Abstract
Due to globalisation, many companies have established or acquired production plants worldwide in order to capture the market opportunities that lay beyond their national borders. This has resulted in the emergence of international manufacturing networks (IMNs), which consist of multiple, interdependent production plants with different characteristics within a single organisation.

Coordination of such networks consisting of multiple plants in different countries is not a simple management task. That is why some companies struggle with it, and turn their global production into a function that hinders their agility and performance; while others turn it into a formidable advantage. Coordination of an IMN requires a company to link and integrate its plants to support its strategic business objectives. A proficient coordination of activities, across multiple plants of an international manufacturing company, leads to competitive advantages.

Despite its significance, the coordination aspect of IMN management has not been studied sufficiently. Operations leaders in today's complex manufacturing world require a common language, tailored tools and frameworks for the management of their network. The research area of international manufacturing lacks empirical evidence of how industrial companies are (or could be) coordinated. Therefore, the overall aim of this research is to develop knowledge that improves the coordination of an IMN.

The data in this study were acquired from case studies carried out on the IMNs of four global manufacturing companies where the majority of data was gathered from a global contract manufacturer headquartered in Sweden. The findings reveal a set of challenges, which influence the coordination of an IMN as one of the main aspects of its management.

In order to improve IMN coordination, a framework has been developed from the results of the studies performed in this research project, as well as the results of previous research related to IMN management. It is composed of two distinctive parts: (1) preparatory steps, and (2) executional mechanisms.

The first part of the framework discusses, and provides an insight into, the strategic relevance of coordination, the establishment of an autonomy balance among plants in an IMN, and mapping an IMN. The second part of the framework contains three mechanisms for conducting coordination in an IMN.

**Farhad Norouzilame** is enrolled as an industrial PhD candidate at Mälardalen University’s research school, Innofacture, while working as a project manager in industry. He holds a M.Sc. in Production and Process Development and a B.Sc. in Mechanical Engineering. His research interest lies in the field of global manufacturing in particular on coordination of international manufacturing networks.
COORDINATION OF INTERNATIONAL MANUFACTURING NETWORKS

Farhad Norouzilame

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School of Innovation, Design and Engineering
COORDINATION OF INTERNATIONAL MANUFACTURING NETWORKS

Farhad Norouzilame

Akademisk avhandling

som för avläggande av teknologie doktorsexamen i innovation och design vid
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Fakultetsopponent: Associate Professor Yang Cheng, Aalborg University

Akademin för innovation, design och teknik
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Sammanfattning

På grund av globaliseringen har många företag etablerat eller förvärvat produktionsanläggningar över hela världen för att fånga marknadsmöjligheter bortom sina nationella gränser. Detta har lett till uppkomsten av internationella tillverkningsnätverk (IMN) som består av flertalet ömsesidigt beroende produktionsanläggningar med olika egenskaper inom en enda organisation.

Att koordinera sådana nätverk, inklusive flera anläggningar i olika länder, är inte någon enkel ledningsuppgift. Det är därför vissa företag kämpar med detta och förvandlar sin globala produktion till en funktion som hindrar deras prestanda, medan andra gör det till en formidabel fördel. Att koordinera ett IMN relaterar till frågan om hur man kopplar och integrerar sina anläggningar för att stödja de strategiska affärsågaben. En kompetent koordination av aktiviteter omfattande flera fabriker i ett internationellt tillverkningsföretag leder till konkurrensfördelar.

Trots dess betydelse har koordineringen av ett IMN inte studerats tillräckligt. Operationsledare för dagens komplexa tillverkningsvärld kräver ett gemensamt språk, skräddarsydda verktyg och ramverk för hanteringen av deras nätverk. Forskningsområdet internationell tillverkning saknar empirisk evidens och riktlinjer för hur industriföretagets IMN kan koordineras. Det övergripande syftet med denna forskning är därför att utveckla kunskap som förbättrar samordningen av ett internationellt tillverkningsnätverk.

Data i denna studie har insamlats genom att utföra fallstudier på IMN hos fyra globala tillverkningsföretag där största mängden data samlades från en global kontraktstillverkare med huvudsäte i Sverige. Resultatet avslöjar en rad utmaningar som påverkar koordineringen av ett IMN som en av huvudspekterna hos dess ledning.

För att förbättra IMN-koordinering har ett ramverk utvecklats. Det föreslagna ramverket innehåller resultat från de studier som utförts i detta forskningsprojekt samt kunskaper från tidigare forskning relaterade till IMN-hanteringen. Dessas består av två distinkta delar av (1) förberedande steg och (2) utförandemekanismer. Den första delen av ramverket diskuterar och ger insikter om den strategiska relevansen av koordination, betydelsen av att upprätta en autonomibalans bland anläggningarna i ett IMN och att minska hierarkin i ett IMN. Å andra sidan innehåller den andra delen av ramverket tre mekanismer för att genomföra koordinering i ett IMN.
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Looking back at the years devoted to this project, I can flashback to many great meetings and discussions, at both the university and the company, while the seasons passed by. Time, unstoppable and irreversible, was spent on this project because my main goal was to discover and learn through leaving my comfort zone.

Although the biggest part of this sailing journey was meeting great people, exploring the outer world, learning and enjoying, another part was sometimes hitting some rocks and typhoons. But, if I can still write this text then I guess I have survived. Doing a PhD is not simple, and doing it in an industrial context makes it even more challenging and interesting. Most of what I was reading became tangible in an industrial environment, and much that I saw in reality was discussed by different scholars around the world that made me passionate.

A positive attribute of this environment was that I never felt totally alone. I was privileged to have special support from my academic supervisors: Professor Mats Jackson, Dr Erik Bjurström and Dr Anna Granlund. I was lucky to have you and the diversity of your perspectives: otherwise I don’t know what my academic destiny would turn out. Mats’ valuable leading guidelines, Erik’s strategic and to the point injections of knowledge, and my academic angel, Anna’s great and sometimes uncompromised comments were vital for me. May your great attitude reflect back into your life. I also want to express my gratitude to all of my previous teachers, supervisors, professors and colleagues, especially in MDH and particularly at INNOFACTURE research school. It is impossible to forget the great memories we made together in the last few years.

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Stockholm,
Farhad Norouzilame
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Publication

Appended papers

Norouzilame was the main author and presented the paper. He performed the literature review, data collection and analysis together with Moch. Riedel and Bruch reviewed the paper.

Norouzilame initiated the paper and conducted the data collection and analysis. Norouzilame was the main author and Bruch and Bellgran reviewed the paper.

Norouzilame was the main author in this paper. Mengel participated in the writing process, analysis of the results and review.

Norouzilame initiated the paper. Norouzilame and Sjögren collected the data. Stenholm participated in the writing process. Bergsjö reviewed and quality assured the paper.

Norouzilame was the main author of the paper. Wiktorsson contributed to the data collection and reviewed the paper.
Additional publications (not included in this thesis)


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Parts 2: Appended Papers
PART 1

SUMMARISING CHAPTERS
1 Introduction

This chapter provides an introduction to the thesis and its background. A general description of the challenge is presented. Also, the research objective, research questions and the research boundaries are provided. Finally, the chapter ends with an outline of the thesis.

1.1 The rise of international manufacturing networks

The recent decades have witnessed a remarkable shift in the business environment that has forced manufacturing companies to rethink how to operate their plants in order to survive in turbulent surroundings. Meanwhile, the phenomenon of globalisation has led to the explosive growth of foreign direct investments (FDIs) and international trade (Cheng et al., 2011). For example, in 2013, foreign affiliates of multinational corporations (MNCs) i.e. companies that directly affect FDIs in order to carry out manufacturing activities abroad (Pontrandolfo, 1999), employed 71 million people, sold $35 trillion of goods, and had $97 trillion of assets (UNCTAD, 2014).

To tap into the opportunities of a globalised economy, in recent decades many manufacturing companies have stepped over their national borders and established operations abroad. In a long-term evolution, the role of manufacturing networks has changed “from supplying domestic markets with products, via supplying international markets through export, to supplying international markets through local manufacturing” (Cheng et al., 2015, p. 392). The term ‘international manufacturing network’ (IMN) is established in the literature and refers to a network of dispersed plants, under the ownership of a single company, which have matrix connections, affect each other and cannot be managed in isolation (Shi and Gregory, 1998, Rudberg and Olhager, 2003).

1.2 Research on IMNs and their coordination

Research on the coordination of IMNs is positioned in the area of global operations management, which in turn belongs to the larger field of production/operations management (P/OM) research. P/OM research has traditionally focused on individual production plants² (Shi and Gregory, 2005). On a plant level, there have been thorough studies of structural decisions i.e. the physical configuration of the resources in a production plant (Hayes and Wheelwright, 1984, Barney, 1991, Miltenburg, 2009) and of infrastructural

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¹ The term ‘network’, unless otherwise specified, has been used as a short form to refer to an IMN.
² The term ‘production plant’ or the simplified version ‘plant’ in this research refers to the most basic construct in an IMN. Other authors have used interchangeably other terms, such as: factory, manufacturing site, manufacturing entity, subsidiary plant and production unit etc., which all refer to the same concept.
decisions i.e. the activities that take place within the structure of a plant (Lewis and Slack, 2002). A combination of structural and infrastructural decisions results in capabilities for a production plant, which are often measured across the dimensions of: cost, quality, delivery and flexibility (Miltenburg, 2005). The ‘manufacturing strategy’ field of research addresses the effects of such decisions on the competitive advantages of a plant, and consequently on the long-term business strategy of a firm (see e.g. Lewis and Slack, 2002, Hayes et al., 2005, Miltenburg, 2005).

Meanwhile the phenomenon of globalisation became widespread in the late twentieth century (Russell, 1998), much research was devoted to the ‘internationalisation’ of firms. For example, Hymer (1976), in his ‘industrial organisation theory’, and Johanson and Vahlne (1977), in their ‘Uppsala model’ studied the process of the internationalisation of a company from a business perspective. Along with the studies on the international business field, a growing interest emerged around international manufacturing and the management of IMNs (De Toni and Parussini, 2010). As shown in Figure 1, during the last few decades there has been more research done on the network-level compared to the plant-level, whereby studies related to networks has gained momentum in recent years.

![Figure 1 – The annual number of network-level vs. plant-level publications (adapted from Cheng et al., 2015)](image)

The literature on the management of IMNs includes two dimensions: configuration and coordination (Rudberg and West, 2008, Miltenburg, 2005, Shi and Gregory, 1998). Also, strategy has been mentioned as a separate decision layer in IMN-related studies (Friedli et al., 2016), which takes a major part of the literature on IMNs. While configuration of an IMN deals with the structural decisions such as the location and the number of plants in the world where each activity in the value chain takes place, coordination of an IMN discusses infrastructural decisions on how the linked activities the plants of an IMN are managed (Colotla et al., 2003, Porter, 1986). Coordination of an IMN includes decisions on the interactions of the plants within an IMN (Friedli et al., 2014, P.19), and how to share...
knowledge and resources effectively and efficiently between the dispersed plants (Netland and Aspelund, 2014).

Apart from the strategy related studies, more research has been carried out on IMN configuration than on IMN coordination (Pontrandolfo, 1999, Cheng et al., 2015). By analysing 674 papers from 30 renowned journals between 1986 and 2011, Mundt (2012) comes to a similar conclusion (see Figure 2).

![Figure 2 – Distribution of strategy, configuration and coordination-related research in a set of articles (adapted from Mundt (2012))](image)

Despite the importance attached to coordination as a critical feature of geographically-dispersed plants (Fleenor, 1993, Rudberg and West, 2008), few studies of IMNs have addressed the coordination of manufacturing activities (Pontrandolfo, 1999, Cheng et al., 2015).

The shortage of coordination-related research could be due to several factors. First of all, it is apparent that the IMN-related research has followed the chronological evolution of operations i.e. the evolution from an individual or limited number of plants to a network of operations. Since the initial challenges of many companies in establishing or acquiring production plants abroad was on the number and location of those plants, much of the research focused on IMN configuration. Furthermore, it is relatively more difficult to study and analyse coordination as it has a qualitative nature. Also, the wide variety of definitions of coordination and its multiple perspectives (Koontz, 1980), adds to the complexity of its study.

The research presented in this thesis attempts to increase the knowledge of the coordination of IMNs. Firstly, it tries to understand coordination and its challenges in the context of IMN. Secondly, models and methods are suggested in order to overcome those challenges.
Finally, the suggested models and actions are integrated into a framework for the coordination of an IMN. Figure 3 illustrates the position of the current research in a wider context.

![Figure 3 – Positioning of the current research in the wider context of research](image)

### 1.3 The critical significance of coordination in IMN management

A proficient coordination of plants in an IMN sheds light on how the distributed plants should be linked together in order to realize a company’s business strategy (Meijboom and Vos, 1997, Colotla et al., 2003, Cheng et al., 2015). Several authors have attributed certain network capabilities to a proper coordination of an IMN (Shi and Gregory, 1998, Colotla et al., 2003, Feldmann, 2011). Friedli et al. (2016) confirmed this by highlighting that an efficient coordination of activities, across multiple plants of an international manufacturing company, can lead to competitive advantages for them.

Furthermore, as more organisations become reliant on interdisciplinary teams of specialists and distributed operations (Faraj and Xiao, 2006), the importance of coordination increases. If performed well, coordination provides cost advantages, enhances the effectiveness of multiple operations, and improves the performance of plants (Friedli et al., 2016, Flaherty, 1986). Also, a proper coordination provides guidelines for the effective and efficient transfer of knowledge between dispersed plants (Netland and Aspelund, 2014). It enables the realisation of the potential synergy that exists among different plants in a network (Flaherty, 1986, Vereecke and Van Dierdonck, 2002).

However, the underlying advantages generated by the coordination of a globally dispersed network of plants are accompanied by certain challenges. The expansion from an individual plant (or a small number of plants) to a globally-dispersed network of plants entails taking many constructs into consideration, which turns the management of an IMN into a complex task (Mundt, 2012). The senior managers of IMNs are challenged when trying to
link and integrate their plants, in order to support the overall strategic business objective of a company, whilst simultaneously attempting to align a network of plants with varying cultures to the ever-changing requirements of the market (Cheng et al., 2011).

Kinkel and Maloca (2009) state that underestimated coordination needs are among the top five reasons for the back-sourcing of a site. In another study, where the barriers to effective management of an IMN were investigated, six out of the eleven most mentioned barriers were related to coordination (Klassen and Whybark, 1994).

Nevertheless, coordination is not a simple task of management. That is why some companies struggle with it, and turn their global production into a function that hinders their agility and performance, while others turn it into a formidable advantage (Ferdows, 2009). Procedures, which link or integrate plants, must be established in order to orchestrate the plants of an IMN to achieve the strategic objectives of a multi-plant manufacturing company (Cheng et al., 2011).

Despite the experience accumulated in recent decades from the coordination of multiple production plants, there is still lack of research regarding coordination (Cheng et al., 2015). According to Ferdows et al. (2016): “While many scholars have recognized the growing complexity and importance of managing [manufacturing] networks, the scholarly literature still does not offer many tools for how to manage them” (p. 1). The research studies of a few scholars in the field of IMN management (e.g. Friedli et al., 2014, Feldmann, 2011, Cheng et al., 2011, Rudberg and West, 2008) consider some aspects of coordination. However, there is still not much research in this area that yields holistic models and frameworks for the coordination of IMNs. As Mundt (2012) explains, the leaders of global operations require a common language, tailored tools and frameworks for the management of their network. Such a framework should take the influencing factors into consideration, and integrate them as a whole, so that by using them people working on coordination can coordinate the network’s flows proactively (Cheng et al., 2011).

1.4 Research aim, thesis objective, and research questions

As concluded from the introduction so far, coordination is an essential management dimension for the operation of IMNs. However, as supported by Friedli et al. (2014) and Cheng et al. (2015), the coordination of IMNs has not been studied sufficiently in comparison to the configuration aspect. While there is a need to familiarize the senior management of international manufacturing companies with coordination-related theories, it is also important that research in this field is developed with empirical input from the industrial context. Considering the shortage of holistic knowledge regarding IMN coordination, and the increasing need for coordination in practice, the overall aim of the research presented in this thesis is as follows:
The overall aim of this research is to develop knowledge that improves the coordination of an international manufacturing network.

