Investigation of managerial capabilities and challenges of a core plant role

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Abstract

The competitiveness within the global market has forced large manufacturing companies to reorganize their global operations. To act proficiently abroad is therefore no longer a choice but an important prerequisite.

In global production networks, there are different plant roles that serve different purposes. One of the important roles within these networks is the core plant role. There are limited amount of the researches done regarding the core plant role. There is also a lack of consistency regarding the definition of the core plant role. It is also evident that there is a knowledge gap regarding the managerial aspects of this plant role both in the academia and in the industry.

Managing a core plant requires certain capabilities. It is important to target this knowledge gap since global manufacturing is becoming a common norm for large enterprises and the importance of the core plant role is getting more evident.

There is also a lack of understanding towards the challenges that a core plant must deal with both within the organization and globally towards the other plants within the manufacturing network.

To address this knowledge gap further, two research questions were created “What key capabilities are required in order to manage the core plant role?” (RQ1) and “What are the main challenges in managing the core plant role?” (RQ2).

Case study was chosen as the research method for this study since it is the most appropriate method when investigating a phenomenon in its own context. Interviews were the main research technique used to collect data. 18 semi-structured interviews were conducted in eight different cases. A literature review was conducted and was the foundation for the interview guide used in the interviews and for the data analysis.

The results show that various capabilities are important for the management of the core plant role. Proximity to R&D and knowledge were the most emphasized factors. For the main challenges in terms of managing a core plant, the communication, cooperation and coordination where the most challenging aspects. Based upon finding, two frameworks have been proposed a concluding generalization and contribution of this research study.

The study provides a generalization based upon data that has been collected from companies from different industries. These findings are a contribution towards both the large enterprises operating globally and the academia.

Key words
Global manufacturing, production network, core plant, core plant role, case study.
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1 Introduction

This chapter presents the background and the problem description of this study. Furthermore, it breaks down the aim and the research questions that are required to answer and fulfill the purpose of the study. In conclusion, the delimitations are presented to show what is excluded.

1.1 Background

In order to stay competitive in the global market, manufacturing companies have to design and manage their manufacturing plants in accordance to the business priorities of the company (Feldmann et. al., 2011). International manufacturing companies are forced to adapt their structure and organization of the company in order to respond towards ever-increasing demands of its global customers (Barlett and Ghoshal, 1989; Rudberg and Olhager 2003). To act globally is therefore often no longer a choice but a prerequisite and the plants are often parts of large manufacturing networks in order to successfully reach the operational goals.

In the global manufacturing network, the plants have different roles. These roles started became assessed in the 1960s with Skinner (1964) being one of the pioneers. Vorkurka and David (2004) made a framework and classified three different types of plants; standardizers, customizers and automaters. This categorization was based upon technical data such as plant size, volume, layout, process etc. However, it lacked the strategic parameters for the plants such as managerial capabilities e.g. a certain type of leadership (Feldmann et. al., 2011). Ferdows (1997) therefore made another categorization including six strategic roles a plant could be assigned based on two parameters to determine their significance; “site competence” and “strategic reason for location”. Among these six plant roles, core plant (or lead plant) is the ultimate role, being the global hub for process and product knowledge.

The core plant role is an important notion however yet not easily defined. Fusco & Spring (2003) tested Ferdows (1997) model and found in their research that roles changes over time. Vereecke and van Dierdonck (2002) also tested the same model by collecting data from 50 different plants and came to the conclusion that the perception of headquarters or the top management about a plants strategic role could vary a lot. Moreover, achieving a well operating core plant will not only benefit the companies financially but also help creating a robust production network since the core plant is essential for creation of new processes, products, technologies for the entire company (Ferdows 1997). The core plant role is thus challenging since establishes a center in production network and effects other plants by its activities.

1.2 Problem description

The core plant role disengages responsibilities such as being a knowledge hub and being a focal point of the network. Still, it is not clear what the particular core plant role implies in detail. Managing a core plant requires certain capabilities. It is important to target this knowledge gap since global manufacturing is becoming a common norm for large enterprises and the importance the core plant role is becoming ever more evident.

There is also a lack of understanding towards the challenges that a core plant must deal with both within the organization and globally towards the other plants within the manufacturing network. Ferdows (1997) discuss briefly about the competition
between the plants in the production networks for obtaining the core plant role. This sparks up a discussion around how the current core plant deals with this situation and if it becomes a challenge for the core plant to deal with this internal pressure.

Hayes et al. (2005) discusses networking as one of the key capability. Flaherty (1996) argues that transfer and diffusion of production technologies and knowledge between the plants are crucial capabilities. Thomas et al. (2015) discusses about capabilities from a network and site perspective in their conceptual framework, and one of their conclusions where that plant capabilities needs to be aligned with the manufacturing strategy.

This study is derived from the desire of several large Swedish companies in order to better manage their core plant role. There is a lack of common understanding regarding what basic capabilities and preconditions that are required from the core plant role. A reference point explaining the most common prerequisites will not only benefit the companies with existing or new core plants but it would also provide a solid foundation for future.

In summary, although various researches have been conducted upon the concept of plant roles (Ferdow, 1997; Vokurka and Davis, 2004; Gupta and Govindarajan 1991; Vereecke and van Dierdock 2002), a knowledge gap and deep analysis upon the particular role of core plant exists. Furthermore, a clear picture upon how to maintain the role and the prerequisites that are required to achieve operational excellence is lacking.

1.3 Purpose and research questions

The purpose of this thesis is to provide support for managing the core plant role by clarifying its content, required capabilities and challenges.

In order to be assigned the core plant role some preconditions and capabilities have to be aligned for the plant. Therefore, it is important to contextualize and further examine the fundamentals that are obligatory for the plant to get the role.

**RQ1**: What key capabilities are required in order to manage the core plant role?

Managing a plant with a core plant role is a demanding task. There are various areas and aspects that require concern in order to achieve successful management. The subsequent research question addresses this issue as following:

**RQ2**: What are the main challenges in managing the core plant role?

1.4 Delimitations

In this study the core plant role is regarded from a production perspective. Aspects such as purchasing, supply chain and product development are considered to certain extent but then from a production perspective. Also no one from the headquarters or top management level in the investigated case companies partook in the interviews which mean that the top management and headquarter perspective is unobserved.
1.5 Disposition

In chapter 1, the introduction for this research is presented. The motivation behind the particular phenomenon of core plant is broken down into a problem description. Furthermore, the research questions are presented along with the delimitations.

All the theories are presented in chapter 2. This chapter helps to create the context in which this research is related to and acts as a foundation for the result analysis chapter.

Chapter 3 presents the methodology and the research approach that were used in order to solve the aim and research questions. Data collecting techniques and sources are presented along with how the data analysis was conducted.

The investigated cases are presented in chapter 4. Each case starts with a general description, its production network and finally how its core plant role operates.

In chapter 5, the empirical findings are analyzed together with the theories and the results are presented in order to answer the research questions. Two tables are presented, listing various factors regarding capabilities and challenges.

Subsequently, findings and method are discussed in the chapter 6. The two research questions are discussed separately. For each research question, a framework is proposed based upon the findings as a contribution. Suggestions for future studies are also mentioned towards the ends of chapter 6.

The final chapter, chapter 7, concludes the whole research. The whole research is summarized, outline and the key conclusions are summarized.
Theoretical background

2 Theoretical background

In this chapter the key concepts and definitions around this thesis are presented in order to give the reader more insight and context around the core plant role. The chapter starts with a generic discussion about global manufacturing and production networks and gradually goes deeper into the core plant role.

2.1 Global manufacturing

The requirement of efficiency and growing competition is forcing global companies to review and reorganize the roles of their plants in the manufacturing network (Yip, 1989; Bartlett & Ghoshal 1989; Ferdow 1997a). These issues are more complex and critical for companies, which have shifted manufacturing of components or whole products abroad away from company's headquarters. In the last three decades' researchers have identified many reasons and advantages of shifting manufacturing to plants in other countries (Ferdows 1997a). The figure below shows the main drivers for MNC to spread their production abroad.

Figure 1 The main drivers behind the global spread of production Ferdows' (1997a).

Geographical distribution of operations and activities of a global company pose many types of challenges and require many organizational changes. The company do not only require a new and efficient supply chain and logistics system for flow of material and components for cost effective manufacturing, it also requires a new management in order for the organization to make virtuous decisions and receive proper feedback information (Gailbraith, 1990; Flaherty, 1996; Ferdows 2006). For continuous evaluation and improvement, clear roles and responsibilities of various plants must
be predetermined be the top management in order avoid challenges (Ferdows, 1997b).

Initially in the late sixties, different global companies went through the transformation through different steps. Researchers have learnt a lot by studying the case studies of these companies and have proposed models to study and organize roles of various plants in an international company with its manufacturing and markets spread globally (Skinner, 1964).

As the competition for the manufacturing companies is intensifying along with the globalization, the complexity to operate and manage a production network has increased (Bartlett & Ghoshal 1989; Ferdows 1997a). Competitiveness does not only lie upon managerial aspects of single plant, but also upon implementing and managing an integrative strategy on the network of plants (Ferdows, 1997a). Hayes & Schmenner (1978) discusses that from a logistical perspective, supply chain optimization is required to be managed. From an organizational perspective, generation and transfer of knowledge need managerial attention. Ferdow (1997b) advocates the knowledge aspect as well and claims that more knowledge in a plant leads to a higher strategical role in the production network.

Researchers have tried to identify drivers or capabilities for allocating manufacturing facilities in specific sites and location (Ferdow, 1997b; Meijboom & Vos, 1997; Verecke & Dierdonk, 2002; Chen et al., 2013; Golini et al, 2014). Following are some of the drivers and capabilities that the above-mentioned researchers have identified as contributable for a company's success:

- Lower manufacturing cost
- Low-cost energy, proximity to market
- Access to peculiar skills and knowledge
- Possibility for business expansion and
- Sustainability

### 2.2 Strategic Plant roles

It is well known that plants in different countries have different functions, resources and responsibilities. Ferdows (1997b) classifies plants into six different categories. These are classified according to their strategic reasons along with the plants competence (Ferdows 1997b).

An Offshore Factory is set-up in a country to take advantage of its features, such as low wages, low taxes and cheap raw material, for lowering production cost. Such a factory has very limited responsibilities and powers. It depends on other units or headquarters of the company for instructions, plans, procurement decisions and technology.

A Source Factory is also set-up to avail of advantages of low cost production but its manager has more powers and responsibility regarding procurement, production planning and process changes for product customization.

A Server Factory is a complete production plant, but with limited responsibilities and powers like offshore factory, to serve a country or a region. Main goal is to take advantage of factors for low production cost and tax regulations. A server factory has
Theoretical background

powers to handle product and process changes to cater to regions market requirements.

