppliers are of more importance than others; this is based on volume purchased or the direct purchasing cost. According to Håkansson (1989) earlier studies have detected that, ten of a firm's most important suppliers are related to 70 % of the total purchasing costs (applies in the merchandise industry).

Since purchasing has a direct affect on the financial results obtained by a firm, the firms ways of handling the process according to purchase, selection of suppliers and the work connected to each of the suppliers are of importance. Additional companies should be aware of the financial winnings that can be developed in pursuant to supplier relations. The relationship developed between the firm and some of it most important suppliers can be crucial for the signification of a firm's expansion and survival. Firms are no struggling to find ways of improving the efficiency and effectiveness of both marketing and procurement efforts, and are therefore seeking ways to perform these critical functions better while reducing costs in the value-adding process (Cannon, et.al. 1999). Managers worldwide are now experimenting with different types of relationships strategies so that they can find the relationship that suite their firm best, as a result in a more productive and enduring relation (Cannon, et.al. 1999).

3.1 Single or Multiple sourcing strategies

Today there exist different opinions on which relationship strategies that are to be preferred. Quality management practitioners as for example W. Edwards Deming strongly support the Japanese model of supplier relations, recommending closer relationships with fewer suppliers, so that they can improve the co-ordination and get a higher quality on the products to a lower total cost (Richardson et.al. 1995). If a firm is in the situation where there only are a few available suppliers in the market delivering a specific product, the buying firm is facing uncertainty and dependence, and there is also a high level of risk involved. In situations like these they might try to secure the situation by enter into a sole source strategy with only one supplier. When companies are dealing with sole sourcing the buying firm often make substantial investments in the relationship, this might increase the buyer's dependence on the supplier which further can lead to opportunistic behaviour from the suppliers side. Because of high switching costs the buyer might be forced to stay with the supplier although the supplier might play unfair by increasing the prices, lower the quality and generally lower the performance (Richardson et. al. 1995). Although there is a risk in the exposition of a sole sourcing strategy this is now the trend and many quality management practitioners argue that the added cost of co-ordinating closely with a few suppliers will be more than offset by the reduced costs of scrap, rework, warranty claims, etc., and the added benefits of higher quality products (Richardson et.al. 1995). In spite of this many firms still don't find this as the overall best strategy, and therefore many companies continue to rely on the competitive market and a more transactional orientation, also known as a multiple sourcing strategy.

It is well know that Porter is an admirer of the multiple sourcing strategy which recommends competition between the different actors to assure low price and high quality to the lowest total cost. This strategy is focusing on increasing the bargaining power in the purchasing by keeping the number of sources sufficient to ensure competition, but also small enough to be an important buyer for each source (Richardson et.al. 1995). Traditional economic theory claims that in a market where many suppliers are competing to sell comparable goods, the market becomes a ready source of information on price and quality (Cannon, et.al. 1999).

The literature recommends both soul sourcing and multiple sourcing, and there is no clear differential for when to use which of them. Firms are therefore experimenting with different sourcing strategies to find the right strategy that can make their business more productive and more permanent. It is the market conditions and the situational factors that reflect the key conditions in which relationship form the firm should enter into.

An Agency cost model

In this section an agency cost model made by James Richardson and James Routmasset is presented. This model captures the economic tradeoffs (relevant incentives and costs) between the costs to set up and coordinate with suppliers and the incentive for performance provided by competition. The model try to present the economic reasoning behind both sole sourcing and multiple sourcing and try to determine the conditions under which alternative supplier arrangements that is to be most efficient (Richardson et. al. 1995).

"The agency cost theory (or transaction cost theory) of organizations seems well suited for analyzing the choice of sourcing strategy. Sole and multiple sourcing represent alternative organizational forms and governance structures for managing the agency costs in a buyer-supplier relationship" (Richardson et.al. 1995).

According to Jensen and Meckling (1976) an agency relationship is "a contract under which one or more persons (principals) engage another person (the agent) to perform some service on their behalf which involves delegating some decision-making authority to the agent".

By using the agency cost theory, a firm will organize so that it can minimize the total agency cost. In a buyer-supplier relationship an agency cost will be all costs related to activities undertaken to ensure supplier performance, including the costs incurred if the supplier performs poorly (underperformance of the supplier = shirking) (Richardson et.al. 1995).

Although it is assumed that people are opportunistic in the sense that they may *shirk* in a self-interested manner by trying to minimise effort if it fulfils their needs, it is not assumed that they will willingly misrepresent or lie about that effort. It is assumed that if the

principal and agent do not share the same levels of information and as such, the agent can opportunistically take advantage of the situation, sometimes to the detriment of the principal. This latter situation is known as moral hazard and is often the result of asymmetric information.

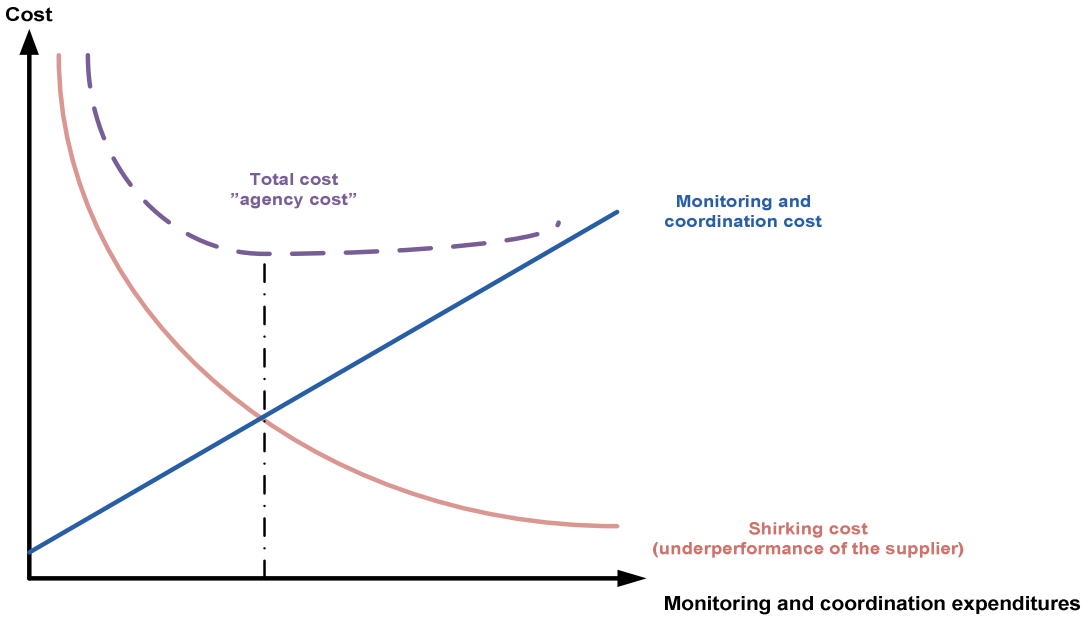

Figure 4 – An agency cost analysis of sourcing strategies

To ensure supplier performance, the firm should invest in the relationship, monitor the performance of the suppliers, and manage rewards and penalties. The agency costs are the total cost consisting of monitoring, other performance assurance costs and shirking costs. By looking at the model we see that the shirking can be reduced by increasing the monitoring or other performance incentives. According to the agency theory a firm will chose the performance assurance activities (the cost of the performance assurance plus the cost of any shirking) that minimizes the total agency cost (Richardson et.al. 1995).

"We can recast Deming's argument in terms of agency costs to state that sole sourcing minimizes performance assurance costs and therefore total agency cost. Deming argues that sole sourcing reduces total costs which include purchase price as well as costs associated with poor supplier performance (downtime, process adjustment to accommodate incoming variability, rework, administration, follow-up of orders, service, and damage to a company's reputation with its customers" (Richardson et.al. 1995).

We can accordingly argue that poor supplier performance can result from lack of communication and co-ordination between the buyer and supplier, and is therefore necessary to improve the suppliers performance and to lower the following-up costs related to the relationship. According we can argue that by entering into a single source strategy (enter into a closely relationship with one supplier) the firm will have less co-ordination costs in proportion to a multiple sourcing strategy. Lower co-ordination costs will have a direct impact on the total costs, which is in favour for the buying firm.

The conventional view of this is that some researchers have argued that the total cost is minimized by competitive sourcing. In a situation with competitive sourcing the supplier can be induced to provide high performance because the buyer has the option to switch suppliers if he is not pleased with the relationship concerning the overall product and performance. The supplier will perform at the level of performance specified by the buyer, in threat of losing business. We argue that the set up, monitoring and co-ordination cost will be relative higher when dealing with multiple suppliers, but when dealing with competitive sourcing the level of monitoring and co-ordination also may be considerable lower because the supplier's performance will be higher (Richardson et.al. 1995). Because of the competition between the suppliers, the multiple sourcing strategies are seen as the most effective performance inducement, and the total agency cost would therefore be lower.

The previous section shows that both the single sourcing and the multiple sourcing strategies have their advantages and disadvantages. The buying firm should therefore try to find the sourcing strategy that will minimize their total agency cost and accordingly maximize their profit.

A firm's purchasing department acts in accordance with many different suppliers and it is therefore important to have a system that organizes their suppliers. This can be done by classifying the suppliers or the products after some given criteria's.

3.2 Kraljic's purchasing portfolio

Not all buyer- supplier relationships are to be managed in the same way. Since suppliers represent different interest to the company, purchasing managers need to develop differentiated strategies towards their supply markets (Gelderman et. al. 2002).

Two concepts are considered to be of importance when it comes to understanding buyer – supplier relationships; this is power and interdependence. Both these issues play an important role in Kraljic's purchasing portfolio approach. This approach is increasingly being used by purchasing practitioners for managing different supplier relations and developing appropriate purchasing strategies (Caniëls, et.al. 2007).

In 1983 Peter Kraljic introduced the first, comprehensive portfolio approach for the determination of a set of differentiated purchasing strategies to use in purchasing and supply management (Gelderman, et. al. 2002). In the development of theory in this field, the matrix is generally considered as a breakthrough. The issue of influencing the balance of power between the company and its key suppliers is the key when developing purchasing and supply strategies (Weele, 2005). Sensible guidelines were given for managing the supplier relationships by categorizing the variety of products in a 2x2 matrix (Gelderman, et. al. 2002).

According to Kraljic (1983) the general idea behind the matrix was to minimize supply risk and make the most of the buying power. Kraljic's model classifies a firm's purchased intermediate goods into four categories on the basis of the dimensions accounting for risk on one hand and using buying power on the other hand. Accordingly these dimensions are represented by "profit impact" and "supply risk" running from high to low. Profit impact have for its object the strategic importance of purchasing in terms of the value added by the product line, the percentage of raw materials in total costs and their impact on profitability (Kraljic, 1983). The higher the amount of money involved, the higher the financial impact of purchasing on the bottom line. The supply risk is composed of the complexity of the supply market measured by supply scarcity (possible suppliers), speed of progress in technology, situations of monopolies and oligopolies, obstacles of new suppliers to enter this market, and complexity of the product (Glöckner, et.al.2005).

According to Kraljic (1983) the company's situation can be evaluated in terms of these two variables. The management can determine the type of supply strategy the company needs both to exploit its purchasing power vis-à-vis important suppliers and to reduce its risks to an acceptable minimum. The purchasing portfolio matrix made by Kraljic consists of a classification of the products in four categories; strategic products, bottleneck products, leverage products and non-critical items (routine products) which each requires a distinctive strategic approach toward suppliers (Gelderman, et. al. 2002).

Kraljic purchasing portfolio is illustrated in figure 5.

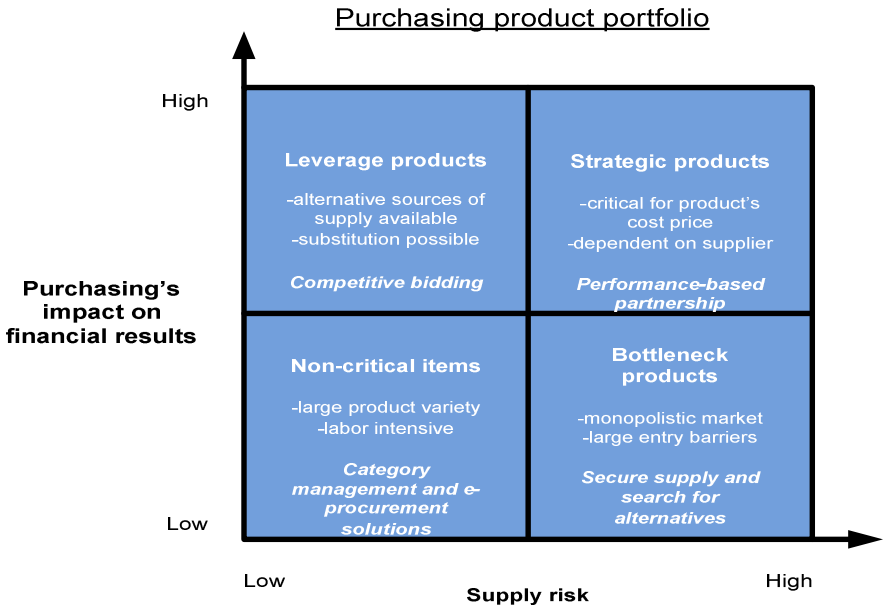

Figure 5 - Purchasing product portfolio

By using the matrix developed by Kraljic, companies will have some guidelines for how to manage their supplier relations, and a basis for which supplier strategy that is recommended. The intention is to find out which suppliers we should develop closer ties to, and which suppliers we should interfere with through general agreements or in a more market transactional way.

However, Kraljic's classification purchasing portfolio matrix might be too simple. The underlying reason for this is that some products can be placed in more than one category box, as for examples bottleneck products which also can be strategic products for a company.

Another way of classifying products is by using a classification where the products are classified after their purpose. Products can be classified as products to the primary stream or as products to the secondary stream.

- Primary stream; raw material, components, and purchase related to the customer.
- Secondary stream; running- and maintenance purchase, and investments.

Purchase to the primary stream includes raw materials, components which are entered into the final product, and purchase which is directly pointed towards the customer, as for example marketing (Brynhildsvoll et.al. 2002). Within the primary stream it is common that there are only a few suppliers delivering the products needed, but where the total cost of these purchases often constitutes to the highest purchase cost for the firm. The recommended strategy when dealing with products within the primary stream is to develop long-term relations with the supplier (Brynhildsvoll et.al. 2002).

Purchase to the secondary stream includes running- and maintenance purchase, and investments. Running- and maintenance purchase is roughly speaking products that are connected to the maintenance of the conduct of the firm, and are products as for example office supplies, tools, etc..,. Within the secondary stream we find the majority of a firm's suppliers, but the products ordered to this stream are usually of little value (Brynhildsvoll et.al. 2002). As a result many firms therefore try's to standardize the assortment so that they can use the same supplier for many different products and accordingly save costs related to transportation, follow-up, etc..,. The buying firm will then be able to concentrate on only a few suppliers in total, simultaneously the buying firm will get more time to concentrate on the primary stream.

By combining Kraljic portfolio matrix with the classification of products after their purpose a firm might get an alternative on how to evaluate the sourcing strategy to use when buying products. In this thesis, suppliers that deliver non-critical items as running- and maintenance for the secondary stream will be investigated.

