Bachelor Thesis

The impact of outsourcing on the planning environment and planning method of a company which manufactures high complex products

Autumn term 2006

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Executive Summary

Today outsourcing is a widely-used method for companies to face the problem of a more and more competitive business world. Especially offshore outsourcing to a distant country, where the labour costs are comparatively low, is quite popular in the media. Nevertheless, a lot of companies fail in accomplishing the high gains they hoped for. One reason for this is the miscalculation of the effects of outsourcing on the company which leads to a wrong behaviour of the management during the outsourcing process. Hence, a better understanding of the impact of outsourcing is crucial for the success of a company. To improve this, one way is to analyse the planning environment and the resulting planning method of a company before and after outsourcing.

In this Bachelor Thesis a framework of Jonsson/Mattsson is used to determine the planning environment and the best fitting planning method. It is based on twenty planning environment variables, whereby Jonsson/Mattsson named seven of them to be essential for the identification of the planning environment. These are BOM complexity, degree of value added at order entry, volume/frequency, production process, shop floor layout, batch sizes and throughput time. Furthermore, to compare companies, four main groups of planning environments are defined. At least, suggestions are made in the framework which planning method fits best to which group of planning environments.

First analysing the impact of outsourcing in theory based on a model company and then comparing the results with the empirical data collected from ITT Flygt, the purpose of this Bachelor Thesis is to display the effects of outsourcing on the planning environment and the resulting changes for the planning method of a manufacturing company.

For achieving this goal, the first step is to determine the planning environment and the resulting optimal planning method for a model company. As the next step, the effects of outsourcing on the environmental variables are analysed and possible resulting changes on the planning environment are discussed. Then, the impact of these changes on the planning method is examined. Finally, the theory developed on the base of the model company is compared with the empirical data of ITT Flykt. Hence, the following research questions are answered within this Bachelor Thesis:

1. How does outsourcing of the production of a single module by a manufacturing company affect its planning environment in theory?
2. How does the changing planning environment impact the existing planning method of the company in theory?

3. How did the outsourcing of the production of a single module by ITT Flygt affect its planning environment and method and what are the differences to the developed theory?

Before answering this research questions, a prerequisite is to define the main characteristics of the model company and the kind of outsourcing process, which has to be similar to the empirical data to guarantee the comparability. The characteristics are high complex products, broad product range, short lead time, no inventory of final products, a cellular shop floor layout and the whole production before outsourcing in Sweden. The outsourced matter is the production of a component to an external vendor in China, whereby the component is implemented in every final product. Applying the framework on the model company and ITT Flykt, the result is that both are in an assemble-to-order environment before outsourcing and that both should use the material requirement planning method.

The first result of the research is that the limitation of Jonsson/Mattsson to seven planning environment variables is not sufficient to determine the impact of the assumed kind of outsourcing on the planning environment. Hence, the other thirteen variables are also analysed, both for the model company and ITT Flykt. Moreover, a suggestion is made to add an eight essential planning environment variable, the inventory level, to the framework.

Regarding the first research question only one of the eight essential variables changes towards a make-to-stock environment. Hence, the planning environment of the model company does not change because of outsourcing of a single component. Due to this the planning method stays the same, too. The empirical data of ITT Flykt confirms these results.
Acknowledgement

Writing the Bachelor Thesis was only possible with the help, time and effort of many people. Hereby, we would like to express our appreciation to all the people who supported our research and helped us with the creation of this thesis.

First of all, we thank our examiner Helena Forslund, who gave us substantial feedback and counsels during the seminars and assist us with the general issue of writing a Bachelor Thesis. Furthermore, we are grateful for all the consultancy and guidance of our tutor Petra Andersson. She gave us helpful advices and suggestions in order to improve our thesis.

In addition, we would like to thank our opponents Ralf Drauz and Daniel Handel for the opinions, comments and suggestions during the preparation seminars. Moreover, we are also appreciative for the feedback of all the other seminar members.

At least, a special thank goes to our interview partner Mr. Lennart Fagerström of ITT Flygt. He added a vital value to our research work by answering our questions and providing us with relevant and substantial information during a personal interview as well as during telephone interviews.

Växjö, January 2007

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List of abbreviations

ATO assemble-to-order
app. approximately
BoM Bill of Material
cf. confer
D delivery lead time
ETO engineer-to-order
MTS make-to-stock
P production lead time
p. page
PoV point of view
pp. pages
RMP repetitive mass production
SOP Sales and Operational Planning
WIP work-in-progress
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1 Introduction

The introduction chapter is meant to give the reader an overview of the subject, motivation and course of the thesis. Starting with a background part the reader is given an impression about the importance of outsourcing for companies and its history. Subsequently, a problemising part leads to the research questions that will be addressed. Finally, the objectives and the theoretical and practical relevance of this thesis are referred to.

1.1 Background

Due to globalization the business world has become more and more competitive in the last decades. Almost every company is not only competing with other companies in the same region anymore, but also with companies all around the world. Additionally, the customer demands to be provided with more diversified and customized products and the product live time decreases as a result of the fast developing technology.

To respond to these changes, academics suggest companies to determine their core competences and to focus on them, “During the 1980s, top executives were judged on their ability to restructure, declutter, and delayer their corporations. In the 1990s, they'll be judged on their ability to identify, cultivate, and exploit the core competencies that make growth possible [...]”.¹ By doing so, companies become better focused and more specialised and, therefore, able to respond better to the customers' wishes. Nevertheless, the question appears what happens to the non-core areas of a company which do not provide a competitive advantage. An area could be a whole process like transportation as well as the manufacturing of a standardized component for the final product. Depending on the kind of area, there are different kinds of possibilities to solve this question and an often used one is outsourcing, which will be the main topic of this Thesis. It is defined as “[…} the operation of shifting a transaction previously governed internally to an external supplier through a long-term contract, and involving the transfer to the vendor.”² The main idea behind it is to let a non-core area be done by an external provider, which has specialised in this. Therefore, theoretically, the area is performed better, e.g. with lower costs or a higher quality. A quite common example for an outsourced process is the transportation of goods which is usually done by freight companies. Nevertheless, outsourcing is not identical with a classical purchasing process, as it “[…] not only consists of purchasing products or services from external sources, but also transfers the responsibility for business functions and often the

associated knowledge (tacit and codified) to the external organization."³ Therefore an outsourcing process has a much bigger impact on the company’s strategy and success.

The term of outsourcing was first used in the 1970s by manufacturing executives; however the concept of outsourcing was certainly be used a long time earlier. Nevertheless, outsourcing did not become more prominent until the 1990s, when companies were searching for a solution to overcome a severe recession the U.S. economy was facing.⁴ Nowadays, it is an often used tool for companies.

1.2 Problemising

Describing the advantages of outsourcing in the background chapter, outsourcing sounds promising for every company. But how successful have companies really been in outsourcing in the past?

In fact, a survey from 1996, asking 1000 managers, revealed that only 5% of them thought that outsourcing has delivered the high gains they hoped for.⁵ Moreover, a review of the benefits and problems of outsourcing led to the conclusion that “failure to achieve the anticipated cost improvement is a frequently occurring aspect of outsourcing”⁶ and that “in the absence of fully developed service level monitoring the development of quality may on occasion be illusionary”.⁷ The lack of quality in outsourced areas might even force the company to reverse the outsourcing process and re-develop a company-intern solution.

Taking these results into account the question comes up, what problems are responsible for these? To analyze this question, the causes of the problems have to be determined, which results from the changes due to outsourcing. Theory provides us with a broad variety of sources for this topic, but this Bachelor Thesis focuses only on the changes in the planning environment due to outsourcing and the resulting effects for the planning method. The reason for this is that only a deep and detailed analyse of one specified area leads to a gain in additional knowledge. Furthermore, as there are several kinds of outsourcing, it is reasonable to limit this Bachelor Thesis to a specific one, since the resulting effects on the planning environment are quite different, when one outsource a single component or a whole part of the production. This thesis will deal with the outsourcing of the production of one

⁴ Corbett, Michael, 2004, p. XIII.
⁵ Harbhajan, Kehal, S., 2006, p. 5.
⁷ Jennings, 2002, p. 27.
module which is implemented in every end-product of the company. The main driver for this outsourcing is the reduction of costs. Furthermore, the focus is only set on a manufacturing company, not taking into account its suppliers and its customers.

To analyse the changes, a before and after-analysis is a reasonable approach:

![Planning environment and method of the manufacturing company BEFORE](Diagram)

![Planning environment and method of the manufacturing company AFTER](Diagram)

**Figure 1.** Before- and After-analysis

The first step is to analyse the planning environment and the optimal planning method of a manufacturing company in its original state before outsourcing. Secondly, the outsourcing process has to be explained to determine the premises for the last step; the analysis of the planning environment and the optimal planning method after the outsourcing. Thereby, in this thesis, the analysis is done from the point of view of the manufacturing company; the changes for the vendor are not analyzed.

For determining the planning environment and the resulting planning method, a framework is needed. In this Bachelor Thesis the following one of Jonsson/Mattsson is used:
1 Introduction

Figure 2. Framework Jonsson/Mattsson (adapted from Jonsson, Mattsson, 2003, p.874)

The first step of this framework is to analyse the environmental variables which are describing the planning environment. These can be allocated to three main groups, “variables related to the product, the demand and the manufacturing process”. Using these variables, the generic type of planning environment of the analysed company can be determined. Generally, every company has its own specific type, but to compare companies, four main groups are defined which will be explained in detail later on in the theory chapter:

- Complex customer products (engineer-to-order)
- Configure to order products (assemble-to-order)
- Batch production of standardized products (make-to-stock)
- Repetitive mass production

The next part of the framework deals with the planning methods. They can be divided into four parts: detailed materials planning, capacity planning, scheduling and sequencing. To limit the amount of this Bachelor Thesis to a reasonable value, only the detailed materials planning is taken into account. This can for example be a re-order point or a material requirements planning system. For every company the question appears which planning methods to choose. To come to a decision, the planning environment of the company has to be taken into account. A survey with 84 responding companies, which has already been done in 2003 by Jonsson/Matsson⁹, leads to suggestions which planning method matches best within which planning environment. The selection of the right planning method is simplified.

The aim of this Bachelor Thesis is to combine this framework with outsourcing, first in theory and then comparing the results with the empirical data of one company, ITT Flygt. The reason for this approach is that it has not been done before. Hence, applying this framework to determine the planning environment and planning method after and before outsourcing might lead to a better understanding of the effects of outsourcing.

This train of thoughts leads to the following research questions, which will be explored within this Bachelor Thesis:

1. How does outsourcing of the production of a single module by a manufacturing company affect its planning environment in theory?

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2. How does the changing planning environment impact the existing planning method of the company in theory?

3. How did the outsourcing of the production of a single module by ITT Flygt affect its planning environment and method and what are the differences to the developed theory?

1.3 Objectives

The main purpose of this Bachelor Thesis is to display the effects of outsourcing of the production of a single module on the planning environment and the resulting changes for the planning method of a manufacturing company.

In this context, first the framework of Jonsson/Mattson is explained in general and then used to determine the planning environment and the resulting optimal planning method for a model company producing high complex products. Secondly, the changes of the planning environment due to outsourcing of a single module are analysed by determining the effects of outsourcing on the environmental variables. Afterwards the impact of these changes on the planning method is examined. Finally, the theory developed in the second part is compared with the empirical data of ITT Flygt and a conclusion is provided.

1.4 Theoretical and practical relevance

This Bachelor Thesis offers a theoretical as well as a practical relevance. Although the topic of outsourcing is already discussed in theory quite narrowly, the approach of combining the framework of Jonsson/Mattsson with this topic has not been done before. Hence, it contributes to the theoretical discussion in literature, since it might lead to a better understanding of outsourcing.

Furthermore, the research within this thesis will of course offer a practical relevance in so far as the co-operating company will benefit from the results. First, the research gives the company the opportunity to apply the framework of Jonsson/Mattson to itself and therefore, to check, if they are in the right planning environment. Additionally, the comparison of their
planning environment variables with the ones of the quite similar model company might lead to the identification of room for improvement.
2 Methodology

In this chapter the nature of the research within this thesis is described. It starts with an explanation of the scientific perspective and the research approach. Secondly, the following paragraph deals with the thesis’ data collection and helps to overview the theoretical and empirical resources employed. Afterwards, the scientific credibility of the thesis is explored. The last paragraph, finally, sums up the earlier ones and provides an overview over the methodology used for the research in this Bachelor Thesis.

2.1 Inductive versus deductive research

To do a research of a topic either a test of existing theory in practice or a generation of new theory from empirical data can be chosen. In literature these two approaches are termed deductive and inductive. ¹⁰

“Deductive research starts with existing theories and concepts and formulates hypotheses that are subsequently tested; its vantage point is received theory. Inductive research starts with real-world data, and categories, concepts, patterns, models, and eventually, theories emerge from this input.”¹¹

This thesis deals with the concept of outsourcing and with a framework for determining the planning environment and the optimal planning method of a company. Therefore the starting point is a study of literature for both topics. Combining them as the next step to determine the impact of outsourcing on the planning environment and hence on the planning method leads to a development of new theory. Finally, these results are compared with the planning environment and method of a company before and after outsourcing. This empirical data will be developed by using the mentioned framework.

Summarized, then the conceptual model consists of three parts: an analysis of the existing theory, a further development of it and an application of existing theory in practice. Hence, this thesis is deductive.