A Contributor Factory, has roles of a source factory and server factory combined in one. It also has engineering and production capability to try new process technologies. It also has partial power to decide its own local suppliers.

An Outpost Factory is set up for the purpose of getting a foothold for the company in an important area, initially to get information about the market, competitors, raw material suppliers, skills and other knowledge.

A Lead Factory is according to Ferdows (1997b) the headquarters of the company where new products, new processes and new technology are developed. This factory has the highest managerial powers and responsibilities. This plant controls and process feedback from other type of plants of the company.

In practice, a plant may incorporate more than one role. Over a period of time, the roles of a plant may also change depending on its performance and ambitions and the expansion goals of the company. The six types of plants could be placed at three different levels. The plants at a lower level have ambitions and possibilities to climb to the next higher level (Ferdows 1997b).

Figure 2 Model defining various plant roles and their path to higher strategic roles (Ferdows, 1997a).

There are ambiguities regarding required. Plant competencies (see y-axis, figure 2) for the different plant roles as well as surrounding how the roles are related (Meijboom & Vos 2004). To clarify these ambiguities, the plant competences could instead include the following activities.
Theoretical background

- Creation of new processes and products for entire company (Lead)
- Complex product development (Lead)
- Complex process development (Lead)
- Recommendation on complex product & process development (Lead)
- Simple product development (Source) (Contributor)
- Simple process development (Source) (Contributor)
- Production planning (Source) (Contributor)
- Responsibility for purchasing and/or local distribution (Source) (Contributor)
- Recommendation on simple product & process development (Server)
- Production Scheduling (offshore)
- Production (Outpost)

This proposed redefinition of required plant competencies not only clarify existing roles of various plants, but also helps study dynamically changing role of plants in international production networks.

Ferdows' (1997a) model defining various plant roles and their path to higher strategic roles has been applied and verified by several scholars. Vereecke & Dierdonck (2002) examined the model on 50 different plants. Their results show that the model is valid for describing and assessing the plants in today’s production networks.

Fusco & Spring (2003) similarly tested Ferdows model in the Brazilian automotive industry. Their conclusions show that these companies in this kind of branch had a high concentration of “source” and “lead” roles for the plants with special logistical arrangements.

Bartlett and Ghoshal (1989) observe that multi-national companies realized through experience that it was not efficient to give symmetrical roles and responsibilities to different levels of plants. The roles, powers and responsibilities of offshore and outpost plants must be differentiated and communicated clearly from core plant for smooth and efficient running of the company. They classify the roles of plants in four types based on the strategic importance of local environment and level of local resources as shown in figure below.

Figure 3 Bartlett and Ghoshal's model of generic roles of national organizations
Theoretical background

- Plants that have low level of competence and low level of strategic importance in terms of market, is called implementer class of plant. Its main role is to maintain the commercial viability of the company by producing and delivering products. Offshore and outpost types of plants in Ferdows (1997b) fall in this category.

- Offshore plants with strong local resources and capabilities earn enhanced role, in spite of their low strategic and market importance. They are called contributor plants. The company may use these plants for testing new technologies and processes for broader use.

- A plant located in a strategically important market site which has also high level of resources and capabilities is called Strategic leader. Such a plant coordinate with company’s headquarters to plan and execute company’s global production, logistics and market strategy.

- A black hole plant is located in a strategically important site but has low level of resources and capabilities. Such a plant is generally set up to explore new markets as well as a way to learn about competitors and customers.

2.3 Manufacturing Capabilities

Strategic capabilities are a set of distinctive features of a plant which help the management to develop a strategy to succeed in a competitive market. In the manufacturing domain, these strategical capabilities are classified in four types (Größler & Grübner 2006):

1. Ability to produce at low cost
2. Ability to produce at high quality
3. Ability to provide reliable and fast delivery to customers
4. To have flexibility in manufacturing the changing mix and volume of products

Besides these four capabilities, other capabilities are also identified and are shown to be relevant for plant’s success in a competitive market. Strategical capabilities have similarity in notion to company’s resources and company’s priorities but these are distinct from it. Resources is defined as what a company possesses or has access to in terms of competences or special production machinery and infrastructure or environment. Capabilities of the company refer to what it is able to do by using these resources. Priorities are the strategic decisions the management makes regarding resources and capabilities for current and future success of the company.
Theoretical background

Figure 4 Correlation between capabilities and performances, resources and priorities.

The relationship between company’s capabilities, resources and priorities is described in figure 4 and consider the capabilities as driving force for company’s performance and success (Größler & Grübner 2006).

Three kinds of relationships are identified in literature regarding manufacturing capabilities. These are Trade-off, World Class Manufacturing (WCM) and accumulative.

According to trade-off relationship, one capability can only be improved at the cost of the other (Skinner 1974). For example, achieving lower cost of a product can only be achieved at the cost of lowering quality. The rationale behind believers of this relationship is that each improvement requires extra resources, which are limited and fixed. According to the WCM, in modern large manufacturing companies, it is possible to make simultaneous improvements in multiple capabilities (Boyer & Lewis, 2002). In practice, both trade-off and simultaneous relationships between capabilities are observed in most companies. Another phenomenon is observed regarding various strategic capabilities. According to this, improvement in one capability can amplify some other capability automatically (Schmenner & Swink, 1998). For example, improvement in quality can have a positive effect on delivery capability.

Größler and Grübner (2006) have tried to explore the relationship between four key capabilities, namely cost, quality, delivery and flexibility. Using empirical data from International Manufacturing Strategy Survey (IMSS-3) and using statistical analysis, they found that the following accumulating and trade-off relationship exist among capabilities. The data from 465 plants was used.

They found that:
- Improvement in quality capability has a direct positive impact on delivery, cost and flexibility capabilities
Theoretical background

- Improvement in delivery capability has a direct positive impact on cost as well as flexibility capabilities
- Improvement in flexibility capability has a direct negative effect on cost capabilities.

Größler (2007) observed that although capabilities, resources and strategy are dynamically changing, static analysis has been used in literature to study them. He proposes and applies dynamic analysis to manufacturing strategy. The performance of a company depends on how it utilizes its internal resources and capabilities to an external context of market and competition. There are two distinct views on what a company’s strategy is based on. It is market based view or resource/capability based view. In market oriented strategy, the company is analyzed from an external perspective. Its success depends on the market and competition. However, a pure market oriented strategy ignores strength/limitations of company’s resources and capabilities. On the other hand, a resource oriented strategy is only based on company’s resources and capabilities and ignores the market demands, competition and dynamics. In a real situation, company’s strategic resources/capabilities are being dynamically changed to improve their durability and their security regarding being copied. Some resources/capabilities are obsoleted or replaced over time.

Größler (2007) uses the data from a case study of Jackson Precision Casting from a text book and applies dynamic resource-based view of strategy to study performance of company in the realistic situations (Hill, 2000).

Größler (2007) concludes that there exist a lot to explore regarding company’s strategy based on dynamic nature of its resources/capabilities. It proposes that commercial software packages to model system dynamics should be used explore strategic space.

2.4 Headquarters’ Role and Influence

Multinational companies (MNCs) can have their production units, marketing units or both distributed over multiple countries. These features create new challenges in management of their distributed assets and resources and flow of information and knowledge among various units. For a MNC, flow of knowledge is important for affecting technological changes, managing expansion in new markets and starting new production units in low cost countries. The headquarter of the company, where the core management team is located, plays an important role in this area by coordinating inter-unit knowledge sharing and transfer (Ciabuuschi 2010).

Ciabuuschi (2010) have studied the role of headquarter (HQ), in improving the performance of knowledge transfer among units of an organization. Two performance parameters, namely efficiency and effectiveness, are considered in their study. Efficiency refers to the amount of resources and time used for achieving the required knowledge transfer. Effectiveness refers to the extent to which the transferred knowledge is absorbed and adapted by the receiving unit.

The influence of the headquarter can be exerted in three different modes (Ciabuuschi 2010). These are distribution of decision making rights, resource allocation and through direct intervention. The first two is indirect, whereas the third is direct influence. The first two influence factors are adapted from the study by Ghoshal and Barlett (Ghoshal 1988). The study by Ciabuuschi et. al (Ciabuuschi 2010) was carried on data collected through interviews from 141 innovation transfer projects of 14
MNC’s in several OECD countries, including Sweden. The results were collected and analyzed to study the positive or negative impact of three HQ influence mechanisms on two performance parameters. The results are summarized in the following figure showing relationship of three mechanisms and two performance parameters through six heuristics (H1, H2, H3, H4, H5 and H6).

The study showed that distribution of decision making rights by the headquarter had a positive impact on the efficiency as well as effectiveness of knowledge transfer (H2+, H1+). H1+ indicates that the distribution of decision making right has a positive impact on knowledge transfer effectiveness. But allocation of extra resources by the headquarter had a negative impact on knowledge transfer efficiency (H4-) but positive impact on transfer effectiveness (H3+). Similarly, HQ direct intervention had a negative influence on efficiency (H6-) but positive influence on knowledge transfer effectiveness.

![Diagram showing relationship between knowledge transfer and various management aspects](image)

**Figure 5** Relationship between knowledge transfer and various management aspects

One of the important responsibility of the HQ through its core plant is to keep track of the technological advancements in the area of their production and prepare their production units for upgradation with new technology. This is necessary for MNCs to maintain their competitive edge. Groennveld (1997) took this issue one step further by predicting and road-mapping the technological advancements and preparing their business and new product plans accordingly (Groennveld 1997). Road-mapping requires the simultaneous consideration of new product ideas, market and new technologies and interactions between these over time. Groennveld discusses the importance of road-mapping during the idea and concept of new product.

### 2.5 Knowledge Management in MNCs

Knowledge is considered to be one of the most important strategic resources for any company, especially a multinational company (MNC). Therefore, effective knowledge management (acquisition and creation of new knowledge, intra-transfer and application of knowledge among units and security of knowledge) is crucial for a company to achieve and maintain a competitive edge (Gold et.al. 2001).

Gold et.al. (2001) argue that three types of infrastructures, namely technical, structural and cultural infrastructures, are required for effective management of
knowledge resources. Technological infrastructure, for example software tools and databases, ties the whole company together by providing platform for communication. Structural infrastructure refers to norms and other mechanisms for security of knowledge as well as assigning responsibility for effective knowledge management tasks. Cultural infrastructure refers to platforms and opportunities for discussions and sharing ideas. This helps in promoting a common organizational vision among the units and subsidiaries in a company. Gold et.al. (2001) identify four capabilities in terms of processes for knowledge management. These are knowledge acquisition process, knowledge conversion into useful form process, application of knowledge process and protecting knowledge process.