Relationships can be divided into strategic and non-strategic relationships. In a strategic relationship there are two or several companies that are working together to reach a goal that they would not be able to reach on their own. When two or several companies are related to each other it is important that they build a stable relationship that can give long-term success. A relationship like that requires that both companies scarify time and money which leads to an investment in knowledge and resource. A non-strategic relationship is characterized by a high number of suppliers available, and where the supply risk of the product is low. In situations like these the contractor are free to select suppliers, and therefore have market power over the supplier (Weele, 2005). In a non-strategic relationship there is not any strategic advantages connected to the present situation, and the buying company should therefore adopt the more traditional open market negotiation approach (Doran, 2002). Strategic relationships should be developed when dealing with strategic and bottleneck products, while non-strategic relationships compasses for leverage and routine products.

Strategic relationships

Strategic products:

Looking into Kraljic portfolio the strategic products represent a considerable value to the organization in terms of high impact on financial results and a high supply risk (Caniëls, et.al. 2007). Strategic products are high-tech products, which often are supplied after customer specifications (ex. by ordering a new car). This is products that are ordered and supplied in high volumes, but where often only one supplier is available, causing a significant supply risk. In order to counterbalance this risk, firms will aim at building a partnership relation with its supplier, in expectation to reduce the supply risk to a minimum by evolving mutual trust and commitment (Caniëls, et.al. 2007). A close and lasting cooperation with suppliers can also lead to improvements in the product quality, delivery reliabilities, lead times, product developments and might also lead to a cost reduction (Caniëls, et.al. 2007). When dealing with strategic products, a change of supplier in the short term can lead to considerable switching costs. Because of the high volume the product price also can be very sensitive, and a small change in price will have direct impact on the cost of the end product (Weele, 2005).

In a buyer-supplier relationship the balance of power can be differentiated between two different sub-segments: (Weele, 2005) First,

balanced relationship: In a market where several sellers and buyers are present at the same time we have a balanced relationship. In this situation neither of the two parts dominates the other, and it is a mutual interest in keeping the relationship stable. Here relationships are developed over time (Weele, 2005). Second,

the one-to-many approach (buyer-dominated segment or supplier dominated segment) is commonly seen as a seller-centric portal where many buyers do transactions with one seller, or vice versa (Hannås, 2007). According to the one-to-many relationship it is not a mutual dependency and therefore a relationship will be more important for one of the parts, the relationship is one-sided. Kumar et. al. (1995) uses the term interdependence asymmetry in this respect, which is defined as the difference between the two partner's levels of dependence. *"Buyer- supplier relationships that are characterized by asymmetric interdependence are believed to be deficient because the independent partner experiences high power and might be attempted to exploit it"* (Caniëls, et.al. 2007). McDonald (1999) and Anderson, et.al. (1989) indicates that power imbalances within a buyer-supplier relationship can lead to unproductive partnerships, whit less cooperation and greater conflicts. However, an unbalanced relationship does not automatically involve misuse of power (Caniëls, et.al. 2007). The company that is dependent of the other will try to commit to the other firm by building relations so that he can be sure of getting/selling the product he want to buy/sell.

According to Kraljic (1983) each segment in the portfolio should have different strategies. For the strategic products the partnership strategy (strategic alliance between the buyer and supplier) is applied. The communication and interaction between the subcontractor and the supplier is usually intensive and complex.

Bottleneck products:

The Kraljic portfolio defines the bottleneck products by a high supply risk and with a low purchasing impact on the financial results. These items represent a relative limited value in terms of money, but they are vulnerable in regard to their supply (Caniëls, et.al. 2007).

When dealing with bottleneck products a firm often only has one supplier available, which in connection gives the supplier all the power and the opportunity to have high price, long delivery time and bad service on their products. These products are important for the buyer because without the bottleneck component the whole production can stop. For the bottleneck products the securing supply strategy is applied (if necessary at additional cost) (Weele, 2005). Keeping extra stocks of the material, or develop consigned stocks agreements with their suppliers are example of this strategy (Caniëls, et.al. 2007).

Non strategic relationships

Leverage products:

As illustrated in figure 4; Kraljic portfolio defines the leverage products by a low supply risk and with a high purchasing impact on financial results. Since leverage products have such a high purchasing impact on small changes in price, it will have relatively strong effect on the end product cost (Caniëls, et.al. 2007). Leverage products are products that can be obtained from various suppliers, as a consequence this segment is buyer dominated. The buyer has many possibilities and incentives for negotiation and should therefore organize competitive bidding and only have sort-time contract (Caniëls, et.al. 2007). Example of leverage products can be raw material, packaging and standard semi-manufacturing commodities (Weele, 2005).

This is a non-strategic relationship because of the high number of suppliers and the low supply risk, which results in a low switching cost for the buyers. In this situations the contractor are free to select suppliers, and therefore have a market power over the supplier (Weele, 2005). However abuse of this power can lead to a shift in the Kraljic matrix, where the leverage products changes to a strategic product because different price agreements among the suppliers and cartels are developed (this is not legal). For the leverage products the competitive bidding strategy is applied.

As visualized above, there has been a high focus on both strategic-, leverage- and bottleneck products. However, this thesis the focus is on non-critical items. The non-critical items will in this thesis be investigated more in detail to see which affect these products have on the purchasing function.

3.2.1 Non-critical items (routine products):

The Kraljic portfolio defines the non-critical items by a low supply risk and with a low purchasing impact on financial results. Products like this usually have small value per item and there exists many alternative suppliers in the market. According to Weele (2005) most items fall into this category, examples are cleaning materials, office supplies, maintenance supplies, fasteners, etc. The problem in this group is that the administrative costs often take more money than the value of the product itself. Weele states that "80 percent of the time and energy of purchasing is used for these products". Dirk-Jan Kamann argues that more than 85% of all the firms' suppliers are to be found within the routine products, supplying less than 10% worth of all inputs and causing at least 60% of all invoices and therefore organizational costs.

Non-critical items can be characterized as products with a high frequency. It is products that a firm often order and which take up almost all the storage space. By that vary fact that we are dealing with a high amount of orders, it can totally accumulate high costs related to the follow up of this orders. These costs have earlier been looked at as immaterial, and it is therefore relevant to illuminate the costs related to the problems concerning ordering of non-critical items, since they can be critical in the long run.

In situations where we are dealing with non-critical items the firm should try to organize a more efficient purchasing, so that they can pay attention to more important products (Weele, 2005). Non-critical items require a purchasing strategy that is aimed at reducing administrative and logistic complexity (Olsen, et.al. 1997). System contracting is generally advised as the way of doing business with suppliers of non-critical items, and the buying firm should therefore work out some simple and efficient ordering routines with their suppliers, standardizing the product assortment, and reducing the number of suppliers by buying a package of similar products from a certain supplier (Weele, 2005). In this way it is possible to have only one supplier for several products – pooling of requirements (Caniëls, et.al. 2007). Accordingly the buying firm will concentrate on only a few suppliers in total, and try to build a stable relationship with them.

As both the classification theories request, the buying firm should concentrate on only a few suppliers in total, and try to build a stable relationship with them when dealing with non-critical items. Based on this, the next section of this paper will examine the relational contract theory and look at the effect buyer-supplier relations can have on the firms dealing with non-critical items.

3.3 Relational contract theory

The traditional model of purchasing strategy was for buyers to keep suppliers at an arm's length to avoid dependence on suppliers and to maximize bargaining power (Croom, 2001). In recent years the trends in supplier relationship management have shifted, and there have been an increase in the academic literature according to theories that emphasis the benefits of close, long-term relationships among different organizations. The reason for the growing interest of this field might be that the managing of relationships between various parties is becoming more crucial as the industry moves away from fragmented and adversarial ways of working and moves towards collaboration (Faisol, et.al, 2005).

The concept of relational contract theory evolved from Macaulay's work from 1963, but has later been additional advanced by Macneil (Faisol, et.al. 2005). The relational contract theory is a theory that emphasizes the benefits of close, long-term relationships among different organizations based upon trust and contractual obligations. When entering into a relational contracting relationship based on trust, a win-win situation can be created for both parts, such as cost reductions, better quality and delivery routines, and better product development (Croom, 2001). The development of trust between the organizations is seen as a function of the length of the relationship between them. Trust based relationships between buyers and sellers produce significant economic and strategic benefits in the form of noticeably lower costs of doing business and greater ability to meet strategic goals. We are seeking a shift in the business practice, from managing contracts towards managing relationships.

In *A Review of the Concepts and Definitions of the Various Forms of Relational Contracting*, relational contracting has been defined as: *"Relationship contracting is based on recognition of mutual benefits and win-win scenarios through more cooperative relationships between the parties. Relational contracting embrace and underpin various approaches, such as partnering, alliancing, joint venture, and other collaborative working arrangements and better risk sharing mechanisms. Relational contracts are usually long-term, develop and change over time, and involve substantial relations between the parties."*

Relational contracting theory aims to develop a long term relationship where both parts can gain value. The purpose of entering into an organizational relationship is based on the fact that you will be better prepared and have the opportunity to respond more quickly and flexibly to accelerating change in technology, competition, and customer preferences (Webster, 1992).

According to the relational contract theory, the length of the relationship between the buyer and supplier is positive related. The older a relationship is, the greater the likelihood that it has passed through the "critical phase" of instability to a phase of stability with a recognition of mutuality of interests and benefits for both firms (Dwyer et.al. 1987). However in some situations a long relationship can develop in a more negative direction. The impact of close buyer-supplier relations can lead to a higher probability of opportunistic behavior from one of the parts involved because of investment of specific assets in the relationship.

The basic understanding of transaction cost economics (TCE) is that firms must make investments to transact with each other (Howard et.al. 2007). When dealing with non-critical items, it is not necessary for the buying firm to invest in the suppliers' production of the product to share the risk, but it is likely that the buying firm invest money (time, work related to follow up of contracts, production cooperation etc..,) to build a stronger relationship. The longer the relationship between the buyer and the supplier has excited, the more time and money is invested in that relationship. A buying firm that make unilateral investments in a relationship can be exposed for opportunistic behavior from the suppliers side, because the supplier understand that the specific investments done in proportion to that relationship have no value outside the exchange relationship for which they were made. In a situation like this, the supplier is the one with the power and therefore has the opportunity to perform opportunistic because he knows that a change of supplier will result in high switching cost for the buying firm since it will be forced to invest time and money in a new relationship. Not all suppliers will behave opportunistically, but it is not possible to distinguish those who will cooperate from those who will be opportunistic.

In this research the analysis will indicate which effects the length of the relationship between one company and their suppliers has. The results of the analysis will indicate if it is beneficial for a company to enter into close long term relationships with their suppliers, or if it might be more beneficial to interact in relationships with a shorter time frame, when dealing with non-critical items.

As earlier argued, the length of the relationship in some situations can develop in a more negative direction, resulting in inaccurate deliveries and higher costs for the buying firm. From this we derive hypothesis 1.

Hypothesis 1: The length of a relation between a buyer and a supplier of non-critical items may have a negative influence on delivery accuracy; hence result in higher cost for the buying firm.

The benefits of close, long-term relationships among different organizations might also be affected by the contract type that is used between the buyer and the supplier. According to the relational contract theory, it is likely to believe that the contract itself is an expression on how close the relationship is. The more comprehensive the contract is the more comprehensive the relationship is.

If the contract regulated is based on a price agreement, it is likely to believe that the relation between the firms is more lose than with a written contract. It is therefore reasonable to assume that suppliers with a written contract deliver their orders later than suppliers with a price agreement. When there is only a price agreement between the buyer and the supplier it is easy for the buyer to change supplier if he is not satisfied, the supplier will therefore perform as the buyer request in fair of losing him, and accordingly try to impress the buyer so that he might be receptive to enter into a more permanent contract (written contract) later. When there is a written contract between the buyer and the supplier, this contract is developed for a period of years, and often contains a clausal saying that the buyer are obliged to buy products from that exact supplier, and accordingly are not allowed to buy products from the suppliers competitors. The supplier can then behave opportunistic by delivering their products later because it will not result in any consequence for the next years, since it is of a relatively low probability that a firm will

violate the contract because this might result in a higher cost than what the actually cost of late deliveries is. From this we derive hypothesis 2.

Hypothesis 2: Suppliers with a written contract may tend to have less accurate delivers than those with a price agreement.

Another issue when it comes to relations, which is not very discussed in the relation contract theory, is the geographic distance. However, this is discussed in just in time (JIT). The principle of JIT management is that all products should become available at the very moment and in exactly the right quantity when they are needed in the production process (Weele, 2005). If products are going to become available at the exact time they are needed, the ordered materials must be delivered frequently (sometimes several times a day). Because of the frequent deliveries, often a local supplier is preferred. Accordingly we derive hypothesis 3.

Hypothesis 3: The longer the geographic distance (in km) between Hustadmarmor and the supplier is, the more inaccurate the delivery is.

The next section of this paper will look at how power and dependence affects a relationship between a buyer and a supplier, and look at how this power and dependence can be equalized.

3.4 Power Dependence Relations theory

This section described the Power Dependence Relations Theory, with emphasis on how power and dependence affects a relationship among different business actors.

In 1962, Richard Emerson developed a theory based on the power aspects of social relations. Emerson studied the aspects according to power more deeply, and the basis for this theory was a critical conduct to the idea concerning power as a general resource (Hernes, 1998). Emerson proposed that power is a relational concept, and to understand power we must conceive it as; power is a property of social relations and not an attribute of the actors. By this he means that; -to say that "X (an influential person) has power" is vacant, unless we specify for "over whom" (Emerson, 1962).

According to Emerson power resides implicitly in other's dependency, in other words we can say that the power that exists within a relation arises because of some kind of dependence.

Dependence: *"The dependence of actor A upon actor B is (1) directly proportional to A's motivational investments in goals (gratifications) mediated by B, and (2) inversely proportional to the availability of those goals to A outside of the A-B relation"* (Emerson, 1962).

If the dependence of one firm provides the basis for the power of the other, that power must be defied as a potential influence.

Power: *"The power of actor A over actor B is the amount of resistance on the part of B which can be potentially overcome by A"* (Emerson, 1962).

As mentioned earlier, the power that exists within a relation arises because of some kind of dependence. Actor A is dependent of actor B, if A needs something that B has the access/control over. When we are dealing with mutual dependence both parts can give, or refuse to give what the other part wants. We can therefore say that power is equal to your control over others interests (Hernes, 1998).

Emerson also place emphasis on four generic types of how to *balance* operations according to the power that exists between the participants in a relation. In an unbalanced relation (here A is the most powerful actor, because B is the most dependent of the two), balance can be restored either by an increase or a decrease in dependence between the actors. Structural changes in power-dependence relations tend to reduce power advantages (Emerson, 1962).

The four generic types of balancing operations:

1. If B *reduces motivational investment* in goals medicated by A
2. If B cultivates *alternative sources* for gratification of those goals
3. If A *increases motivational investment* in goals mediated by B
4. If A is *denied alternative sources* for achieving those goals

"While these four types of balancing operations are dictated by the logic of the scheme, we suggest that each corresponds to well known social processes. The first operation yields balance through motivational withdrawal by B, the weaker member. The second involves the cultivation of alternative social relations by B. The third is based upon "giving status" to A, and the fourth involves coalition and group formation" (Emerson, 1962).