¹⁰ Gummesson, 2000, p. 64.
2.2 Scientific paradigm

“A paradigm is a shared perspective of reality and a way of looking at the world as if through coloured spectacles. A paradigm is a ‘worldview’ or ‘map’, which provides a general outline and direction for scientific activity.”\(^\text{12}\)

In theory, two scientific paradigms are described: the positivistic and the hermeneutic one. While the positivistic paradigm focuses on causal relationships using statistical analysis and objective “facts”, the hermeneutic one uses a more personal interpretative process to “understand reality”.\(^\text{13}\) The characteristics of these two paradigms are shown in the following figure:

<table>
<thead>
<tr>
<th>Positivistic paradigm</th>
<th>Hermeneutic paradigm</th>
<th>Characteristics of research within this thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research concentrates on description and explanation</td>
<td>Research concentrates on understanding and interpretation</td>
<td>Research contains descriptive, explanatory, and interpretative parts</td>
</tr>
<tr>
<td>Well-defined, narrow studies</td>
<td>Narrow as well as total studies (holistic view)</td>
<td>A narrowed, well-defined view is taken</td>
</tr>
<tr>
<td>Vantage point is primarily deductive</td>
<td>Vantage point is primarily inductive</td>
<td>Vantage point is deductive</td>
</tr>
<tr>
<td>Research concentrates on generalisation and abstraction</td>
<td>Research concentrates on the specific and concrete (“local theory”), but also attempts generalisations</td>
<td>Generalisation of results will be barely possible</td>
</tr>
<tr>
<td>Clear distinction between facts and value judgements; search for objectivity</td>
<td>Distinction between facts and value judgements is less clear; recognition of subjectivity</td>
<td>Second part of theory will be self-construct based on theory, recognition of subjectivity</td>
</tr>
<tr>
<td>Statistical and mathematical techniques for quantitative processing of data are central</td>
<td>Data is primarily non-quantitative</td>
<td>Data is non-quantitative</td>
</tr>
<tr>
<td>Researchers discover an object of research external to themselves rather than “creating” the actual object of study</td>
<td>Researchers partially create what they study, for example, the meaning of a process or a document</td>
<td>Concept of outsourcing and the framework is external theory, but the combination of both is new developed</td>
</tr>
</tbody>
</table>

Figure 3. Hermeneutic and positivistic paradigm (adapted from Gummesson, 2000, p. 178)

The research of this thesis concentrates on description, explanation and interpretation. First of all, the concept of outsourcing and a framework for the manufacturing planning environment are described and explained in the theory. Then, these two topics are combined and the changes of the planning environment due to outsourcing are interpreted. Collecting


\(^{13}\) Gummesson, 2000, p. 177.
the empirical data of the company will be done in a descriptive and explanatory way again and finally the theoretical and empirical data is compared in an interpretative one. Hence, regarding the first criteria, the thesis is both, positivistic and hermeneutic.

Since the planning environment is only determined for the manufacturing companies, the thesis provides only a view on one part of a supply chain. Therefore, only a narrowed, well-defined view is taken and the thesis is positivistic.

Concerning the third decisive factor, it does support the positivistic approach bearing in mind, that this thesis will be deductive in nature.

The aim of this paper is to find specific and concrete suggestions for one kind of outsourcing process in a defined kind of manufacturing. As a result, it is not possible to generalise the findings for all kind of outsourcing. Additionally, even if the outsourced area is the same, the planning environment of the companies may still differ leading to a low possibility of generalisation of the findings. So this criterion provides a hermeneutic approach.

As the second part of the theory is self-developed, a distinction between facts and value judgement is less clear, hence leading to a hermeneutic approach concerning the fifth criteria.

Regarding the planning environment variables, the thesis’ approach seems to be hermeneutic in nature, as the planning environment variables are described and not determined in the first part of theory. In the second part the trends of changes are considered. Therefore, the sixth aspect can be interpreted as hermeneutic.

Combining the topic of outsourcing with the knowledge about the planning environment described by the framework of Jonsson/Mattsson, new theory is developed. Therefore, the theory is partly created in this thesis which leads to a hermeneutic approach.

Taking into account all these factors, this thesis is classified as both, positivistic and hermeneutic in nature with a slight tendency towards the hermeneutic approach. Four out of seven criteria are clearly identified as being hermeneutic, while two criteria support the positivistic approach. Only the first one, the kind of research concentration, is hermeneutic and positivistic.

This approach impacts this Bachelor Thesis in a positive way, since the first part of the research is supported by theory and facts, while the newly developed theory and the
analytical part is based on understanding and qualitative interpretation. Hence, this thesis is not limited to one angle of approach; it takes into account both perspectives: facts and understanding to support validity. Thus this approach is beneficial for the result of this paper.

2.3 Research approach

For scientific data collection and analysis different research strategies are available that differ from each other by “[…] the type of research question posed, [...] the extent of control an investigator has over actual behavioural events, and [...] the degree of focus on contemporary […] events”14

Considering these three conditions, the researcher has to pick the right research approach out of the five following research strategies.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Form of research question</th>
<th>Requires control of behavioural events?</th>
<th>Focuses on contemporary events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>how, why?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Survey</td>
<td>who, what, where, how many, how much?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Archival analysis</td>
<td>who, what, where, how many, how much?</td>
<td>No</td>
<td>Yes/No</td>
</tr>
<tr>
<td>History</td>
<td>how, why?</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Case study</td>
<td>how, why?</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Figure 4. Situations for different research strategies (adapted from Yin, 2003, p. 5)

Since the aim of this thesis is to figure out how outsourcing affects the planning environment and method of a company, the set of potential research strategies is narrowed down to the experimental, historical or case study method.

It is also not necessary to control the behavioural events, since the aims of this thesis are to develop new theory combining the concept of outsourcing with the framework of determining

14 Yin, 2003, p. 5.
the planning environment and method and to compare the results with empirical data of one company. Thus, only the history and the case study approach remains.

Finally, the investigated company is included in the course of the research. This is been done by having several short telephone-interviews, constant mail-contact and one longer personal interview based on a questionnaire with ITT Flygt. Hence, the historical method can be excluded, leaving the case study approach as the most appropriate one for the research within this thesis.

2.4 Data collection

In order to conduct an appropriate research, it is essential to collect adequate theoretical and empirical data. Theoretical data can be collected by reviewing relevant literature, articles and Internet sources. Empirical data has to be gathered by means of interviews, observation, or studies of archival records or other documents.\(^\text{15}\)

2.4.1 Theoretical data collection

The theoretical data of this thesis is based on several sources like books, articles and the Internet and can be divided in two main parts, the data for concerning outsourcing and the data for determining the planning environment. For both parts the library of Växjö University has been the main contact point for books. Searching for articles the key source was ELIN – a search engine for articles.

Since the topic of outsourcing is a heavily studied issue, it was quite uncomplicated of finding books and articles for it using the key word “outsourcing”. In contrast to this theory supporting the second topic was more complex to get, especially as this thesis focus on a framework of Jonsson and Mattson, which was developed in 2003. Therefore, due to the timeliness of the framework, the available theoretical data is quite limited. Keywords for searching were “planni ng environment” and “environment variables”. Furthermore, the searches for the planning environment variables were done by using their name as keywords.

\(^{15}\) Yin, 2003, p. 85.
2.4.2 Empirical data collection

The first step in collecting empirical data was to find a manufacturing company which has recently outsourced. Therefore, the Technikcentrum, located on the campus of the Växjö University, and the Tutor of this thesis, Petra Anderson, were contacted, if they could provide us with names of fitting companies. Out of these, ITT Flygt was the only one willing to cooperate.

Answering the third research question requires a good knowledge of ITT Flygt. Hence, several telephone-interviews and one personal interview were chosen to collect the empirical data. Additionally, a questionnaire was sent out to collect more basic knowledge and to give the interviewee the possibility to prepare himself for the interview.

2.5 Scientific Creditability

The term scientific credibility refers to the scientific quality of the research in the context of this thesis. It can be tested by assessing the construct validity, internal and external validity, as well as the reliability of the research.

2.5.1 Construct validity

The construct validity deals with “[…] establishing correct operational measures for the concept being studied”. 16 To secure this validity, it is important that the research is based on “[…] multiple source of evidence, in a manner encouraging convergent lines of inquiry …” 17 The construct validity of this the theoretical part of this thesis is secured by using multiple sources like scientific books and articles. Since the interviews and the questionnaire are based on this theoretical data, also the construct validity of the empirical data and the analysis is ensured.

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16 Yin, 2003, p. 34.
17 Yin, 2003, p. 36.
2.5.2 Internal validity

"Internal validity is only a concern for causal (or explanatory) case studies, in which an investigator is trying to determine whether event x led to event y."\(^{18}\) Thereby it is important to figure out if an external event z could have caused and influenced event y.\(^{19}\)

The second part of the theory mainly consist of cause-and-effect-relationships, therefore the internal validity is important for this thesis. To secure the internal validity logic models are used. The concept is to match empirically observed events to theoretically predicted ones by stipulating a complex chain of events over time\(^{20}\)

2.5.3 External validity

The external validity describes the possibility of generalisation of a study. It is given, when its results can be generalized beyond the research context.\(^{21}\)

As this thesis is dealing with one specific outsourcing process and with one kind of manufacturing company, its results can not be generalised to a large extent. Furthermore this thesis focuses on the empirical data of only one company.

2.5.4 Reliability

Assessing a research with regard to its reliability is necessary to ensure that another investigator, who employs the same procedure as has been performed in a previous research, achieves the same results. The goal of reliability is to minimise the errors and biases in a study.\(^{22}\) It is expected that another researcher, who uses the same procedure as in this thesis – including the same theory and the same interview questions – will derive the same results. To secure the reliability of a study a detailed documentation of the procedures is crucial. In this thesis this is done by constructing the conceptual model which provides the reader with a guideline for this research.

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\(^{18}\) Yin, 2003, p. 36.
\(^{19}\) Yin, 2003, p. 36.
\(^{20}\) Yin, 2003, p. 127.
\(^{21}\) Yin, 2003, p. 37.
\(^{22}\) Yin, 2003, p. 37.
2.6 Summary of methodology

The following figure provides the reader with an overview about the used methods and procedures of this Bachelor Thesis.

**Figure 5.** Summary of methodology
3 Theory

The theory chapter gives the reader the insight into the framework of Jonsson/Mattsson that is applied to analyse the impact of outsourcing. After describing the 20 environmental variables, the four main planning environments are presented. Afterwards, the planning methods and their optimal matching in the planning environments are described. Finally, the reader is introduced into the outsourcing and its different characterisations.

3.1 The framework of Jonsson/Mattsson

The material planning “concerns balancing supply and demand and in this respect deals with the initiation, control, and monitoring of manufacturing and purchasing orders in order to maintain an uninterrupted material flow and value-adding activity in manufacturing.”\(^\text{23}\) If the material planning method does not support the company’s basic mission in the marketplace the company will face costly mistakes.\(^\text{24}\) To choose the accurate material planning method (e.g. Kanban, Material Requirement Planning, Re-Order Point System…) the company has to take into account its planning environment which is determined by certain variables. The framework applied in this thesis is developed by Jonsson/Mattsson in 2003 to examine the planning environment of manufacturing companies and the fits of the planning methods. The partial outsourcing of manufacturing may effect the environmental variables and hence the adequate choice of the manufacturing planning method.

3.1.1 The environmental variables

The environmental variables can be classified into three groups: related to the product, to the planning perspective and to the production process.\(^\text{25}\) This will help to describe the four main types of the planning environments later on.

3.1.1.1 Related to the product

The product related variables are bill of material (BoM) complexity, product variety, degree of value added at order entry, product data accuracy, proportion of customer specific items, and level of process planning.

\(^{24}\) Vollmann et al., 2005, p. 447.
The complexity of the bill of material (BoM)  

“The Bill of Material is narrowly considered to be an engineering document that specifies the ingredients or subordinate components required physically to make each part number or assembly.”\textsuperscript{26} It is necessary to detect which components, parts and raw material are required and to compute how much of them are exactly needed to produce a certain end item. It has been shown that the product structure has much to do with inventory and on-time delivery and thus with the planning environment. The so called “pyramid shape” with “fewer final assemblies, more components at the lower levels, only two to four level of subassemblies and parts, and less commonality” is favourable. "The primary reason why an inverted pyramid shape is troublesome is that increased commonality, especially when combined with larger lot sizes, creates capacity problems in feeder operations. When lot sizes are smaller, greater commonality is an asset."\textsuperscript{27} Most of the real-world manufacturing firms have Bills of Material with more than five levels in depth.\textsuperscript{28}

Product variety  

Product variety can be defined as “the existence of optional product variants”\textsuperscript{29}. Based on a standard product, the customer can chose between several combinable options for a product to get an item that fits best to his needs. The implication of the product variety is the level of standardisation possible and hence the manufacturing process layout, the production/purchasing batch sizes and the inventory level of finished products. A high level of product variety augments the level of customer service because it is more probable to fulfil the customer’s needs. A lower level of standardization leads to a lower level of inventory (make-to-stock environment), or a higher level of postponement (assemble-to-order environment) or to longer lead times (make-to-order environment).

Degree of value added at order entry  

The degree of value added at order entry can be seen as the level of product customisation after the order entry. One can distinguish between four levels of customisation\textsuperscript{30}: The most influence, a

\textsuperscript{26} Vollmann et al., 2005, p. 183.  
\textsuperscript{27} Ritzman et al., 1984, p. 145.  
\textsuperscript{28} Ho, Li, 1997, p. 587.  
\textsuperscript{29} Jonsson, Mattsson, 2003, p. 876.  
\textsuperscript{30} Amaro et al., 1999, pp. 352 – 353.
customer can exert, is on a purely customised product, where the item is designed, fabricated and delivered individually. A tailored customised product is a basic design “modified to the customer’s needs or specifications, e.g. changing its size or processing capacity”. In a standardised customisation products are only individualised by adding or removing various standard features from a basic design. When buying a non-customized product, the customer has to “take existing design as it is.” The major difference between these forms of customisation is the level of infiltration into the supply chain – ranging from no infiltration for non-customized products up to the infiltration of the whole supply chain in a purely customised product. A company has to “decide the scope of their responsibility for the design and specification of products, the sourcing and purchasing of materials relative to the customer” which effects the manufacturing capabilities required, the activities performed after receiving the order and thus the delivery lead-time.