Two primary ways for collecting new knowledge is to search and acquire entirely new knowledge, and creating new knowledge from existing knowledge through collaborations with partners. For making available knowledge usable, it must be converted to suitable forms for distribution and storage. Easy and efficient processes and tools must be provided to retrieve the available knowledge and apply it, handle various situations in production, supply-chain and decision making. Security oriented processes help protect company's knowledge from illegal access and theft (Gold et.al. 2001).

Gold et.al. (2001) have shown through theoretical arguments and survey of senior executives, that both knowledge management infrastructures and knowledge management processes lead to organizational achievements and effectiveness. The discussion and analysis in the paper highlights the fact that it is important to organize and manage knowledge in a large company using tools and processes for company's success. It is worth spending money for building and maintaining the required infrastructure.

In a large MNC, with geographically subsidiaries, knowledge management poses many challenges. One of the specific issues to handle, is the transfer of new knowledge, acquired by a subsidiary is transferred within the MNC. What type of organizational infrastructure and conditions are required to make the subsidiary knowledge transfer successful and efficient? This question is addressed by Foss and Pedersen (2002). They argue that intra-MNC knowledge transfer is affected by the amount of knowledge creation and knowledge absorption of its subsidiaries. It is also influenced by the sources of knowledge and organizational instruments in transfer of knowledge. They classify subsidiary knowledge into three types; internal, network and cluster knowledge. Knowledge generated through local R&D or learnt through practice is called internal knowledge. Knowledge acquired through inputs from external partners like, suppliers, customers etc., is called network knowledge. Knowledge created by a well-educated work force in collaboration with external research institutions, for example through a funded research project, is called cluster knowledge (Foss 2002). Foss and Pedersen (2002) conclude through their questionnaire based survey of over two thousand employees in subsidiaries of MNCs in seven European countries (including Sweden). They conclude that effectiveness of the knowledge transfer is strongly affected by the type of knowledge. Different organizational mechanisms are required for transfer of different type of knowledge. Their research show that it is easy to transfer internal knowledge as compared to network or cluster knowledge. Inter-dependence of subsidiaries also has positive impact on knowledge transfer.
2.6 3C Collaboration Model

The success of an organization or a project depends heavily on how its various parts or departments or units collaborate among themselves efficiently to achieve its goal. To understand the role and importance of intra-organization collaboration, many frameworks and models have been proposed. 3C collaboration model is one of the widely used models to study collaborative activities (Ellis et. al 1991).

3C model divides collaboration into three inter-related dimensions which are the following, communication, coordination and cooperation (Fuks 2006). Communication refers to the activity of exchanging messages and negotiations among people and units of organization. Coordination refers to the management of people, activities and resources. Cooperation refers to the joint work of various people in the work place when they carry out various tasks. The 3C model is generally represented using a triangle as shown below.

![Figure 6 The 3C Model](image)

In literature, 3C model has been used for classification of application and analysis of collaborative systems (Bretain et al, 1997). There are also attempts made to use a variation of 3C model for implementation of efficient software system (Laurillau, 2002).

Hugo Fuks (2006) demonstrate inter-relationship between the three Cs in different collaborative contexts by augmenting the triangle with directional arrows with annotations. In each context, one of the C is closer to the main purpose of the system. For example, in a common group work for a document writing, communication is the main activity with an aim to divide work and avoid wasting of effort due to any duplication. In this context, communication also helps in resolving conflicts (coordination) and redistribution of work (cooperation) if needed. In a context of adaptive manufacturing plant, the coordination component of 3C will dominate. It will trigger communication to re-allocate work and resources. Fuks et. al. (2006) also observed through analysis that within each C there are 3Cs. That means, for example, that communication activity in an organization itself requires elements of cooperation, coordination and communication.

In a manufacturing plant with distributed production, Coordination of production and coordination of resources will be the most important activities. Communication
Theoretical background

will also play very important role in helping the coordination and cooperation activities. Companies are using common computer tools as well as specialized tools to assist in communication, cooperation and coordination activities among members and units in a collaborative context. AulaNet is a web based specialized tool which helps in representation and analysis of collaboration system based on 3C model (Fuks 2006).

2.7 Core plant

The core plant plays an important role in efficient transfer of knowledge within the network of plants in which production is distributed. Efficient flow of information from the R&D department of the company to various manufacturing plants is crucial for effective utilization resources and capabilities in various plants and for maintaining the competitive edge in the market (Foss & Pedersen 2002).

The R&D department in a company plays the crucial role in improving manufacturing processes, exploring and incorporating new technologies, and improving existing products and developing new products. Thus, R&D department is continuously generating new knowledge which must be evaluated and steps must be worked out to incorporate this knowledge into improving the production in various manufacturing plants. There are two distinct ways in which this knowledge transfer has been attempted in various companies. In the first way, R&D department directly deals and transfer the relevant new knowledge and information to various plants in the company. With this method, each plant has the responsibility of incorporating this knowledge in its manufacturing plant. The second and more efficient way emphasizes that only the core plant interact with the R&D department and with that particular cooperation, creates new processes, products and technologies for all the manufacturing plants in the company. The core plant also has the role of transferring the new manufacturing knowledge to various plants. The core plant may also have its own manufacturing activities along with these roles (Deflorin et al. 2012).

The proximity with the R&D department makes it easier for the core plant to connect with the rest of the production network. Knowledge such as new products, new technologies or processes, which is usually developed in the R&D department, together with the core plant. The idea is that this information should be transferred throughout the production network (Enright and Subramanian, 2007). The core plant improves manufacturing methods for the whole network, by training personnel about new methods, which will push the production plants towards continuous improvements. This will eventually lead for a more stable manufacturing process throughout the network (Simon et al. 2008). If there are any change which has to be done in a production plant, they usually report this to the core plant. The core plant can either makes the changes with the R&D department, or make them themselves. The solutions get transferred to the whole production network or where the changes are needed. The core plant works as a knowledge creator for the network, and the other production plants are the recipients of the knowledge (Enright and Subramanian, 2007).
3 Method and implementation

This chapter starts first with describing the strategy of the research and the method that was used for this study. Thereafter the data collection techniques will be presented and lastly, the analyzing of the data will be presented.

3.1 Research Strategy

The choice of research strategy is equivalent to the choice of the path to answer the research questions (Saunders et al., 2012). The research strategies that are used in this study are case study and literature review. In the following subchapters, these methods are further explained and their role in the data collection process.

Case study

Yin (2003) describes case studies as the preferred strategy when questions like “How” or “why” are being scrutinized, when the investigator has little or no control over the events and finally when the phenomena in question has a real life background affecting the circumstances. The concept of the core plant has a rather open definition and has no definitive clarification. This is related to what Yin (2003) emphasis, regarding investigation of unexplored subjects. Therefore, to further investigate the key capabilities for a plant, which has been assigned a core plant role, requires scrutiny in its real-life context. Yin (2003) defines case study as an empirical inquiry since it investigates a contemporary phenomenon (core plant role) within real-life context (large companies with equally substantial production networks). Another significant characteristic with empirical inquiry is that the boundaries between the context and phenomenon are not clear (Yin, 2003). Case studies can also be explained as the most suitable choice in terms of understanding the interaction between a certain circumstance and the context of it (Dubios & Gadde, 2002). This can be related to the area of core plant, where the field is relatively unexplored. Hence, the importance to understand the concept of core plant and the content of the area is relatively high. Therefore, a case study is the best choice to understand and analyses the core plant concept.

According to Bryman and Bell (2011), the use of multiple strategies is favored within scientific articles since the data collection has a richer approach compared to a single research strategy. A single case study usually goes deeper in the study than it usually does in multiple case studies. Although, the difficulty with these studies is to generalize the results (Voss et al., 2002). The complexity and lack of knowledge of core plant excellence forces one to use a multiple case study. This is because of more data from different sources needs to be utilized for analyzing and for the result to be generalized.

Case selection

For this particular study, eight different cases within seven different companies were chosen for the collection of data. Each case constitutes of a core plant, which were the main target of the investigation. The cases were selected due to that all of the cases are appointed as core plant in their large manufacturing network. Eight cases were chosen as cases for the research, and are scattered around Sweden.

In total there were eight different cases at seven different companies. One of the company group had more than one core plant in their production network, therefore two different cases were carried out within one company.
Method and implementation

Table 1 An overview of all the cases and their industry

<table>
<thead>
<tr>
<th>Case</th>
<th>Type of industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case A</td>
<td>Automotive</td>
</tr>
<tr>
<td>Case B</td>
<td>Automotive</td>
</tr>
<tr>
<td>Case C</td>
<td>Automotive</td>
</tr>
<tr>
<td>Case D</td>
<td>Furniture</td>
</tr>
<tr>
<td>Case E</td>
<td>Pharmaceutical</td>
</tr>
<tr>
<td>Case F</td>
<td>Automotive</td>
</tr>
<tr>
<td>Case G</td>
<td>Automotive</td>
</tr>
<tr>
<td>Case H</td>
<td>Automotive</td>
</tr>
</tbody>
</table>

Data collection

For this study, the methods that were appropriate to choose were interviews and document studies.

Interviews

Interviews were the first priority and the main method to use, when collecting qualitative data. According to Williamson (2002), interviews is a technique to utilize when collecting qualitative data and it is also the method which is used mostly in case studies. When the researcher has limited or no knowledge, the technique of interviews is the most suitable to gather data. It becomes easier to manage a higher rate of response using interviews, due to interactions of personal contact is included. The aim is to understand the respondents' opinions and receive an extensive amount of their own thoughts (Williamson, 2002).

The interviews were carried out in eight different cases, with two different respondents in each case. Either the respondents were interviewed in groups or individually. The respondents were chosen based on their competence regarding core plant role. The interviews were semi-structured, which means the list of questions were the same, but it was open for follow-up questions depending on what the respondents' answers (Williamson, 2002). The interviews were carried out for approximately 60-90 minutes. The two interviewers had different responsibilities during the interviews. One of the interviewers had the oral responsibility of the interviews. This meant that he would carry out the actual conversation with the respondents. The other interviewer had the responsibility taking notes. This meant that he would write as much as possible of the respondents' answers, due to the reliability of the recording of the interviews. Also, if data is written down manually, there is more chance to remember where to find a desired data.
Method and implementation

Document studies

Documents, which was handed out during the interviews was used as complements for the interviews.

Literature review

The literature review includes to identify, analyze and sum up conceptual literature. These theoretical literatures may contain books, articles, research reports, conference papers and other similar material. The literature review offers the researcher a background for a study. It will be simplified for the researcher to understand the issues and the context of the research. One important aspect of the literature review is that it can provide the researcher to choose an appropriate research method for the study (Williamson, 2002).

Various search databases were used in order to find appropriate articles for this study. Scopus, primo (based upon Jönköping University library) and Google-Scholar were the most common used search engines to find books, journals and conference papers.