Although some aspects of coordination have been addressed, such as the distribution of decision making or knowledge transfer in an IMN context (see e.g. Maritan et al., 2004, Tsai, 2001, Van Wijk et al., 2008) as well as in the wider context of organisational theory (see e.g. Faraj and Xiao, 2006, Okhuysen and Bechky, 2009), a complete picture of coordination within an IMN is required before it can be improved to its fullest extent.

In addition, because many of the developed theories are not fully diffused into the management systems of international manufacturing companies, there is a need to elaborate on the prerequisites and explain how the developed models can be integrated and embedded in the management system of a company. Although the adoption of a holistic frameworks for coordination can lead to competitive advantages of global manufacturing companies, a lack of the conditions needed at the outset might decrease the effectiveness of their application.

Thus, there is a need to investigate the significant aspects of IMN coordination, developing holistic frameworks in association with those aspects, and provide guidelines about the right prerequisites for better utilisation of such frameworks. Having addressed the mentioned need, the objective of this thesis is specified as follows:

The objective of this thesis is to develop a framework for improved coordination of an IMN.

Considering the background of the research, the described gap and the research objective, two research questions have been formulated:

RQ1: What are the key challenges related to coordination of an IMN?

The first question is posed primarily to gain a deeper understanding of coordination within IMN context so as to identify the challenges faced. Understanding coordination in IMN context and identifying the related challenges will enable a better design of such framework.

RQ2: What are the necessary steps and mechanisms for improving coordination of an IMN?

The second question follows on from the first one and pursues the steps and mechanisms that must be conducted in order to handle and overcome the coordination-related challenges in IMN context. It is important to understand what the required steps and mechanisms are, and how they need to be conducted.

1.5 Research scope and delimitations

The overall theme of this research is to improve the operations of internationally dispersed manufacturing companies by improving the coordination of such networks. There are two
types of flows in the plants of an IMN: physical and non-physical (Wiendahl et al., 2007). Due to the strategic importance of the coordination of non-physical flows (particularly the flows of knowledge), such non-physical flows are the main focus of this study. Also, the coordination of physical flows has been addressed in previous research (See e.g. Chan et al., 2005, Tsiakis and Papageorgiou, 2008).

Although the focus of this research was on the coordination aspect of IMN management, the configuration aspect has been introduced and referred to deliberately, whenever necessary, because both of those aspects are closely related (Pontrandolfo, 1999).

In this thesis the terms ‘IMN’ and ‘network’ are used synonymously, and refer to the intra-company network of a single company. Thereby, this research excludes supply chains that encompass multiple plants of multiple organisations (Rudberg and Olhager, 2003). So, although each IMN of the companies studied belonged to larger international value chains, considering the objectives of this research, the supply chain perspective was excluded.

Looking closer at the generic types of networks, the network of the main company involved in this research (company A) had a combination of local and web structures (Miles and Huberman, 1994) (see section 2.2. in Chapter 2 for more information on the classification of network structures).

In addition, the majority of the case studies in this thesis were conducted in a manufacturing environment in the automotive sector at a global contract manufacturing company headquartered in Sweden. This signifies certain boundaries for the data collected in this research. However, additional data from other companies, also headquartered in Sweden, were incorporated after the licentiate degree. Therefore, the management methods and practices reported herein represent mainly a Scandinavian management perspective. More information about the companies involved in this research is provided in section 3.3.

1.6 Outline of the thesis

This thesis is organised into seven chapters, as illustrated in Figure 4:
• Chapter 1 (Introduction) describes the research area, the background of the research, the problem statement, the research objective, and the research questions. It makes the reader familiar with the research objective, research questions, and the boundaries of this particular study.

• Chapter 2 (Frame of reference) presents the theoretical frame of reference.

• Chapter 3 (Methodology) explains the applied research methodology in detail, along with a description of each constituent study of this research.

• Chapter 4 (Summary of results) presents a brief overview of the results of the studies conducted.

• Chapter 5 (Analysis) contains an analysis of the results.

• Chapter 6 (A framework for IMN coordination) describes the proposed framework, including explanations of its different parts.

• Chapter 7 (Conclusions) concludes the research with a discussion and suggestions for future research.

• The publications of this research are appended to the end of the thesis.
2 Frame of reference

This chapter contains an overview of previous research related to the research area of the current thesis. The chapter is organized into three main streams. First, previous literature on the subject of coordination is presented. Then, research regarding IMN and its different management aspects is presented followed by some literature on IMN coordination. Finally, there is a short reflection on the existing research.

The aim of this section is to provide a composite of existing research sub-areas in P/OM and, in particular, the area of international manufacturing in order to provide: (1) a general understanding of coordination, (2) a concise summary of literature on IMN management and (3) an overview of research regarding IMN coordination.

2.1 General literature on coordination

Everyone has a sense of what ‘coordination’ is. A well-organised football team, a well-managed event, a well-run airline or a well-functioning production plant, all require coordination of their different constituent elements. However, coordination is most noticeable when it is lacking (Malone and Crowston, 1994). Coordination can occur in many kinds of systems, such as: human, biological, computational, and organizational systems. This is why coordination is studied in a variety of disciplines, e.g.: psychology, computer science and organisational theory (Malone and Crowston, 1994). Among those disciplines, ‘organisational theory’ is closest to the topic of this research as an IMN itself is a specific type of organisation. In order to shed some light on the origins of coordination and understand its fundamentals, there follows a review of coordination in the context of organisational theory.

Coordination is a comprehensive and inclusive concept. Several definitions of coordination have been provided. Coordination has been defined primarily as: ‘the function of ensuring that the behaviours of an organisation’s subunits are properly interwoven, sequenced and timed, so as to accomplish some joint activity or completion of a task’ (Mascarenhas, 1984). Malone and Crowston (1994) define coordination as: ‘the process of managing the interdependencies among related activities’. Fussell et al. (1998) define coordination as: ‘the extra work organisations and individuals must complete when they are working in concert to achieve some goal, over and above what they would need to do to reach the goal individually’.

In a more recent study, coordination is defined as: ‘the degree of functional articulation and unity of effort between different organisational parts, and the extent to which the work activities of team members are logically consistent and coherent’ (Powell et al., 2004).
Almost all organisations experience a certain degree of similarity and difference among their constituent parts that leads to interdependencies among those parts (Martinez and Jarillo, 1989). Effective organisations are the ones that differentiate their subunits, in response to their immediate dynamic and diverse environment but, at the same time, maintain coordination and integration among them (Mascarenhas, 1984).

The definitions above emphasize some common characteristics of coordination. They refer to the collective nature of work, existing interdependencies among the activities, and a result accomplished by the coordination of interdependent activities. Okhuysen and Bechky (2009) mention three integral conditions needed to accomplish coordination:

1. Accountability: the question of who is responsible for specific elements of the task. By creating accountability, the members of an organisation make clear where the responsibilities of interdependent parties lie.
2. Predictability: enables interdependent parties to anticipate subsequent task-related activity, and the time it happens. Being able to anticipate task-related activity allows parties to plan and perform their own work, and is essential for coordinated activity.
3. Common understanding: enables the participants in an interdependent activity to increase their knowledge of the work that is to be done, how it is to take place, and the goals and objectives of the work. This knowledge includes: the knowledge on the task itself (Cannon-Bowers and Salas, 2001), the parties involved (Reagans et al., 2005), and the context, organisation and strategy (Pinto et al., 1993).

A term that is used repetitively in the context of coordination is interdependency. Interdependency is defined as: ‘the extent to which an organization’s task requires its members to work with one another’ (Cheng, 1983). Mascarenhas (1984) postulated the existence of three types of interdependence among different activities (as described in Table 1): pooled, sequential, and reciprocal, and added that those types of interdependence required coordination by: rules, plans, and mutual adjustment, respectively.

<table>
<thead>
<tr>
<th>Type of interdependence</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pooled</td>
<td>where two or more subunits of an organisation depend on a common resource</td>
</tr>
<tr>
<td>Sequential</td>
<td>where actions taken in one subunit have a direct impact on another one, but the reverse is not true</td>
</tr>
<tr>
<td>Reciprocal</td>
<td>when actions taken in subunit A directly affect subunit B and vice versa</td>
</tr>
</tbody>
</table>

Table 1: Different types of interdependence among the subunits in an organisation (adapted from Thompson, 1967)
Mascarenhas (1984) suggested that coordination can be achieved by: (1) programming the behaviour in order to prevent unexpected contingencies, by specifying the activities in one unit in parallel to an inter-dependent one, and (2) feedback and communication, i.e. the interactive communication between the members of different subunits in the organisation. The author adds that the performance of those actions in seeking coordination could be performed in different ways:

- **Impersonal Methods**: the use of legitimate methods that are distributed in the company, such as standard operating procedures, deadlines, regular reports, and schedules.
- **System-Sensitivity**: the ability of members of a subunit to foresee the impact on other subunits of actions taken in one subunit, and thereby to undertake appropriate behaviour that avoids conflict or sub optimization.
- **Compensation System**: the use of a reward system that does not encourage key members of a subunit to pursue the parochial interests of their own subunit at the expense of the rest of the organisation.
- **Personal Communication**: the use of communication and feedback involving verbal interaction between individuals, such as group meetings, telephone conversations, and face-to-face communication.

Following a review of the related literature, Martinez and Jarillo (1989) provided a list of common coordination mechanisms. They define a coordination mechanism as: ‘any administrative tool for achieving integration among different units within an organisation’. They divide the mechanisms into two groups: formal (including grouping the organisation and shaping a formal structure, centralization and standardization, planning of strategy and different functions etc., and output and behaviour control), and informal (including cross-departmental relations, informal communications such as meetings, conferences etc., and socialization i.e. building a culture of sharing strategic objectives and values).

### 2.2 International manufacturing networks

Research on the management of IMNs has developed from the management of a single plant. There is a vast body of literature on how to manage, organize, optimize, plan and operate production plants. The field of IMN management research, rooted in operations management, extends the boundaries from the plant towards internationally-dispersed but inter-connected plants (Shi and Gregory, 2005). By reviewing 107 IMN-related articles from
Cheng et al. (2015) refer to two distinct levels of analysis within the field of IMN research:

1) Plant-level analysis: considering plants as the basic construct of an IMN, and
2) Network-level analysis: considering the IMN as a coordinated network (aggregation) of its basic constructs i.e. the constituent plants

### 2.2.1 Production Plant vs. Manufacturing Network Perspective

#### Production plant perspective

Although a plant is a dependent sub-unit of an IMN that needs to be considered as an integrated component in a globally dispersed network of plants (Prasad et al., 2001), it is still an entity with its own role and mission. The body of literature on plant-level studies includes two main dimensions: (1) the location of plants, and (2) their strategic role.

Primarily, the location of plants has been researched by scholars who incorporated the effects of both qualitative and quantitative factors, with their main focus being cost optimisation (see e.g. Canel and Khumawala, 1996). The location-based research matured over time by providing generic models that supported systematic decision making (see e.g. Meyer and Jacob, 2008). Later research revealed that, although the ‘cost-factor’ must be considered, it is not the only factor involved. This led to a more strategic approach to research on the plants of an IMN, beyond merely ‘low-cost manufacturing’.

On a plant level, several models were developed that assume a certain range of expectations (or so-called ‘role’) for a plant within an IMN. For instance, De Meyer and Vereecke (2000) refer to four types of plants by analysing the role of the plants of eight international companies, and considering several characteristics of the plants, such as: age, autonomy, size, relationships with suppliers, level of investment, capabilities developed in the plant and performance in terms of quality, cost and speed. These four types are: (1) isolated plants receiving few innovations, (2) blueprint plants receiving lots of innovations but returning hardly any, (3) host plants with an essential role in the knowledge network, and (4) true innovators with a high level of autonomy and many sources of innovations.

The concept of a ‘strategic role’ for the plants of an IMN however, gained much attention due to the work of Ferdows (1997), who introduced six distinct plant roles (as illustrated in Figure 5) based on the strategic reason for a plant’s location and its competence level.

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3 Their first sample journal set included 156 potentially related papers. However, after performing the second review to clearly understand the contributions and ensuring that they fit IMN research, their sample decreased to 107 articles. The definition of IMN was used as the main criterion for article identification. From those articles, 40 were concerned with plant-level analysis and 67 were network-related.
Ferdows (1997) describes each plant role as follows: (1) an offshore factory is established to produce specific items at a low cost; (2) a source factory is as competent to produce products as the best factory in the network, besides having more authority on supply-chain decisions; (3) a server factory supplies specific national or regional markets, and has limited authority over modifications to product and production methods; (4) a contributor factory also serves a local market, but it has extended responsibilities regarding product and process engineering, as well as choice of supplier; (5) an outpost factory is established primarily to gain access to the knowledge that a company requires, which is more of a hypothetical role; (6) a lead factory is a crucial plant that has the ability and knowledge to innovate, and creates products, processes and technologies for the company. It has a decisive role in the choice of suppliers, purchase of machinery and large projects.

Several researchers have validated, tested (Vereecke and Van Dierdonck, 2002) and used (Feldmann and Olhager, 2013, Meijboom and Vos, 2004, Thomas et al., 2013) Ferdow’s model which seems, so far, to be the predominant model for classifying the strategic role of plants in an IMN. Some scholars have adopted Ferdow’s model for further studies of the competences of plants. For instance, Feldmann and Olhager (2013) conducted a survey of more than 100 Swedish plants. They concluded that the competence of a plant in an IMN comes in certain bundles, beginning with production-related competence, developing into supply chain-related competence and finally gaining development-related competences.

**Network level perspective**

Research at the network level provides a broader perspective, by looking at an IMN through a holistic lens. From this perspective, an IMN is an integrated system of nodes (plants) with certain connections that cannot been managed in isolation (Colotla et al., 2003, Khurana, 1999). An IMN could be regarded as plants belonging to one organisation (intra-company) that, in turn, can function as a part of a greater value network (see Figure 6). An IMN differs
from a supply chain, in the sense that IMNs refer to the internal manufacturing network of a single organisation, while a supply chain include multiple plants of multiple organisations.

**Figure 6 - IMNs and supply chains as two different value networks (adapted from Rudberg and Olhager (2003))**

### 2.2.2 Strategic perspective on international manufacturing networks

In the realm of manufacturing, strategy refers to a pattern of decisions, both structural and infrastructural, which result in competitive capabilities that are consistent with the long-term overall business strategy (Skinner, 1969, Hayes and Wheelwright, 1984, Bourne et al., 2000). Within the literature related to manufacturing strategy, there are different views on how a firm should compete in the market, such as: the resource-based view (RBV), and the knowledge-based view (KBV). The essence of the RBV is that the tangible or intangible resources that are distributed across firms provide a momentous potential of competitive advantage (Wernerfelt, 1984, Kraaijenbrink et al., 2010). On the other hand, the KBV considers a firm to be an institution for integrating knowledge (Grant, 1996) and believes that competitive advantages could be generated on the basis of the knowledge possessed by a company, and the ability to develop it. It focuses on how organisations create, acquire, apply, protect, and transfer knowledge (Cabrera-Suárez et al., 2001).

The capabilities of a plant are the outcomes of decisions taken on its structural and infrastructural elements (Hayes et al., 2005). Such capabilities are measured along the dimensions of different manufacturing priorities (Hayes and Wheelwright, 1984). Table 2 lists the common competitive priorities at a plant level and associated decision categories.

Similar to the plant-level, structural and infrastructural decisions can be made on a network-level that, that are associated with the two categories of configuration and coordination, respectively (Cheng et al., 2015, Friedli et al., 2014, Rudberg and West, 2008). Configuration of an IMN refers to the location in the world where each activity in the value chain takes place, whereas coordination discusses how similar or linked activities are coordinated with each other (Porter, 1986). Considering an intra-company IMN as a set of nodes (plants) and the linkages (interplay) between them, it could be construed that the configuration aspect deals with the design of the nodes (structure), whereas coordination...
revolves around the linkages and relations between those nodes (infrastructure) (Mundt, 2012).