<table>
<thead>
<tr>
<th>Proportion of customer specific items</th>
<th>Customer specific items that are added to the delivered products influence the level of standardisation since they cannot be added to other products. A trade-off has to be made between customer service and level of standardisation because the higher the proportion of customer specific item the lower the level of standardisation and the higher the level of customer service. It can be integrated into the variable “product variety” and therefore the mentioned implications can be applied as well.</th>
</tr>
</thead>
</table>

<table>
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<tr>
<th>Product data accuracy</th>
<th>“The data accuracy in the bill of material and routing file is another variable that influences the planning environment. While the BoM describes the materials needed for a product, the &quot;routing file is describing the operations, which must be performed in order to manufacture an item&quot;. Inaccurate product data lead to uncertainties in the production process which have to be covered with safety stock e.g. if the purchasing department orders 400 components of X,</th>
</tr>
</thead>
</table>

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31 Amaro et al., 1999, p. 353.
32 Amaro et al., 1999, p. 353.
based on the BoM, but the actual demand in manufacturing is 500, a stock out will occur. A consequence of incorrect data in the routing file can be an unfeasible or inefficient production layout. Thus, a high accuracy in product data induces a reliable material planning.

**Level of process planning**

“Process planning is the systematic determination of operations (machines and tools) and their sequences for manufacturing a part effectively and economically.”  

The process planning provides information route, processes, process parameters, machines, and tools required for production. An optimal process planning satisfies technological constraints and is optimal with respect to some performance criteria. A high level of process planning is required if setup costs are high and production process is complex.

### 3.1.1.2 Related to the demand

From the demand perspective, the environmental variables are: *P:D ratio, volume/frequency, inventory accuracy, type of procurement ordering, demand characteristics, demand type, time distributed demand, and source of demand.*

**P:D ratio**

“In the P:D ratio, both “P” and “D” are lengths of time, where P measures the production lead-time and D measures the delivery lead-time (the time from order to delivery).” With the help of this ratio, one can find out how much planning and production needs to be based on forecasts. If the production lead time is less than the delivery lead time the manufacturing company is enabled to plan, schedule and deliver without immediate pressure of customer lead time. “If D is very short relative to P, production needs to be performed on speculation, i.e. with uncertain information concerning customer demand.” Most manufacturing firms facing a P:D ratio > 1 deal with poor customer service, backorders and high inventory.

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37 Zhang et al., 2003, p. 611.  
38 Tan, Khoshnevis, 2000, p. 53.  
40 Amami, 2000, p. 2.  
41 Wikner, 2005, p. 213.  
42 Amami, 2000, p. 2.
Volume / frequency

This variable describes “the annual manufactured volume and the number of times per year that products are manufactured”\(^{43}\). It gives insight about the structure of the demand. Depending on the market and the product, a company can face a situation where either huge orders are placed by a very few number of customers or small orders are place by a relatively high number of customers. In another variant, the manufacturer can publish its production schedule and customers are placing call-off orders. Obviously the frequency of production sets the frequency of the production planning (which is an important factor to set the level of sophistication of the material planning method.) A low frequency in production needs to be based on a more imprecise forecast because demand has to be foreseen for a longer time horizon and the level of uncertainty in demand is an important factor for the choice of the right material planning method. A high frequency in production however hinders the company to benefit from economies of scale.

Type of procurement ordering

Two endpoints determine the range for this variable: on the one side, a company can order by order procurement or by blanket releases from a delivery management.\(^{44}\) In a Vendor Managed Inventory System, which reflects one kind of delivery management, „the exact needs of the customer over time are continually passed back to the supplier, which can decide how it wishes to fulfil them.“\(^{45}\) On the other side, the manufacturer is ordering its needs from the supplier, based on forecasts or allocated customer orders.

Demand characteristics

If the demand for various items is unrelated to each other, one calls it independent demand. By contrast, the dependent demand arises as a direct result of the need for some other item, usually a higher-level item of which it is part.\(^{46}\) For example, the demand for a finished item is independent but the demand of its components depends directly on the finished item.

Demand type

There are three different ways to asses the demand: First, a

\(^{44}\) Jonsson, Mattsson, 2003, p. 876.
\(^{45}\) Vollmann et al., 2005, p. 581.
\(^{46}\) Chase et al., 2005, p. 591.
company can forecast the quantities and timing of customer demand with various methods. It is an estimation of what might occur in the marketplace.\textsuperscript{47} The allocation of customer placed orders is a second way and comprises almost certainty since these orders have already been placed. Third, calculated requirements, as a result of the material planning method used, represent a way where orders are placed according to company’s safety stock policy.

\begin{itemize}
\item \textbf{Time distributed demand} 
Depending on its level of depth, the time distributed demand can shed light about the development of the demand. If e.g. the demand is only expressed by an annual figure that is reviewed every month only a rough statement can be made. But if the daily demand for the next 40 days is given every day, a more detailed insight into the development is provided.

\item \textbf{Source of demand} 
Having in mind the different types of procurement ordering, the manufacturing company itself can be a supplier offering vendor managed inventory (VMI) to its customers. This system shifts the process of reviewing and replenishing of the stock from the customer to the manufacturer. As a result, the manufacturer delivers when and how much he wants, as long as the promised stock level is guaranteed, supporting the optimal use of his capacity and logistics.\textsuperscript{48} In contrast, the manufacturer receives customer orders directly from the customer including the exact amount and specification of the desired product.

\item \textbf{Inventory accuracy} 
“The inventory accuracy, i.e. the conformity of the inventory record values in a bookkeeping system to the actual values”\textsuperscript{49} is uncertain due to poor discipline and complacency in keeping the data up to date.\textsuperscript{50} It concerns “every level of the business from ordering, through receiving and put away, to replenishment, picking and shipping.”\textsuperscript{51} A trade-off has to be made between costs in lost-sales because of stock outs and costs for matching computer data and
\end{itemize}

\textsuperscript{47} Vollmann et al., 2005, p. 19.
\textsuperscript{48} Vollmann et al., 2005, p. 581.
\textsuperscript{49} Wännström, Jonsson, 2006, p. 568.
\textsuperscript{50} Witt, 2006, p. 31.
\textsuperscript{51} Witt, 2006, p. 32.
actual inventory status. The reason for the inaccuracy is that the products and the belonging data move at a different speed. Although the product moving speed has increased a lot in the past the speed of the data hasn’t been adjusted to the speed of the product.\textsuperscript{52} Like the product data accuracy the inventory accuracy affects the reliability of the manufacturing planning.

3.1.1.3 Related to the manufacturing process

The necessary variable from the manufacturing process point of view are: \textit{Batch size}, \textit{sequencing dependency}, \textit{manufacturing unit}, \textit{shop floor layout}, \textit{throughput time}, and \textit{number of operations}.

\textbf{Production process} The design of the production process flow refers to how the manufacturer is organising the material flow during manufacturing. It ranges on the one end from a Job shop layout, where small batches of a large number of products require different sequence of processing speed. On the other end, products can be made 24 hours/day in a continuous flow layout, where undifferentiated materials are highly automated converted into finished products.\textsuperscript{53} The level of standardization of the product has a big influence on the choice of the layout since e.g. a continuous flow is not designed to be interrupted for specific customer product specifications.

\textbf{Shop floor layout} Embracing three different categories, the shop floor layout is the format of how the different departments of the company are arranged in a facility due to the work flow of production. In a process layout, departments with similar equipment/functions are grouped together. The cellular layout is a format, where dissimilar machines are grouped into work centres to work on products that have similar shapes and process requirements. Products, made in a continuous line layout, pass through an assembly line that is arranged according to the progressive steps required to produce it. Influencing factors are among other criteria: demand, processing requirements and

\textsuperscript{52} Witt, 2006, p. 32.
\textsuperscript{53} Chase et al., 2005, pp. 210-211.
Batch sizes

As a result of the trade off between carrying inventory costs and setup costs/order costs of components, parts and raw material, the batch size is the typical manufacturing order quantity. "It is well known that if batch sizes are very small, frequent setups will be incurred and machines will be highly utilized. This can lead to long waiting time delays. However, if batch sizes are too large machines will be processing the same part for long periods of time. This may lead to problems in coordinating the proper types and quantities of parts. High inventories often result."\(^{55}\)

The batch sizes set constraints that influence directly the material planning method. Since the calculated quantities seldom match the batch sizes, the applied planning method has to be able to cope with these constraints.

Number of operations

A very complex product makes a number of operations necessary to produce it. The number of operations thus indicates the level of complexity of a product. The higher the number of operations required the less flexible is the production process and the higher is the manufacturing throughput time.

Sequencing dependency

"The extend, to which set-up times are dependent on manufacturing sequence in work centres"\(^{56}\), is called sequencing dependency. When two consecutive orders require different tooling requirements, a tool change and hence associated setup time has to be incurred. A setup can be avoided, if the two orders can be handled by the same tool.\(^{57}\) In a manufacturing company, a “tooling competition is present, thus resulting in all tools not being available at all times. Sequence dependency is present and often an important operating consideration."\(^{58}\) The more complicated the manufacturing sequence, the higher the sequencing dependency and the setup times. Consequently, system loads increases, flow times extend and

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\(^{54}\) Chase et al., 2005, pp. 227-228.

\(^{55}\) Enns, 1999, p. 15.


\(^{57}\) Ghosh et al., 1992, p. 1241.

\(^{58}\) Ghosh et al., 1992, p. 1239.
Tardiness occurs more often and longer. These implications have to be taken into account in the material planning.

**Throughput time**

“Manufacturing throughput time is defined as the length of time between the release of an order to the factory floor and its receipt into finished goods inventory or its shipment to the customer.” As being part of the P:D ratio the implications of the manufacturing throughput time are equivalent.

### 3.1.2 The planning environments

“The choice between producing to stock or to order is a strategic one, related to the type of service companies aim to provide to their customers, either standard or custom-made products.” A scoring system is taking into account the seven variables BoM complexity, degree of value added at order entry, volume/frequency, production process, shop floor layout, batch size and throughput time. Depending on the marked answers an examined company can be assigned to one of the four planning environments by adding the default factors assigned to every answer and planning environment. In the following, the four planning environments are presented. The scoring system will be applied later on to assess the impact of the changing variables on the planning environment.

#### 3.1.2.1 Complex customer products (engineer-to-order)

In an engineer-to-order environment (ETO), “products are manufactured to meet a specific customer's needs and so require unique engineering design or significant customisation. Thus, each customer order results in a unique set of part numbers, Bill of Material, and routing.” This environment means a 100% pull system, where all manufacturing and developing action begins after receiving customer’s order. The problematical uncertainty is not “when” the customer places his order but rather “what” he is going to buy. Typically, the ETO environment can be characterised as an environment, where products are complex with deep and wide BoM (low standardisation). The manufacturing batch sizes are typically small and equivalent to customers order quantity while manufacturing throughput

59 Ghosh et al., 1992, p. 1245.
60 Johnson, 2003, no page available
61 Wänström, Jonsson, 2006, p. 566
62 Amaro et al., 1999, p. 349.
64 Amaro et al., 1999, p. 351.
times and the delivery lead-times are long. The production process is designed for one-off
production and often a functional layout is applied.65

3.1.2.2 Configure to products (assemble-to-order)

One talk about an assemble-to-order (ATO) environment, when a company is offering final
products to its customers, which can be assembled by standardised parts in a number of
different options. The modules/parts necessary in the assembling or finishing process,
purchased or fabricated in-house, are planned and stocked in anticipation of future customer
orders.66 Thus, “the number of finished goods is substantially greater than the number of
modules that are combined to produce the finished product.”67 With fewer modules than
finished products, the management and the forecast turn out to be more a lot easier.68 The
focus for a company is more on the question “what” is the customer going to buy rather than
when. “The uncertainty underlying an ATO business is fundamentally one of product mix
rather than one of product volume”69

Characteristically, in the assemble-to-order (ATO) environment the “number of customer
orders is rather large and delivery lead times much less than ETO.”70 But still, a P:D ratio > 1
can be recorded.71 “Throughput times for the assembly or finishing operations are short and
the batch sizes are typically small. […] Line and cellular layouts are more common than
functional layouts.”72 The wide product range offered with few standardised modules makes it
crucial that modules are combinable into a viable product.73

3.1.2.3 Batch production of standardized products (make-to-stock)

A company that chooses a make-to-stock (MTS) policy produces its goods ahead of demand
and fills customer’s orders directly from stock in order to provide short delivery times.74 In
contrast to the preceding environments, the challenge in a MTS environment is the
determination of when, how much, and how to replenish the stock at a specific location.75
The range of products is clearly narrower than in ETO and ATO. The main trade off is
between inventory carrying cost and the customer service level offered.