The material found on the search engines was sorted after its relevance and number of citations in relation to the year of publication. A substantial amount of publications was declined during the sorting process based upon keywords, titles and abstract.

The search process was iterative throughout the study and the search preferences were modified and specified parallel to the study’s progress. The outcome of the literature review was the foundation for the analysis chapter and in identifying the factors for both of the research questions.

Table 2 Overview of the conducted interviews

<table>
<thead>
<tr>
<th>Interview</th>
<th>Case</th>
<th>Type of interview (Single/Group, face-to-face/Skype)</th>
<th>Respondent (Function)</th>
<th>Duration (hours.minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Single, face-to-face</td>
<td>Head of project management</td>
<td>1.03</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>Single, face-to-face</td>
<td>Project manager at Global support department</td>
<td>1.36</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>Single, face-to-face</td>
<td>Head of manufacturing</td>
<td>1.27</td>
</tr>
<tr>
<td>4</td>
<td>B</td>
<td>Single, face-to-face</td>
<td>Operation director</td>
<td>1.00</td>
</tr>
<tr>
<td>5</td>
<td>C</td>
<td>Group, face-to-face</td>
<td>Research and concept development</td>
<td>2.13</td>
</tr>
<tr>
<td>6</td>
<td>D</td>
<td>Single, face-to-face</td>
<td>Supply chain manager</td>
<td>1.33</td>
</tr>
<tr>
<td>7</td>
<td>D</td>
<td>Single, face-to-face</td>
<td>Category manager</td>
<td>0.58</td>
</tr>
<tr>
<td>8</td>
<td>E</td>
<td>Group, face-to-face</td>
<td>Senior advisor &amp; Lean</td>
<td>1.49</td>
</tr>
</tbody>
</table>
### Method and implementation

<table>
<thead>
<tr>
<th>Number</th>
<th>Gender</th>
<th>Type of interview</th>
<th>Position in the company</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>F</td>
<td>Single, face-to-face</td>
<td>Business development strategy manager</td>
<td>0.56</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>Single, face-to-face</td>
<td>Senior company specialist in logistics</td>
<td>1.04</td>
</tr>
<tr>
<td>11</td>
<td>G</td>
<td>Group, face-to-face</td>
<td>Manufacturing technology managers</td>
<td>1.25</td>
</tr>
<tr>
<td>12</td>
<td>G</td>
<td>Group, face-to-face</td>
<td>Managers of knockdown global operations</td>
<td>1.24</td>
</tr>
<tr>
<td>13</td>
<td>G</td>
<td>Single, Skype</td>
<td>Director of final assembly technology</td>
<td>1.04</td>
</tr>
<tr>
<td>14</td>
<td>G</td>
<td>Single, Skype</td>
<td>Site manager</td>
<td>1.11</td>
</tr>
<tr>
<td>15</td>
<td>H</td>
<td>Single, face-to-face</td>
<td>Production manager</td>
<td>1.03</td>
</tr>
<tr>
<td>16</td>
<td>H</td>
<td>Single, Skype</td>
<td>Technical Manager</td>
<td>1.16</td>
</tr>
<tr>
<td>17</td>
<td>H</td>
<td>Single, Skype</td>
<td>Technology director</td>
<td>1.24</td>
</tr>
<tr>
<td>18</td>
<td>H</td>
<td>Single, Skype</td>
<td>Technology director</td>
<td>1.08</td>
</tr>
</tbody>
</table>

#### 3.2 Data analysing

The data has been analyzed in accordance to the five steps for analyzing qualitative data proposed by Yin (2009).

**Step 1: Compile Database**

Each interview resulted in 30-50 pages’ worth of transcribing material along with handwritten notes taken during the actual interview. Some case company’s provided documents and other material in order to show how their company operated globally and domestically. This material was organized in a proper manner both virtually on predefined hard disks and physically in suitable folders.

**Step 2 Disassemble data**

Yin (2009) recommends using a various software tools that provide sorting coding of the gathered qualitative data. In this study, MAXQDA was used in order to add and sort the transcribing material along with other material. The questions from the interview guide were used as a reference point for making the several code categories in which the data from the transcribing documents were transferred.
Method and implementation

**Step 3 Reassemble data**

The codes from the MAXQDA were reorganized and broken down into specific categories. This enabled to see how many and what the different cases said about a specific factor or category related to the research questions.

**Step 4 Interpret Data**

Once the data was properly organized, MAXQDA allowed the user to project the different codes next to each other, in the case the answers from the various cases next to each other enabled an opportunity to create a narrative with portraying patterns.

**Step 5 Conclude**

The final step was to conclude the findings using the results from the software and by combing the results from the literature review. It was important to ensure that the conclusions could be tracked back and were aligned with the analyzing from MAXQDA and the fact the narrative was appropriate and provided answers to the research questions.

3.3 Validity

Triangulation is a combination of using two or more different methods of data collection to strengthen the findings (Denzin, 1970). Although there are two different kinds of triangulation methods: method triangulation and source triangulation. Method triangulation means to use different kinds of data collection methods in order to check the consistency of the findings. Source triangulation is basically to double check the given information which is received from different people and also from different times (Williamson, 2002).

For this study, triangulation is necessary to be applied to get a high exactness and credibility. Due to conducting interviews in different places with different people at different times, the sources triangulation will be applied. To be able to achieve a high exactness and credibility, several interviews needed to be conducted. For this study, there will be eight different cases and in every case there will be two interviews performed. All of these interviews will be necessary due to obtain a study of high reliability when comparing the data and confirming the similarities throughout all of the collected information.

Saunders et. al. (2009) state that validity is concerned with how accurate the results and findings are with the research objectives. Validity can be divided into two different categories, internal and external validity (Yin, 1994).

Internal validity refers to the inevitability of the results. The fact the no other factors affect the outcome except the chosen independent variables by researcher (Williamson, 2002).

External validity pertains the generalizability of the findings. Basically meaning if the findings from the research can be applicable in other settings, context or treatments. The choice sample population has a noteworthy impact on the findings external validity (Williamson, 2002).

In this study, different companies were investigated for data gathering. This allowed the result to be generalizable compared to the single case study. In each case company, two representatives with deep knowledge about production networks and
plant management were going to be interviewed. This sort of triangulation (as mentioned in the previous subchapter) endorses internal validity of this report. Also having the theoretical framework from the literature review keeps the result relevant and on track with topic.

3.4 Reliability

Williamson (2002) describes reliability as consistency of results when it is applied more than once in a similar context and yet produces similar results. Most experiments are therefore conducted several times in order to ensure that the results are not a coincidence.

The reliability will be high since the same interview guide was going to be used in all of the case companies. However, all of the companies that were taking part in the study are from Sweden. This can affect the reliability in a negative manner if a similar industry outside Sweden. The questions in the interview guide are semi-structured, which means that answer from the respondent can vary depending on how they are proposed by the interviewer. This might affect the reliability as well.
4 Empirical findings

The chapter presents the different cases. The presentation of each case starts with a general information about the case company, afterwards about its production network and finally about their core plant role.

4.1 Case A

General information

Case study A is conducted within a leading company in the construction machinery industry. The products which they are producing includes tracked and wheeled operated excavators, wheel loaders, compactors and asphalt machines, dozers, and loaders. The company was founded back 1832 in Sweden. The headquarters is located in Belgium. The number of employees are approximately around 15 000 people, and their turnover is up to 53 billion SEK.

The company have manufacturing facilities in Sweden, Germany, France, Poland, India, South Korea, USA, Mexico, and Brazil. The examined case company is located in a heavily industrialized area, where they primarily develop wheel loaders and dump trucks and also manufacture the axels and drivelines for wheel loaders and dump trucks.

Core plant role

Case company A has been a core plant between ten and twelve years. One of the crucial reasons that made them a core plant was of the expertise that was established in the company. With that particular expertise, they have the responsibility to transfer this competence to the other factories in the production network. Another important aspect which plays a major role in the core plant, is that they have access to a department for designing new products (R&D). This allows them to find smart solutions which can later be transferred to the rest of the plants. Having a R&D function close to the plant distinguishes this plant from the other ones in the production network, whom in basically apply the know-how from the core plant through carryover projects.

The company believes that having knowledge and experience are two crucial factors for a core plants success. Both in terms of having a competent staff and having proper, structured working processes.

Nevertheless, there are some challenges that the studied case faces. There are a lot of responsibilities which is included in the core plant role, which the case company feels that they have. The company describes that the rest of the network feels that they need more volume in the production, where this responsibility relies on the core plant. They can also experience that the cultural aspects can be a barrier, such as the language, where information and transformation can be interpreted incorrectly or simple misunderstandings can occur. They feel that the skills can be slightly improved in these areas.

The headquarters in Brussel have a standard of how a core plant should be structured and how it should operate. The investigated core plant takes the responsibilities to build the concepts and strategies for the whole production network regarding different managerial aspects, e.g. production layout for a particular product or the ramp-up process. Although, these regulations are being carried out together with the
other plants globally. The factories in China and Brazil have the mandate to change the layout so it can be mutual adapted. When it comes to organizational changes, each plant has their own authorities to change for their own benefits. They are not dependent on the core plant.

Even though they have a mutual way (working cross-functionally) of working with the rest of the production network, the strategical roadmap of most of the projects starts in the core plant. They work continually to develop both internally and externally. They have meetings together with the rest of the network for improvements and developments, but they do not have any specific meetings regarding the core plant concept.

4.2 Case B

General information

Case B is part of a company which in turn is part of a large company group. They are divided into two main business division: aerospace and transportation. Case B belongs to the latter mentioned business division which specializes in the rail vehicle manufacturing. Case B is located in the eastern part of Sweden, and is responsible for production development. The plant specializes in manufacturing high voltage equipment such as power converters for medium power trains.

The company has around 2000 employees and has a revenue above 5.7 billion SEK. The production network consists of plants which are spread around the globe, with sites in USA, Spain, India, China and Brazil. The Spanish plant has the role of center of excellence and specializes in the production development of high power train. The plant in Sweden has the same role but for medium power train and together with the Spanish plant provide development solutions to the other plants in the manufacturing network, whose main purpose is to serve the domestic market.

Core plant role

Case B have only recently decided to adopt the core plant philosophy which they call center of excellence. Although the decision to operate globally in this way was officially taken in 2015 the discussion and evaluation had been going on for two years before the confirmation of taking the decision. The company call their core plant for Centre of Excellence and their goal is to be more efficient in their global operations. The previous way of working caused sub optimization between the other plants along with an internal competition within the network. This led ultimately to poor utilization of the resources and settings that was not cost efficient for the company.

Case B was assigned the core plant role in their network mainly because they have a large staff of officials including an R&D department and a procurement department. The plant has a long history of successful production followed by highly competent staffs that has great knowledge in development of medium power trains.