In the interest of simplifying the four generic types of balancing operations in relations, Emerson uses an example of children in the context of play. Emerson (1962) considered two children which was equally motivated and equally capable for contributing toward the pleasure of collective play. By assuming that each has the other as his playmate, we can say that child A and child B, form a balanced relation. Suppose now that a third child, C, moves into the neighbourhood and makes the acquaintance of A, but not B. The A-B relation will be thrown out of balance by virtue of A's decreased dependence upon B.

Operation number one: Withdrawal

In operation number one there is a powerful actor, A, making demands of the dependent actor B. This can be related to as an unbalanced A-B relation, and to change this unbalance, actor B has to reduce his motivational *withdrawal* (Emerson, 1962). This can be explained by a child B that loses some of his interests in the collective play under the impact of frustrations and demands imposed by A. This will give actor A less power and lead to a more balanced relation.

Operation number two: Extension of power network

This operation takes place through alterations in a structure we call *a power of network*, defined as two or more connected power-dependence relations (Emerson, 1962). Those who want to decrease their dependence of others should seek other alternatives. Here we can look at our child example again and see that when the C-A relation is connected through A with the A-B relation, it forms a linear network C-A-B. As you can see, the network throws both relations within it out of balance. The tensions of imbalance in the A-B and A-C relation will make B and C to form new friendships or to interact with each other (Emerson, 1962).

Operation number three: Emergence of Status

In this group structure we are discussing status and status hierarchies. The weakest member's power can increase by giving the "actor with the power" status recognition in for example forms like ego-gratifications to monetary differentials (Emerson, 1962). By giving status recognition, the weak part can increase the strong parts interest to continue the relationship.

Operation number four: Coalition Formation

In this operation Emerson claims that balance is achieved through collapsing two-relational networks into one group-person relation with the emergence of a collective actor. Two member units can increase their power by acting as one single actor in the process of dealing directly with the third actor (with most power).

The supplier size is considered as one of the factors that influences the level of business cooperation in supplier-buyer relations. The power of a supplier in a relationship is normally measured by the market share he holds compared with the total market share. However, in this research the power of a supplier will be measured according to how large he is. This paper has taken basis in the running income of a supplier for one year, and looked at how the size of the running income affects the relationship between the supplier and buyer. It is reasonable to assume that large suppliers have more power than small suppliers. Power can lead to opportunistic behaviour from the supplier's side, resulting in higher costs for the buying firm. A large supplier will naturally have more buyers than a

small supplier and therefore the buying firm will not be as important for a large supplier than as for a small supplier. From this we derive hypothesis 4.

Hypothesis 4: The larger a supplier is the more power he has over the buying firm.

In this research the Emerson's theory is used to see which power-dependence relations that exist within the network concerning a company and their suppliers. Each supplier has been investigated according to their performance of deliveries of non-critical items, and an examination of how the size of the supplier affects this performance is composed. By looking at the four generic types of balancing operations, we might be able to balance some of the relationships that now are considered to be unbalanced relations. By using this theory and the balancing operation that it propose, a company might get a stronger position according to their suppliers and further avoid the problems they experience in the purchasing department in the future.

3.5 The Economic Order Quantity (EOQ) Model

According to the impact purchasing has on the financial results obtained by a company, this paper will use the economic order quantity model to calculate the total cost accumulated for a firm with ordering problems of non-critical items where the supplier doesn't deliver the products at the time agreed upon. When a firm experiences problems concerning the delivery of non-critical items, this might affect a firm's inventory level since non-critical items are products that are of high frequency and which occupy most of a firm's storage. When a firm experience problems concerning the delivery of these products, they will be forced to increase their safety stock (to ensure stock out), which in turn will affect the firm's holding costs. The labour connected with the follow up of orders for non-critical items also is resource-draining and time consuming, leading to extra labour costs for the firm.

"The purchase, production and/or distribution of inventories are issues of concern to all organizations. There are very large costs incurred as a result of replenishment actions, shortages and utilization of managerial and clerical time in making and routinely implementing inventory management decisions. Thus, properly designed decision rules, based on mathematical modelling, can lead to substantial benefits" (San Jose, et. al. 2003).

The economic order quantity (EOQ) model dates back to 1915 and form the basis for all inventory control models developed subsequently (Nahmias, 2005). Ford Whitman Harris first presented the familiar EOQ model in a paper published in 1915, but it is Wilson that has got the credit for the model because of his in-depth analysis of the model.[1] This mathematical model is a simple and fundamental inventory model that describes the trade-offs between fixed ordering costs and holding costs, and is the basis for the analysis of more complex systems (Nahmias, 2005). The model estimates the amount of goods a firm should order, to meet the projected demand while minimizing the total holding/inventory cost. When a firm orders a large quantity, this might reduce the ordering cost since the orders are less frequent and because the shipping/transportation expenses per unit often is

[1] http://www.resourcesystemsconsulting.com/blog/archives/13

reduced. However, lager quantities will lead to a higher holding cost because it requires more storage. If the firm orders small quantities instead, this will reduce the holding cost and also require less storage space since there will be less inventory, but the ordering and shipping expenditures will become higher.

Given a known level of annual demand, a firm should try to balance the cost of ordering smaller quantities more frequently to minimize holding cost, against the cost of making a smaller number of larger-quantity purchases to minimize ordering and transportation cost. The EOQ model balances the different costs with the intension to find the optimal order point to a minimum total cost (Zinn et. al. 2005). As you can see from the figure below the lowest total cost is where the order costs intersect with the holding costs.

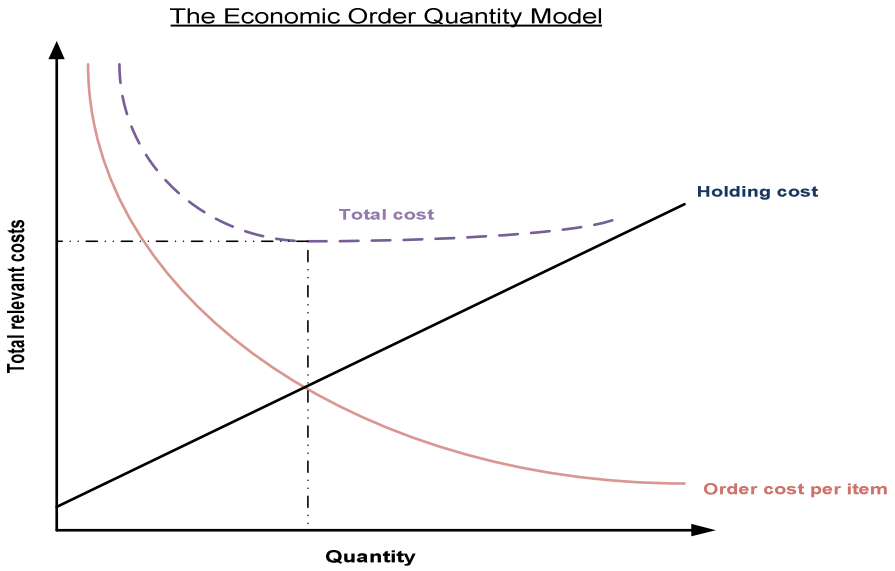

Figure 6 – The Economic Order Quantity Model

"This figure shows that by ordering more on the X axis, the holding cost line increases in a proportionate manner. The downward sloping curve which commenced high on the Y axis and decreases as it approaches the X axis and moves to the right is the ordering cost curve. This curve represents the total ordering cost depending in the size of the order quantity. Obviously the ordering cost will decrease as the order quantity is increased thereby causing there to be fewer orders which need to be made in any particular period of time. The sum of the holding cost curve and the ordering cost curve is represented by the total cost curve, where the minimum point of the total cost curve corresponds to the same point where the holding cost curve and the ordering cost curve intersect". [2]

The EOQ model exists of three significant classes of inventory management costs. That is order costs, holding costs and penalty costs for not meeting the demand (Nahmias, 2005).

- ***Order costs / Setup costs*** - basic production or purchase costs (the number of orders placed in the period ^{x} order costs).
- ***Holding cost / Inventory carrying cost*** – this is costs that accrue as a result of having capital tied up in inventory. These include the opportunity cost of lost investment revenue, physical storage costs, insurance and breakage costs (average inventory level multiplied by the carrying costs of 1 unit of stock for one period).
- ***Penalty cost / Shortage cost*** – the cost of not having sufficient stock on hand to satisfy a demand when it occurs.

[2] http://www.pafis.shh.fi/~stecon02/afis/ws2/overview/overview.html

The assumptions given for the EOQ model:

1. *The demand rate is constant and known (the item is in the mature stage of the product life cycle).*
2. *The order quantity need not be an integral number of units, and there are no minimum or maximum restrictions on its size.*
3. *The unit variable cost does not depend on the replenishment quantity; in particular, there are no discounts in either the unit purchase cost or the unit transportation cost. In other words it does not make any difference how much we order; the price of the product will still be the same.*
4. *The cost factors do not change appreciably with time; in particular, inflation is at a low level.*
5. *The item is treated entirely independently of other items; that is, benefits from joint review or replenishment do not exist or are simply ignored.*
6. *The time between the placement of the order and the receipt of the order is known and constant.*
7. *No shortages are allowed.*
8. *The entire order quantity is delivered at the same time. In other words we can say that the inventory from an order arrives in one batch at one point in time.*
9. *The planning horizon is very long. In other words, we assume that all parameters will continue at the same values for a long time.*
10. *The only relevant costs to the inventory model are the costs of placing an order and the costs of holding or storing inventory over time.*

(*Source:* Silver, et.al.1998)

According to many researchers the simple EOQ model is the grandfather of all inventory control models, where demand is assumed to be constant, no stock-outs are permitted, and only holding and order costs are present (Nahmias, 2005). The EOQ model assumes that the unit production cost is independent of the order (production) quantity (which is fixed), it takes no account of quantity discount and also assumes that the items produced are of perfect quality (Tripathy, et. al. 2003). According to this we can say that the EOQ model is simple to use, but does it address in real life problems? Several studies and papers developed the past couple of decade have showed the limitations of the EOQ model. In reality it is not likely that a firm experiences a situation where the product quality is perfect and where a firm face constant demand (when the demand for a product is entering

a growth phase, the demand does vary over time) (Tripathy, et. al, 2003). It is an unrealistic assumption to assume that all products purchased or produced are of perfect quality since the product quality is directly affected by the reliability of the production process. In real situations most manufacturing processes are not defect free, which results in items that requires rework. Even though there is a high focus on the quality of the production in the society today, rework is unavoidable and will always take place in a production system.

Rosenblatt and Lee (1986) have done some further research of the EOQ model and presented a new EOQ-model that deals with the problem of imperfect production. Porteus (1986) and Rosenblatt et.al (1986) states that the process is in control at the beginning of the production, but that the control might fade out through the production process, resulting in defective items that require rework. Porteus (1986) and Rosenblatt et.al (1986) goes deeper in their studies and also assumes that once the process is out of control, it remains in that state until the completed production lot has been produced, and that the defective units generated are not discarded but reworked instantaneously at an extra cost. They have both concluded that a firm should produce in smaller lot sizes, this to attain a lower level of defects because the firm will be able to detect the defects earlier. Still there are many researchers that are studying the EOQ model, and a recent study done by Chang (2004) considers the EOQ inventory problem with imperfect quality items, as characterizing defective rate and demand per year as fuzzy numbers/random variables. Wang, Tang and Zhao (2007) also studied the EOQ model in proportion to fuzzy variables. Their paper is investigating an inventory decision making problem where imperfect quality items are considered. The percentage of defective items in each lot size is assumed to be a random fuzzy variable, and the setup cost, holding cost, and inspection cost are characterized as fuzzy variables. The goal is to find the best lot size such that the expected long-rung average profit reaches the maximum (Wang et.al. 2007). Jaber, Bonney and Moualek (2009) have also done some research on production processes that generate defects requiring rework. They have adopted the paper of Porteus (1986) to estimate the number of lots by using an EOQ model with entropy costs (Jaber et.al. 2009).

The classical inventory EOQ model also assumes that the supplier is paid for the item as soon as the items are received, and that it takes no account of quantity discounts. However, in practises the supplier often offers the customers a permissible delay in payments to attract new customers and increase sales, since the customer consider it to be a type of price reduction (Ouyang et.al. 2005). To motivate faster payment and reduce credit expenses, the supplier also often provides the customers a cash discount (Ouyang et.al. 2005).

Goyal (1985) was the first person to consider the EOQ model under the conditions of permissible delay in payments, and are often referred to when the inventory systems under condition of permissible delay in payments are discussed (Huang et.al. 2003). Shah (1993) and Aggarwal and Jaggi (1995) are some researchers that have extended Goyal's model, they have advanced the model to allow for deteriorating items. Jamal, Sarker and Wang (1997) further generalized Aggarwal and Jaggi's model to allow for shortages. Recent research have focused on the pros and cons of price discount versus trade credit, and Chang, Hung and Dye (2001) are just some researchers that have extended the EOQ model according to issues with linear trend demands and trade credits. San Jose and Garcia-Laguna (2003) studied an inventory model with backorders where the purchase unit price depended on the ordered quantity. The reason for their study was that this situation of quantity discounts appears in practice when a salesperson offers a fixed compensation to a client for not losing the sale (San Jose et.al. 2003).

As stated above, there is no doubt about the fact that the EOQ model has its weaknesses. Despite of this, the EOQ model is very popular and is often used of firms within the area logistics and inventory control. This research paper has the main focus on non-critical items, which might be the product category that is best suited for the EOQ model. Non-critical items are products that fulfil many of the assumptions of the EOQ model. Examples are constant demand rate, the item is in the mature stage of the product life cycle, the cost factors does not change appreciably with time, the planning horizon is very long etc..,

In this research paper the original EOQ model will be advanced so that it compasses the research problem examined. When dealing with delay of orders from a supplier, this directly affects the purchasing department according to the follow up of these orders. One of the responsibilities of the purchasing department is to ensure that products are available for the firm when needed. When the product ordered is not received at the time agreed upon the purchasing department need to follow up these orders by so called dunning. The labour cost connected to the follow-up of these orders accordingly can be defined as a dunning cost. The dunning cost will in this research paper be added to the ordering cost to get a reflection over how it affects the firm used in this research financially through one year.

The optimal function which minimizes the total costs of a firm is given by the classical square root formula:

$$\mathrm{EOQ} = \frac{\sqrt{2AD}}{\mathrm{vr}}$$

where

Q = the replenishment order quantity, in units.
A = the fixed cost component incurred with each replenishment (order cost).
D = the demand rate of the item (demand per time period).
v = the unit variable cost of the item. This is not the selling price of the item, but rather its value in terms of raw materials and value added through processing and assembly operations.
r = the carrying charge, the cost of having one dollar of the item tied up in inventory for a unit time interval.
TRC (Q) = total relevant costs per unit time, that is, the sum of those costs per unit time which can be influenced by the order quantity Q.

(*Source:* Silver, et.al. 1998)

The objective is to determine the quantity to order which minimizes the total annual inventory management cost.