66 Amaro et al., 1999, p. 351.
67 Vollmann et al., 2005, p. 22.
68 Vollmann et al., 2005, p. 22.
69 Vollmann et al., 2005, p. 449.
70 Jonsson, Mattsson, 2003, p. 878.
71 Vollmann et al., 2005, p. 448.
73 Vollmann et al., 2005, p. 22.
74 Vollmann et al., 2005, p. 449.
Significant for an MTS environment are the medium to large sized quantity orders which are small compared to the manufacturing batch size. The number of customer order is large. Typically, throughput times and batch sizes are neither long and large nor short and small when compared with the conditions in planning environments ETO and repetitive mass production.\textsuperscript{76}

### 3.1.2.4 Repetitive mass production

Typical for a repetitive mass production (RMP) is that “products are made in large volumes on a repetitive and more or less continuous basis. […] It concerns standardized products or optional products made or assembled from standardized components characterized by having flat and simple bills of materials. The products are made-to-stock or made-to-schedule.”\textsuperscript{77} The manufacturer is designing the initial product with the help of specification identified in market surveys and anticipated product requirements. The only option for the customer is to select or identify the design on the market, which satisfy his needs most closely.\textsuperscript{78}

In a RMP environment, the manufacturer gains efficiency through stability and control.\textsuperscript{79} The throughput time is kept very short\textsuperscript{80} and unit costs low.\textsuperscript{81} It is applied in a market situation with small and frequent customer orders by a multitude of individual buyers – often call-offs from a delivery schedule. Usually, the manufacturing is carried out in some form of line layout.\textsuperscript{82}

### 3.1.3 The planning methods

Before giving an overview where certain planning methods fit best, a short definition of the Re-order Point System, the Runout-time Planning, Kanban and the Order-based Planning is provided. Then, the Material Requirement Planning as the most common method is explained more thoroughly and its match/mismatch with the four planning environments is shown.

A company using Re-order Point System is monitoring its inventory status perpetually and places its order when the stock is reaching a certain level.\textsuperscript{83} The Runout-time instead is the

\textsuperscript{76} Jonsson, Mattsson, 2003, p. 878.  
\textsuperscript{77} Jonsson, Mattsson, 2003, p. 878.  
\textsuperscript{78} Krishnapillai, Zeid, 2006, pp. 29 – 30.  
\textsuperscript{79} Vollmann et al., 2005, p. 615.  
\textsuperscript{80} Jonsson, Mattsson, 2003, p. 879.  
\textsuperscript{81} Magnusson et al., 2005, p. 4.  
\textsuperscript{82} Jonsson, Mattsson, 2003, pp. 878-879.  
\textsuperscript{83} Chase et al., 2005, p. 600.
time left till a stock out of the item occurs. Hence, when applying Runout-Time Planning an order is placed when the Runout-time equals the delivery lead time of the supplier. In a Kanban System, "orders are released to producing work centres when the number of on hand and in-progress containers is less than authorized number of containers."\textsuperscript{84} If one is planning with the help of an Order-based planning, only those parts are purchased which are necessary to produce one order placed by a customer.

The following Figure 6 indicates the level of appropriateness of the different planning methods and the four main planning environments. The assignment is based on logical assumptions and is empirically tested.\textsuperscript{85} The following symbols are employed to describe the level of effectiveness and user satisfaction:

\begin{itemize}
  \item +++ good match, planning method is expected to perform with a high degree of effectiveness and high satisfaction
  \item ++ Poor match, planning method can be expected to work reasonably well and satisfactory
  \item + Combinations are considered to be neutral from the point of view of effectiveness and user application.
  \item - Mismatch, planning method should not be used in this environment. If still applied, user satisfaction is not to be expected
\end{itemize}

<table>
<thead>
<tr>
<th>Planning method</th>
<th>Planning environment</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>ETO</td>
</tr>
<tr>
<td>Re-order Point</td>
<td>o</td>
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<tr>
<td>Runout-time</td>
<td>o</td>
</tr>
<tr>
<td>MRP</td>
<td>+</td>
</tr>
<tr>
<td>Kanban</td>
<td>-</td>
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<tr>
<td>Order-based planning</td>
<td>+++</td>
</tr>
</tbody>
</table>

\textbf{Figure 6.} matching of planning method and planning environment (adapted from Jonsson, Mattsson, 2003, p. 879.)

\textbf{The Material Requirement Planning (MRP)}

The Material Requirement Planning is “the logic for determining the number of parts, components, and materials needed to produce a product. MRP also provides the schedule

\textsuperscript{84} Krajewski et al., 1987, p. 42.
\textsuperscript{85} Jonsson, Mattsson, 2003, pp. 879-880.
specifying when each of these materials, parts, and components should be ordered or produced.\textsuperscript{86}

MRP is the central instrument for companies assembling end items from components produced in batch manufacturing processes.\textsuperscript{87} Although it works reasonably well in all planning environments it has its strength in planning items with dependent demand. It works best in environments with complex standardised products or product options, long manufacturing lead-times and items with time variations and uneven demand. Comparing these prerequisites with the ATO and MTS environment shows that MRP-system bears the best results in those two surroundings.\textsuperscript{88}

### 3.2 Outsourcing

#### 3.2.1 Outsourcing defined

The term outsourcing is a combination of the terms “outside”, “resource”, “using”, which means going outside the firm to use the resources of other companies. It became popular in the late 1980s for subcontracting information systems. Since that time it was also applied to other types of functions or activities. The following Figure 7. \textit{Different definitions of outsourcing (adapted from Espino-Rodrigues, Padrón-Robaina, 2006, p. 51)} presents some significant definitions from the literature.

<table>
<thead>
<tr>
<th>Authors (year)</th>
<th>Concepts of outsourcing</th>
</tr>
</thead>
<tbody>
<tr>
<td>McCarthy and Anagnostou</td>
<td>Not only consists of purchasing products or services from external sources, but also transfers the responsibility for business functions and often the associated knowledge (tacit and codified) to the external organization.</td>
</tr>
<tr>
<td>(2004)</td>
<td></td>
</tr>
<tr>
<td>Quélin and Duhamel (2003)</td>
<td>The operation of shifting a transaction previously governed internally to an external supplier through a long-term contract, and involving the transfer to the vendor.</td>
</tr>
<tr>
<td>Casani et al. (1996)</td>
<td>Long-term link related to the development of determined activities or tasks that are not essential to...</td>
</tr>
</tbody>
</table>

\textsuperscript{86} Chase et al., p. 653.
\textsuperscript{87} Vollmann et al., 2005, p. 223.
\textsuperscript{88} Jonsson, Mattsson, 2003, p. 880.
<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rothery and Roberson (1996)</td>
<td>The act of turning to an external organization to perform a function previously performed in-house. It entails the transfer of the planning, administration and development of the activity to an independent third party.</td>
</tr>
</tbody>
</table>

These definitions have in common that outsourcing refers to acquire determined activities from an external organization with a strong strategically and long-termed focus. Thus outsourcing is best defined as „[…] a strategic decision that entails the external contracting of determined non-strategic activities or business processes necessary for the manufacture of goods or the provision of services by means of agreements or contracts with higher capability firms to undertake those activities or business processes, with the aim of improving competitive advantage.“\textsuperscript{89} This definition includes three important characteristics: First, it states that outsourcing has to be a strategic, long-term decision. Second, it argues that firms must be able to identify which activities can be outsourced and third, it comprises the concept of business processes (note that a business process is not a good).\textsuperscript{90}

### 3.2.2 Reasons for Outsourcing

The reason for outsourcing can be very different,\textsuperscript{91} but most of the reasons focus on several basic considerations. One argument is that outsourcing allows improving the return on investment. This is because the outsourcing company is able to reduce its assets for example in expensive technology, warehouses or equipments. Furthermore many companies also expect reductions in operating costs (top ten list number 1). Surveys that asked companies for the reasons of outsourcing, show that costs and pricing are almost always among the top three determinants.\textsuperscript{92} Fore example, 63 percent of firms do not outsource because they believe outsourcing will not reduces their costs.\textsuperscript{93} Figure 8 shows the top-ten list (evaluated with the help of a company survey) of reasons for outsourcing.

\textsuperscript{89} Espino-Rodrígues, Padrón-Robaina, 2006, p. 52.
\textsuperscript{90} Espino-Rodrígues, Padrón-Robaina, 2006, pp. 50-52.
\textsuperscript{91} Chase et al., 2005, p. 413.
\textsuperscript{92} Lynch, 2002, no page available.
\textsuperscript{93} Langley, Allen, Tyndall, 2001, p. 7.
Another consideration is that the company has to improve its focus in order to cope with its competitors for example through focusing on its core business (top ten list number 2).\textsuperscript{94} Or it simple faces a lack of knowledge or skill or it does not have the required resources and therefore has to search for the capabilities somewhere outside (top ten list number 3 and 5).\textsuperscript{95} Besides these reasons from the top-ten list, quality and shorten lead times are two other main and often mentioned reasons for outsourcing. These are very important criteria especially for manufacturing companies since shorter lead times will result in less in-transit inventory and shorter time to market. A reasonable quality compared to the price is another important factor for differentiating from competitors and for gaining and maintaining customers.\textsuperscript{96}

### 3.2.3 Different kinds of outsourcing

Outsourcing can be divided into three different levels: tactical, strategical, and transformational.

**Tactical outsourcing** means that a company will get a better service for less investment and management time from a outsource provider. It focuses on constructing the right contract and making the vendors stick to that contract. Reasons for tactical outsourcing are for example immediate cost savings. Quite often, the company is already in trouble and uses

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\textsuperscript{94} Prahalad, Hamel, 1990, p. 79. \\
\textsuperscript{95} Brown, Wilson, 2005, p. 37. \\
\textsuperscript{96} Duening, Click, 2005, p. 30.
tactical outsourcing as a direct way to address problems. The outsourcing is most likely executed from the purchasing department.

**Strategic outsourcing** is about outsourcing a certain function of a company to be able to focus on core businesses. It requires a strong secure relationship between the vendor and the company. This means a strategic long-term partnership with the emphasis of mutual benefit, instead of a pure vendor - buyer relation, which is quite often adversarial. Therefore the focus is on building long-term value due to working with a small number of best-in-class integrated service providers instead of a large number of vendors.

**Transformational outsourcing** refers to outsourcing everything the company does not do well, including core businesses. Therefore, the purpose of outsourcing is redefining the business. This might be quite questionable since core business is usually the most important part of a company.97

These three categories can further be grouped depending on where they are taken place: Onshore, Offshore, and Nearshore.

**Onshore outsourcing** stands for the fact that the vendor is operating in the same country. For example a Swedish company outsources a function to another Swedish company. This type is most common because it does not entail large risks and it is easy to evaluate and to choose a vendor.

**Nearshore outsourcing** refers to outsourcing to a company in a close country. In many cases the countries share borders.98

**Offshore outsourcing** means to outsource a function to a company in a distant country. Popular offshore countries are for example India, China and Pakistan. This type of outsourcing is increasing fast because of the attractiveness of the Asian market and the rising competition in the home countries.

### 3.2.4 What to outsource

Literature shows three different approaches that explain the reasons for outsourcing and that help to identify what to outsource. These are Transactional Cost Theory, Resource-Based

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98 Duening, Click, 2005, pp. 23-27.
View and Power Theory. The first two are the most widespread theories and have in common that they assume that the decision making is based on rationality and experience with a focus on realising profit. To cope with this one-sidedness, one can use the power theory, which also considers non-quantitative data. This means that this theory not only considers the main superior business objectives but also other interests and non quantifiable goals, e.g. power or authority.99

Resource Based View
As already mentioned in the background chapter, top executives should be judged on their ability to identify, cultivate and exploit core competences.100

Core Competencies are those functions that differentiate the company from the rest.101 They provide potential access to a wide variety of markets and they should make a significant contribution to the perceived customer benefits of the end product.102 Primary they are the reasons why customers buy the product.103 Therefore core competencies should be difficult for competitors to imitate.104 Non-Core Functions are “[…] processes that either add significant value to the core product or service or provide the means for supporting the company and retaining employees (for example cleaning, payroll, maintenance, and so on).”105

The proposition about top executives goes hand in hand with the resource based view. It states that outsourcing allows a company to focus on its core competencies.106 That means core competences should stay in-house and non-core activities can be outsourced.107 Therefore, it answers the question from a strategically point of view which resources should stay in the company and which can be outsourced.108

Transactional Cost Theory
After the core and the non-core activities are identified, the transactional cost theory can help to determine what elements of the non-core competencies are best to outsource.109 The idea

99 Dibbern, Heinzl, 2000, p. 4.
100 Prahalad, Hamel, 1990, p. 79.
106 Chase et al., 2005, p. 413.
behind this theory is that you have to handle additional transactional costs through outsourcing. \(^{110}\)

Transactional Costs are:

- Initiation costs – outsource provider selection, announcements, etc
- Agreement costs – Contract negotiations
- Coordination costs – coordinating processes, costs for management, etc
- Control Costs – to control your partner
- Adoption costs – adoption in the IT-System \(^{111}\)

Consequently transaction- or also called coordination-costs are costs that occur when making an economic exchange. A company has to deal with that kind of costs when it produces something on its own and just as well as when it lets someone produce it for itself. This approach helps to decide what to outsource as a result of cost differences between the original in-house situation and the outsourcing situation. It simple tries to minimise the total costs (consisting of transactional and production costs). \(^{112}\)

**Power Theory**

Due to rationalisation, reorganisation or outsourcing resources are lost or shifted to other departments or companies. The power theory states that through these facts a company’s department gains or looses power compared to the other departments. It further argues that every department tries to maintain and gain as much power as possible. Therefore it answers the question what to outsource as a matter of power. That means the departments that have less power compared to the others might be outsourced. \(^{113}\)

### 3.3 Conceptual model

The conceptual model displays the theoretical basis employed for answering the research questions. Therefore the first part of the conceptual model consists of the framework of Jonsson/Mattsson.

Limiting the Bachelor Thesis to one Model company and to one kind outsourcing process, this framework can be used to determine the planning environment, the resulting planning

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\(^{111}\) Schwarze, Müller, 2005, p. 7.

\(^{112}\) Dibbern, Heinzl, 2000, p. 5.