**Table 2- Capabilities and related decision categories at a plant level (adapted from Leong et al., 1990 and Miltenburg, 2008)**

<table>
<thead>
<tr>
<th>Competitive priorities</th>
<th>Description</th>
<th>Decision categories</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>to control the financial input to manufacture the product</td>
<td></td>
<td>Capacity, Facilities, Technology, Vertical integration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Structural</td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td>to provide products whose features meet or exceed customers' specifications and expectations</td>
<td></td>
<td>Quality, Organisation, Planning and control, Performance measurement</td>
</tr>
<tr>
<td>Delivery</td>
<td>Speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>to meet the expected delivery speed</td>
<td>Infrastructural</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reliability</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>to keep delivery promises on time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td>Order size</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>to quickly change order size</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>to quickly change delivery time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There is a consensus among the scholars within the area of IMN management that four network capabilities could be derived from a network of plants (Shi and Gregory, 1998, Colotla et al., 2003, Friedli et al., 2014, Cheng et al., 2015). These four network capabilities are: accessibility, thriftiness ability, manufacturing mobility, and learning ability. Table 3 lists the definitions of network capabilities, along with some examples of how they influence decisions at a network-level.
Table 3 - Capabilities and related decision categories at a network-level

<table>
<thead>
<tr>
<th>Network capability</th>
<th>Description</th>
<th>Decision categories</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>The ease of access that an IMN has to different markets, customers, suppliers, skills as well as production resources</td>
<td>Structural</td>
<td>Factory - characteristics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Geographic - dispersion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vertical integration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Organization - structure</td>
</tr>
<tr>
<td>Thriftiness ability</td>
<td>The ability to achieve cost savings from economies of scale and scope and reduced duplications of activities</td>
<td>Infrastructural</td>
<td>Coordination - mechanisms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Knowledge transfer mechanisms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Capability building - mechanisms</td>
</tr>
<tr>
<td>Manufacturing mobility</td>
<td>The ability to move products, production volumes, processes and personnel between factories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning ability</td>
<td>The ability to learn from internal and external performance and practice comparisons between factories</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regarding the configuration of an IMN, by investigating the foci and characteristics of plants belonging to Fortune 500 companies, Schmenner (1982) identified four generic strategies regarding the structure of an IMN:

- **Product plants**: each plant focus on certain products
- **Process plants**: each plant takes a part of the entire production process
- **Market area plants**: plants produce multiple products but to serve a particular region
- **General purpose plants**: plants with a mixed responsibility on products, processes and markets

Another categorisation of production networks is that of Miles and Huberman (1994), who consider how the stages of production are distributed in the production network, resulting in five generic types of production networks: world factory, local for local, hub and spoke, sequential or convergent, and web structure. Those structures are illustrated and described in Figure 7.
Once the global set-up of an IMN is configured and the strategic roles of the plants are specified, the coordination of the network becomes the prime challenge.

### 2.3 Coordination of international manufacturing networks

In an early study by Flaherty (1986), the coordination of an IMN was characterised as managing a number of plants internationally that may or may not make similar products. In a later and more specific definition, IMN coordination has been defined as: ‘the management and organisation of global activities, including decisions on the interaction of plants, the plant’s autonomy level, and resource assignment and exchange’ (Friedli et al., 2014, P.19). Netland and Aspelund (2014) also relate an IMN’s coordination to the effective and efficient sharing of knowledge and resources between the dispersed plants. Cheng et al. (2015) identified three general streams of studies on coordination: the introduction of practices related to IMN coordination, the transfer of production technology and knowledge, and the optimisation of physical distribution.

Two fundamental issues of IMN coordination, as discussed in related literature (Colotla et al., 2003, De Toni and Parussini, 2010, Fleury and Costa Ferreira, 2016) are:

1. The governance of a network and the autonomy level of network plants
2. The management of internal flows and their interdependencies among the plants
2.3.1 Autonomy of plants in an IMN

The autonomy policy encompasses institutional rules in two areas of centralisation and standardisation. Feldmann (2011) defines the centralisation of decision-making as: ‘the distribution of decision-making authority for manufacturing decisions’. In this regard, Maritan et al. (2004) refers to the degree to which plants can make their own decisions on planning, production and control as the main indicators of the autonomy of a plant. They explain that the spectrum of autonomy ranges from the total hierarchical control by the parent company (centralised), to the full autonomy of each site (decentralised), as shown in Figure 8.

![Figure 8 - Centralised-decentralised spectrum (adapted from Maritan et al. (2004))](image)

Feldmann and Olhager (2011) provide another perspective regarding the autonomy of plants by referring to three distinct decision-making strategies: centralised at the headquarters (HQ), decentralised at the plant level, and integrated between the central HQ and local plants.

Regarding the standardisation aspect, Maritan et al. (2004) mention that the standardisation of some aspects may limit the plants’ autonomy, but they do not discuss this further in any detail. Friedli et al. (2014) mention that: “intuitively, standardisation of processes gives headquarters the opportunity to retain parental control, even if their execution is decentralised” (Friedli et al., 2014, P. 117). They even proposed a framework (see Figure 9) that considers the dimensions of standardisation and centralisation simultaneously by considering three aspects: systems, decisions and processes (Friedli et al., 2014, P. 117).
Another model that involves the decision-making domain of plants in an IMN is the one by Ferdows (1997) that was presented earlier. In his model, specific roles have been defined for plants in a network (see Figure 5). Each role is associated with specific responsibilities for production, supply chains or development (both product and production). However, this model and similar ones do not consider the autonomy of plants in their interaction in specific.

The next section covers the literature relating to another aspect of coordination, i.e. the management of existing interdependencies and flows between the plants in an IMN.

2.3.2 Management of flows and their interdependencies within an IMN

A significant step in the coordination of an IMN is to identify the existing flows and their interdependencies among the plants to be managed. Two types of flows among the plants of an IMN are physical and non-physical flows (Wiendahl et al., 2007). The physical flows include tangible objects, such as products and materials (mainly associated with the internal supply chain), whereas the non-physical flows consist of intangibles, such as information and knowledge.

Regarding the management of physical flows, several authors have worked on algorithms for handling production and distribution problems within IMNs, and have put forward approaches to determine the optimal configuration of a production and distribution network (See e.g. Chan et al., 2005, Tsiakis and Papageorgiou, 2008). The management of non-physical flows on the other hand includes the management of information and knowledge flows within an IMN as two distinctive non-flows flows in an IMN (Gupta and Govindarajan, 1991). The management of information and knowledge has been the topic of previous research (see e.g. Gaonkar and Viswanadham, 2001, Bender and Fish, 2000, Deflorin et al., 2012).
Information is data that acquire meaning through relational connections, whereas knowledge is the appropriate collection of information, such that its intent is to be for useful applications (Bellinger et al., 2004).

Information in an IMN is of three different types: (1) strategic, regarding the long-term and short-term strategies; (2) tactical, regarding demand forecast, inventory management, customers and market trends; and (3) operational e.g. the scheduling of production (Gaonkar and Viswanadham, 2001).

Knowledge, divided into explicit and tacit types (Nonaka and Konno, 1998, Liyanage et al., 2009), is considered as a state of mind, an object, a process, access to information and a capability (Alavi and Leidner, 2001). In this thesis, the term ‘knowledge’ is used broadly to refer to the managerial and production knowledge that flows through an IMN.

Knowledge, and its internal transfer within an IMN, is a driver of learning ability and it is, therefore, a critical source of competitive advantage (Watson and Hewett, 2006, Miltenburg, 2005). In order to manage the manifold knowledge flows in an IMN, there is a need for a comprehensive knowledge management strategy that takes into account the creation, validation, presentation, distribution, and application of knowledge (Bhatt, 2001).

Argote et al. (2003) classified the literature on KM into six categories, based on two dimensions, as shown in Figure 10.

![Figure 10: Organisation of KM-related literature (adapted from Argote et al. (2003))](image)

A distinctive advantage of IMNs is their ability to acquire and utilise knowledge across borders (Mudambi, 2002). Therefore, it is significant for global manufacturing companies to understand and practice how to conduct proficiently knowledge transfer (KT) projects. KT is defined as: ‘a process by which an organisation (or unit within one) identifies and learns specific knowledge that resides in another organization (or unit) and reapplies this
knowledge in its own contexts’ (Oshri et al., 2008). A successful KT project leads to the effective and efficient application of knowledge in different parts of an organisation (Liyanage et al., 2009).

In this regard, some scholars have focused on the transfer of ‘soft knowledge’ (Hildreth and Kimble, 2002), such as knowledge of a cultural and social character (e.g. Netland and Aspelund, 2014). Others have concentrated on the transfer of a more ‘concrete’ type of knowledge, such as production know-how (Ferdows, 2006).

Another aspect of KT that has received the attention of scholars is measuring the extent to which knowledge is transferred from one unit to another within an organisation. Foss and Pedersen (2002) stressed the importance of KT in capturing the application of knowledge by IMN units. However, Argote et al. (2003) measured KT as the ease of time and effort spent helping others to understand the source’s knowledge. Another model for evaluation of KT is suggested by Kirkpatrick (1998), where the author refers to four levels of knowledge capture, each impacting the next level: (1) reaction, (2) learning, (3) behaviour, and (4) results. That author adds that none of the levels should be skipped to proceed quickly to the next level that might be assumed to be more relevant (Kirkpatrick, 1998). Further, the work of Pérez-Nordtvedt et al. (2008) conceptualized KT according to four dimensions, that is: usefulness (the extent to which such knowledge is relevant and salient to organisational success), comprehension (the degree to which the new knowledge is fully understood), speed (how rapidly the recipient acquires new insights), and economy (the costs and resources associated with the KT).

The direction of KT has also been studied. This includes: the transfer of knowledge from the lead plants to a subsidiary (‘forwards’ transfer), from one subsidiary to another subsidiary (‘lateral’ transfer), (Dellestrand and Kappen, 2011), and even from a subsidiary to the lead plants (‘reverse’ transfer) (Ambos et al., 2006).

Among the few existing studies on the coordination of IMNs is the one by Rudberg and West (2008), in which they present a coordination model originally developed at Ericsson Radio System. They incorporated the recent research on manufacturing networks found in the literature into their global operation strategy, and provided guidance concerning key areas such as: facilities, capacity, process technology, vertical integration, quality management, organisation, and planning and control systems (Rudberg and West, 2008). Compared to similar models, such as the ones proposed by Bhatnagar et al. (1993), this model involves a set of contemporary and wider decision categories. Although the Network Model Concept of Rudberg and West (2008) provides a wider perspective (compared to previous similar concepts), and suggests the need for an institutional perspective, regulations and guidelines, it does not discuss in detail other significant aspects, such as a plant’s autonomy and KT. Their model does not either provide specific mechanism for conducting coordination in IMNs.
2.4 A short review of the literature on IMN management

The body of literature that deals with international manufacturing is multi-sided and interdisciplinary, with blurred boundaries among its parts. Rooted in international business, and affected by the globalisation of operations, literature on IMN management has evolved from having a business focus in the 60’s, to studying the network of operations in the recent decades (De Toni and Parussini, 2010).

As mentioned earlier in the introduction chapter, much research within IMN-related studies has been devoted to strategy-related topics. In this area, there has been thorough studies of the long term fortune of operations, through the achievement of unique competitive advantages (e.g. Barney, 1991, Bartlett and Ghoshal, 1989, Miltenburg, 2009, Rudberg and Olhager, 2003). Furthermore, the literature regarding the configuration aspect of IMN management provides a rich domain of studies on the number, location and role of the plants in a network of operations. The work of scholars such as: Meijboom and Vos (1997), Brush et al. (1999), Ferdows (1997), Vereecke et al. (2006) and Feldmann and Olhager (2013) has covered the configuration aspect very well.

However, the literature on the coordination aspect of the management of IMNs is not as comprehensive as the literature that deals with its other management aspects. The earlier research on coordination does not provide many useful reports on best practices from industrial cases and, while a considerable number of studies in OM deal with IMN configuration, less attention has been devoted to coordination issues (Cheng et al., 2015). There is a need for new holistic tools and frameworks for the coordination of IMNs (Mundt, 2012) to add to the very few existing models, such as the Network Model Concept of Rudberg and West (2008).

Earlier research on the management of IMNs contains isolated studies of some coordination-related aspects, such as knowledge and culture transfer, or the issue of autonomy among plants in a network. However, although such studies are useful, they do not provide a holistic view of the network level. In order for the senior managers and the global operations managers of IMNs to be able to manage their network proficiently, there is a need to have the entire picture and then provide useful tools to deal with each partial challenge.
3 Research Methodology

This chapter provides an overview of the research approach and the case studies serving as the basis for this thesis. In addition, it contains details of each case study and the methods used to collect and analyse the data. This allows the reader to review the quality of the research. Finally, the chapter ends with a discussion on the validity and the reliability of the research.

3.1 Methodological approach

Research is an organised, systematic, data-based, critical, scientific inquiry or investigation into a specific problem, undertaken with the objective of finding answers or solutions to it (Sekaran, 2006). A researcher’s philosophical point of view reveals his or her stance in making assumptions and selecting methods to conduct the research. Hudson and Ozanne (1988) stated that four research paradigms exist with regard to the manner in which a researcher views the world: positivism, realism, constructivism, and pragmatism. It has been also mentioned that, sometimes, researchers may need to modify their philosophical assumptions over time and move to a new position on the continuum (Collis and Hussey, 2013). The research contained in this thesis is positioned between interpretivist and pragmatism. In contrast to a positivist researcher, who accepts the existence of a single objective reality (Hudson and Ozanne, 1988), that could be extracted by means of clear research topic, appropriate hypothesis, and adopting a research method while being detached from the participants (Carson et al., 2001), an interpretivist believes that reality is relative (Hudson and Ozanne, 1988). From an interpretivist’s perspective, it is difficult to interpret reality as fixed while it is socially constructed (Carson et al., 2001) through a mutual interaction between the researcher and the participants. Additionally, because the aim of pragmatic research is to support action (Saunders et al., 2011), and since the current research was performed with the aim of supporting actions regarding the coordination of an IMN, the research is therefore affected by philosophy of pragmatism.

An abductive approach has been taken in this thesis, because it gives a new insights to existing phenomena by examining these from a new perspective (Kovács and Spens, 2005). The abductive approach neither follows the pattern of pure deduction, nor of pure induction (Taylor et al., 2002). Abductive reasoning emphasises the search for suitable theories to make an empirical observation, what Dubois and Gadde (2002) call ‘theory matching’. This provides an opportunity to go in ‘back and forth’ directions between theory and empirical studies, in order to suggest a suitable theory and then apply it (DuBois and Oliff, 1992).
The abductive approach suited this research, because the goal was to extend the existing theories. Using the abductive approach, the researcher started with some theoretical knowledge related to the topic. However, to examine closely this starting point, the objective has been to perform ‘theory matching’ i.e. to find out if those theories matched the empirical findings, and vice versa.

3.2 Research process

The motivation for the research in this thesis was to overcome the coordination-related challenges of manufacturing companies within a multi-plant setting. And the aim was to develop a knowledge-base by creating pragmatic and research-based solutions, namely to support global operation managers in the coordination of their IMN.

The research process is defined as: ‘the sum of all the sequential steps that a researcher engages in that are necessary for following the path of a specific research’ (Kovács and Spens, 2005). This research is composed of five empirical studies (labelled I-V) and three main literature reviews. Figure 11 provides a schematic overview of the empirical studies and the literature reviews against the timeline of the doctoral study.

The literature reviews were carried out in order to acquire the fundamental knowledge relevant to the research area, and also to develop a theoretical reference for the studies as a part of the design phase (Yin, 2009). In parallel with the empirical studies, literature reviews strengthen the ground and increase the legitimacy of a research project (Karlsson, 2009). A summary of the reviewed literature was presented in Chapter 2.

![Figure 11](image)

*Figure 11 – The studies performed, including literature reviews and empirical studies.*

The research project began in October 2012 with studies reviewing general literature in the P/OM area (particularly the flexibilities of production systems), in order to define and clarify relevant research questions. After screening the literature and having joint discussions with the industrial partner, initial research questions were formed. The research questions were refined during the process. However, the boundaries of the research were
always kept within the management of an intra-company IMN. The preliminary results of the studies up to and including case study II, were summarised in a published licentiate thesis that was presented at the end of November 2015. After the licentiate phase, the research questions were refined and three more studies were conducted. At this juncture there were also some changes in the supervision constellation, both in the academia as well as the industry. Each case study has resulted in respective publications that are appended to this thesis. And the overall result of the research project is contained in this thesis.

All of the studies were of a qualitative nature. This suited the nature of this research, because the interpretivist discipline is socially constructed by using qualitative methods, such as unstructured interviews and participant observations, rather than determined by mathematical models and statistics (Carson et al., 2001). The research path did not follow a rigid direction: it evolved along the way. The dynamic relations between the constructs of such a qualitative research (research objective, theoretical framework, research method and research questions) made the research path evolutionary (Maxwell, 2012). Therefore, the studies and their focus were not entirely defined in advance. Instead, they were dependent on the results of previous studies as well as the feedback from the supervisory team (both at the academy and in industry). The adoption of a flexible research path was consistent with the epistemological positioning of this research as an interpretivist adopts a more flexible research structure (Carson et al., 2001), one that is more receptive to the capture of meaning in human interaction (Black, 2006). Due to the complex, multiple and unpredictable nature of what is perceived as reality in such positioning, the prior knowledge from previous research is insufficient for developing a fixed research design (Hudson and Ozanne, 1988).