Total cost per period = inventory holding costs per period + order costs per period.

As mentioned earlier the parameters involved in the equation is assumed not to change with time, and it is therefore reasonable to think in terms of using the same order quantity, Q each time that the replenishment is made. Moreover, since demand is known and it is not allowed for planned shortages, we find that each replenishment will be made when the inventory level is exactly ay zero (reorder point equal to zero) (Silver, et.al. 1998).

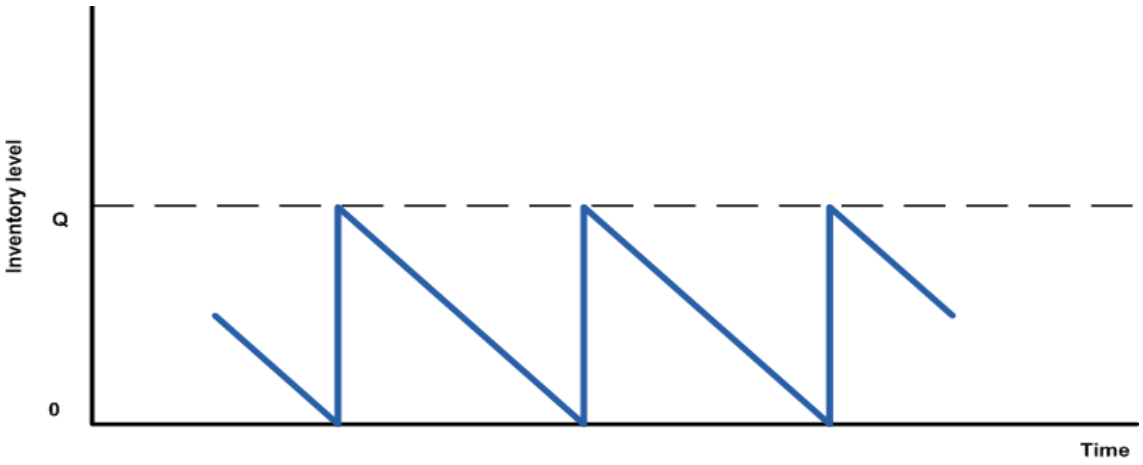

Figure 7 – Behaviour of Inventory Level with Time

The replenishment costs per unit time (Cr) are given by;

$$Cr = (\mathrm{A} + \mathrm{Qv}) * \mathrm{D/Q}$$

or

$$Cr = \frac{AD}{Q} + Dv$$

"The time between replenishments is given by Q/D, is the time to deplete Q units at a rate of D units per time (D is usage of a period of time; normally 12 months is used). Therefore, the number of replenishments per unit time is D/Q" (Silver, et.al. 1998).

According to Silver, et.al. (1998) the second component (Dv) is independent of Q and, thus will have no effect on the determination of the best Q value. Dv represents the constant acquisition cost of the item per unit time which cannot be affected by the magnitude of the order quantity. Based on this, the variable will be neglected in the future evaluation of the model.

In the case of ordering problems concerning non-critical items, an extra cost called dunning (the labour cost related to the follow up of orders) will be included in the replenishment cost. The replenishment cost will be affected by the "dunning" by having an extended shift of the replenishment curve.

My replenishment cost will now be;

$$Cr = \frac{AD}{Q}$$

The dunning variable that is included in the replenishment cost consists of;

$$Dunning = \frac{(labour\ cost * number\ of\ dunnings)}{Number\ of\ orders}$$

The next step is to find out how to determine the inventory carrying cost during one time unit. *"The costs of carrying items in inventory includes the opportunity cost of the money invested, the expenses incurred in running a warehouse, handling and counting costs, the costs of special storage requirements, deterioration of stock, damage, theft, obsolescence, insurance, and taxes"* (Silver, et.al. 1998). The most common convention of costing is to use;

$$Carrying\ costs\ per\ year = I\,vr$$

where *I* is average inventory level, in units.

The average inventory level, measured over one period is, ½ Q and the total inventory costs for the considered period can then be formulated as;

$$Cc = \frac{Qvr}{2}$$

If we now combine the replenishment equation and the inventory cost equation we find the total relevant cost per unit time.

$$TRC = \frac{AD}{Q} + (\frac{Qvr}{2})$$

According to these equations the replenishment costs per unit time decreases as Q increases (there is less replenishment), whereas the carrying costs increases with Q (a larger Q means a larger average inventory) (Silver, et.al. 1998).

By substituting the equation, we find that the two cost components are equal at the EOQ and we obtain the simple result;

$$TRC = \sqrt{2\mathrm{AD}vr}$$

When a firm experience problems with the delivery of ordered products from the supplier, this directly affects the lead time. Unstable lead time leads to uncertainty and accordingly a larger safety stock is needed. The safety stock can be defined as extra units of inventory carried as a protection against possible stock outs, and is a function of the cycle service level, the demand uncertainty, the replenishment lead time, and the lead time uncertainty (Chopra et.al. 2004). The safety stock is an assurance for the firm, and is used when the firm has problems with estimation of the predicted demand or lead time for the product. The safety stock helps firms meeting their sales demand when it exceeds the demand they forecasted without changing their production plan.

A firm's safety stock amount can have a direct impact on the financial result, and is often seen as a drain of financial resources. Large safety stocks results in high holding costs of the inventory, and additional products that are stored over a period can be destroyed, expire, or break during the storage. However, a small safety stock can result in stock outs, and additional production stop and lost sales.

In this paper the focus is on firms that have a problem concerning the delivery of products from their suppliers. When the delivery of orders from the supplier becomes a problem it results in an uncertainty in the lead time, and accordingly the buying firm invest in a higher safety stock to be certain that a given amount of the product always is on storage so the firm can avoid stock outs. This result in a higher level of the safety stock than what would be necessary if the products ordered were delivered at the right time.

As concluded above, uncertainty in the lead time directly results in a higher safety stock. But how much higher will the safety stock be? Is it reasonable to believe that for each dunning, the buying firm will expand the safety stock by one. If this is the case the function will be linear. However, it is not reasonable to believe that a firm will have an exponential grow according to the dunnings (one dunning per day too late delivered). In proportion to the learning curve, it is assumed that the safety stock will increase into a certain level, before it will be exponential declining. As workers gain more experience with the requirements of a particular process, or as the process improves over time, the efficiency is introduces in to the process, and the number of hours required to produce an additional unit declines (Nahmias, 2005). In this case, the purchasers will see a repeated pattern as time goes by, and gradually they will develop some routines and now which safety stock that is suited. This can be viewed as one exponential effect, as learning by doing (Nahmias, 2005). The firm should therefore evaluate the level of their safety stock by looking at the numbers of dunnings over a time period.

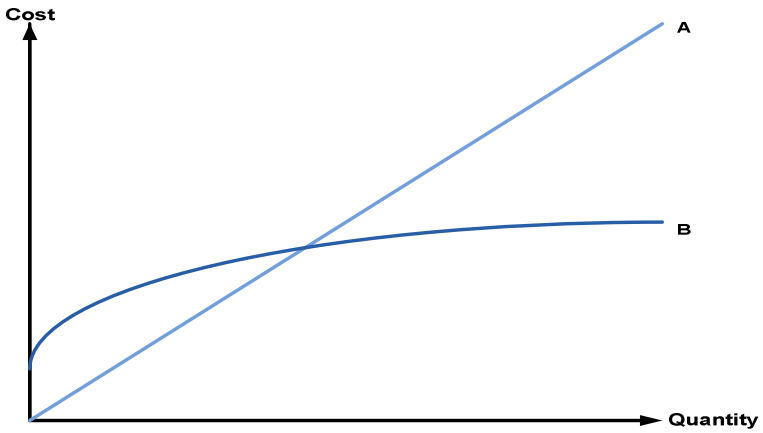

Figure 8 – Linear and exponential declining safety stock

As shown in the figure above, A is linear indicating that the firm will expand their safety stock by one for each dunning. B is exponential declining, and according to the learning curve the firm should evaluate the level of their safety stock by looking at the dunnings over a time period.

Model of the relations related to the theory and hypothesis

Previous different theories have been discussed, and I have argued for four hypotheses which all may have an impact on a supplier's behavior. These are all summarized in research model, figure 9 below.

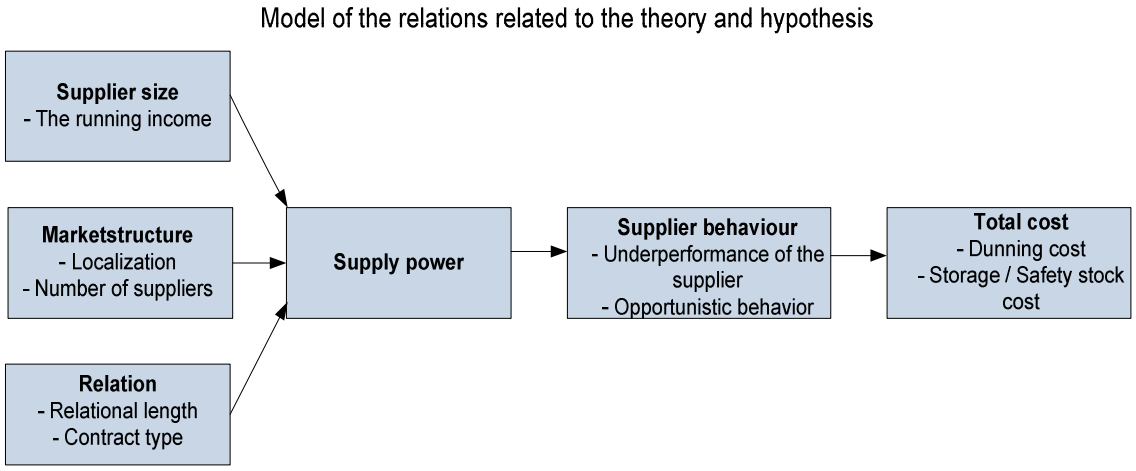

Figure 9 – Model showing variables that affects late deliveries of non-critical items

In the front edge of the analysis there will be a short presentation of Hustadmarmor AS which is the case company used when examine problems related to non-critical items. The statistically material collected to use in the analysis is assembled from Hustadmarmor AS, and is data covering one year, 2008.

4. The white minerals industry

"Industry, innovation and advanced technology – in harmony with nature"

The history of the "white minerals" industry started when Kjell Steinsvik in 1948 established Hustad Bruk AS, including two subsidiary companies Hustadjord AS and Hustad Kalk og Marmor AS. At that point in time the poor coastal areas in Romsdal gave rise to concern and Steinsvik wanted to do something to strengthen the basis of existence in Romsdalen.[3]

Hustad Kalk og Marmor AS was the branch company which was focusing on the exploitation of geoponic calcium. In 1976 they decided to stake heavily on the calcium-carbonate as additive in the paper industry and therefore began a closer cooperation with Omya AG. Hustad Kalk og Marmor AS was divided into two parts, Hustad Kalk AS owned by the Steinsvik family, and Hustadmarmor AS owned 50% of Hustad Kalk AS and 50% of Omya AG (Håndboken om Hustadmarmor, 2007). We can today say that this was the start and the footstone for today's business activities at Hustadmarmor AS.

Hustadmarmor AS is a Norwegian refining company that is located in Elnesvågen. Here they produce calcium carbonate/liquid marble as a raw material that is used in paper as both filler and coating pigments. The liquid marble contributes to an improvement of the paper quality, and its introduction into modern printing papers has resulted in major environmental advantages. Coatings consist of calcium-carbonate which gives a smooth surface and world-class printing quality. Hustadmarmor is the worlds leading producer of pigments to the international paper industry and has a close and long-term partnership with

[3] http://www.hustadmarmor.no/web/omya_no.nsf/CompanyHistory?ReadForm&omya_langid=2&omya_navid=010001

European paper producers. At this point in time 99.8% of the production goes to the paper industry, and almost everything is export trade. [4]

Since almost all of the production goes abroad and far away form the production unit, Hustadmarmor which is situated beside the sea, has taken the natural choice of using cargo ships as transportation of finished products. Over 3.2 million tons of finished products have to be distributed abroad during a year.[5] This in reality means that 8.500 tons must be shipped from the factory in Elnesvågen each day, 365 days per year (this corresponds to 274 tankers/cars per 24-hour period if they decide to not use ships). Efficient and environmental transportation is one of the goals for Hustadmarmor concerning the distribution, and due to this Hustadmarmor have invested in 16 custom built ships that can take maximum 17 000 tons liquid marble. In average one ship leaves from the quay structures/depot in Elnesvågen each day and transport the finished products to tank farms located in Oulu, Husum, Gävle, Förby, Kalmar, Hamburg, Emden, Moerdijk, Ridham Dock and Aberdeen. The products are further sent from the tank farms to the end customers by vehicles or trains. Most of the raw material that is transported to Hustadmarmor for further manufacturing usually also is mainly transported by ships. The raw material comes from mines in Eide, Fræna and Brønnøysund.

Hustadmarmor has been a part of the Omya Group since 1976, and in 2007 Omya became the sole owner of Hustadmarmor. Omya is a leading global producer of industrial minerals, mainly fillers and pigments derived from carbonate and dolomite, and a worldwide distributor of chemical products. [6]

Omya's major markets are the paper, plastic, paint/coatings/adhesives industries as well as construction environment, agriculture, food and pharma. Omya now has a global presence extending to more than 100 locations in over 50 countries and 6000 employees

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4 http://www.hustadmarmor.no/web/omya_no.nsf/CompanyHistory?ReadForm&omya_langid=2&omya_navid=010001

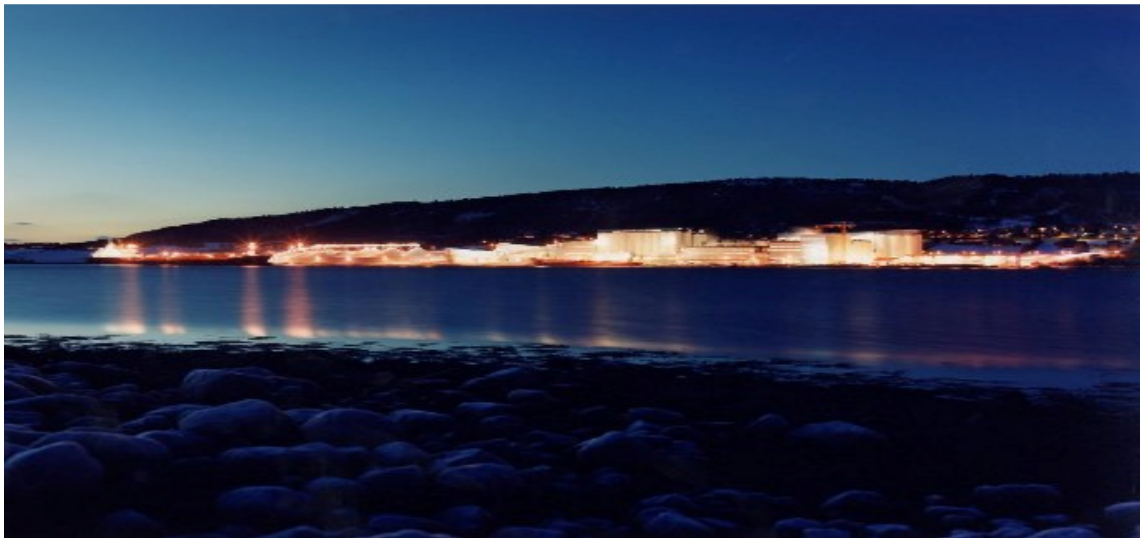
5 http://www.hustadmarmor.no/web/omya_no.nsf/Sites_Lang2/FF4E520B0EE7E013C125711500730ABD?OpenDocument&omya_langid=2&omya_navid=010003

6 http://www.omya.com/internet/corporate/q2wcontent.nsf/vwWebDirectName/home

(Håndboken om Hustadmarmor, 2007). Of this 170 employees are stated at Hustadmarmor, and additionally there are also about 70 hired personnel. Hustadmarmor now has the largest production unit in the Omya concern, and produced approximately 3.2 million tons liquid marble in 2007. Hustadmarmor AS has an annual turnover equal to about NOK 1.8 billion and is a world leader within the production of liquid marble to the paper industry.