\(^{113}\) Dibbern, Heinzl, 2000, p. 9.
method and their changes due to outsourcing. This step is identical with answering the first two research question:

1. **How does outsourcing of the production of a single module by a manufacturing company affect its planning environment in theory?**

2. **How does the changing planning environment impact the existing planning method of the company in theory?**

Finally, this theoretical impact of outsourcing is compared with the empirical data of ITT Flygt, which has been gathered in a qualitative way by interviews and a questionnaire.

3. **How did the outsourcing of the production of a single module by ITT Flygt affect its planning environment and method and what are the differences to the developed theory?**
Theory:

Planning variables:
- 6 product-related
- 8 demand-related
- 6 manufacturing-related

Focus on 7 variables

Planning environment:
- Complex customer products (ETO)
- Configure to order products (ATO)
- Batch production of standardized products (MTS)
- Repetitive mass production (RMP)

Planning method:
- Re-order point system
- Runout-time planning
- Material Requirement Planning
- Kanban
- Order-based planning

Limitation to one type of company and to one kind of outsourcing

Comparison with empirical data of ITT Flygt

Theoretical Impact of outsourcing

Results matching?

Figure 9. Conceptual Model
4 Theoretical analysis

The purpose of this chapter is to analyse theoretically the impact of a specific outsourcing process on the planning method of a model company. Therefore, the changes due to the outsourcing process of the seven environmental variables are analysed and the scoring system is employed to research impacts on the planning environment. After enlarging the framework, it is answered, whether a change of the planning method used before outsourcing is advisable.

4.1 Description of the model company

To enable a thorough discussion about changing environmental variables due to outsourcing, a model company has to be defined. Assumptions about the company’s structure, its product and the outsourced process will help to make proper conclusions about the occurring impacts. To make the argumentation more concise the model company will be called “REVUE“ from now on.

REVUE is a Swedish manufacturer who is producing high complex products for the world market. Its customers are provided with a broad product range (without the possibility of adding customer specific items) and a short lead time. REVUE itself has decided not to take any inventory of final products while facing demand by a high number of customers ordering low to medium quantities.

The manufacturing of the modules/components and the assembling of end-items is done with the same machines. A cellular layout is applied as the shop floor layout.

The board of directors of REVUE has decided to decrease the high labour costs by outsourcing the manufacturing process of module A to an external vendor in China. The reason for choosing module A is that the labour costs for the manufacturing are high. The saved costs will help REVUE to run the production process more profitable. Since REVUE’s customer have been content over the years, the design of the end-items needs to be maintained.

Figure 10. extract of the BoM of a REVUE product
One very important component X of this module is made in Sweden and shipped to China. This is because its production belongs to the core competence of REVUE. Figure 10 shows graphically the structure of the considered end-item. Together with other raw materials, purchased by the Chinese supplier, the module A is manufactured in China, shipped back and held in stock in Sweden. An independent material planning system is implemented in China but the module A is made after the product specifications, which are solely developed by REVUE.

A high level of collaboration is crucial to ensure the high level of quality that REVUE is proud of. Conclusively, the process can be seen as a strategic offshore outsourcing. The cost-reducing as the reason to outsource can be found on number one of the mentioned top 10 reasons for outsourcing (cf. Figure 8).

To enable a post-prior comparison, the point of view for the further consideration is set on the Swedish manufacturer REVUE and the assembling process of the final products made in Sweden. Figure 11 and Figure 12 provide an overview about the company and outsourcing specific details of REVUE.

<table>
<thead>
<tr>
<th>Company</th>
<th>REVUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products</td>
<td>• High complex product</td>
</tr>
<tr>
<td></td>
<td>• Broad variety</td>
</tr>
<tr>
<td></td>
<td>• No customer specific items</td>
</tr>
<tr>
<td>Customer structure</td>
<td>• large number of customer orders with medium quantities a year</td>
</tr>
<tr>
<td>Customer preferences</td>
<td>• Short lead time</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>• Models/components and end-assembling are done with the same machines</td>
</tr>
<tr>
<td></td>
<td>• Cellular shop-floor layout</td>
</tr>
<tr>
<td></td>
<td>• No inventory of finished goods</td>
</tr>
</tbody>
</table>

*Figure 11. Company-specific characteristics*
Table: Outsourcing process

<table>
<thead>
<tr>
<th>Outsourcing process</th>
<th>REVUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outsourced part</td>
<td>Module A: High labour costs</td>
</tr>
<tr>
<td>Outsourcing reasons:</td>
<td>Reducing labour costs and therefore production costs</td>
</tr>
<tr>
<td>Location of the vendor:</td>
<td>China</td>
</tr>
<tr>
<td>Relationship to the vendor</td>
<td>External provider, but with close relationship</td>
</tr>
<tr>
<td>Responsibility: Purchase</td>
<td>By the vendor for the module except the one special part</td>
</tr>
<tr>
<td>Responsibility: Manufacturing</td>
<td>Own material planning system</td>
</tr>
<tr>
<td>Responsibility: development</td>
<td>Development by REVUE</td>
</tr>
</tbody>
</table>

Figure 12. Outsourcing process-specific characteristics

4.2 The planning environment and method before outsourcing

The scoring of the planning variables of REVUE in Figure 13 has been made based on the mentioned assumptions about the model company REVUE. After summing up the numbers the highest score is resulting in the planning environment “assemble-to-order”. Before outsourcing the manufacturing of module A, REVUE is working in an assembling-to-order environment. In this environment MRP is the optimal planning method (cf. Figure 6).
4.3 The impact of outsourcing on the main environmental variables

To enable a post-prior scoring of REVUE, the changes of the main environmental variables, namely BoM complexity, degree of value added at order entry, volume/frequency, production process, shop floor layout, batch sizes, and throughput time, are observed. First, the before-situation is described and secondly the impact of outsourcing on this specific variable is shown with the help of logical argumentation.

BoM complexity

Due to the assumption that the products of REVUE are highly complex the complexity of the bills of material was classified as “3-5 levels of bill of material” before the outsourcing.

The result of switching the production of module A to China is a slightly less complex BoM. From the Point of view (PoV) of REVUE
the different sublevels of the module A, except the component X, disappear. Assuming that other module of the product have a similar complexity, the variable won’t change because the other modules are not influenced by the outsourcing process.

No change of the levels.

Degree of value added at order entry

REVUE’s customers receive products that are assembled-to-order. Thus at the moment of order entry, the modules are already produced and ready for the assembling process.

After the outsourcing, module A is delivered by the Chinese manufacturer and held on stock in Sweden as well until REVUE receives a customer order. The shipping of the component X and module A does not increase the value of the product. Thus, the degree of value added does not change. Before and after outsourcing, module A and the other modules are held on stock, ready to be built together when the customer places its order.

No change of the variable.

Volume/frequency

It is assumed that REVUE has a large number of customer orders with medium quantities a year, i.e. that they face a demand which is allocated to a lot of different customers who order small and medium quantities a year.

Near-termed, REVUE will not pass through the expected savings to its customer via lower prices because the process hasn’t been running profitable in the past and the savings are needed to run the process more profitable after outsourcing. So, due to the outsourcing of module A, the customer structure won’t change because there are no incentives. Thus, REVUE will still face a demand with various different customers placing small or medium orders.

No change of the variable.

Production process

Assuming an “one-off or infrequent batch production”, the final assembling of the end-items is made shortly after the customer
order entry. Because of the high product variety and REVUE’s policy to guarantee a short delivery lead-time, orders are either slightly allocated or realised one by one. The end-items are assemble-to-order thus another production process, which is resulting in finished-items on stock, is not suitable.

No impact on the variable appears as there is no change in REVUE’s policy to offer a wide product range with a short lead time by avoiding inventory of end-items. Thus, another production process of the end-items is not reasonable due to the outsourcing of the module A.

**No change of the variable.**

**Shop floor layout**  
As mentioned in 3.1.1.3 the shop floor layout depends on the work flow of production, hence on the product layout. Commonly, a cellular layout is applied in an ATO environment.

The design of the products is not changing due to the outsourcing of manufacturing of module A. Hence, there is no impact on the shop floor layout.

**No change of the variable.**

**Batch sizes**  
REVUE is offering its customers assembled-to-order products. The batch sizes of end-items are therefore equivalent to customer orders.

As aforementioned the volume/frequency of the customer orders won’t change after the outsourcing. There is as well no need to change the policy of offering a wide product range with short delivery lead-time by having no inventory of end-items. Therefore, the batch sizes of the company won’t change.

**No change of the variable.**

**Throughput time**  
Manufacturing throughput time in an assemble-to-order environment indicates the time necessary to assemble the end-items from modules/components that are on stock. Although REVUE is
producing high complex products a short manufacturing throughput time is achieved by having cellular line layout and an appropriate design of the end-product.

A change of the shop floor layout as well as a change of the product design does not occur due to the outsourcing. The transport time for the shipping to China and return are only included in the production time of module A. Hence there is no impact of outsourcing on the manufacturing throughput time of the end-item.

No change of variable.

4.4 The impact of outsourcing on the planning environment and method

The framework of Jonsson/Mattsson uses the just examined seven environmental variables to determine the planning environment of a company. In the case of REVUE, no change of the seven variables could be examined due to the outsourcing of manufacturing a module A. Therefore, a change in the applied planning method is not required.

4.5 Enlarging the focus

The fact that there is no change of the main environmental variables due to the specific outsourcing leads to the observation of the changes of the remaining 13 variables mentioned in the concept of Jonsson/Mattsson. If any significant effects can be noticed, their implication on the planning environment are highlighted. Finally, reflections about an enlargement of the framework and its consequences on the REVUE model case are presented.

4.5.1 The impact of outsourcing on the remaining variables

First, the prior situation is briefly described. The settings are based on assumptions based on the assumptions made about REVUE. Second, the implications of outsourcing on the variables is examined which is based on logical argumentation.
**Product variety**

As one of its competitive advantages, REVUE is offering a wide product range to its customers, assembled-to-order from standardized modules.

Assuming that the Chinese vendor is producing the same module A as it has been produced in-house, no product changes and hence no change in product variety are occurring.

**No change of the variable.**

**Customer specific items**

The vast product range that REVUE is offering its customers makes it possible to fulfil the demand. Exceptional customer specific needs cannot be met with customer specific items due to the high cost arising by designing and manufacturing those.

Outsourcing of module A does not allow any change of this policy because capability to manufacture module A is outsourced. Therefore, customisation in Sweden is more than ever impossible. The Chinese vendor is only able to produce the standardized modules A as well because of its absent overview about the whole product and the implementation of module A in it.

**No change of the variable.**

**Product data accuracy**

One can assume very high product data accuracy at REVUE because everything has been produced in-house before outsourcing. All product data has existed only ones in the computer system\(^{114}\) and necessary calibration on modules and components could be discussed personally. It was made sure that all required modules and components fit together because REVUE’s engineers had the overview about the whole production process.

After outsourcing another party is involved in the whole production process. Assuming no shared product data base between the two companies, two BoM of the module A exist which increases the

\(^{114}\) Vollmann et al., 2005, p. 184
probability of inconsistent data. The overview of the whole production process is more difficult because of two different production plants. Hence, necessary adjustments in the production processes require more coordination and increases product data inaccuracy. Another problem is the different languages in the two companies that can lead to more misunderstandings. One can conclude that product data accuracy decreases. A lower product data accuracy lead to higher fault rate in production and thus to a higher safety stock required to cover those faults.

**Product data accuracy decreases.**

**Level of process planning**

The level of process planning before the manufacturing of the end-items has been very sophisticated before the outsourcing due to the high complexity of the products. Although cellular layout is applied, where similar products are produced in one production cell, set ups are inevitable and bear high set up costs.

The process planning itself gets slightly easier because the manufacturing of module A does not have to be taken into account anymore. But due to the high setup costs and the lasting complexity of the product, the process planning stays very sophisticated.

**No change of the variable.**

**P:D ratio**

REVUE’s high complex products require a long production lead time P. It is the time needed to produce the whole product and deliver it to the customer. The delivery lead time D is relatively short because of the low manufacturing throughput time. Therefore a P:D ratio > 1 can be assumed.

Due to the transportation of component X to China and the transportation of the module A back to Sweden, round about 10-12 weeks have to be added to P. Although we are assuming high complex product, the other modules required to assemble the end-item, won’t have such a long throughput time and therefore a high
increase of the P and hence a high increase of the P:D ratio is the result.

**P:D ratio increases strongly.**

### Type of procurement ordering

All components and raw materials needed to produce the subassemblies and the final products are purchased by placing an order.

The outsourcing process has only a negligible impact on the type of procurement ordering. The materials required to manufacture module A, except component X, are now purchased by the Chinese vendor. Taking into account that the remaining raw materials and components still need to be procured by REVUE, one can assume that the type of procurement ordering is not changing.

**No change of the variable.**

### Demand characteristics

REVUE is selling its products to various customers around the world. The demand for these end-products is independent.

After shifting the production of module A to the Chinese vendor the demand is still to be characterised independent since there is neither an impact on the volume/frequency nor on the product design.

**No change of the variable.**

### Demand type

Forecasting of customer demand is not done in contrast to the forecast of the modules, which are made-to-stock This is common usage in an assemble-to-order environment.\(^ {115}\)

This characteristic does not change because of the outsourcing. All end-items are still assembled-to-order and the demand for all modules has to be forecasted. Solely the time horizon for

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\(^ {115}\) Hsu, Wang, 2001, p. 59.
forecasting module A and hence component X is pushed further away due to the long lead time.