That being said, a model suggested by Blessing and Chakrabarti (2009) was used as an overall guide in taking the main steps of the research project (see Figure 12). The design of the research methodology (DRM) includes four distinctive stages: research clarification (RC), descriptive study I (DS I), prescriptive study (PS), and descriptive study II (DS II). The studies conducted in this research were either of the clarifying or descriptive types, except for the developed framework, which was prescriptive. The application of the models and framework developed in this research could be performed in future as DS II.
During the RC phase, in the first year of the study, the focus of the research was determined by studying the related literature and by the feedback from the industrial need. Next, DS I was conducted, which included the empirical studies. The PS concluded the work by producing a framework, which was the objective of this research. The techniques of data collection were of a qualitative nature. Detailed information about these techniques in each study is given in Section 3.4.

An interactive approach in an academia-industry tie

The research presented in this thesis was conducted as a part of the ‘Innofacture’ research school at Mälardalen University in Sweden. The project lasted for about six years (2012-2018), and involved ten industrial companies in Sweden and twenty PhD students. The project was mutually financed by the Swedish ‘Knowledge foundation’ (KKS) and the participating companies. The purpose of the research initiative was to increase competitiveness and create value both for the university and the industrial partners in Sweden.

Because the research was conducted in a collaborative context, involving academia (namely the researcher and the academic supervision team on the theoretical front) and industry (namely the participating company and the industrial supervisors on the empirical front), an interactive research approach was adopted (see Figure 13). Interactive research is characterised by a continuous joint learning process between the researcher and the participants, where the main focus is on the outcome of the research in terms of new theories and concepts (Svensson et al., 2007). In this approach, the researcher strives to establish a close collaboration with practitioners to conduct practically-oriented studies, a task that is not usually a part of traditional research (Ahlström et al., 2007). Although, sometimes, the researcher and practitioners had different objectives in performing such

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4 http://www.mdh.se/idt/forskning/forskarskolor/innofacture?l=sv_SE
research, they both focused on joint learning about the coordination of an IMN through a multi-step process.

The research project coincided with a project initiated in the main company studied in this research. The project was supervised and led by the Chief Operating Officer (COO) of the company and managed by the researcher. It aimed at developing a model for managing the network of company A, and henceforth was called XNMS. The XNMS project was ongoing between the years 2012 to 2017 and involved people with key roles at the network level. Each person was responsible for a part of the project (internally called a ‘module’). The project included six modules, each one focusing on a particular aspect that was crucial for the management of the company’s network. Figure 14 illustrates the structure of the project, including the modules and responsible persons.

The project team met usually every two months (mostly in the HQ in Sweden). This resulted in 17 meetings during the PhD study period. Each meeting had a specific theme. All
meetings followed a similar agenda where, initially, there was a discussion of important activities and events, both internally in the network and external to the network. Then, the theme of the meeting (i.e. the main focus of the meeting that normally was a certain module of it) was discussed. In this part, the participants were free to bring up different examples from different plants and projects related to the theme of the meeting. The ‘responsible person’ had to document and build a framework for his or her specific module. Each meeting was concluded by some final feedbacks and planning of the next steps. A summary of each meeting was saved in the intranet of the company. During the project, the company initiated several global projects which involved a few plants at the same time. The fact that the XNMS project members were actively involved in such network-level projects provided valuable input into the project.

3.3 Research method

A case study method was chosen as the main research methodology in order to conduct the constituent studies of this research project. A case study is an empirical inquiry that investigates a contemporary phenomenon (the ‘case’) in its real-world context and suits for enquiring the ‘how’ and exploratory ‘why’ type of research questions (Yin, 2009). Furthermore, the current research is of a qualitative nature. Qualitative research can be conducted by using a variety of research methods. Case study enables gathering a rich set of data (particularly qualitative data) from practice, in order to facilitate the understanding of a phenomenon from different aspects (Voss et al., 2002). Another unique advantage of the case study method for exploratory studies is its ability to adjust the collection of data during the research process (Eisenhardt, 1989). Furthermore, because IMNs are complex systems, the case study method has the advantage of being certain that researchers are making valid observations and contributions to the body of P/OM knowledge (Stuart et al., 2002).

3.3.1 Case selection and case companies

This section of the thesis contains information on: the selected case companies, the plants that were involved in the studies, the rationale behind such choices, and some additional information regarding the main case company that was studied longitudinally.

The empirical data set for this research was collected from the network of four companies (see Table 4). However, the majority of data was collected from the network of company A. Therefore, the data collection comprised of:

- An in-depth, longitudinal case study of the main case company (company A) for the research project over five years, and a joint project including four workshops, meetings, visits to the plants and informal discussions.
- Complementary data from three other case companies (companies B-D).
Table 4 – Key characteristics of the participating case companies and their degree of involvement

<table>
<thead>
<tr>
<th>Company</th>
<th>Company A</th>
<th>Company B</th>
<th>Company C</th>
<th>Company D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (employees)</td>
<td>~1200</td>
<td>~132,000</td>
<td>~40,000</td>
<td>~15,000</td>
</tr>
<tr>
<td>Manufacturing footprint</td>
<td>11 plants, 6 countries</td>
<td>34 plants, 27 countries</td>
<td>15 plants, 7 countries</td>
<td>17 plants, 10 countries</td>
</tr>
<tr>
<td>Industry sector</td>
<td>Automotive, construction and mining, general industries</td>
<td>Robotics and power and automation technology</td>
<td>Automotive</td>
<td>Mining and construction</td>
</tr>
<tr>
<td>Products</td>
<td>A wide range of driveline and transmission components</td>
<td>Industrial robots, Automation solutions, High voltage transmission</td>
<td>Commercial vehicles and diesel engines</td>
<td>Construction equipment</td>
</tr>
<tr>
<td>Product variety</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Process complexity</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Data incorporated</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Case study I</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Case study II</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Case study III</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Case study IV</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>○</td>
</tr>
<tr>
<td>Case study V</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

The case companies were chosen according to the criterion that each had to have an internationally-dispersed presence, which included at least 10 production plants in different continents, in order to be a suitable example of an IMN. All the companies in this study met this criterion, and so represented a suitable case to be studied in this research.

In addition to global dispersion, the IMN of company A had recently expanded with new plants that were added to the network, both through mergers and acquisitions (M&A) or organic ‘green field’ development. The dispersion and diversity of the plants, in terms of their products, processes and existing micro-cultures, made company A a suitable choice for being a longitudinal case. More information regarding company A and its IMN is provided in the following section.

3.3.2 The main case company

Company A was an international contract manufacturer in the sectors of: automotive, mining and construction, telecommunication and general industry. At the time of writing this thesis, the company operated 11 production plants in six countries. Headquartered in
Sweden, the company’s IMN produced a wide range of mechanical and electromechanical components. Figure 15 shows the number of plants and their geographical location.

Each study herein looked at a certain aspect of the IMN of the company A. This is elaborated in detail in section 3.4. Because the researcher was present at the headquarters (HQ) of company A, most of the data were collected from the senior managers, production engineers, etc. present at the HQ of the company. That being said, during the research project the researcher visited plants in Germany, Brazil, and the majority of plants in Sweden, where key people were interviewed (e.g. plant managers and production engineers).

Although the company’s plants supplied a variety of products to the automotive, construction, mining, telecommunication and general industries, the majority of the current research is a result of studying the plants involved in supplying the automotive sector, and in particular commercial vehicles. Focusing the case study on a homogenous product group was recommended by Feldmann (2011), because it leads to less ambiguous research results. This focus on the production of commercial vehicles meant that a plant in Sweden and a subsidiary plant in China were excluded from this research study because they supplied the telecommunication sector.

Since its establishment in 1982, the network of this company has grown from a single plant to 11 plants in six countries. The company’s IMN was quite young, and most of its plants were established after 2010. Similar to other IMNs, the evolution of the network took many years, and the plants acquired various types of knowledge, both internally from the
company’s plants and externally through other sources. More information about the plants within the IMN of company A and their evolution is provided in Chapter 4.

3.4 Case studies and their specifications

In total, five case studies were conducted. Figure 16 provides a visualisation of how the studies are related to the research questions of this thesis, as well as the resulting publications. Furthermore, Table 5 provides a detailed overview of the empirical studies including the: case companies involved, topic of each study, contribution to the research questions, unit of analysis in each study, data collection techniques, study outcome and resultant papers (appended to this thesis).

![Diagram of case studies and research questions relationship](image-url)

*Figure 16 – The performed studies and their relation to the papers and research questions*
<table>
<thead>
<tr>
<th>Case study</th>
<th>No. of case companies</th>
<th>Study subject</th>
<th>Contribution to RQs</th>
<th>Unit of analysis</th>
<th>Data collection techniques</th>
<th>Study outcome</th>
<th>Related paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1</td>
<td>Challenges of a contract manufacturer’s production networks</td>
<td>RQ 1</td>
<td>IMN of a global contract manufacturer with a focus on challenges and opportunities</td>
<td>Interviews, documents, observations</td>
<td>Mapping two different types of production networks and their respective challenges and opportunities</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>1</td>
<td>Commonalities among the plants in an IMN of a global contract manufacturer</td>
<td>RQ 2 (indirectly)</td>
<td>Plants of a global contract manufacturing and their interrelations</td>
<td>Interviews, documents, observations</td>
<td>Increased understanding of the synergies among plants of a global contract manufacturer, Identification of commonalities among an IMN’s plants</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>1</td>
<td>Interrelations among the network capabilities of an IMN</td>
<td>RQ 2</td>
<td>Network capabilities of the Company A’s IMN and their interrelationships</td>
<td>Interviews, documents, observations</td>
<td>Insight to the interrelation between network capabilities of an IMN</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>3</td>
<td>Knowledge transfer within IMNs</td>
<td>RQ 2</td>
<td>Knowledge transfer projects in the IMN of the studied cases</td>
<td>Interviews, documents, observations</td>
<td>Mapping of internal/external knowledge flows, Increased knowledge on KT process in IMN context</td>
<td>4</td>
</tr>
<tr>
<td>V</td>
<td>3</td>
<td>Coordination of IMNs, an industrial practice</td>
<td>RQ 1 (indirectly)</td>
<td>Coordination practices in IMN context</td>
<td>Interviews, documents, observations</td>
<td>Increased understanding on IMN coordination, A coordination framework including guidelines on autonomy and coordination mechanisms</td>
<td>5</td>
</tr>
</tbody>
</table>
3.4.1 Case study I- The challenges of a contract manufacturer when managing its IMN

Case study I was performed in order to understand the challenges of operating a multi-plant network of geographically-dispersed production plants for a contract manufacturing company. The unit of analysis in this study was the network of case company A, with a focus on the challenges and opportunities it entailed.

Data were collected via semi-structured interviews. Also, informal discussions were held with people who had different roles in the organisation of company A and documents were studied where required. Ten semi-structured interviews were conducted in case company A (see Table 6). Given the extensive information provided by some respondents, some interviews had to be extended, resulting in multiple sessions.

<table>
<thead>
<tr>
<th>Source (XNMS Proj.)</th>
<th>Technique</th>
<th>No.</th>
<th>Participant (s)/Respondent (s)</th>
<th>Duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>Project meetings</td>
<td>17</td>
<td>XNMS project team</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Informal discussion</td>
<td></td>
<td>Other employees</td>
<td></td>
</tr>
<tr>
<td>Interviews</td>
<td>Semi-structured interviews</td>
<td>2</td>
<td>Chief Executive Officer</td>
<td>60, 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Chief Operating Officer</td>
<td>60, 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Production Manager</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Key Account Manager</td>
<td>60, 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Purchase and Sales Manager</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Supplier Quality Manager</td>
<td>60, 30</td>
</tr>
<tr>
<td>Documents</td>
<td>Company presentation</td>
<td></td>
<td></td>
<td>Unlimited access</td>
</tr>
<tr>
<td></td>
<td>Project reports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Working procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meeting reflections</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The purpose of the interviews was to gain an understanding of the challenges and opportunities presented by an IMN, as experienced by the people working in different roles and levels in the company.

During this study, four plants of the production network of company A were visited: two in Sweden, one in Germany and one in Brazil. Apart from a guided tour, the global production network of the company was explained by a Key Account Manager, and the strategy of the company was presented by the CEO of case company A.

The documents used in this study contained information regarding geographical distribution, core competence, product groups and customers of each plant in the network.
In order to achieve the goals of this study, after the initial steps of data analysis, i.e. data cleaning, codification and categorisation (Merriam, 2014), the data were searched for recurring patterns (Yin, 2009) around the main challenges regarding network management.

The researcher had the main responsibility for planning and conducting the study, by gathering data from the IMN of the company A.

### 3.4.2 Case study II- Commonalities among plants in a contract manufacturer’s IMN

Case study II was a single case study performed at company A. The aim was to identify the potential for synergy among the production plants in the global network. The unit of analysis in this study was the interrelations among the plants in the network. Data were collected through interviews, observations and documents, as described below.

In total, ten semi-structured interviews were conducted in this study: details are provided in Table 7. All the respondents except an external one (Executive Supplier Quality Manager) were based at the company’s HQ. They all had responsibilities at a network level, and therefore their jobs related to other production plants in the network. Also, due to the extensive amount of information provided by some of the respondents, multiple sessions of interviews were organised.

<table>
<thead>
<tr>
<th>Source</th>
<th>Technique</th>
<th>No.</th>
<th>Participant (s)/ Respondent (s)</th>
<th>Duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observations</strong></td>
<td>Project meetings</td>
<td>17</td>
<td>XNMS project team, Other employees</td>
<td>90</td>
</tr>
<tr>
<td>(XNMS Project)</td>
<td>Informal discussion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GEMBA Meetings</strong></td>
<td>Operation meetings</td>
<td>2</td>
<td>Operation managers, production engineers from the headquarters</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Interviews</strong></td>
<td>Semi-structured interviews</td>
<td>3</td>
<td>Chief Executive Officer, Chief Operating Officer, Production Manager</td>
<td>120, 90, 60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Chief Operating Officer, Production Manager</td>
<td>90, 90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Key Account Manager, Supplier Manager</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Executive Supplier Quality Manager</td>
<td>120</td>
</tr>
<tr>
<td><strong>Documents</strong></td>
<td>Company presentation, Project reports, Website content, Meeting reflections</td>
<td></td>
<td></td>
<td>Unlimited access</td>
</tr>
</tbody>
</table>

Table 7 – Details of the interviews conducted in case study II
The respondents were selected based on their roles on a global level in the organisation, and their knowledge about the plants of the network. An external respondent was also interviewed, as suggested by the CEO of company A, due to his continuous contact with the case company as the ‘supplier quality manager’, and him having an unbiased point of view about the different plants. The interviews were carried out based on an interview guide designed to bring forth the related theories for discussion. The interviews covered the following topics: the challenges and opportunities of a global production network from a business and an operational perspective, and the challenges and opportunities of the production network from a managerial perspective.

In addition to the plants visited during case study A, one new production plant of the company in Sweden was also visited. The plants in China and Hungary, and one of two new plants in Sweden that joined the network in 2014, were not covered in this study.

The documents used in this study contained information on: the layouts of three production plants, the product portfolio of the case company (e.g. axle components, gearbox and gearwheel and various shafts), and different processes (e.g. hard machining, soft machining, heat treatment, quality control, etc.) in the network plants.

The method of data analysis was similar to that used in the previous study. After the initial steps of organising the data, the dataset was searched for repeated patterns regarding the interrelations among the plants of an IMN as the unit of analysis.

The researcher’s role in this study went beyond being purely observatory, owing to his involvement in the XNMS project and the related project meetings. The researcher participated in the meetings as a project manager as well as researcher. So, the researcher had a facilitator role in the meetings as well, as he tried to introduce the existing related theories from the literature to the people involved (all having roles on the network level of the company). In addition, the researcher participated in two ‘Gemba’ meetings at the headquarters plant (Gemba meetings were management meetings that were held daily to control and set the right priorities and act and react in real time to disruptions) in which he was that of a passive observant.