Another capability that was emphasized by the interviewees was the Swedish working mentality in term of working in cross-functional teams. This enables the Case Company B to solve complex problems and win valuable customer orders.

Since case B have only recently been assigned the core plant role, they are dealing with issues regarding authority and mandate. There is a stated vision from the top management upon the breakdown of authority and mandate related topics, however there needs to be more clarity on how this vision will be carried out in practice on the
Empirical findings

operational level. Some guidelines and structure is required in the current state in order to refine the efficiency in terms of management and production. Nevertheless, case B has not adopted this centralized authority prior to the received core plant role.

The plant does not have a dedicated budget for production development, however their future projects will require. In terms of communication with the rest of the network, case company B have forums where the different representatives from each plant can exchange information. The whole network shares the same CAD-software however the rest of the IT-systems are fragmentized which sometimes cause extra work. Not having this commonality, a barrier for efficient team work between the plants.

4.3 Case C

General information

Case C is conducted within a company, which is involved in the automobile industry. It was founded back in 1927, and have its headquarters in Sweden. Products that are being produced are mainly cars and car engines. In Sweden, there are two facilities. The facility in western Sweden are responsible for the manufacturing of cars, but this plant is not part of the core plant network. Also, there is a facility in the central part of Sweden, where the manufacturing of the engines is taking place. The total of employees of the case C company is up to 16 000 employees and the revenue is approximately around 104 billion SEK.

Case C does not only have manufacturing facilities in Sweden, but also in China as well. The particular facility that was examined was the headquarters. Both of the respondents have positions in the research and concept development for engine production.

Core plant role

The total number of production sites are two. Case C is relatively new in the core plant role, due to that their second production site was built in 2013, located in China. Since the Chinese plant is new, the production site in Sweden became the obvious choice of being the leading plant due to its knowhow and resources.

Even though the case company have the experience, history and the competence, they still do not count the actual plant as a core plant. The core plant in their network is not a physical plant, they see it as a virtual plant, where they designing products virtual, though IT-software. This virtual plant technology has progressively developed over the years and has the capability to simulate various production management scenarios and different outcome. So the aim is to first simulate the desired outcome with the virtual plant and find out which parameters are required and later on apply these on the Swedish plant or the Chinese plant. The virtual plant will also allow to create the possibility generate data to take better decisions. The regulation of the virtual plant is however at the moment done in Sweden. Their goal is to be geographically independent in the future but since the whole concept is new, it will be managed by the plant with most competence and knowhow.

They think that this concept will be used in the future and it is an image of the next-generation factory. This concept is a rather new model and it does not only have its advantages, but there are some requirements which is needed for the new concept,
such as the proper knowledge and skills. If they have the knowledge for this system, they will be able to build the right flexibility for cooperation between the productions. The virtual plant is controlled from Sweden, because the case company is originally Scandinavian. Even though, the global production site should be involved in the projects. Even prototypes should be able to be validated everywhere in the network. The production in China have the right to have the mandate to give some suggestions of change, as long as it does not interfere with the process of the product design. Both Sweden and Kina have the authority to make their own decisions, within their own organizations. They are not tied to the virtual plant under any circumstances.

4.4 Case D

General information

Case D belongs to a large multinational group that designs and sells furniture, appliances and home accessories. Case B is located in the southern part of Sweden, where product development and supply chain functions are operated. The visited site has above 1500 employees with a revenue above 4.6 billion SEK. This case company has large production network with manufacturing plants located all around the globe. They categorize their sites into internal and external supplier groups. Manufacturing sites belonging to the internal supplier group are strategically acquired sites in order to serve the market according to the supply chain and business strategy of the company. The examined case company works closely with the internal suppliers with providing resources and support in order to manufacture the products in appropriate volumes and quality.

Core plant role

Case Company D is the headquarter and is responsible for coordinating product development and supply chain functions along with other strategic planning related with the company group’s business strategies. The company divides their operations into categories depending on their product range. A sub organization that coordinates each product category is responsible for the various functions regarding the value chain.

Case D does not have a production network with their own plants however they own a very advanced supply chain network with suppliers who manufactures and distributes the goods according the strategic plan made from Case Company D. The geographical location of these suppliers has a huge significant for the case company. Highly advanced statistical tools are used in order to gather necessary data to find out where in a region a supplier should be located in order suit the logistical and distributional circumstances properly.

The company works very close with their suppliers and provides them support for their own business development while maintaining the desired quality they have on their products. They have for example their own Lean coordinators that they send out to various plants in order make the production more efficient and manufacture the goods with higher quality. Nevertheless, these supplier plants are fundamentally fully autonomous when it comes to their approach and methods of manufacturing. Case D has very little impact upon the suppliers’ production system and manufacturing strategies.

The case company do have a few suppliers within their network, whom has done well with their production development and shared their knowledge and innovative
Empirical findings

methods with their others in their supplier network, mostly with suppliers with limited recourses.

4.5 Case E

General information

Case E is part of a multinational group in the pharmaceutical and biotechnological industry. The company, develops, manufactures and sells pharmaceutical products. The examined plant is located in Sweden and is one of the largest manufacturing sites within the whole group. The case company has above 5300 employees and has revenue over 54 billion SEK.

The production network consists of 26 plants evenly spread out around the globe. The group has acquired many of them. Majority of plants only have the packaging function. The plant in Sweden is one of the largest pharmaceutical factories in the world and provides production development solutions for the rest of the network.

Core plant role

Case E has traditionally always been the main factory of their manufacturing network. 75% of the tablet sales of the whole group is manufactured in the plant Case E. However, two years ago, they officially became the launch plant for all the new products within their network. Which basically means that all new products are manufactured and tested in Sweden first and later assigned to the other plants.

Apart from being a plant with large facilities and having the convenience of great manufacturing technology, one of the main reasons that case E have the role of core plant is because of the fact that they are located in Sweden. Being part of this industry requires that the factories are located in areas where clean water and air is obtainable, the infrastructure is at the advocate level and the fact that the plant is not expose to any natural catastrophes.

The Swedish government has also shown interest in the company and offered help through providing financial support through tax adjustments for the plant. The most decisive reason for being a core plant was the proximity to the R&D, both geographically and operationally.

The products produced in pharmaceutical industry can be classified into three main stages. In the first stage, the key substance is developed and manufactured. These substances are then pharmaceutically formulated into different drugs and products in the second stage and finally in packed according to the rules and requirements of the product in the final stage.

All three of the above mentioned stages are conducted at case E. Majority of the plants in the network are focused on the packaging phase. Different rules and laws on the good along with packaging information are customized in these globally located packaging factories.

This gives Case Company E a big mandate on the value generation in the rest of network. Since their substance development and pharmaceutical formulation has a direct impact on the capacity utilization in the whole network.
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In order to be a core plant, a large amount of investments is put into R&D and development of processes, technology and production. Approximately 2 billion SEK are capitalized each year for the development of the plant.

4.6 Case F

General information

Case F is a company that are involved in the aeronautics industry. The company was founded in 2012, where two companies were merged. Their main products are aircraft engines and electronic components. The headquarters is located in western part of Sweden. The total amount of employees is estimated to 2500 and the turnover is approximately around six billion SEK.

Case E have two production sites in Sweden; the headquarters in western Sweden and another one located more in the eastern part of Sweden. There are also two other facilities that are located abroad; one in Norway and one in the US.

Core plant role

The case company is and has been a core plant since the company was acquired by another large company 2012. Before they got acquired, the case company was a core plant in the manufacturing network, and they continued to act as a core plant also within the new company. There are many aspects that makes the case company a core plant. The large production volume and the expertise, which is required to operate the core plant, compared to the rest of plants within network are two of the main reasons. The R&D department as well as the department of development is located in western Sweden. It means that they have the resources to the development of various processes, not only in the civilian production, but also in the military production as well.

According to the case company, the biggest advantages they have as core plant is that they are located close to the R&D department. They also had the main competence in quality, knowledge of economy, and administrative aspects. They believe that there is a benefit to be close to the management, but at the same time they consider it as a drawback, due to there are risks that they can be easily examined, by the top management, compared to the rest of the production network. There is also some competition in the network, especially from North America which has expanded lately, as they have “merged” several factories into one plant. The case company perceives that there are a lot of responsibilities undertaking the core plant role, and that they have special requirements and must always perform at its peak, which includes long-term strategies and plans.

According to the case company, they regard that they have a great influence on the other facilities, because of the size. Therefore, when the other facilities need to improve something, the core plant needs to assist them with the proper resources. The core plant has money which is set aside to improve processes and development, because their research and development department receives research funds.

The case company works in a way, where all of the business units have their idea of how they should perform their work. The idea is that everyone in the production network should not work exclusively in their respective niches, instead they should provide each other with ideas, which includes different ways to work. If the plants need assistant, the core plant should be able to send skilled personnel. Also, they
Empirical findings

have projects where directors around the network should meet and discuss and exchange ideas and proposals which will benefit the entire production network.
4.7 Case G

General information

Case G is a large automotive company which develops and manufactures trucks with specialization of heavy duty chassis production. The company belongs to a larger group which owns several brands. Case G is focusing on the production of chassis. This case company has a large production network with plants located in USA, Thailand, India, Japan, Brazil, Australia, Belgium, Russia and France. Different truck brands that are part of this company group are manufactured and assembled in different countries depending on the truck brand.

Core plant role

There are a total of 13 plants in the production network, but all of them are not linked to the same core plant. Eight of these plants are connected to the case company, which is located in Gothenburg. The idea to establish a core plant was discussed already in 2006, however formally they have been a core plant for about one and a half year. Two of the main reasons why they were chosen as the pilot plant was because that the R&D is nearby the core plant and also that they possess the primary competence to operate compared to the rest of the plants in the network. They serve as an introduction plant, where they work with the earlier phases in the production development. The core plant is responsible for testing and verification of the products before they are getting launched on the market. The development of the tools used in the production network is also a core plant responsibility. The idea they have is to develop the platform which should be utilized later in the production. Their solution will facilitate for the other production plants in the network.

According to the case company, there are several capabilities which are significant for a core plant. They believe that the large size of their plant is one of the reasons why they became a core plant. Because of their size, they have access to a development center and are capable of global development. They believe that the right resources are the key to succeed as a pilot plant such as personnel with the proper expertise and experience, which is required to operate the plant. The key personnel should be able to be spread out in the manufacturing network to support the other plants. They want to give everyone in the production network the same conditions and opportunities and prioritizing their own interests. This system can also be a little challenging for the role as pilot plant. They need to have trade-offs and find solutions which benefits the whole network. They want to have a working method which is more of a long term way of work. To have a balance of daily activities, daily production related issues, and future projects could be very challenging. They must constantly evolve, not only for themselves, but for the entire network.