*No change of the variable.*

<table>
<thead>
<tr>
<th>Time distributed demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>The demand of end products is not forecasted and REVUE’s customers do not provide them with information about their future demand. This assumption is based on the consideration that REVUE sells its products to various customer with small and medium demand. Thus, a complex system to process various customer demand data does not pay off.</td>
</tr>
<tr>
<td>As aforementioned, the volume/frequency does not change due to the outsourcing process and therefore the conditions for forecasting end-items do not change.</td>
</tr>
<tr>
<td><em>No change of the variable.</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>The demand is fulfilled by assembling to a specific order. No contracts are made with their end-customers since REVUE has many customers with low volume of orders. So specific VMI contracts with customers are not that beneficial.</td>
</tr>
<tr>
<td>Obtaining the same volume/frequency after outsourcing leads to the conclusion that there is no change on this variable.</td>
</tr>
<tr>
<td><em>No change of the variable.</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inventory accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>To provide the customer with a short lead-time, modules necessary to assemble the finished items are produced and held on stock at REVUE’s site. Finished products are directly delivered to the customer so no inventory of finished items is held.</td>
</tr>
<tr>
<td>Outsourcing of the manufacturing of module A has a huge impact on the inventory accuracy because the inventory level is increasing intensely. There are two main reasons for that: First, inventory of module A is now held on three different places namely in China (until the required shipping size is reached), in-transit and</td>
</tr>
</tbody>
</table>
in Sweden. Three different places of inventory require three times of handling, verifying quantities and quality and storing the inventory which raise the probability of inaccuracy of actual inventory level and recorded level in the system. Second, a higher inventory of module A has to be held in Sweden due to the long manufacturing lead time of module A. The fact that the materials, which are required to produce module A (except component X) and are not purchased and stored in Sweden anymore, cannot compensate the rise of the inventory level. The consequence of this high level of inventory is a high probability of inaccurate inventory data because this higher inventory has to be handled more often.

**Inventory accuracy is decreasing.**

<table>
<thead>
<tr>
<th>Number of operations</th>
<th>Recalling the high complexity of the products, one can assume a high number of operations necessary to assemble the end-items.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The premise that product design is not changing leads to the result that the number of operations for the assembling process is not changing.</td>
</tr>
</tbody>
</table>

**No change of the variable.**

<table>
<thead>
<tr>
<th>Sequencing dependency</th>
<th>Although a cellular layout is applied to reduce the necessity of changing tools a high sequencing dependency is present at REVUE’s assembling site. Especially since the existing machines are used for the manufacturing of the modules as well as for the final assembling of the end-product. The reasons are the high product variety and the high amount of various customer orders.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>As aforementioned, no impact of outsourcing on the product variety and the volume/frequency can be examined. But sequencing dependency decreases slightly because the production of module A does not have to be taken into account anymore. But the effect is small because the production of the other remaining modules and the end-assembling remains complex.</td>
</tr>
</tbody>
</table>
Small decrease of sequencing dependency.

### 4.5.2 Consequences for the planning environment

The impact of the changes of the variables *product data accuracy, P:D ratio, inventory accuracy* and *sequencing dependency* on the planning environment cannot be examined directly. The limitation of the applied framework to the seven variables used in the framework makes this impossible.

A closer look to the effects of the considered outsourcing on the inventory level reveals similarities between the four variables. As aforementioned, the decrease in the product data accuracy has to be compensated by a higher safety stock of module A to prevent stock outs. The probability of stock outs increases because more faults in the production occur and this leads to a higher consumption of the inventory than the calculated consumption. This variability yields to the need of a higher safety stock.

Increasing the production lead time, as it was observed in the P:D ratio, results as well in a higher inventory.\(^{116}\) The in-transit inventory, calculated as the annual demand of the considered item multiplied by the transit time in days through 365, is increasing immensely. Before involving the Chinese vendor into the manufacturing process of module A, no transport was required and hence no in-transit inventory occurred. Transportation of component X to China and transportation back to Sweden of module A increases the production lead time, in-transit inventory arises and therefore inventory level increases.

The high probability of inventory inaccuracy is a result of the increasing inventory level of module A. To prevent cost-intensive stock-outs this inaccuracy has to be compensated with a higher safety stock. Thus, the variable “inventory accuracy” is contributing to a higher inventory level as well.

The declining sequencing dependency is the only variable that counter acts the increasing inventory level. Comparing chapter 3.1.1.3 tardiness, higher flow times and higher system load are the consequences of a high sequencing dependency. As observed, the sequencing dependency of the assembling process at REVUE’s site is only slightly decreasing after the outsourcing. Therefore, only a negligible contribution to the inventory level can be detected.

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\(^{116}\) Vollmann et al., 2005, p. 376.
4.5.3 Adding inventory level to the analysing framework

In 1993 Terry Hill presented a framework to identify the manufacturing and business implications of his five process choices types, namely Project, Jobbing, Batch, Line, and Continuous. These process choices are similar to the four planning environments presented by Jonsson/Mattsson. Figure 14 shows the connections between Jonsson’s planning environments and Hill’s process choices. The process choice “batch”, which is positioned between jobbing and line, has not been assigned to one of the planning environments.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer-to-order</td>
<td>Project, Jobbing</td>
</tr>
<tr>
<td>Assemble-to-order</td>
<td>Jobbing, Line</td>
</tr>
<tr>
<td>Make-to-stock</td>
<td>Line</td>
</tr>
<tr>
<td>Repetitive mass production</td>
<td>Line, Continuous</td>
</tr>
</tbody>
</table>

Figure 14. Comparison between frameworks of Jonsson/Mattsson and Terry Hill (according to Jonsson/Mattsson, 2003, p. 878.)

According to Jonsson/Mattsson, connections between the two frameworks are identifiable. This leads to the conclusion that distinctive features in the process choices can be applied to show differentiations in the planning environments of Jonsson/Mattsson. To characterise the five different process choices, the inventory level was used among other criteria. To make a statement about the impact of the inventory level on the planning environments, the variable “inventory level” is added to the seven main variables provided by Jonsson/Mattsson.

Hill distinguished between inventory level for components/raw material, work-in-progress and finished goods. For the REVUE case, the inventory for work-in-progress (WIP) as well as the finished good inventory can be disregarded. The WIP inventory, as the inventory for all “parts and subassemblies in the process of becoming completed finished goods” does not change because the WIP inventory refers to the modules needed in the final assembling process. It has been shown that this process does not change in the examined REVUE case and therefore the WIP inventory is neglected. The finished good inventory is not important for the REVUE case as well because prior and post outsourcing, REVUE delivers its finished goods directly to the customer without storing it. Hence no inventory of finished goods is held. Therefore, only the inventory of components and raw materials and its implications on the planning environment is considered.

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118 Grant et al., 2006, p. 425.
Figure 15 shows the different levels of inventory of components/raw material in the 5 different process choices.\textsuperscript{119}

<table>
<thead>
<tr>
<th>Process choice</th>
<th>Inventory of components/raw material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
<td>Small, as required</td>
</tr>
<tr>
<td>Jobbing</td>
<td>Low, as required</td>
</tr>
<tr>
<td>Batch</td>
<td>Associated with the Make-to-stock or make-to-order nature of the business</td>
</tr>
<tr>
<td>Line</td>
<td>Low, planned with buffer stock</td>
</tr>
<tr>
<td>Continuous</td>
<td>Planned with buffer stock</td>
</tr>
</tbody>
</table>

Figure 15. Inventory level of components/raw materials in the different process choices. (According to Hill, 1993, pp. 118-128.)

As one can see, the two process choices similar to the ATO environment, Line and Jobbing, are characterized by a low level of inventory of components/raw materials. The difference between jobbing and line is that, although line inventory tends to low inventory in components/raw materials, a buffer stock is added. Hence, one can assume that the inventory level in line is higher than the inventory level in jobbing.

4.5.4 Analysing the impact of the changing inventory level on the planning environment

The thoughts in chapter 4.5.3 lead us to the examination of REVUE’s increasing inventory of module A with the help of Hill’s characterisation. It was concluded that inventory level of module A is increasing and that more safety stock has to be held to cover the various uncertainties. Therefore it can be reasoned that the additional variable “inventory level” in the enlarged framework is tending to the process choice “line” and therefore to the MTS environment.

\textsuperscript{119} Hill, 1993, pp. 118-128.
4.6 Conclusions about the impact of outsourcing on the planning environment and the planning method

With the additional variable “inventory level” relating to the inventory level of components and raw materials one out of eight variables is changing towards the make-to-stock environment. Unfortunately, a quantitative analysis of the change cannot be given since the impact is evaluated qualitatively. Therefore, a scoring system for inventory level and hence the enlarged framework cannot be applied to show the post-outsourcing situation of REVUE.

It has been shown that the other seven variables do not change. Therefore the ratio of one out of eight leads to the conclusion that the planning environment of REVUE is not changing due to the outsourcing of manufacturing of module A.

If the planning environment is not affected the optimal planning method in an ATO environment, MRP, does not have to be changed. Even the fact that a slightly tendency towards a make-to-stock environment can be asserted, does not bear another optimal planning method. Material Requirement Planning is working optimal as well in a MTS environment (cf. Figure 6).
5 Empiric

In this chapter the empirical data, gathered at the researched company ITT Flygt, is presented. First of all, the company and interviewee are introduced briefly. Secondly, the outsourcing process is described, followed by an introduction of the company, to which the manufacturing of a single module has been outsourced to. Finally, the results of the interview and, in particular, the changes on the planning environment variables are illustrated.

The empirical study is based on the collected data from the interviewed company ITT Flygt AB - produktionsenhet in Emaboda (this part of the company is called in short “Lindås”). To reach an easier and more concise analysis the gathered data concerning environmental variables, planning environment and method are arranged according to the theoretical analysis. Before going into details, the company, the history of outsourcing, and the outsourcing process itself are described in general.

5.1 Introduction of Lindås

The following chapter is based on received information from http://www.flygt.com, prospects, annual and financial reports and on the personal interview conducted 4th of December 2006 with Mr. Lennart Fagerström. He is project manager for group logistics and planned, organised and supervised the outsourcing process from the early beginnings in the middle of 2004 until now. The interview took place at the manufacturing facility Lindås in Emaboda which is located approximately 50km to the east of Växjö.

Lindås was founded in Emaboda in southern Sweden in 1901 by Per Alfred Stenberg. Beginning in 1929, pumps, a high complex product, were produced in cooperation with Hilding Flygt. But until 1954 the business was limited to Sweden. In 1947, the company invented the first submersible drainage pump and in 1956 the first submersible sewage pump. The speciality of the submersible pumps is that both parts, the motor and the pump are underwater, while the motor of a normal pump has to be outside of the water. Having this competitive advantage, the company was expanding onto the international market rapidly during the 1950s and 1960s. In 1968, the company was taken over by the ITT Corporation and finally, in 1991 it was renamed to ITT Flygt.
Nowadays, Lindås is the world leader in producing submersible pumps, mixers and accessories, operating in 130 countries and owning 44 companies around the world wholly or partly. Nevertheless, a big part of the production still takes place in Sweden and 1500 of the approximately 4000 employee work there. Among this 1500 people, 1200 work in the manufacturing plant (Lindås) in Eneboda and the other 300 people are employed at headquarter in Stockholm (ITT Flygt AB) where the strategically planning (e.g. Sales and Operation Planning, SOP) for the whole company takes place. In 2005, the overall revenue was $979 million while the biggest part was earned on the European market (cf. Figure 16. Distribution of Lindås revenue)

![Pie chart showing Lindås revenue distribution]

**Figure 16.** Distribution of Lindås revenue

Regarding Lindås core competencies, the ability of producing submersible pumps, which is secured by patents, is the main competitive advantage. Their actual products can be allocated to four product groups; drainage pumps, sewage pumps and mixers, propeller pumps and the monitoring and controlling equipment. They are produced for wastewater-, construction-, mining- and industry-companies and can be used in several ways, e. g. for pumping return-activated sludge in a wastewater treatment plant. As the possibilities of applications of Lindås’ products are quite high, the company offers a broad range of variants. "To ensure a short delivery lead time which is, next to the price, the most important factor for the customers, Lindås planning environment and method can be identified as assemble to order for almost all pumps and material requirement net planning for all subassemblies and materials."\(^{120}\)

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\(^{120}\) Mr. Lennart Fagerström, 2006
5.2 History of outsourcing at Lindås

In 1994 the board of directors of ITT Flygt AB decided to build a factory in Shenyang - China. The main reasons were to enter the Asian market and to get closer to it through the fact that the transportation to Shenyang (8 weeks) is already done before the order entry. So ITT Flygt AB decided to outsource the assembling for the Asian pumps. The relationship to the vendor ITT Shenyang Ltd can be described as close because it is a part of the ITT Group and therefore it is a subsidiary of Lindås. There is no consistent IT-Software. Sales and Operation planning is done once a year in Stockholm by ITT Flygt AB but master Production Scheduling, Material Requirement Planning, Capacity Planning and Shop Floor Control is done by every subsidiary itself. Mr. Fagerström classifies the relationship as “[…] long-termed, very close and good but a main objective was and is still to keep all the gathered knowledge and competences in our company - Lindås.”

ITT Shenyang Ltd operates with a different shop floor layout (line layout) compared to Lindås (cellular layout). Moreover, it uses less high tech machines with less capacity. The manufacturing in ITT Shenyang Ltd can be described as more labour intensive compared to Lindås. Although the labour costs in China are only 15 percent of the Swedish labour costs ITT Shenyang Ltd had problems to compete with cheaper pumps from Asia. The quality of the finished pumps was worse compared to the pumps from Lindås. It had problems to get skilled employees and the annual manufactured volume was too little to achieve an optimal capacity usage. Consequently, the board of directors of Lindås decided to insource the assembling for the pumps again. Nowadays, Lindås outsources only 30 percent of the manufacturing of the pumps for Asia especially when it has capacity problems (that means 70 percent of the pumps for Asia are still manufactured by Lindås).