3.4.3 Case study III- Interrelations among the network capabilities of an IMN

Case study III was of an exploratory nature. The objective of this study was to investigate empirically the interrelations among the different network capabilities i.e.: accessibility, thriftiness ability, manufacturing mobility, and learning ability. Understanding the network capabilities, and their interrelations, provides a substantial input into the process of strategy formulation for international manufacturing companies. The unit of study was the IMN of case company A, with a focus on the capabilities achieved from it and its interrelations.
Data were collected in two phases from case company A: firstly, on-site interviews were performed mainly at the senior management level who all worked with network-related issues; secondly, the company’s strategy documents were studied in relation to capability formations. Also, additional information was gathered from emails and other documents. Furthermore, the dataset was enriched by observations and informal talks in the XNMS project (see Table 8).

The main focus of analysis in this study was to investigate the interrelationships (either trade-off or accumulative) among capabilities on a network level. Therefore, the dataset was examined for any pattern where network capabilities affected each other.

<table>
<thead>
<tr>
<th>Source</th>
<th>Technique</th>
<th>No.</th>
<th>Participant (s)/ Respondent (s)</th>
<th>Duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations (XNMS Project)</td>
<td>Project meetings</td>
<td>17</td>
<td>XNMS project team</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Informal discussion</td>
<td></td>
<td>Other employees</td>
<td></td>
</tr>
<tr>
<td>Interviews</td>
<td>Semi-structured interviews</td>
<td>1</td>
<td>Chief Executive Officer</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Chief Operations Officer</td>
<td>90; 60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Chief Financial Officer</td>
<td>90; 60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Global quality manager</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Plant manager, China</td>
<td>90</td>
</tr>
<tr>
<td>Documents</td>
<td>Strategy documents</td>
<td></td>
<td></td>
<td>Unlimited access</td>
</tr>
<tr>
<td></td>
<td>Project reports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Working procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meeting reflections</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The researcher’s initial role in this study was to discuss the topic of network capabilities, so as to understand the ‘as-is’ status of network capabilities, and later to investigate the relationships among those capabilities. Furthermore, the researcher interacted with the respondents by bringing the theoretical definitions to the study and discussing them in a practical context.

3.4.4 Case study IV - Knowledge flow and knowledge transfer within IMNs

Case study IV was a multiple case study that was conducted in three parts. The first part focused on ‘what’ different knowledge flows, both within and outside an IMN are. Firstly, data were collected from three knowledge transfer (KT) projects at case company A. The unit of analysis in the first part of this study was the knowledge flows (internal and external) in an IMN. In the second and third part, the data set was expanded by adding data from two KT projects at company B and one KT project at company C. The focus of the second and the third part was on ‘how’ the transfer process was conducted. The unit of analysis in the second and third part of this study was the KT projects and KT processes respectively.
Six KT projects were studied, each of which had different orientations. More information on the collection of data in this study is provided in Table 9.

<table>
<thead>
<tr>
<th>Source</th>
<th>Technique</th>
<th>No.</th>
<th>Participant (s)/Respondent (s)</th>
<th>Duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>Project meetings</td>
<td>17</td>
<td>XNMS project team</td>
<td>90</td>
</tr>
<tr>
<td>(XNMS Proj.)</td>
<td>Informal discussion</td>
<td></td>
<td>Other employees</td>
<td></td>
</tr>
<tr>
<td>Interviews</td>
<td>Semi-structured</td>
<td>2</td>
<td>Project leader</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>interviews</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Heat treatment specialist</td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>2 Global manager XPS</td>
<td></td>
<td></td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>1 Global project director</td>
<td></td>
<td></td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>1 Gear cutting technician</td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>1 Gear grinding specialist</td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>1 Machining technician</td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>1 Manufacturing process specialist</td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>1 Chief financial officer</td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>1 Managing director</td>
<td></td>
<td></td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>2 Production and maintenance</td>
<td></td>
<td></td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>1 Global quality coordinator</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>1 Global quality manager</td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>1 Global industrial development manager</td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td>Documents</td>
<td>Project reports</td>
<td></td>
<td></td>
<td>Full access</td>
</tr>
<tr>
<td></td>
<td>Internal communications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technical documents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Working procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meeting reflections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internal newsletter</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The researcher’s involvement in this study was also one of observation, in the sense that the researcher did not affect the reality being studied. However, the researcher participated in the study to investigate the KT projects at the main case company (where he was employed) and the two other case companies. The study had three goals: to identify different knowledge flows within and into an IMN, to study KT project types in a multi-plant context, and to study the KT process in order to provide a holistic perspective on it. In order to fulfil the objectives of study IV, a multiple case study, consisting of three sub-studies was planned and executed (labelled as Case IV-A, Case IV-B and Case IV-C), each with somehow different purposes and approaches. As shown in Figure 17, the motivation behind conducting multiple studies was to build a comprehensive body of knowledge by consolidating the findings of the sub-studies. Hence, three cases were chosen to complement each other and cover a wider range of data.
3.4.5 Case study V- Coordination of IMNs, an industrial practice

Case study V explored the key issues of coordination, as well as the coordination modes and patterns (practices) used in three organisations that had different strategic IMN structures. The purpose of this case study was to identify the key issues in the coordination of an IMN, as well as the associated coordination practices within the case companies. Data were collected from the network of companies A, B and D. More information regarding the respondents and other data collection sources in this study is provided in Table 10.

![Figure 17- Research design of study IV](image)

Table 10 – Details of the interviews conducted in case study V

<table>
<thead>
<tr>
<th>Source</th>
<th>Technique</th>
<th>No.</th>
<th>Participant (s)/Respondent (s)</th>
<th>Duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>Project meetings</td>
<td>17</td>
<td>XNMS project team</td>
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<tr>
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<td>Informal discussion</td>
<td>Daily</td>
<td>Other employees</td>
<td></td>
</tr>
<tr>
<td>Interviews</td>
<td>Semi-structured</td>
<td>1</td>
<td>Chief financial officer</td>
<td>90</td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
<td>1</td>
<td>Global quality coordinator, Plant manager, China</td>
<td>100</td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
<td>1</td>
<td>Global quality manager</td>
<td>90</td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
<td>1</td>
<td>Global industrial development manager</td>
<td>90</td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
<td>1</td>
<td>Global manager XPS</td>
<td></td>
</tr>
<tr>
<td>Documents</td>
<td>Project reports</td>
<td></td>
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<tr>
<td>Documents</td>
<td>Technical documents</td>
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<tr>
<td>Documents</td>
<td>Working procedures</td>
<td></td>
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</tr>
<tr>
<td>Documents</td>
<td>Meeting reflections</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

The unit of study in study V was the IMN of the three participating companies and their coordination practice. Specifically, it was tried to understand the mentality of senior
management with regard to the establishment of rules relating to institutional autonomy, as well as the management and transfer of information and knowledge within their network.

The researcher’s involvement in this study differed from one case to another. As mentioned earlier, the researcher was the project manager of XNMS at company A. Thus, the level of interaction and participation in this study was considerably higher in comparison to the other cases. In this case study, the researcher participated actively in the project meetings and discussed the theories related to the practices at company A. Concerning other cases, there was less interaction between the researcher and the interviewees, where the focus was mostly on how the IMNs were coordinated.

The objective of the analysis was to identify the routines, methods and tools that were used to coordinate the non-physical flows at the case companies.

3.5 Data analysis

Qualitative data analysis is essentially the process of making sense of data, by consolidating, reducing and interpreting what people have said and what the researcher has seen and read, which will later be communicated to others via reports, books and articles (Merriam, 2014). If qualitative research is to yield meaningful and useful results, it is imperative that the material under scrutiny is analysed in a methodical manner (Attride-Stirling, 2001). There are as many ways of going about making sense of data as there are methods and techniques to produce data. The different qualitative analytical techniques are often aligned with particular methods, theoretical positions, disciplinary areas or topic areas (Merriam, 2014).

First of all, the analysis of the data was conducted as an interaction of theory and the data collected (Miles and Huberman, 1994). The literature reviewed was classified primarily by its focus and then stored in a database. The data collected in the case studies, including interview audio and text files, and notes from observations and document files, were also documented and stored in separate folders.

The qualitative data were analysed using the structure and guidelines proposed by Merriam (2014). The data analysis followed a common path in all of the studies. First of all, it was checked that the transcription was conducted correctly. Typographical errors were corrected and input from multiple sources was adjusted. All interviews were transcribed, saved as separate word-processed files and stored along with their respective transcriptions in a database. Also, data collected from documents and observations were stored with the related studies in the database.

After this stage, data were coded (by phrases, numbers and sometimes colours) as a basis for categorising the data and finding themes (compatible with the body of literature), to which data were sorted (Merriam, 2014). For instance, in the Study IV-2, the collected data were related and categorised based upon the two dimensions of speed and complexity.
During the coding and categorising of the data, self-memos were written to retain the patterns that recurred, as proposed by Saunders et al. (2011). Then, an attempt was made to make sense of the data, in line with the related theories. Making inferences about the data was necessary in order to move up from the ‘empirical trenches’ to a more conceptual overview of the landscape, as described by Miles and Huberman (1994).

The process of data collection and analysis in this research was recursive and dynamic, meaning that the analysis became more thorough as the study progressed, and that the analysis was not necessarily finished when the data had been collected (Merriam, 2014).

3.6 The role of the researcher

Being an industrial PhD student, the researcher had continuous presence, including project management responsibility in company A during the project timeline from October 2012 until November 2017. The time distribution between the academic project and the industrial work was 80 % and 20 %, respectively. Thus, a key aspect of the research was the presence of the researcher in the case company, which facilitated a better understanding in greater depth compared to a few sporadic visits, which otherwise is often the case. This was particularly valuable because it enabled groups of people to be accessed and observations to be made of the production plants, which would have been unlikely otherwise. Also, immersion in the industrial environment and visits to diverse industries made it possible to interact closely with those involved in the collection of data, which in turn helped the researcher to become aware of their challenges and approaches.

The role of the researcher during the studies changed gradually over time, from being solely a passive observer to a participant-observer, which created a distinctive opportunity to perceive reality from the viewpoint of someone ‘inside’ a case rather than someone external to it (Yin, 2009). The challenge regarding participant observation is, however, that of being biased and risking objectivity. Davison et al. (2004) suggest avoiding over-identification with the organisation and its members, in order not to sacrifice objectivity. To tackle this, other external researchers and senior researchers were involved, in order to review carefully the findings of the research. For example, two PhD students from universities in Germany and Switzerland cooperated in studies I and V, respectively. They contributed data from other sources, as well as participating in the analysis and creation of the results. Also, in study IV, two fellow researchers from other organisations in Sweden were involved in the data collection and analysis. In addition, three seniors (all having doctoral degrees, among them one professor) supervised this research project.

Another challenge, regarding conducting research at a physically dispersed organisation, is the capacity of the researcher to be present at the right place at the right time (Yin, 2009). However, the researcher was able to overcome this challenge because he had enough mobility to visit or communicate with people in different plants. Furthermore, owing to
project XNMS, it was possible to meet and interact with key people from the different plants that participated in the meetings.

3.7 Research quality

Research quality can be measured from different aspects, especially when the research is of a qualitative nature (Corbin and Strauss, 2008). The quality of the research is determined by its validity and reliability. There are two types of validity: internal (construct) and external (Saunders et al., 2011). Construct validity refers to the identification of correct operational measures for the concepts being studied (Yin, 2009). It is related to the level of conformity between what is actually studied and the intended subject of study (Saunders et al., 2011).

In order to improve construct validity, which can be problematic in case study research (Yin, 2009), data triangulation (Voss et al., 2002) was performed by means of collecting data from multiple data sources, such as interviews, observation and documents in all case studies. Furthermore, the interviews, which were one of the major sources of data in this research, incorporated several respondents from various roles in the organisation. Also, as mentioned in section 1.6, the findings were reiterated and verified by fellow researchers as well as the supervision team.

The external validity of research is associated with the generalisation of the findings of a study beyond its immediate environment. It has been mentioned that case studies, in particular those of prescriptive theory (Christensen and Carlile, 2009), can be generalized to theoretical propositions (Yin, 2009). However, it may not be appropriate to generalize the results of limited cases to a wider domain (Yin, 2009). Eisenhardt and Graebner (2007) mentioned that single-case studies provide a rich description of a phenomenon, whereas multiple-case studies have higher external validity (Voss et al., 2002). That being said, the results of this study are drawn from a limited number of cases. This makes it difficult to generalize the results to a wider scale. Nevertheless, the external validity of the results of this study was increased by employing two techniques. Firstly, based on the suggestions of Eisenhardt and Graebner (2007), a few more cases were added wherever possible that enabled the possibility of cross-case analysis of the data. For example, in study IV and V, multiple cases were incorporated (see Table 5). Secondly, further investigation in each study was done, as suggested by Christensen and Carlile (2009). For instance, in study IV, KT in an IMN context was studied further from different perspectives, in order to gain a valid view on the phenomenon.

Another aspect of research quality is the reliability of the research, which is defined as: ‘the extent to which the research results can be repeated’ (Arbnor and Bjerke, 2008). In other words, the research is reliable if another researcher is able to replicate the case study and achieve similar findings and conclusions (Yin, 2009). In order to increase the reliability of the research, it was transparent and carefully documented, as suggested by Gibbert et al. (2008). The studies conducted in this research project were all documented to a high degree,
including the interviews, observations and documents. Besides, all the interviews in studies I, III and IV were double-checked with the respondents after transcription and storage in the research database. In addition, a short diary was prepared for case studies II, III, IV, and V. Last but not least, due to constant change in the organisations and people involved, it would be impossible to recreate the exact constraints and conditions (and thus a full replication of the studies (Merriam, 2014)).
4 Summary of results

This chapter summarises the results of the case studies. In total, five case studies were carried out during the research project. More information on each study’s data collection and its results are presented in Chapter 3. The related papers to the case studies are appended later.

4.1 Case study I, IMN management challenges

Case study I was a single case study performed at company A that included a network of production plants located in different countries world-wide. The aim of the study was to understand the challenges associated with managing and coordinating an IMN. The findings from Study A, which are complemented by the findings of the other studies herein, are outlined briefly in the following categories:

- Importance of a clear autonomy in the network
- Transfer of culture and knowledge among the plants in an IMN
- Resource allocation to coordination activities
- Other challenges related to management of an IMN

4.1.1 Importance of a clear autonomy in the network

Based on the data collected from XNMS project meetings at company A, it was observed that there was a lack of clear guidelines regarding the distribution of decision-making power when conducting cross-plant projects. In other words, the responsibility of plants was not explicitly elaborated and communicated through the network. For instance, the global head of heat treatment described how the lack of a mandate from upper management had led to ambiguity and conflict in performing certain tasks in a cross-plant project. The progress of such projects was hindered by the interference of different (and sometimes conflicting) decisions, as well as varying interests. The lack of clarity on ‘who decides on what’ was mentioned frequently, as a hindrance in cross-plant projects at company A.

4.1.2 Transfer of knowledge and culture among the plants in an IMN

Furthermore, according to the interview in study I and by studying the documents (in another case) regarding a project to transfer knowledge from a Swedish plant to the plant in Brazil, it was revealed that the transfer of production know-how among the plants was a constant challenge. Normally, the company followed a routine that was internally called a ‘BOT’ (Build, Operate and Transfer). The ‘BOT’ concept, as the acronym suggests, included three steps. Firstly, a production cell, or the machine that was supposed to be added to a subsidiary plant, was ‘built’ in the plant in Sweden near the HQ. Then, the developed system was run in the presence of the operators and technicians from the
subsidiary plant, whereby they learnt how to ‘operate’ the machines. Finally, the whole system was ‘transferred’ to the subsidiary plant for it to be implemented and run. However, based on the data collected in this study and study IV (that looked deeper into the KT projects), the ‘BOT’ concept was not always a successful model for KT. Particularly, in larger KT projects at company A, it was not possible to transfer the knowledge in the limited time available to the operators and technicians of the subsidiary plants using this concept.

Another challenge, which was mentioned by both the CEO and the COO of company A, was the transfer of the company’s culture in a global context. The company’s culture (including the core values and XPS), along with transfer of production know-how, was mentioned as a challenge in the XNMS project meetings. The CEO of the company stated that: “The employees (in the subsidiary plants) need to be flexible to get converted into our way of thinking”. In this regard, the COO added that, before any acquisition, he has the responsibility for deciding whether a certain plant fits the IMN and where it fits exactly. For example, he explained that he had visited a nominated plant in Hungary that was supposed to join the network5, in order to analyse what the Hungarian plant could do in the company’s IMN, and to investigate how the plant would interact and cooperate with the other interdependent plants.