As a core plant, they believe that the role involves a lot of responsibilities but at the same time not so much of control of the other plants. For example, if the pilot plant proposes changes but the other plants in the network do not agree, the management in each plant can reject the proposal. They have the freedom to make their own decisions regarding changes in the organization. According to the pilot plant, they rather see themselves as a support then a leading factory. Therefore, the other plants have to be involved early in the process of change management for the network.
Empirical findings

4.8 Case H

General information

Case H belongs to the same company group as case G. The difference is that case H is focusing on the production of powertrain (engines and gearboxes).

Core plant role

Case H includes two different physical plants which manufactures within the same product category and belong to the same production network. Informally these plants have the role as core plant for long time but it was only a couple of years ago when the company group decided to reorganize and change approach when the plants received the official role.

Both plants have a long tradition of manufacturing along with highly skilled and competent staff. Some of these have the responsibility to support the other plants in the manufacturing network with problem solving and implementation of new solutions. They also have the scale of economy on their side with large volume production that takes place parallel with production and process development.

These two plants produces both the volumes that are necessary to match the market demand and also tests new solutions, in their pilot plant. Both of these plants have a large manufacturing tradition and a rich historical background with various ownerships. The plants have close relationship to the centralized R&D department and have highly innovative stab of professionals.

The pilot plant is responsible for generating process and production development solutions for the upcoming and current products and provide the rest of the network with these solutions. It is important however to emphasize that these are only suggested solutions and do not have to dictate how future production should be coordinated. All the plants within the network have their autonomy but can use the pilot plants as a supporting function to improve their production.

These pilot plants have their own test facilities and a budget for testing new technologies and experimenting on new ways of developing production related solutions. They follow a technology road map made by top management that have guidelines regarding budget and lead time based upon the various projects.
5 Analysis

The two research questions of the thesis are further scrutinized and analyzed in this chapter. The analysis in each of the questions is based upon two tables and very individual factor is analyzed separately.

5.1 What prerequisites and key capabilities are required in order to manage the core plant role?

Based on the interviews and documents from the case companies, the different capabilities and prerequisites that are important for each case company, have been identified and summarized in table 3. The capabilities and prerequisites that are listed in the first column on table 3 are based upon the literature review as well as on the empirical findings.

Table 3 Relationship between the identified capabilities and the cases

<table>
<thead>
<tr>
<th>Capability</th>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
<th>Case D</th>
<th>Case E</th>
<th>Case F</th>
<th>Case G</th>
<th>Case H</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
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<td>x</td>
<td>x</td>
<td>x</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>Nickerson (2000), Poncini (2002)</td>
</tr>
<tr>
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<td>x</td>
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<td></td>
<td>Hofstede (1997)</td>
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<tr>
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<td>Gold et al. (2001)</td>
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<tr>
<td>Flexibility</td>
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<td>x</td>
<td></td>
<td>Ferdows (2006), Grant (1991)</td>
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<tr>
<td>Competition</td>
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<td>x</td>
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<td>x</td>
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<td>x</td>
<td>x</td>
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<tr>
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<td>(Groenveld, 1997)</td>
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<td></td>
<td>(Roth and Jackson, 1995), (Koufteros et al., 2002), (Ferdows, 1989)</td>
</tr>
<tr>
<td>Proximity to R&amp;D</td>
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<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Nelson (1982)</td>
</tr>
<tr>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Ferdow’s (1997b), Argote and Ingram, 2000), Argote and Ren (2010)</td>
</tr>
<tr>
<td>Experience</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<td>(Penrose, 1959), (Eisenhardt and Martin, 2000)</td>
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<tr>
<td>Tradition</td>
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<td>(Penrose, 1959), (Eisenhardt and Martin, 2000)</td>
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<tr>
<td>Headquarters influence</td>
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<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Analysis

| Scale of economy | X | X | X | X | (Chandler, 1991)  (Bartlett&Ghoshal, 1988) |
| Test and prototyping facilities | X | X | X | X | (Leonard-Barton, 1995) |
| Ability for self-development | X | X | X | X | (Argote, 1999) |

**Proximity to the R&D**

Closeness to an R&D function is essential for a core plant to be manageable. Having an R&D department close to a plant enables the personnel at the core plant to understand and improve process and production development solutions in a much easier manner thanks to the close communication with the people who are designing the products. The senior adviser from Case E highlighted this as well by saying: “To have a R&D close you are very important”. It is also worth mentioning that Case E was located in a different city compared to where their R&D is located. Therefore, it is not only from a geographical point of view it is important but equally from a cooperative perspective. The same could be said about Case H, where the plants are located in two cities in central Sweden yet the R&D is located in western Sweden. In these plants, various representatives from the R&D work close with plants both virtually and physically. Many of the companies embraces the concept of “design for manufacturing” where the product development is based upon the production circumstances and for that reason having an R&D department is important.

Nelson (1982) relates to this by stating that R&D capabilities are related to strength and knowledge. In his research he discusses about private and public technological knowledge that is generated in R&D:s. Private knowledge being internal solutions, methods, processes or blueprints that are restricted with the plant or network. Public knowledge is about information that is available for everyone.

**Experience and tradition**

All the plants studied emphasized the importance of having deep knowledge or competence regarding their production. This had a lot to do with the fact that many plants prior of being assigned the core plant role had been manufacturing the similar products for a long period of time, e.g. Case Company C who had been producing engine related products since 1930’s. The global support manager from Case A said “if one wants to become a core plant then one should have the genuine base knowledge along with experience otherwise it will be very difficult to succeed”.

Prior experience and accumulated knowledge, skills have been important for companies to enter new markets (Penrose, 1959). Dynamic and flexible capabilities e.g. organizational and strategic routines along with resource allocation are developed over time from repetition and (Eisenhardt and Martin, 2000).
Analysis

Knowledge

Having a strong knowledge base, in particular for global operations, allowed newly added plants (both plants that are newly acquired and plants that are built from scratch) to acclimatize into the network. It also benefitted the plants status and political position from top management perspective since they hold an extra and unique value compared to the other plants. This could be related to Ferdow's (1997b) model where he shows the correlation between the site competence and the statuses of the various plant roles, where the “lead plant” role requires the highest amount of site competence. All cases agreed upon that having a strong knowledge base is fundamental for them in both in terms of being core plants and in terms of serving the network.

In terms of knowledge transfer between the plants, one unit is affected by the experience and base knowledge of another (Argote and Ingram, 2000). Argote and Ren (2010) argues that knowledge provides micro foundation for organisations to have dynamic capabilities.

Scale of economy

Another important conclusion that can be drawn is to have an appropriate size of the plant. The economic scale was mentioned throughout some of the interviews and the respondents’ emphasized that having a large volume production is important for their core plants. Größler and Grübner (2006) discusses about this topic. Their capability model show that resources and manufacturing performance has an impact on the organization itself. The larger the outputs the lower will the costs sink in the other activities which is the case in a core plant.

Testing and prototyping facilities

To have the ability to experiment and test new concepts, process and technologies is an important capability for many plants. It is also the capability that distinguishes the plant from having regular plant role from having the core plant role. Different cases had different kind of facilities that have different purposes.

Case G and Case H (who belong to the same company group) are the so-called pilot plants and their responsibility is to generate new methods, processes and other kinds of solutions for the rest of the network. The goal however is not to implement these solutions but to provide it as an option for the other plants.

Case E is the launching site for the network. All new products are primarily produced at the plant (with some exceptions). This adds to the responsibility towards the plant to create and spread the production knowledge. Case E possesses a plant with great infrastructure and advanced technological facilities.

Case B also has facilities where they work on creating standardize work instructions for the rest of the network. Even though their production is very tailored towards the customer demand, they try to improve the standardize processes which are used in most of their products.

Prototyping generates new kinds of organizational capabilities such as variety in products, processes, as well as good cycle of improvement (Leonard-Barton, 1995). Leonard-Barton (1995) also asserts that prototyping protects against inflexibilities or rigidities by introducing new channels of information, new sources of knowledge or new ways methods for solving problems.
Analysis

**Headquarters influence**

The influence of the headquarters towards the rest of the production network is another important aspect, which could be identified. Two cases underlined the power of their plants, and crucial decisions they can make towards the other plants. The manager of research and concept development in case F stresses out the ability to transfer personnel with the right competence through the various pants. The director of manufacturing and engineering component in case H said: “*Most of the specialists are located in the core plan, and gets transferred to the plants which are in need of assistance*.”. Furthermore, he revealed: “*If the core plant has developed a new concept, and another plant refuses and wants to create their own, then we have the right to refuse their proposals*”.

Many cases stressed that their guidelines and their authority is determined by the headquarters or top management (it varies depending on the organizational structure).

Headquarters and top management has large and important influence on the plant and the network it belongs to. A HQ has an important role promoting, coordinating and sustaining knowledge transfer (Chandler 1991). Barlett & Ghoshal’s (1988) conclude, based upon a number of case studies on different Multinational Corporations, that communication between managers from headquarters and managers from plants is the most influencing factor affecting the ability to carry out innovation tasks.

Giving decision-making is a key responsibility for headquarters in MNC (Hedlund, 1986). Through distribution of decision-rights, headquarters can choose and coordination responsibilities in a manner which suites their business strategy (Chandler, 1991).

In many cases, e.g. case B, the network consisted of more than one core plant. Which indicates that the headquarters felt that decision-rights needs to be further allocated into the network.

**Ability for self-development**

One important aspect that the respondents from the different cases brought up was the ability for their own core plant to develop. Majority of cases have the capability to improve themselves. Most of the cases receive or set aside a budget for long-term development and many cases like e.g. Case E, rely heavily on their R&D to developed and improve new products. A lot of the budget is therefore invested in new technology to develop new products, new production systems, and method for solving problems.

Some Case companies like Case G and Case H follow a road map designed by their headquarters, where the importance of projects and current state determines what is required from the core plants. Some projects require the plants to improve themselves in order to tackle the tasks.

All most of the Case companies have functions in their organization that scans and benchmark the operating world, latest technology advancements and the competitors.
Studies show that organizations experience constant periods of self-improvement by two main factors, “learning by doing” and knowledge transfers (Argote, 1999). Most of these core plants have been operating abroad for decades and worked with self-improvement for longer time. The have managed to accumulated large of amount of “learning by doing” knowledge.

5.2 **What are the main challenges in achieving core plant role?**

There were several different factors, which could be identified as challenges, which the core plants could face. There were eleven different challenges that could be identified in the eight cases. These challenges are; communication and cooperation, coordinate, culture aspects, lack of structure and unclear guidelines, financing, adaptability, competition, and headquarters influence. As one can see from the chart, the challenges are very evenly distributed through all the cases.