In order to improve the balance of ITT Shenyang Ltd and to increase the capacity usage, ITT Flygt AB searched for better activities or processes that can be outsourced from Lindås to ITT Shenyang Ltd. In 2004, it was decided to outsource the manufacturing of a component called level regulator which is a very important component of any produced pump. It is responsible for switching the motor of the pumps on and off and the costs are mainly labour costs. Further, it consists of a seal which makes it possible to produce submersible pumps that have the motor under water. This is at the same time, as aforementioned, one of the core competences of Lindås.

121 Mr. Lennart Fagerström, 2006
5.3 The observed outsourcing process at Lindås

Lindås' main reasons for outsourcing the manufacturing of the level regulator were to reduce costs, especially labour costs. In order to keep the knowledge and core competence in Sweden, the seal is still produced by Lindås. So Lindås has begun to outsource 10 percent of the total amount of level regulators in the middle of 2004. Nowadays (December 2006), the outsourcing process is completed and in total 90 percent of the level regulators are manufactured by ITT Shenyang Ltd.

Detailed description of the outsourcing process:
Lindås produces the seal and ships them in big batches (approximately 1500) to the factory in Shenyang every week (one way by ship takes 8 weeks). Besides this, Lindås provides ITT Shenyang Ltd with a 3 months rolling forecast every month (e.g. in January Lindås sends the forecasted amount of level regulators for April). ITT Shenyang Ltd purchases the rest of the materials by itself in Asia and produces the level regulator. Then, the finished level regulators are shipped back to Lindås and put on stock waiting for the assembling of the pumps. Only a few of them are put on stock in order to be sold as spare parts.

5.4 The impact of outsourcing on the environmental variables of Lindås

The following information about the changes is solely received through the interview (see questionnaire in the appendix). To enable a post-prior comparison the point of view for the asked questions has been set only on Lindås, the assembling of the pumps and respectively the end-products (like pumps and level regulators sold as spare parts).

<table>
<thead>
<tr>
<th>BoM complexity</th>
<th>The number of levels in the BoM for the pumps was before and after outsourcing 3 to 5. It decreases only very slightly because the components for the level regulator are not included in the BoM anymore.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of value added at order</td>
<td>Pumps were and are still assembled-to-order for all smaller pumps (app. 98% of all produced pumps). Bigger pumps (app. 2% of all</td>
</tr>
<tr>
<td>entry</td>
<td>produced pumps) were/are manufactured-to-order. The level regulator has been and is still held on stock when the customer order is received. Therefore, it had no effect on the value at order entry.</td>
</tr>
<tr>
<td>No impact.</td>
<td></td>
</tr>
<tr>
<td>Volume/frequency</td>
<td>The volume and frequency of the annual sold pumps (one level regulator goes into one pump) and therefore also the sold level regulators were and are still described as large number of customer orders with medium quantities per year.</td>
</tr>
<tr>
<td>No impact.</td>
<td></td>
</tr>
<tr>
<td>Production process</td>
<td>The productions process for the end-assembling of the pumps is/was batch production (less frequent than monthly). Outsourcing did not change this variable.</td>
</tr>
<tr>
<td>No impact.</td>
<td></td>
</tr>
<tr>
<td>Shop floor layout</td>
<td>The shop floor layout for the end-assembling of the pumps was and is still identified as cellular layout.</td>
</tr>
<tr>
<td>No impact.</td>
<td></td>
</tr>
<tr>
<td>Batch sizes</td>
<td>The batch size for the end-assembling of the pumps is/was equivalent to customer order quantities.</td>
</tr>
<tr>
<td>No impact.</td>
<td></td>
</tr>
<tr>
<td>Throughput time</td>
<td>The manufacturing throughput time was and is very short: Less than a day for the assembling of smaller pumps and at maximum three days for the assembling of the biggest pumps. Due to the fact that the level regulator is kept on stock, outsourcing did not effect the manufacturing throughput time of the end-assembling.</td>
</tr>
<tr>
<td>No impact.</td>
<td></td>
</tr>
<tr>
<td>Product variety</td>
<td>The level regulator was before and is after outsourcing manufactured in 40 different variations. Therefore the variety of the</td>
</tr>
</tbody>
</table>
end-products (pumps and also level regulators sold as spare parts) did not change.

**No impact.**

**Customer specific items**

Pumps have always been assembled out of big combination of standardized modules. “It happens very seldom that these combination possibilities are too less and that customers orders specific items, but actually it is only a matter of additional lead time and costs. Outsourcing the manufacturing of the level regulator did not have any impact on this variable.”

**No impact.**

**Product data accuracy**

Normally Lindås has a very high product data accuracy. They use fixed time intervals (8 times per year) to adjust and renew the BoM and the routing file. In the beginning of the outsourcing process they had some problems in these files, because they use different languages and names for the components. So, outsourcing had especially in the beginning an effect on the product data accuracy.

**Product data accuracy decreased.**

**Level of process planning**

Outsourcing the manufacturing of the level regulator did not change the design of all the other components and products. So, the level of process planning did not change that much. Except for the fact that the level regulator itself has not to be planned anymore.

**No impact.**

**P:D ratio**

The P:D ratio was before outsourcing bigger than 1 (P equalled 10 weeks and D equalled 2 weeks; P:D was about 5). Due to outsourcing, the seal has to be shipped to Shenyang and the level regulator has to be shipped back to Emaboda. Each way takes 8 weeks. Consequently for Lindås, the production lead time includes now the transportation to and from Shenyang and it therefore increases by 16 weeks.

---

122 Mr. Lennart Fagerström, 2006
<table>
<thead>
<tr>
<th><strong>P:D ratio increased strongly.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The material for the level regulator is now purchased by ITT Shenyang Ltd except for the seal. So there was a slight change but the type of procurement ordering did not change at all.</td>
</tr>
<tr>
<td><strong>No impact.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Type of procurement ordering</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand characteristics</td>
</tr>
<tr>
<td>The demand for end-products and spare-parts (like some of the level regulator) is still independent and the demand for components (like the level regulator) is still depended.</td>
</tr>
<tr>
<td><strong>No impact.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Demand type</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>As Lindås assembles pumps dependent on customer orders outsourcing did not change the demand type. It can still be identified as customer orders. Because of the longer lead time, the forecasts for the level regulator now has to be done for a longer time period. But in general nothing changed.</td>
</tr>
<tr>
<td><strong>No impact.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Time distributed demand</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>End-products have never been forecasted. They were and are still assembled when the customer orders. Hence no impact on this variable due to outsourcing can be observed.</td>
</tr>
<tr>
<td><strong>No impact.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Source of demand</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The source of the demand for the pumps and for the level regulator is still customer driven. Outsourcing did not have any impact.</td>
</tr>
<tr>
<td><strong>No impact.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Inventory accuracy</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lindås used and uses cycling counting. That means A - Components are counted twice a year, B - Components are counted once a year and C - Components are counted once every two years. Although ITT-Flygt has now a bigger inventory for the level regulator the inventory accuracy is still high.</td>
</tr>
</tbody>
</table>
Due to the fact that the level regulator is still produced in the same 40 different variations like before the design of the pumps did not change and they are still produced in the same way. The only effect that can be registered is that the level regulator has not to be produced anymore, but the number of operations for the end-assembling of the pumps did not change.

Sequencing dependency decreased a little bit.

5.5 Changes in the planning environment and method of Lindås

As aforementioned, the planning environment was and is identified as assemble to order for smaller pumps (app. 98%) and manufacture to order for bigger pumps (app. 2%). The material planning method was and is based on a MRP-System that includes all materials and components.

For purchasing- or production-batches and furthermore for inventory concerns, Lindås used/uses an ABC-Classification to keep the inventories as low as possible. Mr. Fagerström claims that “[...] outsourcing the manufacturing of the level regulator did not have any big impacts on the planning environment and method of Lindås [...] the only thing we have to
face now is a higher in-transit inventory and a much higher inventory for the level regulator here in Emaboda."\textsuperscript{123}
6 Analysis

This chapter mainly deals with the comparison of the theoretical and the empirical results regarding the changes due to outsourcing. Therefore it is checked before/after outsourcing, if the right planning environment and method are used by Lindås. Subsequently, REVUE and Lindås are compared to determine differences which might affect the results. Finally, the results regarding the planning environment and the planning methods are compared.

6.1 The planning environment and method of Lindås

Figure 17 shows the resulting planning environment for Lindås. It is based on the given information about Lindås’ environmental variables. Due to the fact that these seven variables do not change due to outsourcing this figure can be seen as valid for both situations (before and after outsourcing). The highest score 12 determines the planning environment as ATO – assemble-to-order.

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>ETO</th>
<th>ATO</th>
<th>MTS</th>
<th>RMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>BoM complexity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-5 levels in the bill of material</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Degree of value added at order entry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assemble-to-Order or plan</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Volume/Frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large Number of customer orders with medium quantities every year</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Production Process</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Batch production</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Shop Floor Layout</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cellular Layout</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Batch sizes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>equivalent to customer order quantities/call-off quantities</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Throughput time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short throughput time, a week or less</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Sum</td>
<td>3</td>
<td>12</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 17. Scoring of Lindås
This result goes hand in hand with Mr. Fagerström’s explanations. He identifies the planning environment as assemble-to-order for all smaller pumps (app. 98% of all produced pumps) and manufacture-to-order for bigger pumps (app. 2% of all produced pumps). He further describes the planning method as a material requirement net planning for all components and materials. As Figure 6 in chapter 3.1.3 shows, a MRP planning method is expected to perform with a high degree of effectiveness and high satisfaction in an ATO environment.

Finally, he stated that there was no impact on the planning environment und method due to outsourcing. This is also shown by the result of Figure 17: As there is no effect on the seven variables the scores do not change. Consequently, no effect on the planning environment and method can be found.

### 6.2 Comparison between Revue and Lindås and their outsourcing processes

It is essential for the comparability of the theoretical and empirical results that REVUE and Lindås equals each other to a high extent. Therefore, first in this chapter the company-specific and then the outsourcing process-specific characteristics are compared and analyzed regarding their difference. Furthermore, it is analysed briefly if these differences may affect the results.

#### 6.2.1 Company specific comparison

The four company specific assumptions concerning REVUE, done in chapter 4.1. Description of the model company, regard the products, the customer structure, the customer preferences and the manufacturing.

The products of REVUE are high complex and the customer can order a broad variety of products, but no customer specific ones. Having a high BoM complexity with 3-5 levels, Lindås matches the first criterion. Furthermore a large product variety is offered. The only difference is that Lindås offers customer specific items, as long as the customer is willed to pay more and to accept a longer lead time. However, in fact almost no customer specific products are ordered due to the large product variety. Like REVUE, Lindås also has a large number of customer ordering medium quantities per year. Concerning the customer preferences, both the customer of Revue and of Lindås, see a low lead time and low prices
as important. The first assumptions of the manufacturing, that models/components and end-assembling are done with the same machines, is also matched by Lindås. Additionally, the shop floor layout is cellular and there is no inventory of finished goods for both, REVUE and Lindås. Hence, the company specific characteristics of REVUE and Lindås are almost the same. Figure 18 provides an overview about them:

<table>
<thead>
<tr>
<th>Company</th>
<th>REVUE</th>
<th>Lindås</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products</td>
<td>• High complex product</td>
<td>• High complex products</td>
</tr>
<tr>
<td></td>
<td>• Broad variety</td>
<td>• Broad variety</td>
</tr>
<tr>
<td></td>
<td>• No customer specific items</td>
<td>• Customer specific items possible</td>
</tr>
<tr>
<td>Customer structure</td>
<td>• large number of customer orders with medium quantities a year</td>
<td>• large number of customer orders with medium quantities a year</td>
</tr>
<tr>
<td>Customer preferences</td>
<td>• Short lead time</td>
<td>• short lead time</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>• Models/components and end-assembling are done with the same machines</td>
<td>• Models/components and end-assembling are done with the same machines</td>
</tr>
<tr>
<td></td>
<td>• Cellular shop-floor layout</td>
<td>• Cellular shop-floor layout</td>
</tr>
<tr>
<td></td>
<td>• No inventory of finished goods</td>
<td>• No inventory of finished goods</td>
</tr>
</tbody>
</table>

*Figure 18. Company-specific characteristics*

### 6.2.2 Outsourcing process specific comparison

In chapter 4.1 several outsourcing process specific assumptions are made for REVUE. These are: the outsourced part, outsourcing reasons, location of the vendor, relationship to the vendor, purchasing-responsibility, manufacturing-responsibility and development-responsibility.

The outsourced part at REVUE is a module A which is characterized by high labour and low material costs. From this it follows that the outsourcing reason is to reduce labour costs and hence production costs. Similar to this, the outsourced part of Lindås is also a module, the level regulator, which is assembled in every end-product. As a difference to REVUE the labour/machine-ratio is variable. This means that both, a large use of labour with less machines or a high degree of automation, are possible to produce the level regulator. Nevertheless, reducing production costs like at REVUE is the main reason for outsourcing
and therefore the difference has no impact on the results of this thesis. The location of the vendor is the same in both cases. Concerning the relationship to the vendor, again a difference occurs. While the vendor of REVUE is an external provider, the one of Lindås is a subsidiary. The relationship with REVUE, and Lindås respectively, is close. On the first view, the fact that the vendor is a subsidiary of Lindås may appear problematic, but taking a deeper look at the relationship shows that the subsidiary works quite similar than the external provider. Both vendors purchase the required materials for the module on their own, except that for both modules one special component is delivered from the outsourcing partner. Furthermore the material planning is also done by both; REVUE and ITT Flygt demand the module for a specific date. Finally, the responsibility to enhance the module further on lays at the outsourcing companies.