4.1.3 Resource allocation to coordination activities

It was also revealed from the discussions at the XNMS project meetings, as well as the reflection from a cross-plant project at company A, that the allocation of resources to network activities was challenging. Firstly, it was difficult to choose from the resources available at different plants for inter-plant projects, because each had a unique competence and cost. Secondly, there was occasionally some friction when obtaining resources from subsidiary plants while they tried to maintain their focus on the tasks at the local plants.

4.1.4 Other challenges related to management of an IMN

In an interview with the CEO of the company A, he emphasised that following the strategy of global customers was a significant success factor for the company. The global customers of company A had varying strategies in different markets. As a global contract manufacturer, it was particularly important for the plants of the company to have strategies in line with those of its customers. The production competence and production volumes in different plants of company A needed to be ‘pulled’ by the demand from global customers. It was also mentioned by the CEO that: “… our evolution is based on our developed global partnership… this turns us to be a strategic global partner. It is a work that both the global giants (in our industry) and the local customers will benefit from.” In his opinion, an IMN consisted of fully-owned factories, bearing the branding of the parent company, which would be able to

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5 This plant was added to the network later in 2016 and succeeded to meet its strategic goals and adopt the XPS of the Company A to an acceptable level.
supply its customers with products that were produced locally but to a global standard of quality.

In addition, the CEO of the company referred to the legislations and regulations in different countries as a challenge that influenced the company’s business. He stated that, although the company had certain processes for expansion (both by M&A and green field development), different local legislations made each plant development processes ‘one of a kind’. In other words, no process of plant establishment was exactly the same as another one due to local legislations in the related market. As an example, some production equipment had to wait a few extra months to be cleared by customs during the establishment of a plant in Brazil. This was an unwanted but unavoidable circumstance, due to the national regulations in that country.

4.2 Case study II, Synergetic potentials within an IMN

Case study II focused on the plants of the IMN of company A. The aim was of this study was to explore and identify the commonalities among plants in an IMN that have the potential for creating synergies among those plants.

The data regarding the product portfolio of company A were gathered from presentation documents of the company and its subsidiary plants, together with the company’s website. It was discovered that the company’s product portfolio included a wide range of products that were, in turn, related to various production processes in the different plants of the network. Although some products and/or processes were found in several plants, others were unique to a specific plant. As an example, some of this information is shown in Table 11. As listed in the, some processes, such as: turning, milling, and end milling were common among the plants of the network. However, some other processes were unique to a certain plant. For instance, the process of case hardening was only performed in the plant in Sweden near the HQ, and the process of friction welding was performed exclusively at a plant in the north of Sweden.
**Table 11 – Examples of production processes in some plants of Company A**

<table>
<thead>
<tr>
<th></th>
<th>Sweden 1</th>
<th>Sweden 2</th>
<th>Latvia</th>
<th>Brazil</th>
<th>Germany</th>
<th>Hungary</th>
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<td>Turning</td>
<td>●</td>
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<td>●</td>
<td>●</td>
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</tr>
<tr>
<td>End milling</td>
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<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Curvic milling</td>
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<td>●</td>
<td>●</td>
<td>○</td>
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<td>Spline milling</td>
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<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>○</td>
</tr>
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<td>Diameter grinding</td>
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<td>●</td>
<td>●</td>
<td>●</td>
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</tr>
<tr>
<td>Centreless grinding</td>
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<td>●</td>
<td>●</td>
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<td>○</td>
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<tr>
<td>Induction hardening</td>
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<td>●</td>
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<td>●</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Case hardening</td>
<td>●</td>
<td>●</td>
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<td>Annealing</td>
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<td>Threading</td>
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<td>●</td>
<td>●</td>
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</tr>
<tr>
<td>Tumbling</td>
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<tr>
<td>Friction welding</td>
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<td>Assembly</td>
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<tr>
<td>Broaching</td>
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<tr>
<td>Painting</td>
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<td>Straightening</td>
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<td>Balancing</td>
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<td>Crack detection</td>
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<td>Spline shaping</td>
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<tr>
<td>Spline hobbing</td>
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<td>○</td>
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<tr>
<td>Shot pinning</td>
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</tr>
</tbody>
</table>

Within the IMN of the case company A, some of the products were produced in more than one plant. This created the potential for a synergetic cooperation between those plants. One example of such products was explained in the interview of the CEO, when he said that propeller shafts were produced in two plants: one in Sweden and one in Brazil (as shown in Figure 18). The darker line in the Figure 18 indicates an example of a strong relation (common product, production process or a complementary process) between two plants, which in this case was due to producing a common product. The other lines simply denote a network structure.
Based on the interview with a production manager at the Swedish HQ and the documents regarding the product and process portfolio of company A, it was revealed that some processes were common to certain plants in the network (see Table 11). One example of such a process was gear cutting: this was performed in plants both in Germany and Sweden (see Figure 19). The darker line in this figure indicates an example of a strong relation among certain plants due to having common processes. The other lines simply denote a network structure.

Furthermore, it was revealed from the interviews and documents that, in general, the processes could be divided into two distinct types: production processes and complementary processes. Production processes are those used directly to produce parts, such as: turning, milling, and gear hobbing. Complementary processes are not used directly to produce parts, but are required as a complement to a production process. Examples of such processes are: measurement, calibration, and project management.
In all cases, whether production or complementary processes, there was the potential for synergetic collaboration among plants. Apparently, lead plants had more responsibility regarding each synergetic area to support other plants of the network that struggled with the challenges in those areas.

Further analysis of the data revealed that the market was also a significant, common factor between certain plants that could lead to synergetic effect. In this regard, the role of the marketing and sales department was particularly important, because it needed to circulate new orders to make sure that the right product was assigned to the right plant. Also, apart from the intra-functional communication between the marketing departments, inter-functional communication between the marketing department and the production and engineering functions was necessary in order to ‘anchor’ the incoming orders with the plant managers and the related production experts, so as to achieve the best solution, which may include compromises on different aspects.

4.3 Case study III- Interrelations among the network capabilities of an IMN

The goal of case study III was to investigate the relationships among the network capabilities in IMN context. The interviews of the senior management team at company A indicated that there was not a structured way to measure the network capabilities. In contrast, the company used the ‘Balanced Scorecard’ technique to measure systematically the performance of each production plant, and to summarize the results in a group scorecard. Neither were network capabilities discussed in the strategic management of the network. However, the company accepted the possibility of developing new models, which could give more consideration to the global setting of the company, so as to measure the network’s performance.

The interviews of the CEO and CFO of the company revealed that they had a strategy to make the maximum use of the existing competences available in all of the plants. Therefore, employees from certain plants were invited to join cross-plant teams in specific projects, in order to develop more efficient production systems (mobility). This was particularly crucial during the expansion phase, because it enabled the company to gather people from the lead plants in certain competence areas (such as gear cutting and heat treatment) to support plants with lower strategic roles, to ensure a cost-efficient production ramp-up. Furthermore, the company moved some processes, and consequently the associated production equipment (mobility), from cost-intensive plants to low-cost manufacturing plants in order to reduce the cost of production.

The results of study III revealed some relations among the network capabilities. It was revealed that manufacturing mobility was related to thriftiness ability across both cases, although the nature of the relationships was different. In some cases, a trade-off relationship was identified between manufacturing mobility and thriftiness ability: the
higher the level of manufacturing mobility, the lower the level of thriftiness ability. From the interview of the COO of the company A, it was realized that the company had redundant production flows across some factories that allowed the operation to continue, in case of failure or increased customer demand, by spreading the specific product’s volumes among the network plants. These redundancies ensured the delivery of products to the main customers, which was strategically important for the company due to the nature of its business as a global contract manufacturer. However, having redundancies in its IMN reduced the firm’s ability to realize high levels of cost savings through economies of scale and scope and reduced duplications of activities (lower thriftiness). Nonetheless, the redundant activities and competencies across factories were promoted sometimes, because of the firm’s strategic emphasis on delivery, while low production costs in specific cases were of minor importance.

In contrast, a cumulative relationship between manufacturing mobility and thriftiness ability was observed in another case\(^6\). The first one was necessary in order to benefit from the latter. In this case, manufacturing mobility was a pre-requisite to realize high levels of thriftiness ability, because the company showed flexibility with bundled orders and production volumes at factories whenever it identified that bundling resulted in favourable effects of scale and efficiencies. When there were several orders in the same product category, they were bundled at one factory to temporarily realize scale effects, and thereby thriftiness ability. The flexible bundling of orders and production volumes was an important strategy for the firm to increase its cost competitiveness.

So, opposing results on the nature of the relationship between manufacturing mobility and thriftiness ability across different cases were observed. The contradiction could possibly be explained by the different contingencies that the cases were facing. While fast and reliable deliveries, especially to key accounts, may be of major strategic importance for one company, production at low cost can be of equal strategic importance for another company. Thus, the different relative importance that these firms attached to cost and delivery, as important contingency factors characterizing the manufacturing function’s strategic emphasis, explain the findings and the different nature of the relationship that was observed between manufacturing mobility and thriftiness ability.

Furthermore, manufacturing mobility was connected with learning ability. The transfer of products between plants is basically associated with a transfer of know-how and knowledge regarding those products. Therefore, learning between factories can be a side-effect of moving products between factories. Besides that, based on the findings of this study, learning can also be an antecedent for manufacturing mobility. An exchange of know-how between plants, to transfer and share production competences, might be necessary before

\(^6\) The data from this case were gathered by a PhD student from St. Gallen University and analysed and compared to the data gathered by the author of this thesis. The results are reflected in a joint publication (see Paper 4 for more details on the study and its results).
an actual transfer of production volumes can take place. So, if correctly performed, increased knowledge and production know-how in the plants raises the mobility potential, and more mobility in the network enables increased learning ability. These findings are illustrated in Figure 20.

![Interrelations among network capabilities](image)

*Figure 20 – Interrelations among network capabilities*

### 4.4 Case study IV- Knowledge transfer between plants in three IMNs

This study was performed in three parts. The first part focused on the identification of knowledge flows within an IMN. The focus of the second part was on the categorisation of KT projects based on the tacitness of the knowledge being transferred. Finally, the third part of this study focused on the entire KT process and its success in general. The results are, therefore, clustered into three aspects. Firstly, different flows of knowledge were identified in an IMN, both among the plants of an intra-company network as well as from external sources. Secondly, different types of KT projects were identified. Finally, the KT process itself was investigated, so as to understand its characteristics and to provide a holistic framework with which to conduct successful inter-plant KT projects. The following section provides a summary of the results of this study.

#### 4.4.1 Knowledge flows within and outside of an IMN

The results of this part of the study referred to various knowledge flows in an IMN context, classified into two main categories: internal flows and external flows. Internal flows are the different types of knowledge that exist within the intra-company network of a company. On the other hand, external flows relate to the knowledge that exists outside the borders of a company’s IMN. Figure 21 provides a general illustration of the different sources of knowledge within and across an IMN, divided into internal and external sources.
The sources of internal knowledge flows were identified as:

- The knowledge resided at the plants near the HQ
- The knowledge resided at the subsidiary plants
- Specially trained and educated personnel
- Research initiatives within the firm

And the external sources of knowledge:

- Universities and governmental research institutes
- Consultant companies
- External experts entering the company
- Merged or acquired plants
- Strategic alliances and partners
- Suppliers and customers

The identification of knowledge flows is a prerequisite for:

- Mapping the existing knowledge flows and identifying the knowledge gaps
- The effective management of knowledge flows
- Ensuring the alignment of the existing knowledge with a firm’s strategy

In addition, it was found that the two main non–physical flows of knowledge in an IMN that need to be coordinated were: (1) knowledge of the XPS of a company, including cultural issues and production philosophy, and (2) production knowledge and know–how.
4.4.2 Knowledge transfer within an IMN

The objective of the second part of this study was to develop a model to categorize and gauge different types of KT projects. Gauging the KT projects, based on the type of knowledge and speed of transfer, will help to adopt a suitable strategy with regard to the characteristics of a KT project. Figure 22 presents the findings regarding the position of case projects on a two dimensional matrix that classifies KT projects into four zones based on two criteria: the degree to which the knowledge is either tacit or explicit and the speed of its transfer.

The KT projects in top-left quadrant (zone A) involve the transfer of certain types of knowledge that take a relatively longer time, such as the XPS of a company. KT projects in top-right quadrant (zone B) are those whose knowledge is transferred more quickly despite being complex. An example of a KT project located in the top-right quadrant is the transfer of manufacturing processes\(^7\).

Projects in the lower-right quadrant (zone C) aim to transfer explicit knowledge (e.g. instructions on specific product, customer, equipment, administrative routines and so on) that is required almost instantly in certain plants. These projects concern the transfer of those types of knowledge that are readily coded and thus can be transferred easily. The lower-left quadrant (zone D) contains the transfer of those types of knowledge that are explicit and are transferred over a longer time period. The knowledge in such KT projects can be coded to a high degree. The KT projects in this quadrant are of minor importance.

\(^7\) Knowledge complexity is relative as a certain type of knowledge may be complex for a person or organisation and it may be simple for another. However, in this study, the criteria for classifying a certain type of knowledge as complex is being tacit meaning its transfer would be impossible through a simple means of communication such as an e-mail or telephone call and involves the acquirer making changes to existing behaviours and capabilities (Grant and Gregory, 1997).
4.4.3 A holistic model for performing project in IMN context

Finally, in the third part of study IV, an attempt was made to provide a holistic model for performing a KT process. The model (henceforth called the ‘Network Learning Model’) covers multiple aspects of such a process. The model (including guidelines for each part) is outlined in Figure 23. It is built upon a synthesis of the findings from the case studies and the central linkage to the related theories. Basically, the model depicts an outline of the main factors that influence the quality of a KT process. It is a collection of different aspects that should be considered continuously before, during and after a KT project. Those aspects are explained further in Paper 6.

<table>
<thead>
<tr>
<th>Who</th>
<th>Relationship</th>
<th>Why</th>
<th>When</th>
<th>How</th>
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<tbody>
<tr>
<td>Have a list of the participating parties in the KT project, including their roles and autonomy level. Identify the knowledge carriers in the organisation and select the most suitable resource considering the project context. Identify possible intermediaries in the organisation that can increase the project cohesion by making bonds among the parties involved. Analyse and select the right knowledge recipient in the subsidiary plants.</td>
<td>Investigate the type of relationships: being aware of the dynamics and politics of the involved parties in a KT project, creating a social environment that brings the counterparts closer to each other, especially for involved parties with distant cultures.</td>
<td>Mark out the motivation behind such transfer.</td>
<td>Meticulous planning of time and resource: avoiding too many overlapping projects, performing risk analysis of disturbance in the resources, decreasing the unnecessary travelling costs for less complex projects.</td>
<td>Align the KT method to the type of knowledge, intensity of the project and the expected speed of transfer.</td>
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<tr>
<th>Key resources</th>
<th>Context</th>
<th>What</th>
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<tr>
<td>Specify the required resources, either internal or external to the company, considering the whole project timeline.</td>
<td>Study the background of the project and provide a realistic picture of the current status regarding the knowledge level on both sides.</td>
<td>Understand the type of knowledge: a sensible evaluation of the complexity level of the knowledge.</td>
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<tr>
<th>Follow-up</th>
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<tr>
<td>Measure to what degree the knowledge has been transferred.</td>
<td>A sophisticated analysis of the impact of a KT project on an organisation after its termination. Save the knowledge and experience regarding performed KT projects that can positively affect similar upcoming projects.</td>
</tr>
</tbody>
</table>

**Figure 23- The proposed learning network model for conducting KT projects in IMN context**

Having such a model helps the managers and production engineers that are involved in inter-plant KT projects to have a holistic outlook on the whole process and its multiple aspects. A combination of the models provided for gauging KT projects, and the Network Learning Model for performing KT projects, provides a systematic and long-term way of performing KT projects rather than the informal, ad hoc and most likely not well organised way that is usually the case (Ferdows, 2006).
4.5 Case study V- Investigating coordination practices at three IMNs

Finally, case study V explored the key issues of coordination, as well as the coordination modes and patterns (practices), used in three organisations with different strategic IMN structures. The results of this study elaborated how coordination in the IMNs of three multi-plant manufacturing companies was conducted.