One of Hustadmarmor's goals is to continue the expansion of the company and further be a reliable partner for their customers. If Hustadmarmor is going to be a reliable partner for their customers, it is important that they have the material needed available. As mentioned, Hustadmarmor is facing a problem concerning the ordering process of non-critical items. During unstructured interviews with managers at the purchasing- and inventory department, Hustadmarmor claimed that they often experience to receive confirmation on orders, but where the product or service still didn't arrive at the time agreed upon. The labour connected with the follow up of these orders, especially for non-critical items is resource-draining and time consuming and also leads to extra costs for the firm. The firm will be affected by a higher ordering (labour) and holding cost.

By analyzing the problem concerning order processing mainly regarding non-critical items, we might get an indicator of which factors that is accomplice to this problem, and also get an indicator of how this ordering problem affects the purchasing and holding cost of the firm.



5. Research methodology

The research methodology that is suited to this research is the single-case study approach (Yin, 2003). Yin defines the case study research as *"an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident."* In summary Yin says that a case study research is a comprehensive research strategy that includes the development of a theoretical model, research model design, data collection, and data analysis. The case study method was chosen since the question in this research deals with exploratory issues.

Within empirical research, three types of research can be distinguished; explorative, descriptive and explanative research (Yin, 2003). In this thesis an explorative research is used as a research design, since this is the research design suited when a problem is unclear, or the subject is new to the researchers. Explorative research seeks to find out more about a phenomenon which is little know, and the objective consists in establishing new theories and hypothesis (Yin, 2003).

When analyzing the collected data in this research, statistical programs as SPSS and Stata will be used. Statistics is a mathematical science which presents and explains the collected data, and generally gives an imitation of the reality. The knowledge you have about reality becomes a remedy when analyzing the data's, and a model that is as much as possible alike the reality is build up to explain the factor you would like to analyze.

A common goal when analyzing a problem statistically is to investigate the relations between a dependent variable and the independent variables. In the analysis of this research, the regression analysis will be used as the main tool. The reason for this is that the available data is concrete numbers for demand, price, etc..,.

5.1 Regression analysis

Statistics can as mentioned, be used to analyze possible connections based on the collected data's. First, we study if the dataset indicates any connections, then we study if the observed connection is significant or if it has arisen on random basis. It is also relevant to find out how strong the connections are.

There are different ways of how to study the different connections between the variables. The correlation analysis examine *if* there are any linear connection between the variables, while the regression analysis tell *which* linear connection that best fit the data's.

In statistics, regression analysis refers to techniques for the modeling and analysis of numerical data consisting of a dependent variable (Y) and of one or more independent variables (X) (Ragsdale, 2004). The dependent variable in the regression is modeled as a function of the independent variables, corresponding parameters, and an error term (random variable, representing unexpected variations in the dependent variable). *"The aim of the regression analysis is to identify a function of the independent variables that adequately accounts for the behavior of the dependent variable. After identifying such a function, it can be used to predict what value the dependent variable will assume, given specific values for the independent variables"* (Ragsdale, 2004).

A general multiple linear regression model can be written as;

$$Y_i = \alpha + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} ..... + \beta_n x_{ni} + \varepsilon$$

One of the assumptions of linear regression analysis is that the residuals are normally distributes. The linear regression model, assumes that the relationship between the response variable and the predictors is linear. If this assumption is violated, the linear regression will try to fit a straight line to data that do not follow a straight line.[7] In order to fulfil the assumption about normal distributed variables, the dependent and all the independent variables (except from one binary variable), used in this analysis was transformed to a logarithmic form.

[7] http://www.ats.ucla.edu/stat/spss/webbooks/reg/chapter2/spssreg2.htm

The general multiple linear regression model transformed to a logarithmic form;

$$\ln Y_i = \alpha + \beta_1 \ln x_{1i} + \beta_2 \ln x_{2i} + \beta_3 \ln x_{3i} ..... + \beta_n \ln x_{ni} + \varepsilon$$

Where;

Y = days too late delivered (dependent variable)

X1, X2, X3 = explanatory variables (independent variables)

α, β_1, β_2, β_3 = coefficients

ε = error term

5.2 Multicollinearity

One of the assumptions of the classical linear regression model is that there is no multicollinearity among the explanatory variables (Gujarati, 2003). The term multicollinearity is used to describe the situation when the independent variables in a regression model are correlated among themselves. In situations where two or more explanatory variables are highly correlated, the coefficient estimates may change erratically in response to small changes in the model or the data, meaning that the model can be less precise than if the variables where uncorrelated with one another. Multicollinearity tends to increase the uncertainty associated with the parameters estimates in a regression model and should therefore be avoided whenever possible (Ragsdale, 2004).

The coefficient of determination R^2 is a summary measure that tells how well a sample regression line fits the data (Gujarati, 2003). If the regression analysis shows a high R^2, but few significant *t* ratios, this is a classical symptom of multicollinearity (Gujarati, 2003).

By putting the explanatory variables in a correlation diagram, we can examine if there is any multicollinearity. If we have variables that are highly correlated, the coefficients' will be closely to 1, and there is a perfect multicollinearity. If the correlation coefficients' is closely to -1, we are dealing with a perfect negative multicollinearity. According to this we should study the correlation diagram, and if there are any variables that are highly correlated, one should be considered removed.

To examine the multicollinearity of the variables more deeply, the variance-inflation factor (VIF) method can be used. This is a method of detecting the severity of multicollinearity by looking at the extent to which a given explanatory variable can be explained by all the other explanatory variables in the equation (Studenmund, 2001). As the extent of the co-linearity increases, the variance of an estimator increases, and the limit become infinite (Gujarati, 2003). The degree of multicollinearity is evaluated by the size of the VIF. The higher a given variable's VIF, the higher the variance of that variable's estimated coefficient (Studenmund, 2001). Due to this we can say that the higher the VIF, the more severe the effects of multicollinearity are. Since there is no registered value indicating

when we have a critical VIF, a common rule of thumb is that if VIF > 5, the multicollinearity is severe (Studenmund, 2001).

6. Analysis

According to my research problem this research paper will attach importance to relationships developed when companies are dealing with non-critical items, and look at the genuine cost related to them. For Hustadmarmor it is a known problem that some of their suppliers don't deliver the ordered product within the time agreed upon, this problem is especially concerning non-critical items. The analysis within this research paper will look at which variables that have an effect on late deliveries, and if there exists any clear correlations between late deliveries and some variables. The analysis is developed in order to investigate the underlying cause of why different suppliers deliver too late.

The collected data is from year 2008, and include all orders of non-critical items. For each specific registered order, the price (in NOK), the article number, amount, supplier name, supplier size, ordering date (date of placing an order), certified delivery date, actual delivery date (receipt of the product), lead time, distance, relation length between Hustadmarmor and each supplier, and contract type is registered. Each of the variables included in the analysis will be discussed more in detail.

6.1 Variable description

6.1.1 Numbers of days too late delivered

The variable "number of days too late delivered" will be the dependent variable in the analysis. This variable indicates the derogation between the certified deliver date and the actual deliver date, where only weekdays from Monday to Friday is included (all holidays and weekends are deducted). The variable number of days too late delivered is the actual amount of days each supplier has delivered their ordered products to late.

6.1.2 Product price

The variable "product price" is one of the explanatory variables in the analysis, and is given for every specific article (each single product). In situations where the product price for an article has changed through the year, the average product price has been calculated. The product price will in the analysis be used to see if products that are of high value are delivered more precisely than products of low value.

6.1.3 Number ordered

The variable "amount" is also one of the explanatory variables in the analysis. This variable indicates the numbers of each single article ordered through the year. The variable "amount" will be used in the analysis to see if orders' that contains many of the same articles is delivered later or sooner than orders that contains only a few of the same article.

6.1.4 Lead time

The lead time can be defined as the period of time between the initiation of any process of production and the completion of that process. The lead time variable in this analysis will accordingly indicate the amount of time between placing of an order and the receipt of the products ordered.

6.1.5 Distance

Distance is a numerical description of how far apart objects are. In this research the distance is defined by the geographical length between the different suppliers and Hustadmarmor, measured in kilometres. The distance variable is calculated by NAF Ruteplanlegger.[8]

6.1.6 Supplier size

Supplier size is also one of the explanatory variables in this analysis, and is used to measure the power between the buyer and supplier. The most common way of measuring the size of a supplier is by looking at how the market is shared, and to measure how much of the market share each supplier has. In this research, the data of the market share for each supplier was not available. However, to find an estimate which measures the size of a supplier, this research paper has taken basis in the running income of a company from the year 2007. The running income is the revenue that the firm serve, as a consequence of the operating activity in the company. To collect the data "supplier size", purehelp.no [9] was used.

6.1.7 Relational length

The relational length in this analysis can be defined as the time period Hustadmarmor and each supplier has collaborated. On the basis of absent data from Hustadmarmor's ERP system, the length of the relations is only registered from 1997. For collaboration exceeding 12 years, there are not any solid registered data, and therefore it is assumed that the collaboration has been proceeding for 12 or more years. In situations where there is a contractual agreement between Hustadmarmor and their suppliers settled for years ahead, this time period has been added to the relation. The variable "relation length" is included in the analysis since the collaboration time between Hustadmarmor and their suppliers might effect the outcome of deliveries too late.

[8] http://ruteplanlegger.naf.no/veibok/

[9] http://www.purehelp.no/default.asp?sok=e

6.1.8 Contract type

The variable contract type is registered as a binary variable (with the scale 0 – price agreement and 1 – written contract), and indicates if there is a written contact between Hustadmarmor and the suppliers, or if the collaboration is based on a price agreement. A fixed price agreement can be defined as an agreement whereby a company provides a service or a product at a price which stays the same for the whole period of the agreement.[10] A written contract is a binding legal agreement between two or more parties where all relevant information concerning the relationship should be stated.

[10] http://dictionary.bnet.com/definition/fixed-price+agreement.html

7. Regression analysis

This chapter will present the results of the performed analysis. In the previous chapter both the dependent and the independent variables where explained. Number of observations are 831.

7.1 Data mining

The data used in this analysis is collected from Hustadmarmor's ERP system, Movex. First, all registered orders from year 2008 were collected, resulting in a data set containing 4912 observations. Since this research only focus on non-critical items, all other product groups (strategic-, bottleneck-, and leverage products) were removed from the collected data set. This remove of data's were done in collaboration with Hustadmarmor, since they had the overview over which articles they defined as non-critical items. Hustadmarmor concluded that the non-critical items were registered within the article group's mechanical material, electrical material and equipment. All other observations were removed, which resulted in a data set containing 2026 variables. It is important to mention that office supplies are not included in the analysis of non-critical items because Hustadmarmor has outsourced this article group to a third party logistic.

Within the given article groups, there existed some special products that were not considered as non-critical items, all these products were deleted. Additional all orders containing visual punching errors (ex. the date 17.05.08 is punched as 05.17.08), and orders that were registered without a delivery date (orders not received when the data set were collected) were removed.
When studying the collected data set, it was revealed that the majority of each of the specific articles was ordered from the same supplier throughout the whole year. Specific articles where different suppliers had been used have for simplicity been deleted.

Non-critical items are as mentioned characterized as products with a low value, but where the frequency is high. Accordingly we have in this research only included suppliers that have delivered orders to Hustadmarmor twelve times or more per year, in average once a

month. This selection is performed because this research wants to examine which factors that affects in accuracy deliveries, and also attach importance to relationships developed when companies are managing non-critical items. Suppliers that deliver less than twelve times a year, are looked at as random suppliers, and are of little interest to this research.

To avoid any trends in the collected data set, each single article number were sorted, and all orders were summed up accordingly. The cleaning of the data resulted in a data set containing 831 observations.

7.2 Checking Normality of Residuals

Usually, the firs step of the data analysis is to test the normality of the residuals. *"Residuals are elements of variation unexplained by the regression model generated. Since this is a form of error, the same general principles apply to the group of residuals as would apply to errors in general: one expects them to be normally and independently distributed with a mean of 0 and some constant variance*". [11]

In statistics, normality tests are used to determine whether a data set is well modelled by a normal distribution or not, and it indicates whether our assumptions are reasonable and if our choice of model is appropriate. Hypothesis testing presumes that the model chosen for empirical analysis is adequate in the sense that it does not violate one or more assumptions underlying the classical normal linear regression model (Gujarati, 2003).

In the literature several ways of testing for normality has been discussed, but in this research only four will be considered. The regression model which is transformed to a logarithmic form is checked according to normality of residuals.

A histogram of residuals is a simple graphic device that is used to learn something about the shape of the probability density function of a random variable (Gujarati, 2003). The usual histogram is obtained by splitting the range of the data into equal-sized bins, and for each bin the number of points that fall into it from the data set is counted. [12] However, in this research the **kernel histogram** is used, which is a generalization of the usual histogram. The kernel density estimate can be thought of as a histogram with narrow bins and moving average.[13] Below you can see the kernel density plot analysis when checking for normality of residuals in the data set from this research.