### Table 4 Relationship between the identified challenges and the cases

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
<th>Case D</th>
<th>Case E</th>
<th>Case F</th>
<th>Case G</th>
<th>Case H</th>
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<tbody>
<tr>
<td>Communication, cooperation, and coordination</td>
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<td>Cultural aspects</td>
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<td>Gold et al. (2001)</td>
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<td>Flexibility</td>
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<td>Competition</td>
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<td>Williamsson (1975)</td>
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<td>Long-term view</td>
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<td>x</td>
<td>(Groenveld, 1997)</td>
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<td>Lack of competence</td>
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<td></td>
<td>(Roth and Jackson, 1995), (Koufteros et al., 2002), (Ferdows, 1989)</td>
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</table>

**Communication, coordination, and cooperation**

Having shared and effective communication tools through the whole production network is essential for the network to run correctly. Having a common communication basis can be defined as having the same business software through all the plants, and using the same IT software. The empirical findings clearly show
that all of the cases are facing challenges from a communication, cooperation, and coordination point of view.

In case B, both respondents confirmed that challenges regarding communication can arise in their production network. One of the respondents argued that “We have a huge problem with our IT system, it is fragmented. The only thing that we have in common is our CAD-system”. The other respondent added: “There are forums where you call each other for various meetings, but they are perceived rather short, and they are only reported from the management and upwards. You need more status in the various factories. An efficient communication is missing”.

One of the respondents in case D and one of the respondents at case C also confirm that solutions from the core plant does not always suit the rest of the production plants, due to difficulties in communication and cooperation. Case A, G and H are on the same track. They believe that humbleness is a key word. They think that they have to understand that all of their needs and suggestions cannot always be compatible with the rest of the network. A technical solution is not appropriate in all circumstances.

Case E and F reveals that an efficient way of work in the production network must be established to meet the needs of the customer. Further they said that their whole network needs to be more cooperative and be adjusted globally to be able to meet those demands.

The challenges within communication, cooperation, and coordination can be supported by the theory which Nickerson (2000) and Poncini (2002) states, which is that communication and language skills can be utilized by the strategic management of international operations as a key to successful daily activities within the multinational corporation. They also emphasize that a common communication tool can create and increase the community in various meetings.

Cultural aspects

Many core plants have responsibilities, which is not only carried out internally, but also globally. Different nations have their different language and culture which in turn can have an effect on the way they work towards the core plant and on the entire network. Three of the eight cases highlight that there are some cultural aspects, which can be considered challenging. Both respondents in case A mentioned that the linguistic aspects have a slowing impact towards the production network. “Cultural and language can act as barriers towards the production sites abroad. Some cultures do not want to do something repetitive, and some wants to work in form of orders from the management. Exchange of information can be misunderstood as well between different cultures”, are some challenges within culture aspects they mentioned.

Hofstede (1997) mentions that the multinational networks should be seen as networks of relationships. He further explains that cultural aspects can facilitate to explain the transfer of knowledge that arises between subsidiaries. This is related to the challenges that occur within the production networks, which the investigated core plants encountered.
Lack of structure and unclear guidelines

Having the role as the core plant basically means major of responsibility, both internally and globally. It is important to act as a sort of a leader, which benefits the whole production network. As a core plant it is important to organize the network, such as change management. Case H agreed that there are some responsibilities within the core plant that can be challenging. According to the technology director, who said: “There are difficulties about what you need to do as the role of core plant. For instance, prioritizing; we could end up in a dilemma where we need to choose to either help a plant abroad, which do not have the right resources such as expertise, or keep our competence stay home to fix the issues that the core plant is facing”. Case A had similar opinions and highlighted that one has to tactical and modest at the same time to be able to succeed as a core plant towards the rest of the network, which could be challenging, because they believe that one has to be humble in his judgment before make decisions and prioritizing.

Gold et al. (2001) claims that organizational structure is vital for leveraging technological architecture. It can also be described as the key element for rationalizing collaboration and sharing knowledge across internal organizational limits.

Flexibility

Having a good flexibility will facilitate for a core plant in different matters. Having a good flexibility regarding the core plant level may be to have the right tools or resources, which will lead to take the right decisions which concerns the entire production network. Three cases mentioned that they experienced some challenges within their flexibility. According to both the research and concept developer, and the category and supply chain manager, they emphasize some minor difficulties in the flexibility in their production network. “Building the right flexibility for cooperation between the production sites and to update the entire process”, is what they mentioned. Case D and G also had some similar thoughts regarding the flexibility issues. They mentioned that taking decisions could be challenging for trade-offs and being able to customize the right ambition to the production.

Ferdows (2006) and Grant (1991) highlights the importance of updating the network with various knowledge transfer, which will achieve competitive advantages. They mention that a network should be structured in way which will facilitate transformation of information, knowledge, etc. Many managers report that their systems contain flaws in exchange of information and creativity, which is not compatible for the organization.

Long-term view

Core plants needs to have long-term plans to evolve and improve in terms of the network. Half of the cases underlined that visions can be challenging and needs to be improved. In case B, -one of the respondents mentioned that it includes a lot of long term responsibilities which they to master within a specific time. They needed to re-model the pant to adjust to the new guidelines. For instance, it was mentioned that working hours within various projects needed to be reduced in a long term, which they found challenging. One respondent at case F mentioned similar issues that they were having, which is in the long term work. It was mentioned that they needed to be
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competitive in both short term as well as long term, and that they let their resources prioritize both of them to be able to make it in time in various projects.

Case G, H and E, discussed that having a best-practice model is essential. It is equally important that this model is tested, validated and accepted by the rest of the network. In the case G, some plants disagreed upon what is the master process and didn’t follow the best-practice model that was made them. All of the three cases stated that strong and lenient leadership along with change management is required to deal with these issues.

Road mapping can be described as a process that integrates business and technology along with technology strategy by illustrating interactions between the products along with the technological facilities (Groenveld, 1997).

Most of the investigated case companies have their own technological roadmaps, which they use as tools, implement their technological strategies into other plants. This is however a challenge for the leadership especially in plants which are added into network through acquisition (as in Case G and Case H).

Lack of competence

Having the right competence and expertise are keys to succeed in terms of continuing developing as a core plant, and to provide that competence to the rest of the production plants. Without the proper skills of managing a core plant, then one may question whether it was the right decision to entrust the role of core plant. Three of the eight cases mentioned that finding the right skilled personnel can be challenging. In case C, they mentioned that there is a lack of expertise, considering that the topic is rather new. They also commented on the following: “Finding the right skills within regarding core plant is a key factor, due to that we have just entered this structure”. Case A on the other hand, emphasized the competence outside the core plant. They felt that the challenging part is that their skilled personnel may not be sufficient provided to the rest of the network, due to their lack of knowledge. The support may not be enough for everyone in the network, which could be grueling for the core plant.

According to Roth and Jackson (1995), competence within plants usually indicates to the internal manufacturing expertise and various production technologies or to other specific strategic design choices that will receive competitive abilities. Koufteros et al. (2002), explains that efficient programs and plans needs to be built to be able to achieve these factors. They also include several other aspects such as quality of the management, human resource management and manufacturing planning – they will in turn develop excellent opportunities for manufacturing competence, when properly implemented. Ferdows (1989) also confirms that a more developed competence within plants will expand the plant’s responsibilities and for future tasks as well.

Competition

Competition within the production network may arise, and it could slow down the progress through the production. Aspects regarding competition can include that the non-core plants want more volume, or that they want to be more independent, or that their aim is to “win” the role as core plant. In six cases there were some competition that could occur in their production network. Case F mentioned that several production sites in a different continent have merged into one large unit, to be able to
compete with the core plant for more volume. This results to the core plant needs to perform more. Case G mentioned that a little competition could be useful for the production network, which they consider as a win-win situation, but at the same time reduce the balance in the network, basically because of the independent work, the production sites will strive against.”

Another issue is, competition regarding the core plant role. This was however only evident where the plants competed against volume and strategic mandate regarding similar product range. In Case F, it was mentioned that there was another plant that could potentially take over the role in the future. One of the respondents in Case B mentioned that they had to continuously develop themselves and show positive results otherwise their role could be given to some other plant.

Williamson (1975) discusses that financial success from one plant is sometimes the monetary source for another. However, some plants in this study felt that their network lacked the bigger picture.
Discussion

6 Discussion

In this chapter findings are discussed as well as the method. Each research question is discussed separately in order to provide structure and depth. Also a framework is proposed and discussed based upon the findings. In the method discussion subchapter, the approach, data collection technique, validity and reliability are discoursed.

6.1 Discussion of findings

In this subchapter the two research question of this study are discussed. For sake of clarity, each research question is discussed separately.

Prerequisites and key capabilities (RQ1)

The aim with the first research question was to investigate what prerequisites and key capabilities that are required for managing a core plant. The models provided in the literature for e.g. Ferdrows (1997b) focuses less upon the managerial aspect and emphasizes more on the core plant role in relation to other defined roles in a network. In this study a lot of professionals, who have an important role in their respective companies, explained the most important factors of being the core plant in their network compared to the other plants. In most cases, the decision to make changes in the network, e.g. adding or removing a plant from the production network, are done at a higher level, e.g. top management level or headquarters level.

Different case companies had different interpretation of what a core plant is. They used different names, e.g. pilot plant and Center of Excellence, and they had different purposes of it. In one of the case company (Case G), the core plant role was about testing new methods and providing options for the rest of the network and in Case E, where the plant has a fundamental role for the entire network both in terms of production but also in terms of strategy. The variances of the answers and the variances between the plants forced the finding to use very simple vocabulary in order to generalize the factors. Factors like experience, tradition and knowledge were chosen to since they in their own represented what the investigated plants unanimously agreed upon was the most important factors along with having proximity to the R&D. The conclusion that be drawn from these mentioned factors is that a core plant role is not something a newly acquired or newly built plant can handle. It needs a foundation based upon maturity and innovation.

Managing a core plant role can be described as a supplementary responsibility apart from normal volume production. The responsibility is to influencing the rest of the network in various ways. To handle this responsibility, there need to be certain tools or function available to the plants. In the findings, test facilities, ability for self-development and headquarters support were presented. They are important prerequisites for a core plant in order to handle the extra responsibility e.g. generating new solutions or technology and to be able to continue produce the scheduled volume.

Challenges (RQ2)

The second research question of this study was: “What are the main challenges in managing core plant role?” The context is fundamental when taking into account when trying understanding and analyzing the challenges. Like understanding what the company’s business model is and how they operate their business abroad. A company, for example, who produces trucks (Case G and Case H) would have
Discussion

different obstacles in terms of global manufacturing compared to company whom mass-produces furniture (Case D). It is also worth taking the respondents position and roll in the company, because it is natural to for a person to mention the problems that are more related to their daily work. This was evident when during the triangulation process, some of the answers regarding “challenges” from different respondents (from the same company) differed quite much.