A primary finding concerned the autonomy that existed in the network and how decisions were taken, with regard to the two fundamental knowledge flows in an IMN i.e.: XPS knowledge (including cultural issues), production philosophy and production knowledge and know-how (see Figure 24).

According to the data from the cases, the two main knowledge flows that were coordinated within those IMNs were: (1) the knowledge regarding the culture and XPS of a company, and (2) the production know-how. As illustrated in Figure 24a, four strategies could be assumed hypothetically based on how centralised or decentralised is the coordination of XPS and production know-how. Those strategies and the general positioning of three cases are depicted in Figure 24a and 24b, respectively. For example, the upper-right quadrant represents a situation where XPS and the production know–how are coordinated centrally. In other words, central management is more involved in the coordination of both XPS and production know–how.

![Diagram showing hypothetical strategies and case positioning](image)

*Figure 24- A conceptual model for centralization of XPS and production know-how*

Depending on the delegation of decision making power from the HQ or the central management to the local plants, hypothetically, four strategies concerning the XPS and production know-how could be identified. Nevertheless, in practice the autonomy policy differed from the model that has been presented. According to the interviews in study V,
together with the observations during the project duration, various factors could affect the amount of autonomy given to a plant, such as its: people and their competence, location, distance from the HQ, and surrounding culture of the home country. Figure 25 represents a more realistic demonstration of how the power to make decisions may be distributed in an IMN. As shown in Figure 25, not always is a single autonomy strategy applied to all plants of an IMN. The findings also revealed that the autonomy of plants varied over the time as a part of their evolution.

![Centralization of XPS and production know-how in practice](image)

Furthermore, the results of study V identified the need for mechanisms with which to ‘operationalise’ the coordination of an IMN. This will be discussed further in Chapter 5 of this thesis.

### 4.6 Summary of the empirical findings

From the findings of study I, it was concluded that a constant challenge in the management of an IMN is the transfer of knowledge that resides in certain plants to other plants in the network. This usually includes the transfer of the core values of the parent company from the HQ to the other plants, and of production know-how from lead plants to the other plants. Also, the results of this study showed the importance of investigating the plants’ role in the network and the way in which they interact with other plants. Furthermore, the legislations and regulations in specific countries in a global market were challenging company A and its plants.

The conclusion from the case study II was that the commonalities in the plants of an IMN, such as: common products, common processes, and common markets can be a basis on which synergistic collaboration between different plants can be created. However, the existing potential in the commonalities of the network plants can only be released by a systematic work that includes:
- Identification of the knowledge associated with the commonalities among the plants
- Building the related cross-plant collaborative teams
- Developing a strategy for the inter-plant collaborations and transfer of knowledge
- Implementing the coordination work to realise the inter-plant synergistic potential

Study III’s findings were related to the network capabilities. The study referred to some interrelationships among the network capabilities that an IMN can provide. Understanding the relationships among the network capabilities provides valuable input to the strategy formulation process. Without having insight to the interrelationships among network capabilities, conflicts may arise, due to certain trade-off or accumulative interrelations among the plants.

Study IV yielded insights into the different dimensions of knowledge within an IMN. Firstly, the study identified the different knowledge flows, both within and outside of an IMN. Secondly, the transfer of knowledge between the production plants of an international manufacturing company was investigated. A model was developed for categorising KT projects in an IMN, based on the complexity of the knowledge and the speed of its transfer. The results also included a holistic model of the different aspects of the KT process between the plants of an IMN.

Finally, study V described the coordination practices within three international manufacturing companies. The results of this study included descriptions of different autonomy policies in an IMN, and a model that enabled the classification of plants’ responsibilities in coordination activities. In addition, coordination mechanisms for the operationalisation of coordination were investigated.
5 Analysis

In this chapter the empirical findings obtained from the conducted studies are analysed. The analysis is based upon the research questions described in the Introduction. The findings are then compared to the frame of reference presented in Chapter two.

This chapter has three distinct parts. Firstly, the findings regarding the challenges faced in the coordination of an IMN are reviewed and analysed more explicitly. Next, there is a discussion of the findings primarily related to the general prerequisites for conducting coordination in an IMN. Finally, there is an examination of the mechanism that is required to conduct coordination in an IMN and manage those challenges. The process of data analysis itself has already been described in detail in section 3.5.

The backbone of the analysis undertaken in this chapter are the challenges associated with the coordination of an IMN (RQ 1), and the necessary steps for conducting coordination in an IMN environment (RQ 2).

5.1 Challenges related to IMN Coordination

The first research question of this thesis asked about the challenges related to the coordination of an IMN. In the following section those challenges are discussed in detail.

5.1.1 Challenges regarding the network governance and plants’ autonomy

One significant aspect of the coordination of an IMN is the steering and governance of the network, including the autonomy of network plants (De Toni and Parussini, 2010, Meijboom and Vos, 1997). Because one of the conditions that is necessary to accomplish coordination is accountability, i.e. elaborating who is responsible for specific elements of a task in an organisation (Okhuysen and Bechky, 2009), the contribution of each plant to the larger IMN should be clarified. Although the perception of accountability in organisations has evolved, from the traditional hierarchical authority perspective towards more of a bilateral interaction (Okhuysen and Bechky, 2009), there is still a need to clarify the level of autonomy of the plants, particularly during their interaction.

As mentioned in the findings of study IV, the lack of clear guidelines on the autonomy of plants in a particular inter-plant project led to confusion, frustration and monetary loss at company A. Also, during study V it was observed that the level of autonomy enjoyed by plants varied over time in the IMNs of all of the involved companies. This complicated the creation of an ‘autonomy balance’ among the plants of an IMN. From the analysis so far it is be concluded that:
There is a need for a model that delineates the degree of autonomy that is granted to IMN plants in their interactions. Such a model should be also flexible to allow for changes in the rules that apply to those plants.

The model of Ferdows (1997) and subsequent related research (see e.g. Vereecke et al., 2006, Feldmann and Olhager, 2013) concentrate on appropriate roles for plants of an IMN. These authors introduced ‘roles’ of a configurational nature for plants in an IMN, but they do not discuss explicitly the coordination aspect. What they elaborate on is mainly the involvement of a certain plant in the development of production and supply chain ‘bundles’ with respect to the reason for the establishment of that plant (Feldmann and Olhager, 2013). Although the model of Ferdows (1997) specifies that a lead plant has responsibility for KT within an IMN, it does not go beyond that and explain the role of other plants regarding the coordination of an IMN i.e. the role of a certain plant in the process of KT, its contribution to the coordination of resources, its autonomy level in inter-plant projects, its involvement in sending relevant information to the other plants, and so on. The research of Maritan et al. (2004) provides a deeper discussion on the autonomy of plants in IMN by stating that plants with different roles should have different degrees of autonomy. However, they rather focus on the ‘fit’ between the context of the subsidiary plant and systems used to manage it. Their results do not support their hypothesis regarding the autonomy of plants. Neither do their results provide a model to distinguish among the roles of plants regarding the coordination of an IMN (Maritan et al., 2004).

The analysis of the findings of this research, in particular study V in which the coordination practices of three MNCs where studied, revealed three classes of plants with regard to their coordination role in an IMN (Figure 26).

(1) Class A plants are actively involved in leading and initiating coordination activities. They have full autonomy in network activities. Plants in this class assign both dedicated and flexible resources for coordination activities. Such plants initiate, lead and conduct KT projects in a network. Based on the findings of study V, the lead plants in companies A, C, and D belonged to this class (in the related competence areas). For instance, a lead plant of company C in Sweden led the coordination work regarding both the XPS of the company and specific production know-how.

(2) Class B plants are those that take a supporting role and assist the Class A plants in network activities. The plants in this class do not initiate KT projects, but they may be involved in such projects under the supervision of Class A plants. Flexible resources from such plants are devoted to coordination activities, so as to avoid a lack of resource at Class A plants when multiple projects are being conducted simultaneously. Based on the data from study V, the plants with a contributor or source role demonstrated such characteristics. For instance, it was revealed in study V that a contributor plant in company A in Latvia, under the supervision of the Swedish HQ, acted partially as the sender in a KT project where it assisted the Swedish HQ to transfer a specific item of production know-how to a plant in Brazil.
(3) Class C plants are the plants with fewer responsibilities for coordination activities. Their responsibility is limited to following the coordination work and to being actively involved as recipients in KT projects. Based on the data collected in study V, offshore and server plants reside in this class. For instance, in the network of company D, two plants (one in India and one in Russia), both with a focus on the market (both server plants), belonged to this coordination class and received support from the Swedish HQ (Class A) as well as a plant in Brazil (Class B).

Because the role of a plant in an IMN is strongly related to its competence level (Feldmann and Olhager, 2013, Ferdows, 1997), any knowledge acquired by a plant in an IMN may affect its strategic role (Cheng et al., 2011). The same applies to the coordination-related role of a plant in an IMN. Mudambi and Navarra (2004) state that the increased intensity of knowledge to be found in plants in an IMN grants considerable strategic independence in all aspects of operations and, consequently, increases a plant’s intra-company bargaining power. For this reason, and also because the configuration and coordination aspects are tightly related, the model introduced in this thesis has been integrated into the configurational model of Ferdows (1997). Furthermore, the integration of configuration and coordination roles provides a simple, solid approach to the practical management of an IMN, as it provides transparent input into the contribution of an IMN plant to its structure (configuration) and infrastructure (coordination).

5.1.2 Challenges regarding knowledge transfer within an IMN

According to Watson and Hewett (2006), the ability to leverage the valuable existing internal knowledge and exploit locally created knowledge worldwide is critical in building competitive advantage for MNCs. However, as MNCs aim is to replicate their success beyond their national borders, they will need to focus not only on ‘what’ they should know, but also ‘how’ they need to diffuse knowledge throughout their enterprise (Schlegelmilch and Chini, 2003). As mentioned by the CEO of company A in study I, the transfer of knowledge from the lead plants (what he called ‘best practice’ plants) to the other plants
in the IMN was a key factor for network growth. Also, according to the findings of study IV, the transfer of production-related knowledge among different plants of an IMN was a challenge for the companies involved. At the same time, based on the interviews of the senior managers and the global managers of all three companies, the expansion of those companies was dependent on the continuous implementation of successful KT projects of different kinds.

That being said, according to the findings of studies I and IV, neither company A nor company B had a comprehensive method for transferring knowledge between their plants. Their approach, as mentioned earlier, was to build the desired production system, and then bring the operators and technicians from the receiver plant to the sender plant, where they could learn the processes. Then the whole package was transferred to the subsidiary plant. While this concept provided a swift way of transferring specific sorts of knowledge, it was not totally successful in more complex types of KT projects.

According to the findings of study IV, two major issues identified in conducting KT projects were: (1) the lack of a deep understanding about the complexity of the knowledge being transferred, and (2) the complexity of the KT itself as a multi-aspect process.

Understanding the complexity of the knowledge being transferred in a KT project helps to assign the right type and amount of resources to such project. This, in turn, increases the chance of conducting a KT project successfully. Otherwise, the project resources will not match the actual resources needed to perform it successfully.

Another critical factor was the underestimation of the complexity of KT itself as a process. Because a KT project is performed in a multiplant and multicultural environment, there are various aspects that need to be considered in the transfer of knowledge in an IMN. Ignoring or oversimplification of any of those factors can lead to an incomplete transfer of knowledge which, in turn, leads to irrecoverable loss. From the discussions, it is concluded that:

*To successfully conduct KT projects in an IMN, there is a need for assessing the complexity of the knowledge being transferred in a KT project and adopting a suitable strategy for it.*

Regarding the complexity of the knowledge being transferred in a KT project, a two-dimensional matrix is suggested. Based on the complexity of the knowledge being transferred and the urgency of its transfer (Figure 27), the model (inspired by a typology proposed by Ferdows (2006)) classifies KT projects into four types. In order to perform the KT projects among the plants of an IMN, there is a need to ensure a fit between the transfer methods and the properties of the particular type of production know-how being transferred (Ferdows, 2006).
According to the interviews performed in study IV, the KT projects in the bottom half of the gauging model did not create many challenges and, therefore, they were not subjected to further analysis. The KT projects in the top-left quadrant (Complex Continuous) were more focused on transferring the XPS of the companies. Scherrer-Rathje et al. (2009) argued that the transfer of a company’s XPS is a continuous journey, which cannot be done in short time. One reason for this could be that the XPS of a manufacturing company, apart from its translation of lean philosophy, usually incorporates the vision, culture and values of the company (Netland and Aspelund, 2013). This was supported by the findings of study IV, in which the transfer of the XPS, culture and working ways took around three and five years in company A and company C, respectively. The COO of company A mentioned that different cultures, inherited from the former organisation, and the subsidiary country’s culture needed to be considered in the transfer of knowledge. Vaara et al. (2012) argued that that both national cultural ‘distance’ and differences in organizational culture affect absorptive capacity. A suggested strategy for such KT projects was to introduce a step-wise model, to make it possible to: (1) put the essentials in place in the shortest time possible to be able to run a factory, and (2) have a step-wise plant for increasing the plants’ level regarding XPS.

On the other hand, KT projects in the top-right quadrant (Complex Intensive) are normally those in which the transfer of production know-how takes place on a limited timeline. For such projects, it was particularly important to plan carefully time and resource allocation and to perform meticulous risk analysis to avoid overlapping.

With regard to the complexity of KT as a process, based on the findings of study IV, a multitude of aspects within a typical KT project need to be addressed meticulously and analysed thoroughly before any further step in the process. For example, in a KT project performed at company A, the ‘what’ aspect in the KT (i.e. the required competencies to be transferred) was not stated clearly at the outset. The responsibilities of the different
stakeholders (including people from different plants) was unclear, in the sense that it was not known 'who' would take responsibility for what section of the project, and what resources would be required for each. Furthermore, during the transfer of XPS to the subsidiary plant, the cultural context and the acceptance of a mutually constructive relationship were not considered thoroughly.

Except for company C, which had a scientific approach towards KT projects, the other two companies (A and B) did not have a comprehensive method for performing KT projects. Instead, the management of such transfers was done by ad-hoc methods at meetings of the technicians involved on the sender and receiver sides. Furthermore, an investigation of the impact of the KT projects was not conducted at company A and B unless the project was unsuccessful. So, the best practice knowledge regarding 'how' to transfer a particular type of knowledge was not saved. From those discussions it could be concluded that:

In order to succeed in performing KT projects between plants of an IMN, it is necessary to have a comprehensive model that considers all of the aspects that influence the project’s success.

Figure 28 illustrates a model (the Learning Network Model) that has been suggested in this research. The model includes several key aspects that should be considered during a KT project, followed by guidelines and elaborations on each aspect, and is explained in detail in Paper 4.

![Learning Network Model]

Figure 28 - The proposed model for conducting KT projects in an IMN
Apart from transferring the knowledge of production know-how and the XPS of an IMN, it is also important to distribute relevant information to different plants of an IMN. The ubiquitous availability of information allows integrated, informed and intelligent decision-making (Gaonkar and Viswanadham, 2001). Grant (1996) refers, for example, to important information about the Ford Motor Company, such as: how it is affected by foreign currencies, its inventories in multiple locations within the company, the capabilities of Ford managers, and the quirks of individual machine tools.

Therefore, it is important to have a mechanism for disseminating the relevant type of information to plants of an IMN. Such a mechanism should: filter the relevant information, specify information channels, determine the sender and receiver sides, and have certain routines for the distribution of information within a network.

The dissemination of information may be confused with the transfer of production know-how (Ferdows, 2006). Dissemination is about making operational and technological data more precise and more available to people, whereas transfer of production-related knowledge is a far more complex process.

5.1.3 Challenges regarding assigning coordination resources

The resource-based view posits that competitive advantage can be sustained only if the capabilities creating the advantage are supported by resources that are not easily duplicated by competitors (Hart, 1995). In the case of coordination, the required resources include both tangible and intangible resources. This includes the people needed to perform the coordination and also the IT network, organisational processes and so on.

According to the data from study V, in general two approaches for assigning resources to coordination activities could be identified: (1) assigning dedicated resources that merely worked with coordination issues, and (2) assigning flexible resources that, in addition to their daily tasks at their local plants, contribute also to coordination activities (Figure 29). Each approach comes with advantages and disadvantages. While assigning dedicated resources to coordination activities provides a greater focus and control over the results, it might not be feasible for every company to assign dedicated resources for coordination of its network. On the other hand, using flexible resources, with both coordination responsibilities (network level) and responsibilities at plants, is a more cost efficient solution.