[11] http://www.itl.nist.gov/div898/handbook/pri/section2/pri245.htm

[12] http://www.itl.nist.gov/div898/handbook/eda/section3/histogra.htm

[13] http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm

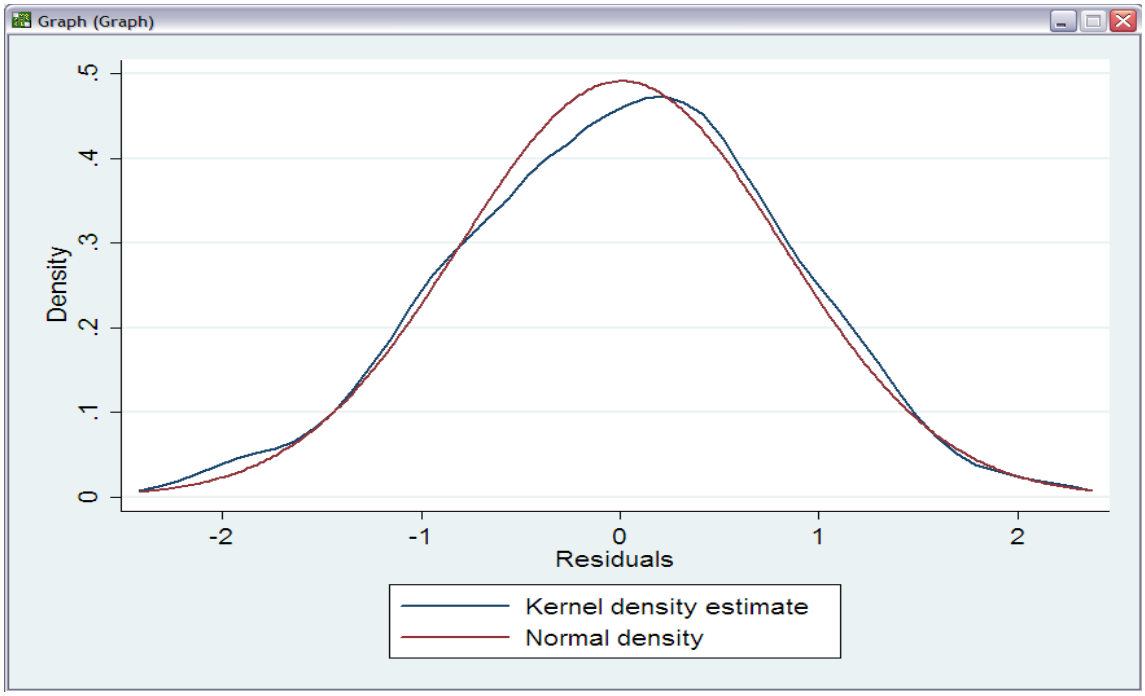


Figure 10 – The kernel histogram developed in Stata

When checking for normality of residuals in a kernel density plot, the normal option requests that the normal density is overlaid on the plot. As the graph shows, the two lines are very close which accordingly indicates that the data set is well modelled by a normal distribution and that there is not any outlier's (an observation that is numerically distant from the rest of the data).

For a wider check according to normality of residuals a **standardized normal probability plot** is carried out. The standardized normal probability plot is used to investigate whether the data set is approximately normally distributed or not. The data from the dataset are plotted against a theoretical normal distribution in such a way that the points should form an approximate straight line. [14] If there are any departures from this straight line, this indicates departures from the normality. The normal probability plot is sensitive to non-normality in the middle range of the data line.[15] Below you can see the standardized normal probability plot carried out from the dataset studied in this research.

[14] http://www.itl.nist.gov/div898/handbook/eda/section3/normprpl.htm

[15] http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm

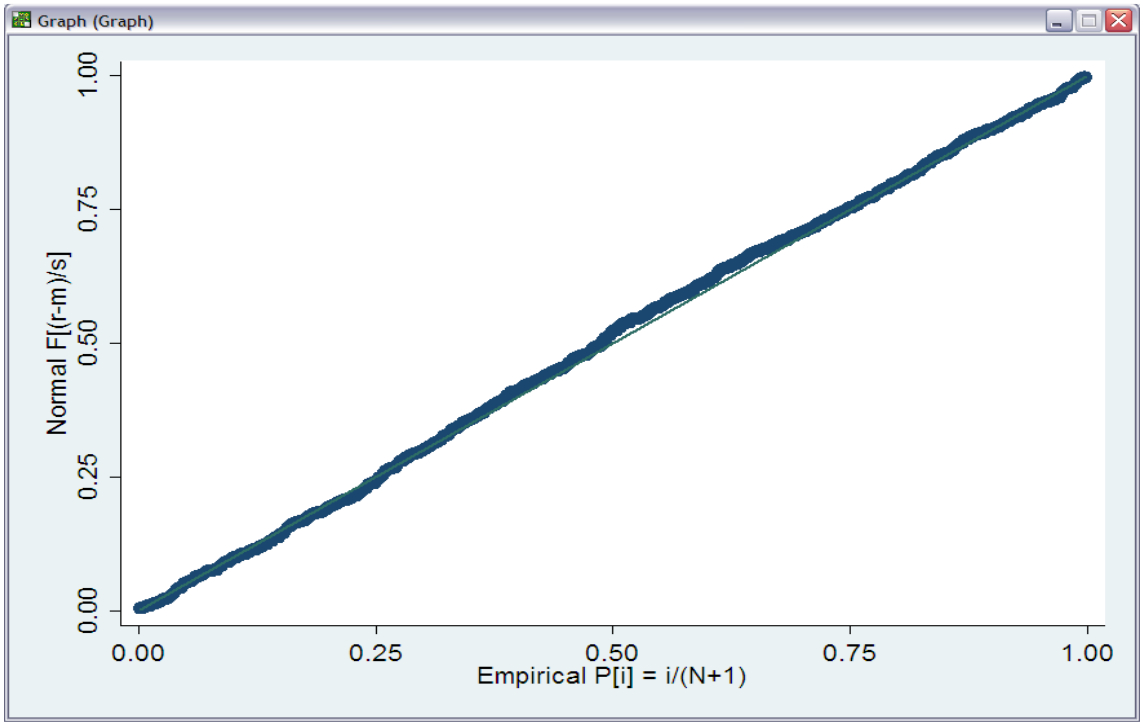


Figure 11 – The normal probability plot develop in Stata

As the graph shows, the normal probability plot shows no indications of non-linearity. The points on this plot form a nearly linear pattern which indicates that the normal distribution is a good model for this data set.

As mentioned the normal probability plot is sensitive to non-normality in the middle range of the data line, but there is also test's that is sensitive to non-normality near the tails of the data line. To check for non-normality near the tails, a **quantile probability plot** is performed.[16] The quantile probability plot is a graphical method which compares the quantiles of the variable in dataset against the quantiles of a normal distribution. Below you can see the quantile probability plot carried out from the dataset studied in this research.

[16] http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm

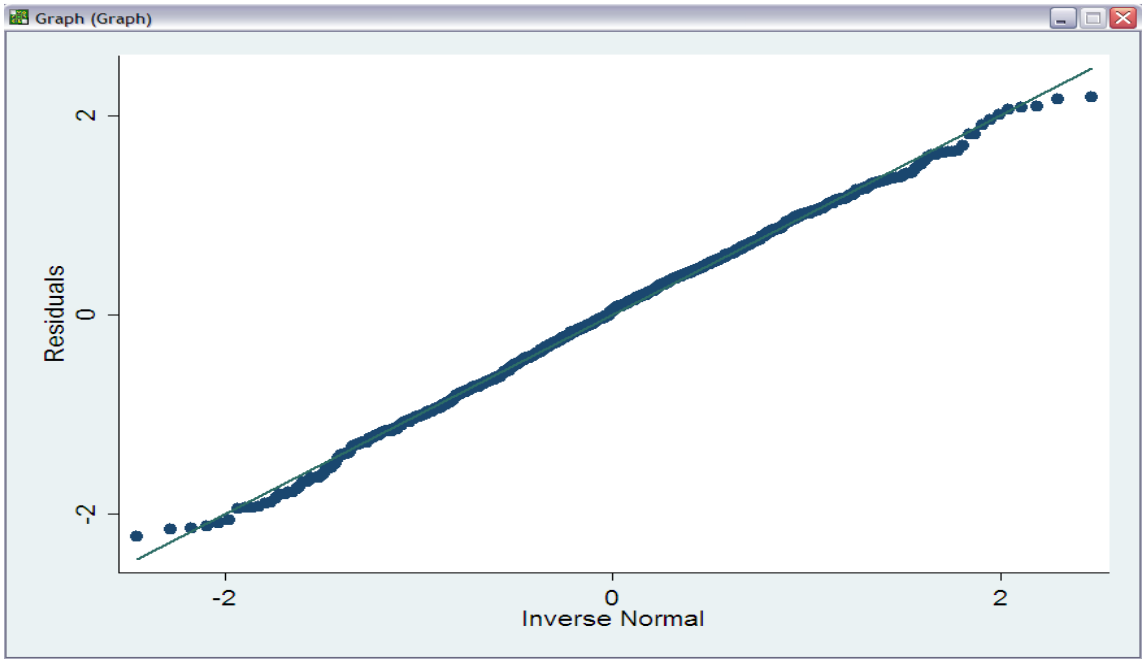


Figure 12 – The quantile probability plot develop in Stata

As the graph shows, the quantile probability plot shows a slight deviation from normal at the upper tail. However, this seems to be a minor and trivial deviation from normality, and the residuals are therefore close to a normal distribution.

Finally, a numerical test is performed for testing for normality. The numerical test used in this analysis is **the inter-quartile range** which assumes the symmetry of the distribution.[17] The inter-quartile range is a measure of the variability distance between the top of the lower quartile, the 25th percentile (Q1) and the bottom of the upper quartile, the 75th percentile (Q3) of a distribution. The formula for the inter-quartile range can accordingly be stated as; Q3-Q1.[18] Below you can see the results of the inter-quartile range carried out from the dataset studied in this research.

[17] http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm

[18] http://davidmlane.com/hyperstat/A78092.html

Table 1. The inter-quartile range develop in Stata

Mean	= ,0079	std.dev	= .8117	(n=831)
Median	= ,0504	pseudo std.dev	= .8346	(IQR= 1.126)
10 trim	= .018			
	Low	high		
inner fences	-2.254	2.249		
# mild outliers	0	0		
%mild outliers	0.00%	0.00%		
outer fences	-3.943	3.938		
# severe outliers	0	0		
% severe outliers	0.00%	0.00%		

When testing for normality the inter-quartile range checks for outliers. The presence of any severe outliers (outliers that consist of point that are either 3 inter-quartile ranges below the first quartile, or 3 inter-quartile ranges above the third quartile) should be sufficient evidence to reject normality at a 5% significant level.[19] Mild outliers are common in samples of any sizes and indicate that the residuals have an approximately normal distribution.

The results from the numerical test of the dataset used in this analysis shows that there are zero mild outliers, and zero severe outliers. Due to this, we can say that the data set used in the analysis is normal distributed.

[19] http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm

7.3 Untransformed variable description

Descriptive statistics are used to describe the basic features of the data in the study. The descriptive statistics should provide a simple summary about the sample and the measures.[20] Descriptive statistics are simply describing what the data shows, and help us present the quantitative descriptions of the dataset in a manageable form.

The untransformed descriptive statistics of the data set used in this research are reported in table 2, and a correlation matrix is reported in table 3.

Table 2. Descriptive statistics, untransformed variables

	Median	Mean	Std. Deviation	Minimum	Maximum
Days too late delivered	2.00	5.39	8.288	0.0	60.0
Number ordered	6.00	71.96	351.494	1.0	6600.0
Product price (NOK)	88.00	2380.17	7345.049	0.0	74000.0
Lead time (days)	12.00	22.36	28.780	1.0	241.0
Distance (km)	477.90	319.77	300.794	21.0	1690.0
Supplier size (NOK)	184284000.00	14024530819.50	189172754320.8	11854000.0	2732296000000.0
Relational length (years)	12.00	12.06	2.9	4.0	16.0
Contract type	1.00	0.51	0.5	0.0	1.0

The descriptive statistics shows that;

The days of late deliveries varied from a minimum of 0 days to a maximum of 60 days, with an average of approximately 5 days. The number ordered varied from a minimum of 1 to a maximum of 6600, with an average at approximately 72. The product price varied from a minimum of 0 NOK to a maximum of 74000 NOK, the average product price was equal to 2380 NOK. The Lead time varied from a minimum of 1 day to a maximum of 241 days, and the average lead time was approximately 22 days. The distance between Hustadmarmor and their suppliers varied from a minimum of 21 km to a maximum of 1690 km, with an average distance equal to approximately 320 km. The length of the relation varied from minimum 4 years to maximum 16 years. The average length of a relationship between a supplier and Hustadmarmor was approximately 12 years.

[20] http://www.socialresearchmethods.net/kb/statdesc.php

Further, as due to possible multicollinearity the correlation diagram is shown in table 3 below. The results indicate that there are no significant correlations between the variables. The highest correlation value observed, was -0.571.

Table 3. Correlation for variables

	Days too late delivered	Number ordered	Product price (NOK)	Lead time (days)	Distance (km)	Supplier size (NOK)	Relational length (year)	Contract type
Days too late delivered	1							
Number ordered	0.005	1						
Product price (NOK)	0.001	-0.063	1					
Lead time (days)	0.555	-0.008	0.204	1				
Distance (km)	-0.049	0.016	0.130	0.158	1			
Supplier size (NOK)	0.014	0.132	-0.021	-0.001	0.044	1		
Relational length (years)	0.078	-0.067	0.007	-0.048	-0.571	-0.003	1	
Contract type	0.091	-0.120	0.132	0.090	-0.483	-0.072	0.657	1

7.4 Results of the regression analysis

In this part of the paper the results of the regression analysis will be presented. Forgoing, the different variables used in this analysis has been explained more profoundly. The number of observations is 831.

Table 4. Dependent and independent variables

Dependent variable:	Independent variables:
Days too late delivered	Number ordered Product price (NOK) Lead time (days) Distance (km) Supplier size (NOK) Relational length (years) Contract type

The regression model used in this analysis will accordingly be;

$$ln\_Days\_too\_late\_delivered = ln\_Number\_ordered + ln\_Product\_price + ln\_Lead\_time + ln\_Distance + ln\_Supplier\_size + ln\_Relational\_length + Contract\_type + \varepsilon$$

Hypothesis:

H0: $\beta_1, \beta_2 \ldots, \beta_n = 0$ *vs.* *HA:* $\beta_1, \beta_2 \ldots, \beta_n \neq 0$

First the assumption of the classical linear regression model, no multicollinearity among the regressors included in the regression model was examined (Gujarati, 2003). Within all models some multicollinearity will exist, because in a real world there is almost impossible to find a set of explanatory variables that are totally uncorrelated with each other. One way to detect severe multicollinearity is to examine the simple correlation coefficient between the explanatory variables (Studenmund, 2001). Accordingly, all the variables used in the regression analysis were put into a correlation diagram, see table 5.

Table 5. Correlation for LN_variables

	Days too late delivered	Number ordered	Product price (NOK)	Lead time (days)	Distance (km)	Supplier size (NOK)	Relational length (years)	Contract type
Days too late delivered	1							
Number ordered	0.123	1						
Product price (NOK)	0.116	-0.513	1					
Lead time (days)	0.713	0.005	0.366	1				
Distance (km)	0.057	0.118	0.064	0.330	1			
Supplier size (NOK)	-0.043	0.243	-0.040	-0.027	0.086	1		
Relational length (years)	-0.050	-0.280	0.283	-0.126	-0.545	-0.140	1	
Contract type	0.016	-0.341	0.342	0.023	-0.499	-0.178	0.585	1

The correlation diagram shoes that the highest correlation is between the variable relational length, according to distance and contract type. This correlation indicated the probability of severe multicollinearity.

To examine the multicollinearity of the variables more deeply, the variance-inflation factor (VIF) method was used. The degree of multicollinearity is evaluated by the size of the VIF. The higher a given variable's VIF, the higher the variance of that variable's estimated coefficient (Studenmund, 2001). In the analysis performed in this paper we find that the VIF is less than 5 for all the variables used, see table 6 below. However, the relational length-, distance- and contract variable has the highest VIF and are therefore of concern.