A quite broad line had to be draw in order to generalize and present the findings, which would be justifying the different cases answers. The factors were chosen primarily based upon the frequently mentioned challenges from the interviews and also some of the literature.

Communication cooperation and coordination where three words that were frequently used to describe problems in managing the core plant. Coordination was commonly used to describe activities that were done parallel to core plant related doings. Communication and cooperation were mentioned as challenges both internally the plant itself between departments and externally between the other plants in the network.

Lack of structure and guidelines is something that some cases struggled with since they have recently adopted the core plants way of working. There was ambiguity about the what role and authority does a designated should core plant and ambiguity regarding the actual working routines.

Based on the findings, it is fair conclusion to draw that a core plant requires strong leadership and management in order to deal with the above mentioned issues. A clear vision (which is one of the listed challenges), is necessary in order to be shared and understood by the whole network and within the plant. The is way competition between the plants would be eliminated (which is a problem for some case companies). Headquarters or top management responsible for the plants have an important responsibility to provide this leadership, transparency and other types support such as education and financial help.
6.2 Proposed framework

Based upon the findings and the listed factors in chapter 5.1 a framework (figure 4) is proposed in order to partially summarize the findings in a more graphical manner but also provide a tangible contribution towards both the companies and the academia.

Knowledge is undoubtedly the foundation that is vital for every core plant regardless of industry or business approach. Both the theory and the empirical finding endorse that. R&D is the place where knowledge, process, technology and understanding are generated. However, to create and manage something one must have an experience. Operating abroad is something that takes time for organizations to get used to. Many of the companies investigated during the case studies have had several decades of experience operating abroad. Having a mature and experienced organization also allows a core plants allow other plants in the network to grow and develop themselves by the e.g. sharing recruitment methods, synergy development along with other aspects.

This thesis has a clear focus on manufacturing companies with high automation. Having testing facilities was a necessity for some these automations prejudiced companies. In order to do a successful knowledge, transfer between the plants, it should be first tested and validated.

Finally, the ability for self-improvement is important in terms of constantly and consistently developing the knowledge-base with the organization and the factory and in terms of avoiding.
For the second research question, which was about challenges regarding the managerial aspects, following framework is proposed. Similarly, to the previous framework on figure 4, this is a graphical summarization and a contribution of this research.

Figure 8 Proposed framework based upon findings about challenges.

This framework circles round the word management, which in this context is relevant since throughout this whole research, majority of the challenges have been able to linked to managerial aspects. The top and middle management in a core plant needs to focus on the four mentioned topics in order to successfully overcome the most common challenges a core plant has to deal with.

3C (Coordination, cooperation, and collaboration) between the plants and internally within the core plant requires strong leadership. Case G and H said that convincing the other plants in their network were not an easy task and required governance.

Lack of structure and guidelines is related to the mandate and authority subject. Clarity and transparency is often earned by structure. If the whole network is aware of what is the best-practice and have common understanding about the visions of the company, then the plant management would be amiable. However even though there are guidelines and configurations sorted out by the managers, strong leadership in terms of change management is required for it the structure to be vigorous and successful.

Finally, the competition can be a problem in networks where the plants share the same circumstances. It is therefore important, once again, that authority and mandate issues are arranged and the plants understands the vision of the network and works towards the bigger picture instead of sub optimizing themselves.
6.3 Discussion of methods

Research method

Multiple case studies were chosen as the research method to collect data about a rather unexplored concept. It was considered as the most appropriate method since the core plant role is best investigated in its real life context, specifically manufacturing plants that have been entitled this unique role. This study's purpose was to generalize and map various factors and by investigating multiple cases a large amount of data was obtained in order to do so. The cases also belonged to different industries that enables the generalization process and legitimizes the choice of method. Even though the eight different cases that were scrutinized provided a great opportunity for finding factors regarding perquisites, capabilities and challenges regarding the core plant role, it also reduced the possibility to go further deep into the factors since it is a rather time consuming method both in terms collecting the method and analyzing its data. Therefore, the findings from this study provide less depth.

Data collecting technique

An interview guide (see appendix 1) was used throughout all the cases and all the respondents were asked the same questions. This was done in order to be consistent with what data that required to be acquired and in order to simplify the analyzing and concluding process. The questions were based upon the literature review and the guide was co-created in collaboration with experienced researchers from the university.

As earlier mentioned, the interviews were of semi-structured nature. The respondents had the opportunity to freely express themselves and portray the narratives behind the answers unreservedly, for each question. This generated into a large amount of data that provided context behind each of the interview questions. However, this also led to large amount of data that was redundant and obscured the data analyzing process.

Nearly all the interviews were transcribed and analyzed through a software tool called MAXQDA. The data was easily added, sorted and coded within the tool and was time efficient in terms of reducing the redundant material. It also provided a graphical possibility to put the relevant answers from the respondents next to each other, which made it easier to draw conclusion. MAXQDA has also used in the triangulation process in for ensuring the gathered data’s reliability.

Some case provided internal documents from the company. However, these documents provided a supplementary data to what the respondents answered during the interview. Some case companies could not share the documents due to confidentiality reasons.

Validity and reliability

The internal validity was ensured through the usage of the interview guide. Interview questions were based upon the research questions and the literature. The same guide was used throughout the whole study and made sure that the only what that was intended to be measured got measured.

The external validity was achieved by spreading by doing eight cases within different industries. The proposed findings and framework are based upon wide range of data.
Discussion

However, it has to be mentioned that all the case companies are from Sweden and majority of them are from the automotive industry. The generalization is therefore more accurate under the mentioned preconditions.

Reliability was achieved by making sure the plants being interview have the core plant role and interview people with appropriate background for answering the interview questions. As mentioned earlier, each case had at least two respondents which enabled the possibility to source triangulated the data. The findings were also compared to the existing literature to make sure the relevance is legitimate. Even though each case managed to provide the desired data, some cases for e.g. Case G and Case H, had more respondents who were willing to contribute to this study. If all cases provided similar amount of participants the finds could have alterations.

6.4 Future studies

This thesis focused upon investigating perquisites, capabilities and challenges for managing the core plant role. Interviews were the primarily the method for collecting the data from the various cases. A more quantitative data using the proposed framework as a reference would show interesting results. A quantitative approach to find out capabilities and challenges would enable the investigator to rank the capabilities and challenges importance in an objective manner. It would also allow distinguishing which industry is accustomed to which targeted factors.

In this study many professionals with high posts in their respective companies interviewed in order to gather data. However, none of the respondents belong to the highest strategic level of their respective organization. A study, where the top management, professionals from the board or headquarters are the respondents to a similar study would have provided a unique perspective to the subject. These people are after the ones who make crucial decisions e.g. adding or removing plants for the network or reorganizing the structure and strategies. Knowing which capabilities and perquisites that are important from their perspective can help understand what capabilities are considered most important in order to obtain the core plant role.

It would also be interesting to examine how a core plant’s performance is measured. What criteria or key performance indicators (KPI) are measured and which tools are most suitable in order to measure the performance. In order achieve tangible results fewer amount of case studies (compared to this study) with a focus on one particular industry e.g. automobile industry. The results would be a great contribution for globally present enterprises as well as for the academia for testing and improving a rather unexplored subject.
7 Conclusion

Within the context of global manufacturing and production networks there are have been many researches exploring various areas in order develop and improve global operations for the manufacturing industry. The study however aims to explore a rather unmapped subject called the core plant role. The goal was to investigate the designated core plants within the Swedish manufacturing industry and map the current state.

One of the aspects that this study aimed to scrutinize was about which prerequisites and capabilities that are required to a manage plant with a core plant role. After investigating eight different cases ten different factors were determined: Proximity to R&D, knowledge/competence, experience, tradition, being located in Sweden, headquarters influence, scale of economy, test facilities, diversity, and ability for self-development. These factors generalize what the different plants from different industries have in common.

The other aspect that this study aimed to address was what kind challenges there are when it comes to managing a core plant. The finds in this research shows that communication/cooperation, coordination, cultural aspects, lack of structure and guidelines, financing, rules and regulations, adaptability, competition, headquarters, visions and lack of competence.

The above-mentioned factors are not necessarily relevant in for all core plant environments however they can be used as a base for taking decisions or planning future actions within the company. The research also contributes to the academia by presenting a framework that can be used as a foundation for several areas within the context of production networks and in particular the core plant role.

To sum up, the objective was to scrutinize a concept by investigating to aspects regarding the management of a core plant. The finds provide both theoretical and practical contributions for large companies operating globally and for the academia to use the finding for further exploration about this subject.
8 References


References


The interview study is the first step of the research project "COPE", which is a joint project between Mälardalens Högskola, and Jönköping University, and a number of companies in order to illustrate the concept main plant, also called "core plant".

The interview study also provides the basis for a Master’s thesis by the students Gautam Nanda and John-Pierre Yalman from Jönköping University. The purpose of the interview study is to examine the prerequisites and capabilities, which is required to operate a core plant, as well as the difficulties and obstacles, which a core plant can encounter. This study will hopefully fill the knowledge gaps, which currently exist in the academic community and the manufacturing industry.

The interview will be conducted by Gautam Nanda and John-Pierre Yalman, students at Jönköping University. The interview will take approximately one hour and your answers will be treated and presented anonymously.

For questions regarding the interview study, please contact:
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For other questions concerning the COPE-project, please contact:
Jessica Bruch
Jessica.bruch@mdh.se
016 – 15 32 19
### Profiling of the respondent

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<th>Length of employment with the company</th>
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Respondent’s role and function in the company?
INTERVIEW QUESTIONS

1. Tell us what it means to be a core plant (Business excellence center, etc)?
   1a. How long have you been a core plant?
   1b. Why were you chosen to be the core plant?
   1c. Which areas do you have responsibilities for?
   1d. How many factories do you have in your production network?

2. What strengths and capabilities do you have as the role of core plant, which other plants in your network not have?

3. How are the prerequisites to be able to operate as the core plant in your production network?
   3a. What mandate can you affect the other plants?
   3b. What mandate do you have, which have a strategic affection on your production network?
   3c. Are there any financial resources which helps for long-term production development?

4. What challenges do you have as the role of core plant?
   4a. What challenges do you have internally?
   4b. What challenges are related to the other factories?

5. In your opinion, are you working in a strategic manner to continually evolve as a core plant?
   5a. If so, how do you work strategically?
   5b. If not, how would you like to develop your strategic work?

6. Do you have any role models in your effort to develop as a core plant?

7. In what areas do you work together with the other plants in your production network?

8. Are there any plants in your production network, that also has the role of core plant?
   8a. If so, how do you interact with them?
   8b. Do you work in the same way?