Summing up this chapter, it can be said that the outsourcing process of REVUE and Lindås equals each other enough to guarantee the comparability of the theoretical and the empirical results. Figure 19 provides an overview of the outsourcing-process-specific characteristics:

<table>
<thead>
<tr>
<th>Outsourcing process</th>
<th>REVUE</th>
<th>Lindås</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outsourced part</td>
<td>Module A: High labour costs</td>
<td>Level regulator: High labour cost</td>
</tr>
<tr>
<td>Outsourcing reasons:</td>
<td>Reducing labour costs and therefore production costs</td>
<td>Reducing production costs and using existing capacities in the subsidiary</td>
</tr>
<tr>
<td>Location of the vendor</td>
<td>China</td>
<td>China</td>
</tr>
<tr>
<td>Relationship to the vendor</td>
<td>External provider, but with close relationship</td>
<td>Subsidiary, hence, close relationship</td>
</tr>
<tr>
<td>Responsibility: Purchase</td>
<td>By the vendor for the module except the one special part</td>
<td>By the vendor for the module except the one special part</td>
</tr>
<tr>
<td>Responsibility: Manufacturing</td>
<td>Vendor has its own material planning system</td>
<td>Vendor has its own material planning system</td>
</tr>
<tr>
<td>Responsibility: development</td>
<td>Development by REVUE</td>
<td>Development by Lindås</td>
</tr>
</tbody>
</table>

*Figure 19. Outsourcing process-specific characteristics*
6.3 Comparison of the changes and impacts due to outsourcing

This chapter is structured according to the framework of Jonsson/Mattson. First the changes of the environmental variables are compared. Then the consequences for the planning environment and method are presented and conferred.

6.3.1 The impact of outsourcing on all environmental variables

The following figure gives information about the impact on all 20 environmental variables from the theoretically analysis (company REVUE) and from the given information by Mr. Fagerström (company Lindås).

<table>
<thead>
<tr>
<th>Environmental variables</th>
<th>REVUE</th>
<th>Lindås</th>
<th>conformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>BoM complexity</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Degree of value added at order entry</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Volume/frequency</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Production process</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Shop floor layout</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Batch sizes</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Throughput time</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Product variety</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Customer specific items</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Product data accuracy</td>
<td>Decreases</td>
<td>Decreased</td>
<td>Yes</td>
</tr>
<tr>
<td>Level of process planning</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>P:D ratio</td>
<td>Increases strongly</td>
<td>Increased strongly</td>
<td>Yes</td>
</tr>
<tr>
<td>Type of procurement ordering</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Demand characteristics</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Demand type</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Time distributed demand</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Source of demand</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Inventory accuracy</td>
<td>decreases</td>
<td>No impact</td>
<td>No</td>
</tr>
<tr>
<td>Number of operations</td>
<td>No impact</td>
<td>No impact</td>
<td>Yes</td>
</tr>
<tr>
<td>Sequencing dependency</td>
<td>Decreases a little bit</td>
<td>Decreased a little bit</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Figure 20.* Comparison of the changes of REVUE’s and Lindås’ environmental variables
Only the difference in the environmental variable inventory accuracy can be found. This difference can come either from a wrong theoretically analysis or from varieties between REVUE and Lindås. Going back to the logical argumentation about the inventory accuracy in chapter 4.5.1, a wrong conclusion is implausible. Higher inventory leads in all probability to a higher probability of inaccurate inventory data. Consequently, the difference must likely come from varieties between REVUE and Lindås. As already mentioned in chapter 5.4, uses Lindås cycle counting. That is described by Mr. Fagerström as a way to differentiate the inventory counting depending on the ABC-Classification. That means A - components are counted twice a year, B - components are counted once a year and C - Components are counted once every two years. Further it must be considered that Lindås has already experiences with outsourcing (the assembling of the Asian pumps in the year 1994). So it sounds very plausible that Lindås was well prepared for outsourcing the manufacturing of the level regulator. Consequently an effect on this variable could be avoided.

### 6.3.2 The impact on the inventory level due to outsourcing

The theoretical analysis shows that the environmental variables of REVUE product data accuracy, P:D ratio, inventory accuracy and sequencing dependency are changing. Chapter 4.5.2 examines a closer look on these four variables and reveals similarities between those:

The decrease in the product data accuracy yields to a higher safety stock. An increasing production lead time leads to more in-transit inventory and therefore to a higher inventory level. Further the variable inventory accuracy is contributing to a higher inventory level as well. Only the declining sequencing dependency is counteracting the increasing inventory level, but all in all the impact of outsourcing leads to a higher inventory level of the outsourced module.

This equals Mr. Fagerström’s explanations about the impacts of outsourcing the manufacturing of the level regulator on the planning environment and method (see chapter 5.5). He explained that the only effect on Lindås, due to outsourcing, is a high in-transit inventory and a much higher inventory in Emaboda of the level regulator

### 6.3.3 Consequences for the planning environment and method

In chapter 4.5.4 it is concluded that the increasing inventory reasons a tendency to the process choice “line” and therefore to the MTS environment. But all in all only one out of eight variables is changing and so the planning environment and consequently the planning
method of REVUE do not change due to outsourcing (see chapter 4.6). These results equal the results for Lindås: First Figure 17 shows that the planning environment and consequently also the planning method do not change. Second Mr. Fagerström explains that […] outsourcing the manufacturing of the level regulator did not have any big impacts on the planning environment and method of Lindås […].”124 Therefore no differences between the logical argumentations and the empirical data can be found.

124 Mr. Lennart Fagerström, 2006
7 Conclusion

In this chapter, the results and generalisations that can be drawn from the analytical chapters are discussed. To add scientific validity, the thesis’ approach is reflected on and criticised. To provide future researches with possible starting points, suggestions for further research are given.

7.1 Results

This Bachelor Thesis contains three research questions which are answered in the following:

1. How does outsourcing of the production of a single module by a manufacturing company affect its planning environment in theory?

In Chapter 4.5 it has been shown that only one out of eight variables is changing towards the make-to-stock environment. The other seven variables do not change. Therefore the ratio of one out of eight concludes that the planning environment of a manufacturing company is not changing due to the outsourcing of a single module in theory.

2. How does the changing planning environment impact the existing planning method of the company in theory?

In Chapter 4.5 it has also been shown that if the planning environment is not changing the optimal planning method in an ATO environment, MRP, does not have to be adjusted.

3. How did the outsourcing of the production of a single module by ITT-Flygt affect its planning environment and method and what are the differences to the developed theory?

Chapter 6.3.3 shows that the given information from ITT-Flygt goes hand in hand with the results of the developed theory. Both Mr. Fagerström and Figure 17 show that there was no effect on Lindås’ respectively on ITT-Flygt’s planning environment and method. Chapter 4.5 concludes the same results for the theoretical analysis. Consequently there are no differences between the empirical data and the developed theory.
7.2 Generalisation

Like mentioned in chapter 2.2, the aim of this paper is to find specific and concrete suggestions for one kind of outsourcing, the one of a single module. Consequently, the results of this thesis can only be generalised for this outsourcing process. Furthermore, the research in this thesis is restricted to one Model company, which is defined by several assumptions. For instance, the end-products are high complex and the manufacturing is done in a cellular shop floor layout. Regarding only these limitations, the possibility to generalise still exists, since the outsourcing process is a quite common one and also many companies exist fitting the model company. However, to be able to use the framework of Mattsson/Jonsson, the outsourcing process had to be restricted to a higher degree, especially in respect to the vendor. With these further limitations a generalisation is hardly possible. Additionally, the empirical data consists only of one company which is not sufficient for generalisation.

7.3 Reflection and Criticism

In retrospect, the decision to choose the outsourcing of a single module in combination with a high complex end product for this thesis was reasonable, although there were only a few smaller changes in the planning environment variables. This is due to the reason, that the combination of the framework of Jonsson/Mattsson with outsourcing is an approach which has not been done before. Furthermore, the researched kind of outsourcing is a common one and from this it follows that it is of high interest for many companies.

To do an oral interview with a representative of the company was also a good decision. It would have been quite difficult to get all the required information only by questionnaires, since an outsourcing process might be slightly different for each company. Additionally, this way it was possible to run the conversation, for instance by digging deeper when the interviewee came up with interesting details or by focusing on aspects that turned out to be crucial during the conversation.

7.4 Suggestion for further Research
After finishing this Bachelor Thesis there are several points that can be taken into consideration for further investigations on this topic:

- The choice of a different outsourcing process (e.g. outsourcing of the production of more modules, outsourcing of end-assembling) might lead to more changes in the framework due to outsourcing. Furthermore, the assumptions for the company might be changed.

- An empiric research with more than one company is crucial to support the theoretical changes of the variables. Therefore, a survey with a bigger sample might be a point for further investigation.

- Regarding the results of this thesis, it was concluded that the use of only seven environmental variables is not sufficient for examining the impact of outsourcing on the planning method. The adjustment of the framework by Jonsson/Mattsson by the variable "inventory level" was done to overcome this drawback. Questions for further research can be whether this adjustment is applicable for other outsourcing cases and whether there might be other variables that can be taken into account as well.
References

Books


Brown, D., Wilson, S., 2005, *The black book of outsourcing. How to manage the changes, challenges, and opportunities*


References

Articles


Dibbern, J., Heinzl, A., 2000, Outsourcing der Informationsverarbeitung im Mittelstand: Test eines multitheoretischen Kausalmodells, pp. 4-10.


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Internet


Appendix

Questionnaire

Following questionnaire has to be seen just as a kind of guideline for discussion. The received information will be used only for our Bachelor Thesis "The impact of outsourcing on the planning environment and method of a company". To show this impact we are going to analyse how the planning environment and method was changed due to outsourcing.

Therefore we ask you some questions about the outsourcing process and your planning method and environment. Consequently your participation is very useful and a very important part of our thesis. We appreciate your help to a great extent and we will of course share with you the result of our thesis!

Kind Regards,

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Master Programme in Logistics, School of Managements and Economics
I) General Questions

1. Interview partner:
   a) Name
   b) Position
   c) Responsibilities

2. What is the core business of your company?

3. How many employees does the company have?

4. What are your end-products? Do they differ for different markets?

II) Outsourcing Process

General questions

1. What kind of the production process did you outsource? To which extent?

2. Who is the vendor and where is it located?

3. Which were the reasons for choosing this vendor?

4. How would you describe the relationship with you vendor regarding:
   a) Responsibilities
   b) IT-Connection and System
   c) Etc.

5. When did the outsourcing process start and end?

6. What were your motivations/main reasons for outsourcing?
All remaining questions have to be seen on the focus of how it was **BEFORE** and how it is **AFTER** outsourcing. Could you recognize some changes?

1. How was/is the production process looking like for the Asian market?

2. How and where did/do you handle the order-entry?  
   (E.g. salesman in Asia, Sweden)?

3. How was/is the transportation done to the Asian market?  
   (e.g. transportation mode, transportation time, transportation frequency,  
   transportation volume)

4. Where were/are the inventories?

5. What was/is the material planning method?  
   (e.g. reorder point system, material requirement planning, Kanban, etc)

6. In which type of planning environment were/are you?  
   (e.g. engineer to order, project / job processing, assemble to order, made to order,  
   line processing, batch production, continuous mass production, continuous  
   processing)

**Product related questions**

1. How complex is the Bill of Material (BOM)?  
   a) 1-2 levels in the BOM and few included items  
   b) 1-2 levels in the BOM and several included items  
   c) 3-5 levels in the BOM  
   d) More than 5 levels in the BOM

2. Do optional product variants exist? How many?

3. To which extent is the end-product finished prior to receipt of customer order?  
   a) Make-to-stock and delivery from stock  
   b) Assembly-to-order or plan  
   c) Manufacturing-to-order  
   d) Engineer-to-order

4. To which extent are customer specific items (e.g. accessories) added to the delivered  
   product?

5. How exact is the product data accuracy in the BOM and routing file?

6. To which extent is detailed process planning carried out before manufacture of  
   products (= Level of process planning)?
Manufacturing process related questions

1. How would you describe the production process
   a) Continuous process production
   b) Continuous mass production
   c) Frequent batch production (more frequent than monthly)
   d) Batch production (less frequent than monthly)
   e) Infrequent batch production

2. How would you identify the shop floor layout?
   a) Functional / process layout
   b) Cellular / flow layout
   c) Continuous line layout

3. How would you characterize the batch size?
   a) Equivalent to customer order quantities
   b) Small equivalent to one week of demand
   c) Medium, equivalent to a few weeks of demand
   d) Large, equivalent to a months demand or more

4. How would you characterize the throughput time in manufacturing?
   a) Short throughput times, a week or less
   b) Medium throughput times, a few weeks
   c) Long throughput times, several weeks

5. What is the number of operations in a typical routing? (=manufacturing steps like single processes e.g. drill, bond, etc.)

6. To which extent are set-up times dependent on manufacturing sequence in work centers?

   Or to put it different:
   Is it quite common that you have to change manufacturing tools for two consecutive orders, or rather not?

Market related questions

1. Which lead time is higher?
   a) Accumulated product lead time
   b) Accumulated delivery lead time to the end-customer

2. What are the annual manufactured volume and the number of times per year these types of products are manufactured?
   a) Few large customer orders per year
   b) Several customer orders with large quantities per year
   c) Large number of customer orders with medium quantities per year
   d) Frequent call-offs based on delivery schedules

3. How do you order your required materials/components?
   a) Order by order procurement
b) Order by blanket releases from a delivery agreement

4. How would you characterize your demand for your products?
   a) Independent (demand is only customer driven)
   b) Depended (e.g. demand results from a BOM)

5. What kind of demand type has your company to deal with?
   a) Demand from forecasts
   b) Calculated requirements
   c) Customer orders

6. Is the demand just an annual figure or rather time distributed?

7. What is the source of demand?
   a) Stock replenishment
   b) Customer order

8. How exact is the accuracy of stock on hand data?

THANK YOU FOR YOUR PARTICIPATION !!!