Table 6. Variance-inflation factor

	VIF
Number ordered	1.524
Product price (NOK)	1.747
Lead time (days)	1.394
Distance (km)	2.119
Supplier size (NOK)	1.106
Relational length (year)	1.929
Contract type	2.129

Further evaluation shoved that the variable relational length had a shift in sign from negative to positive when a regression analysis without the variables distance and contract were run. This shift indicates that there is some multicollinearity among the variables, and based on this there will be performed two regression analyses to avoid this problem. This research therefore estimates two regression models in order to test the four hypotheses.

The first regression model used in this analysis will be;

$$ln\_Days\_too\_late\_delivered = ln\_Numer\_ordered + ln\_Product\_price + ln\_Leadtime + ln\_Distance + ln\_Supplier\_size + Contract\_type + \varepsilon$$

The result of this regression model is showed in table 7.

Table 7.
Dependent variables: Days too late delivered, n=831

Predictor	Coef
Constant	1.531*
Number_ordered	0.010
Product_price (NOK)	-0.063*
Lead_time (days)	0.724*
Distance (km)	-0.163*
Supplier_size (NOK)	-0.047*
Contract_type	-0.169*
Prob > F	0.000
R-Sq =	55.6 %
R-Sq (adj) =	55.1 %

*p-value < 0.05 **p-value <0.1

The result from the first regression model shows that the R^2 is equal to 55.6 %. However, a known problem with the R^2 is that adding another independent variable to a particular equation never decreases the R^2. Accordingly we therefore should be critical to the value of the R^2 when examine the results. In this regression there are 831 observations, where the regression has 6 explanatory variables. This indicates that the explanatory variables in proportion to number of observations are of little concern. A rule of thumb is that 5 times the explanatory variables < number of observations.

The second regression model used in this analysis was;

Ln_Days_too_late_delivered = ln_Number_ordered + ln_Product_price + ln_Lead_time + ln_Supplier_size + ln_Relational-length + ε

Table 8.
Dependent variables: Days too late delivered, n=831

Predictor	Coef
Constant	-0.233
Number_ordered	0.007
Product_price	-0.070*
Lead_time	0.683*
Supplier_size	-0.026
Relational_length	0.257*
Prob > F	0.000
R-Sq =	53.0 %
R-Sq (adj) =	52.6 %

*p-value < 0.05 **p-value <0.1

The result from the second regression model shows that the R^2 is equal to 53 %, which also is acceptable. The decrease in the R^2 can be explained by the remove of the two explanatory variables "distance" and "contract type".

The R-squared values for the models range from 0.53 to 0.556, all with a significant *F* statistic.

7.4.1 Testing which effect the relational length has on deliveries of non-critical items.

As table 8 reports the variable "relational length" is significant to a p-value < 0.05, and with a positive sign. This is what we had expected and what we had proposed in hypothesis 1. In hypothesis 1, we expected that the longer a relationship between a buyer and supplier had endured, the more delayed the deliveries would be because of opportunistic behavior from the suppliers side. The impact of close buyer-supplier relations can lead to a higher probability of opportunistic behavior from one of the parts involved because of investment of specific assets in the relationship.

7.4.2 Testing how different contract types affect the delivery of non-critical items.

The results from table 7 show that the variable "contract type" is significant to a p-value < 0.05. The variable contract type also has a negative sign which indicates that suppliers with written contracts deliver their orders later than suppliers with a price agreement. This was what we expected in hypotheses 2.

7.4.3 Testing which effect the distance has on deliveries of non-critical items.

As table 7 reports the variable "distance" is significant to a p-value < 0.05, however with a negative sign. This is the opposite of what we had expected and of what we had proposed in hypothesis 3. In hypothesis 3, we expected that the longer the distance was between Hustadmarmor and the suppliers, the more inaccurate the delivery would be. The result of the regression analysis indicates that the shorter the distances between Hustadmarmor and their supplier is, the more delayed the deliveries is.

7.4.4 Testing how the size of the supplier affects the delivery of non-critical items.

Table 7 also reports that the variable "supplier size" is significant to a p-value < 0.05, with a negative sign. This is what we had expected and what we had proposed in hypothesis 4. In hypothesis 4, we expected that the larger a supplier is, the more power he will have and accordingly this might indicate that the supplier behave opportunistic, resulting in more delayed deliveries.

The result of the regression analysis shows which affect the different explanatory variables have on imprecise deliveries. In this section an overview over all the suppliers considered in the analysis, and the number of days each has delivered too late through the year 2008, is reported (see table 9). Three figures additionally are constructed to get a better overview of the table.

Table 9. Overview over all the suppliers and their delivery status

Supplier name	Number of days too late delivered	Number of days too late delivered (mean)	Total amount of orders
ABB AS	47	1,4	33
AHLSELL ELEKTRO NORGE AS	76	2,2	35
BRØDRENE DAHL AS AVD. KRISTIANSUND	69	2,7	26
DAMSTAHL AS	293	4	73
DANFOSS AS	84	2,9	29
ENDRESS + HAUSER AS	112	0,7	158
EXXONMOBILE LUBRICANTS AND SPECIALIT	9	0,8	12
J.F. KNUDTZEN AS	33	2,2	15
LEKANG MASKIN AS	52	1,7	32
LÖDIGE	47	2	23
LØNSETHAGEN INDUSTRIV. AS	115	4	28
MOLDE JERNVAREFORRETNING AS	1232	4,5	273
ROLF LYCKE AS	412	3,6	113
SCHNEIDER ELECTRONIC NORGE AS	8	0,3	29
SEW-EUROCRIVE AS MOSS	81	5,8	14
SIEMENS 01116	16	1,2	13
SMC PNEUMATICS NORWAY AS	35	1,3	26
SOLAR NORGE AS	380	3,2	118
STATOIL NORGE AS	39	2,1	19
TESS MØRE AS	151	2	76
TINGSTAD AS	107	3,1	35
VESTCOM AS	54	1,4	40
VESTPAK AS	325	2	162
WESTFALIA SEPARATOR AS	168	10,5	16
SUM	**3945**	**2,8**	**1398**

The first figure shows the total amount of orders ordered from each singel supplier through the year 2008.

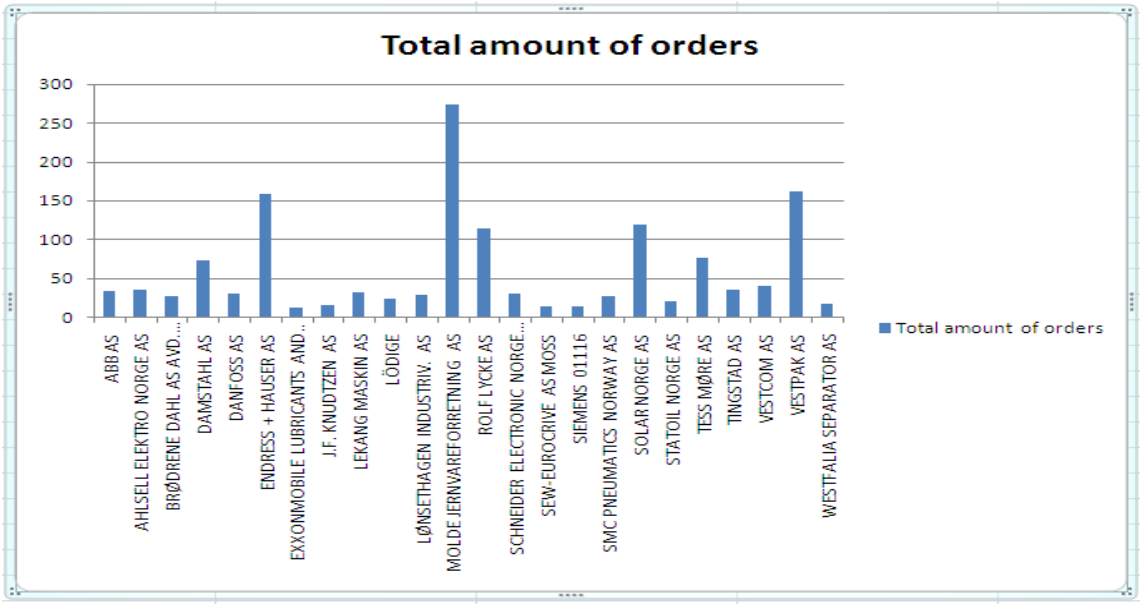


Figure 13 – Number of orders for each supplier

The second figure shows how many days each supplier totally has delivered too late in the year 2008.

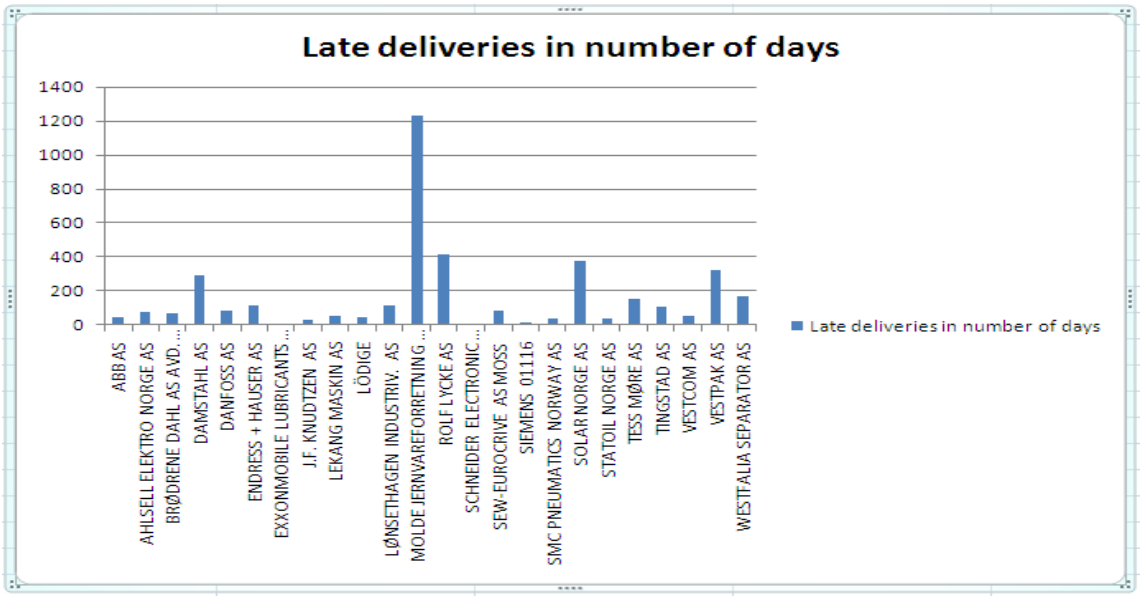


Figure 14 – Late deliveries in number of days for each supplier

The figure above shows the total amount of days too late delivered for each single supplier. However, the mean should also be calculated since some suppliers delivers more orders through the year than others. By calculating the mean, the graph gets a totally different picture than before. The figure is displayed below.

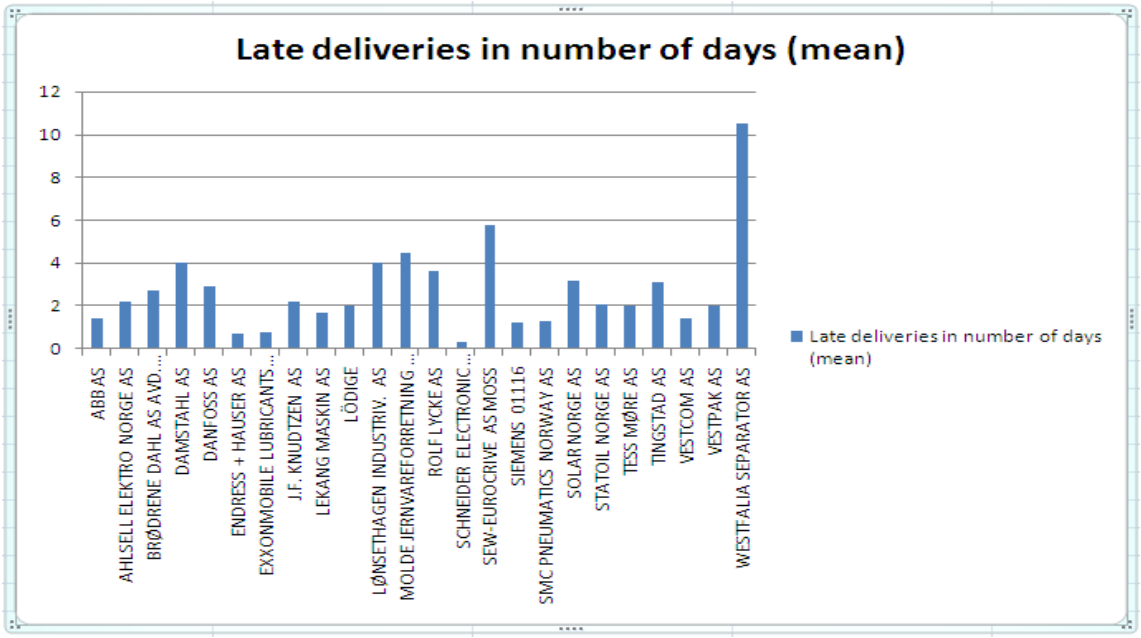


Figure 15 – The mean of late deliveries in number of days for each supplier

According to the graphs above it is prominent that Hustadmarmor has a problem concerning the delivery of non-critical items. This may indicate that the suppliers behave in an opportunistic way, by not delivering their products at the time agreed upon. When a firm experience problems concerning the delivery of goods from a supplier, this leads to frustration and extra cost. One of the costs that will accrue when the delivery of the product is delayed is the "dunning cost". The dunning cost is a direct affect of all the labour connected to the follow up of delayed orders.

7.5 The extra incurred costs when dealing with ordering problems for non-critical items

In this paper the EOQ model has been used when calculating the accumulated dunning costs for non-critical items for year 2008. First, the total relevant costs of non-critical items are displayed when there are no dunning costs involved. Second, three scenarios are given which each represents different time frames of how much labour is connected to the dunning. The three scenarios are developed to show how the costs related to the dunning vary. Hustadmarmor doesn't have any registered time frame on how much work is related to each dunning, but by calculating the cost for three scenarios they will have a hint showing how much the dunnings actually affects the firm financially within the different time frames.

The formula used when calculating the total cost of non-critical items, with and without the dunning cost is the total relevant cost (TRC) formula which is based on the EOQ model.

$$TRC = \sqrt{2ADvr}$$

A - The ordering cost; the ordering cost can be defined as the total expenses of placing and receiving the order. Hustadmarmor does not have any calculations on the actual cost of the ordering process, and therefore an estimate has been calculated. This calculation is based on the whole process from ordering to receiving the order, including the quality check, invoicing and payment. Accordingly it is reasonable to estimate the ordering cost to 250 NOK.

D – The demand rate; the demand rate for non-critical items was totally 1398 orders in 2008 for Hustadmarmor.

v – The unit variable cost of the item; in the dataset the unit variable cost for each item was given. For simplicity, in this research an average cost has been calculated. The total value of all the articles ordered through the year was divided on the numbers of articles. This calculation resulted in a unit variable cost of 127 NOK per item.

r – The carrying charge cost; the carrying charge cost at Hustadmarmor is estimated to 20%. This cost is directly related to stock holding, stockrooms, equipment (book shelf, handling tool etc..,), follow up and administration costs related to the storage, personnel cost, and insurance cost.

Firs the total relevant costs for non-critical items are calculated when there where no dunnings involved in the ordering process.

$$TRC = \sqrt{2ADvr}$$

$$TRC = \sqrt{2 * 250 * 1398 * 127 * 0.20}$$

$$TRC = 4214 \text{ NOK}$$

The result of this calculation shows that the total relevant cost per order is equal to 4214 NOK.

As mentioned Hustadmarmor have a problem concerning the deliveries of non-critical items. Since some of the suppliers don't deliver their products at the time agreed upon, the company faces an extra cost called dunning. The dunning cost used in this equation is a calculation based on the hourly payment of the purchaser at Hustadmarmor, and the total numbers of dunnings. It is reasonable to assume that a firm does not send out a dunning for each day an order is delayed. Therefore, it is in this thesis assumed that Hustadmarmor sends out a dunning the first day an order is delayed, and after this a dunning is sent out every second day. The dunning cost will in this equation be added to the ordering cost.

When calculating the total dunning cost for the orders sent out year 2008, the following calculations where performed;

First the average of the total number of "days too late delivered" for each single article where calculated. When the average of days too late delivered for each single article is known, the numbers of dunnings for each single article where calculated. The "number of dunnings" for each single article where multiplied with the "amount of orders" sent out for each article type, resulting in a variable called "totally amount of dunnings" within one article type. The "totally amount of dunnings" within one article type where multiplied with the hourly payment of the purchaser, resulting in a dunning cost for each article type through the year 2008. By summing up the dunning cost for all the article types, the total dunning cost for year 2008 was obtained. This total dunning cost where divided on the total amount of orders, resulting in an average dunning cost for each order sent out.

Scenario 1: Each dunning takes 15 minutes

In the first scenario, the basis is that each dunning takes 15 minutes, resulting in a dunning cost equal to 77 NOK per order.

$$TRC = \sqrt{2 * (250 + 77) * 1398 * 127 * 0.20}$$

$$TRC = 4819 \text{ NOK}$$

The difference between the total relevant costs of non-critical items when there are no dunning costs involved, according to the total relevant cost when the dunning (15 min) is included is 605 NOK per order. Through the year 2008 the total dunning cost for Hustadmarmor is equal to **845790** NOK.

Scenario 2: Each dunning takes 20 minutes

In the second scenario, the basis is that each dunning takes 20 minutes, resulting in a dunning cost equal to 102.5 NOK per order.

$$TRC = \sqrt{2 * (250 + 102.5) * 1398 * 127 * 0.20}$$

$$TRC = 5003 \text{ NOK}$$

The difference between the total relevant costs of non-critical items when there are no dunning costs involved, according to the total relevant cost when the dunning (20 min) is included is 789 NOK per order. Through the year 2008 the total dunning cost for Hustadmarmor is equal to **1103022** NOK.

Scenario 3: Each dunning takes 30 minutes

In the second scenario, the basis is that each dunning takes 30 minutes, resulting in a dunning cost equal to 154 NOK per order.

$$TRC = \sqrt{2 * (250 + 154) * 1398 * 127 * 0.20}$$

$$TRC = 5356 \text{ NOK}$$

The difference between the total relevant costs of non-critical items when there are no dunning costs involved, according to the total relevant cost when the dunning (30 min) is included is 1142 NOK per order. Through the year 2008 the total dunning cost for Hustadmarmor is equal to **1596516** NOK.

The calculated dunning costs give an estimate of what the direct cost of the in accuracy behaviour of the suppliers is. This research paper is therefore able to measure opportunistic behaviour in direct costs.

For Hustadmarmor there is an uncertainty in the lead time, and accordingly they are forced to invest in a higher safety stock than if their suppliers had delivered their orders on time. To calculate the safety stock, the standard deviation for the demand in the lead time is needed. Since Hustadmarmor doesn't have the required information, it is not possible to calculate the safety stock, and how this safety stock exactly is affected in proportion to uncertainty in the lead time caused of late deliveries. However, we can assume that because of late deliveries, there is an uncertainty in the lead time, resulting in a higher safety stock, which in turn affects the financial of a firm in a negative direction.

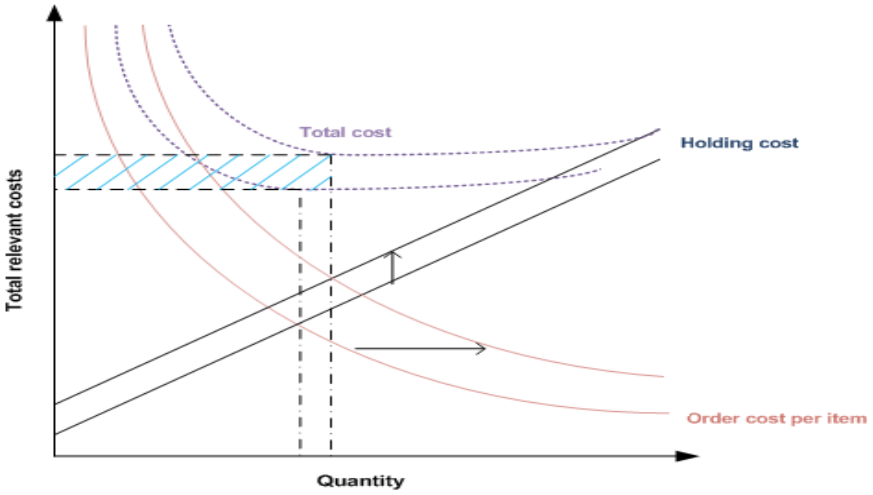


Figure 16 – The EOQ-model, showing a shift in the holding and ordering cost

Figure 16 shows an increased shift in the holding and ordering cost curve. The holding cost curve is affected by a higher safety stock due to problems concerning delivery of non-critical items. The ordering cost curve is affected by the dunning cost, which accumulate when the orders of non-critical items is not delivered at the right time. As an affect of the shifts in the holding and order cost curves, the figure shows that there is an increase in the total cost. The marked blue area in the figure shows the extra incurred costs a firm experience when dealing with ordering problems for non-critical items.

8. Discussion

In this paper the focus has been on non-critical items, and how to handle purchase of these products. Non-critical items have been offered little attention from researchers, although these are the products that are causing at least 60% of all the invoices for a firm. Even though non-critical items are of low value for the firm, the follow up of these products are resource draining and time consuming.

The case study of Hustadmarmor shows that their experienced problems concerning the delivery of non-critical items, in fact not should be a problem since this is products with many alternative suppliers in the market. The follow up of delayed orders directly affects the firm in dunning costs and in extra costs related to safety stocks.

When Hustadmarmor are searching for suppliers of non-critical items, they invite tender from 3-4 different suppliers. This can be stated as a situation where we are dealing with a competitive bidding. In the evaluation of which supplier to choose, different criteria's which are of importance for Hustadmarmor are evaluated according to each single supplier, and the supplier that totally fulfils most criteria's, or totally are best suited for the firm are chosen. To reduce the number of suppliers, generally a package of similar products within the same article group is bought from the same supplier. Hustadmarmor usually enter into an agreement whit the suppliers for a period of 3-4 years. The reason for the length of the contract is that the firm doesn't have available capacity to examine the contracts more often, and accordingly because this is non-critical items which are of little value, and further not prioritized products.

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Since Hustadmarmor choose to concentrate on only one supplier for each article group, we can say that they use the single sourcing strategy; accordingly Hustadmarmor concentrates on only a few suppliers in total, and try to build a stable relationship with them. The risk by entering into a soul sourcing strategy is that you are connected to only one supplier for a given article group, and accordingly invest time and money in that single relationship. In the purchase of non-critical item, it is not necessary for the buying firm to invest in the suppliers production, but it is likely that the buying firm invest time and money (work related to the follow up of contracts, production cooperation, relation investments, etc..,) to build a stronger relationship. A buying firm that make unilateral investments in a

relationship can be exposed for opportunistic behavior from the suppliers side, because the supplier understand that the specific investments done in proportion to that relationship have no value outside the exchange relationship for which they were made. The supplier also know that a change of supplier will result in high switching costs for the buying firm, since it will be forced to invest time and money in a new relationship. In a situation like this, the supplier is the one with the power and therefore has the opportunity to perform opportunistic by for example deliver the products ordered when it suites him.

In this paper, data from Hustadmarmor has been used to analyse which variables that affects late deliveries from the supplier. A survey with a focus on objective observations of a supplier's behaviour is carried through by measuring the supplier's inaccuracy in costs. The behaviour inaccuracy may be one indicator to use when analysing if the supplier acts opportunistic.

In the first hypothesis we tested how the length of a relation would affect the delivery of non-critical items. Theories developed according to relationships, claims that the longer a relationship is, the more trust exists between the firms' involved. However in some situations a long relationship can develop in a more negative direction. The impact of close buyer-supplier relations can lead to a higher probability of opportunistic behavior from one of the parts involved because of investment of specific assets in the relationship.

In this research, we expected that the longer a relationship between a buyer and supplier had endured, the more delayed the deliveries would be because of opportunistic behavior from the suppliers side. This was a correct assumption according to the analysis.

The longer the collaboration time between Hustadmarmor and a supplier has endured, the more Hustadmarmor have invested in the relationship, and accordingly the more opportunistic the supplier will act. As mentioned, the opportunistic behaviour is a result of the investments done in a relationship from the buying firm's side. The supplier is familiar with these investments, and he knows that these investments are of no value for the buying firm outside the relationship. The opportunistic behaviour is therefore a result of the power held by the supplier. For Hustadmarmor it will accrue high switching costs when changing supplier.

In the second hypothesis we tested how different contract types affected the deliveries of non-critical items. The analysis showed that suppliers with a written contract delivered their orders later than suppliers with a price agreement. The inaccuracy from the suppliers with a written contract might be an indication on opportunistic behaviour. The result of the analysis was as we expected because when there is only a price agreement between the buyer and the supplier it is easy for the buyer to change supplier if he is not satisfied, the supplier will therefore perform as the buyers request so that he does not lose him. However, when there is a written contract between the buyer and the supplier, this contract is developed for a period of 3-4 years, and often contains a clausal saying that the buyer are obliged to buy products from that exact supplier, and accordingly cannot buy products from the suppliers competitors. The supplier can then behave opportunistic by delivering their products later because it will not result in any consequence for the next 3-4 years, and it is of a relatively low probability that Hustadmarmor will violate the contract because this might result in a higher cost than what the actually cost of late deliveries is.

In the third hypothesis we tested which effect the geographical distance between a buyer and a supplier has on the deliveries since it is reasonable to anticipate that the distance between the supplier and Hustadmarmor will have some effect on how precise the deliveries will be.

It is reasonable to assume that shorter distances will result in a more precise delivery, since the supplier and the product will be placed in a closer range. However, the results showed that when the distance is long, the deliveries are more precise. This can be explained by the fact that a longer distance requires better organizing of the transportation, and that the distance is taken into more consideration when the delivery time is determined. In today's society the transportation network is very advanced, resulting in immediate deliveries every day, even though the distance is long.

A second explanation on why deliveries are more precise when the geographic distance between Hustadmarmor and their suppliers is long, might be that their only are a few available suppliers within the closest area, which in turn can lead to monopoly for the chosen supplier and accordingly the possibility to perform opportunistic. The effect of this opportunistic behaviour can be that the supplier doesn't prioritize Hustadmarmor and

conscious delivers too late because he knows that there are few other alternative suppliers, and that Hustadmarmor therefore doesn't have the option to switch to another local supplier.

In the forth hypothesis we tested how the size of a supplier affects the deliveries of non-critical items, since the supplier size is considered as one of the factors that influences the level of business cooperation in supplier-buyer relations. A large supplier will naturally have more buyers than a small supplier, and therefore *one* buyer will not be as important for a large supplier, than as it would for a small supplier. Accordingly it is easier for a large supplier to behave opportunistic, because the consequence of eventually losing one buyer is not as critical as it would be for a small supplier.

Hustadmarmor is a large company, and for a small supplier this can be an important buyer which is connected to most of the supplier's income. A small supplier would therefore in a higher degree try to satisfy Hustadmarmor, because of the fear of losing them. Further, a small supplier will have less people involved in the sales and ordering process than compared to a large supplier. It is therefore reasonable to argue that it is easier for a buyer to build a stronger relationship with a small supplier because the contact between the participants will become more personal as compared with a large supplier. Also a large supplier will tend to have more power than a small supplier, and accordingly be likely to act more opportunistic.

As the results of the analysis showed, it is reasonable to anticipate that a large supplier will have more power than a small supplier, and accordingly act more opportunistic.

This paper has carried out a survey with a focus on objective observations of a supplier's behaviour by measuring the supplier's inaccuracy in costs. The behaviour inaccuracy may be one indicator to use when analysing if the supplier acts opportunistic. According to the results it is relevant to assume that the suppliers perform opportunistic and that this behaviour is resulting in higher ordering and safety stock cost for Hustadmarmor.

The opportunistic behaviour form the supplier's side will be accepted of Hustadmarmor until they reaches the breakeven point. If the cost of the opportunistic behaviour is higher than the cost of changing the supplier, Hustadmarmor should change supplier. If the cost of the opportunistic behaviour is lower than the cost of changing supplier, Hustadmarmor

should keep today's supplier. If the costs reach equilibrium, there should be an evaluation on how to handle the situation, because in the long term a change of supplier will be most profitable, but there is always a risk involved when changing supplier. You never know what you get!

9. Conclusion

In this thesis I have focused on non-critical items, and the purchasing process according to these products. This thesis has carried out a survey with a focus on objective observations of a supplier's behaviour by measuring the supplier's inaccuracy in costs. The behaviour inaccuracy may be one indicator to use when analysing if the supplier acts opportunistic. As the results from the analysis shows, long relationships, short distances, written contracts and large suppliers are variables that affect inaccuracy from a supplier, and accordingly contribute to an opportunistic behaviour from the supplier's side. The inaccuracy from the supplier has been measured in costs, and accordingly three scenarios where calculated. The results are shown in table 10.

Table 10. The total dunning cost for the orders sent out year 2008

Scenario 1	845790 NOK
Scenario 2	1103022 NOK
Scenario 3	1596516 NOK

In differ from previous studies, this research shows that there may be high costs involved according to non-critical items. The result in table 10 shows that there are high costs related to ordering problems, and that the total dunning cost for a year accordingly should be of concern for the buying firm. In addition, the cost of the safety stock also should be included. As the results show, the non-critical items might become critical when there are problems according to the purchase of these products. The non-critical items therefore should receive more attention, owing to the fact that it might accumulate large costs related to the purchase of these products.

10. Limitations

To my knowledge, no researchers or research papers have analysed problems concerning the ordering process of non-critical items. The limitation in this thesis is that only one company and its suppliers have been investigated. Accordingly it can be that the findings only are relevant according to this specific company. However, in spite of the limitation, I believe that my investigation gives further insight into how problems concerning non-critical items affect a firm.

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