According to the data from study V, the coordination teams that were formed in company A consisted of: (1) cross-plant intra-functional teams, i.e. groups from the same functions but in different plants, and (2) cross-plant cross-functional teams, which included people from different functions at different plants.
Another challenge in this regard was the prioritisation of the assigned resources. As mentioned earlier, the existence of pooled, sequential or reciprocal interdependencies among the plants makes coordination complex (Mascarenhas, 1984). The existence of such interdependencies, combined with limited resources in an INM, makes it challenging to assign resources to coordination activities. Sometimes, two or more plants in an INM may rely on a resource (pooled dependency), such as a design team or a development team. For instance, it was observed in case study II, in a project performed at company A, that two plants competed over a certain process specialist. Also, sometimes two or more plants competed over a common resource at the same time to win an important contract.

Apart from the inter-plant competition over resources, according to the findings of study V, assigning resources to network activities could result in conflicts between a plant and headquarters. For example, it was observed in company A that, in some situations, resources were assigned to certain tasks in its local production plants; however, they were at the same time required in some projects at a network level. It may not always be advantageous to an individual plant to assign resources to projects at the network level. Yet, in order to contribute to the network and the greater business strategy, resources needed to be devoted to network level projects. This was observed in an inter-plant project in company A, in which a gear manufacturing specialist at the German plant participated at the project meetings in Sweden, while also being involved in daily operational tasks in the plant in Germany. Another example, in the same company, was the simultaneous involvement of a heat treatment expert, both in daily operations in a lead plant in Sweden, as well as in a KT project. The same phenomenon was observed in company B (case study V), where inter-plant KT projects borrowed resources from several plants.

A short-term solution was to discuss this matter among the central management team (CMT) and the plant managers. Having said that, a long-term solution for managing those situations would demand the clear definition of the autonomy level of each plant, together

Figure 29: Strategies for assigning resources to coordination activities
with institutional rules that clarify their responsibility in network-level activities, and the communication of these through the network.

5.2 Improving coordination of an IMN

The second research question in this thesis concerned the steps and mechanisms that are necessary for improving the coordination of an IMN. In expanding from an individual plant to an internationally dispersed network of plants, many aspects need to be taken into consideration (Mundt, 2012). As mentioned earlier, a set of coordination-related challenges will arise in such a transformation. Before any actions are taken to confront those challenges, it is necessary to put in place the prerequisites needed for coordinating an IMN. The following section discusses the preparatory steps that must be taken in order to create the right prerequisites for coordinating an IMN.

5.2.1 Mind-set shift and strategic alignment

Considering the previous theories (e.g. Ferdows et al., 2016, Cheng et al., 2015, Friedli et al., 2014) and the findings of this study as a reference point, a shift is necessary in the management mind-set from a plant-focus approach towards a holistic network-focus. A lack of a global view by the management hinders effective management of international operations (Klassen and Whybark, 1994). Therefore, there is a need to transform the management of a multi-plant manufacturing company, from a plant perspective to a network perspective (Shi and Gregory, 1998, Colotla et al., 2003). It is mentioned in the study of Szweczyzewski et al. (2016) that “the poor performance of manufacturing networks could only be rectified by implementing radical changes to their configuration and coordination” (Szweczyzewski et al., 2016, p. 125) that in turn demands a holistic network perspective. It was observed at company A that, along with the transformation of the company from one having a few plants to one having several interdependent plants, a project was initiated that aimed to improve network management.

Once the importance of network management is understood, it is necessary to align the coordination activities to the long-term strategy of an IMN. Meijboom and Vos (1997) and Cheng et al. (2011) emphasised the need to link and integrate plants in a network to fit the achievement of the strategic objectives of a business. If coordination is performed in line with the strategy of a company, it would turn from being merely a control process on the daily operations and business, to a driver for high performance that leads to sustainable competitive advantages (Ketokivi and Schroeder, 2004). As mentioned earlier Shi and Gregory (1998) argued that four capabilities are derived from the configuration and coordination of an IMN: accessibility, thriftiness ability, manufacturing mobility and learning ability. Although most decisions on the structure of a network (configuration) have infrastructural (coordination) implications, and vice versa (Lewis and Slack, 2002), the latter three strategic capabilities i.e. thriftiness ability, manufacturing mobility, and learning ability are supposed to be associated with the coordination of a network (Colotla et al., 2003).
It should be noted that the strategic coordination of an IMN differs from the coordination of strategy in multi-plant setting. Strategic coordination of an IMN refers to certain coordination patterns that lead to competitive advantages on a network level that, in turn, support the long-term business strategy of a company. However, the latter, i.e. the coordination of strategy aims to anchor a company’s strategy to its plants and make them follow the global strategy of the company.

5.2.2 Delayering an IMN into congruent sub-networks

Because IMNs are complex networks of production plants, with a multitude of interrelations among them (Wiendahl et al., 2007), understanding the interrelation among the plants in such networks is a critical factor for their management (Shi and Gregory, 1998, Feldmann and Olhager, 2013). Consequently, the first steps when embarking on the management of an IMN are to identify, organise and map the existing dependencies among the plants in a network, so as to be able to break down the IMN into manageable sub-networks. Ferdows et al. (2016) proposed to ‘delayer’ a network in order to re-organise an IMN into ‘congruent networks’, i.e. sub-networks within the greater IMN, that work together to complete a mission in line with a company’s business strategy. This is a significance step in simplifying the management of an IMN.

![Figure 30- A geographical delayering of a network into smaller and more manageable sub-networks](image)

That being said, the more diverse the interrelations among plants in an IMN, the more difficult delayering would be. The criteria for delayering an IMN depend on several factors, such as: the nature of the business, geographical location of the plants, target market, management approach, product and production processes, culture in subsidiary plants etc. Figure 30 illustrates an example of delayering a network based on the geographical location
of plants. In most of the cases, each of those geographical regions has interrelations to plants in other regions, through certain commonalities such as product, production process and so on. For example, according to the findings of study II, the network of company A was initially delayered based on a variety of factors, such as: strategic products, geographical location of the plants, and the market. However, different business areas (BAs) were prioritised later as the main factor for segmentation of the network. The BAs were composed of a cluster of competences to produce certain products for a specific market or industry sector. Based on the interviews from study V, delayering the network based on BAs provided consistency and simplicity in managing and controlling the performance of each subnetwork and the production plants within them.

Furthermore, based on the findings of study V, it was also observed in company A that the complexity of managing the interrelations among plants could encourage movement towards decreasing the interrelations among them. However, a fine border exists between decreasing the complexity and risking the potential innovation that lies in interrelation of the plants of an IMN. It has been mentioned that innovation is tied to recombination of existing diverse knowledge types (Carnabuci and Operti, 2013, Kogut and Zander, 1993) that are usually available at different plants in an IMN. Therefore, any type of network segmentation should simplify the management of the network without risking the innovativeness of the company.

5.2.3 Mechanisms for improving coordination of an IMN

Once the strategic significance of coordination is accentuated, the IMN is delayered into manageable congruent sub-networks with clear interdependencies (product, process or market) and each plant’s autonomy is clearly elaborated, there is a need to have mechanisms in order to conduct the coordination work in an IMN.

IMNs are complex multi-plant networks of interrelated plants that are located in several geographical locations having a multitude of flows among them that need coordination. In order to coordinate effectively each of those flows, mechanisms need to be put into effect (Friedli et al., 2014). According to the findings of study II, any relation regarding a product, production process or market could form the basis for inter-plant collaboration among the plants of an IMN. The non-physical flows in an IMN include mainly information and production-related knowledge (Gupta andGovindarajan, 1991, Ferdows, 2006). The production-related knowledge, as mentioned earlier, could be categorised into the XPS knowledge and production know-how.

As mentioned earlier, two fundamental ways of coordinating are: (1) feedback and communication, and (2) programming the behaviour (Mascarenhas, 1984).

According to the findings of this research and the related theories, primarily a mechanism is required for circulating and sharing information within an IMN. However, the transfer of production-related knowledge seems to be far more intricate than sharing information.
This was also observed in the findings of study IV, where transferring production-related knowledge, including the production know-how and XPS of a company, was shown to be a complex process beyond information sharing. Information could be shared by the means of simple communication. Even the explicit type of knowledge that is readily codified (mainly the declarative knowledge or causal knowledge types), can be transferred by sharing it (Ferdows, 2006, Roberts, 2000). However, the tacit knowledge of production know-how cannot be codified easily, and is of a procedural nature (Kogut and Zander, 1993). Thus, it requires a mechanism of its own, beyond merely sharing. As indicated in the findings of study IV, a sophisticated process for the transfer of tacit production know-how that takes into consideration all the influencing aspects is required.

Finally, following the changes in an IMN, there is a need for a mechanism that enables continuous analysis of an IMN in order to ‘sift’ the resources. Considering the discussions mentioned, and based on the analysis of the findings of this research (particularly case studies II, IV, V), and also considering the objective of coordination, three major mechanisms are suggested (see Figure 31). In order to operationalise coordination, these mechanisms need to be embedded into the management routines of an IMN.

Dissemination\(^8\) is about spreading information and the explicit type of knowledge continuously and effectively to the right parties in the plants of an IMN. The significance of having an information-sharing system for the management of subsidiaries in an IMN, and its effect on the evolution of subsidiary plants, have been highlighted previously (e.g. Paterson and Brock, 2002). Regarding the dissemination of information, consideration should be given to its type and quality, and also to appropriate tools in relation to headquarter–subsidiary information exchange (Brandt and Hulbert, 1976, Bartlett and Ghoshal, 2002). In order to disseminate information in an IMN, it is important to have the

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\(^8\) The term ‘disseminate’ in this thesis is used consciously instead of the term ‘inform’ in order to imply a directional spread of information i.e. information that involves motivation and progression.
correct communication and feedback channels (both formal and informal). Some examples of information that could be disseminated are: recent technological developments, market trends, operational performance of plants, organisational changes, success stories, and best practices. Sometimes, missing a simple piece of information by a person in a certain plant may deprive the whole company of potential opportunities.

The Transfer mechanism involves having an effective and efficient process for the transfer of tacit knowledge between the plants of an IMN. Apparently, identification of the knowledge gaps in the overall network and each constituent plant is a primary step before this mechanism. This mechanism usually covers the transfer of the XPS of a company (including core values and culture), and the transfer of critical production know-how. Regarding the transfer of production know-how, models for gauging the KT project and conducting the knowledge transfer project that were introduced earlier could be employed. More information on KT projects types and how to perform KT projects have been provided separately.

Synchronisation\(^9\) is a mechanism that is meant to study the aftereffect of changes in an IMN and react to them. It provides insights into the optimisation of a network by considering fundamental changes in its resources. In today’s complex and dynamic business conditions, it is necessary to address network optimisation (Cheng et al., 2015) that is a complex task beyond merely modelling, simulating and optimising the physical flows (Cheng et al., 2011). It is about an understanding of the interrelations of the plants in an IMN, and how certain changes in one plant may affect the other plants. Usually performed by the CMT, synchronisation allows for a continuous investigation of ongoing changes within and outside of an IMN, in order to understand their effect on the greater network. Among the drivers of change in an IMN are: market trends, customers’ strategies, changes in a plant’s knowledge and competence, and incoming and outgoing resource in plants.

For instance, a plant’s increased knowledge in a certain competence area will most likely affect those plants that have the same or similar knowledge. The plants’ configurational and coordinative roles should be then revised and updated, in order to omit any unwanted redundancy from the network and maintain the autonomy equilibrium. Essentially, the synchronisation mechanism ensures an effective allocation and re-allocation of resources within a network, particularly after major changes in an IMN.

In order to provide a holistic perspective, the results of the performed studies, including the suggested models regarding some aspects of IMN coordination (e.g. coordination roles, KT project gauging model, ‘Learning Network Model’ and the proposed mechanisms), are embedded into a coordination framework which is explained in the next chapter.

\(^9\) The term 'synchronise' literally means to adjust the activities to create order in a system. 
https://www.macmillandictionary.com/dictionary/british/synchronise
6 A framework for IMN coordination

In this chapter a framework for improving the coordination of an IMN is proposed. The framework is divided into two main parts. The first part of the framework includes preparations that are required before conducting the second part i.e. the execution of coordination activities.

Based on the analysis of data provided in the previous section, and considering the related literature, a holistic framework for coordination of an IMN is presented. Figure 32 illustrates the proposed framework including its different parts that were discussed previously in this thesis (including the prerequisites and mechanisms) are put together.

The framework includes two main parts: the preparatory part and, secondly the executional part. The preparation part includes the necessary steps to put in place the right prerequisites before conducting coordination.

The first step in the preparation part is the strategic alignment of the coordination activities, which was explained earlier. The second step is to delayer the large IMN by dividing it into smaller, congruent subnetworks, which reduces the complexity of IMN management. This provides input into the formation of the most appropriate cross-plant coordination teams, which in turn resolves potential conflicts that can arise when assigning coordination teams and required resources.
The third step in the preparations is to map the interrelations within a network to identify the commonalities among the plants. Mapping the products, production processes and different market flows (as explained in study II) through an IMN can help to identify the commonalities among plants in an IMN and provide useful input to the delayering of an IMN. This step can be performed simultaneously with the last step.

Finally, the fourth preparatory step before conducting coordination mechanisms is to clarify each plant’s autonomy level. The model introduced previously (Figure 27) can be used for this purpose. The application of this model can minimise the conflicts that arise around the assignment of responsibility among the plants and the cross-plant coordination teams.

By performing those four steps, the following advantages could be gained:

- Strategic relevance of the coordination activities
- A clear mapping of the congruent sub-networks that provides input into assigning the required coordination resources
- Identification of the interrelated flows (information and knowledge) on different commonalities among the plants such as product, process and market
- A clear description of the plants’ coordinating roles in an IMN (coordination class)
- Gaining a holistic view of an IMN by mapping the entire network, which makes it possible to analyse and compare an ‘AS-IS’ versus ‘TO-BE’ state before and after coordination

Once the preparatory steps are performed, the second part of the framework i.e. the executional part could be initiated. This part of the framework includes the three mechanisms, which were introduced in previous chapter. As shown in Figure 32, dissemination of information, transfer of knowledge and synchronisation of resources are three suggested mechanisms that could be embedded into an IMN’s operational routine. Those mechanisms need to be conducted recurrently and put into effect in order to accomplish the integrative conditions i.e. accountability, predictability and common understanding.

Depending on the configuration of the network and centralisation policy of a company, these mechanisms could be performed by different plants in an IMN. Considering the gathered data, it was revealed that participating companies had a tendency to perform the dissemination of information from the HQ. Also, the development and transfer of XPS was mainly initiated by HQ and performed by the lead plants near their HQ. Intuitively, it is usually the lead plants that are close to the HQ, which conduct XPS coordination as they inherit most the culture of the mother company. An exception was, however, a plant of company C in Brazil, which was actively involved in the transfer of the company’s XPS.

The proposed framework integrates, and is associated with the previous IMN literature on aspects such as the strategic relevance, delayering of an IMN, and previous knowledge on
KT. The novel features of the framework that are developed exclusively in this research study, apart from its holistic perspective on coordination of an IMN, are as follows:

- Introduction of a model for the classification of plants regarding their coordination roles in an IMN (Figure 26)
- Introduction of a model for gauging KT projects, as well as a holistic model for performing KT projects in an IMN ‘learning network model’ (Figures 27 and 28)
- Introduction of three coordination mechanisms from a new perspective compared to the ones discussed in previous literature (Figure 31)
- Incorporating of the ‘synchronisation’ mechanism with the coordination framework that connects the coordination of an IMN to its configuration

In order to secure the strategic alignment of coordination activities, they should be conducted with an awareness of the resulting competitive priorities that is considered in the first part of the framework. Because coordination is judged to be a fundamental determinant of the competitiveness of a manufacturing network (Rudberg and West, 2008), and it aims to integrate plants in an IMN to achieve the strategic objectives of a business (Cheng et al., 2011), the capabilities that are generated from the coordination activities should fit the long-term business strategy of a company.

### 6.1.1 Final remarks on the proposed framework

The current research project is dedicated to the needs of practitioners facing the challenge of coordinating a complex network of internationally dispersed plants. The empirical findings, findings from the literature, observations and the developed models in this study are pieced together to form a framework to improve coordination of an IMN. Considering the context of the studies, the limitations, and the ambition of the researcher of the study, the framework has certain attributes:

- The framework is drawn from limited number of cases, so further generalisations may need to be viewed with scepticism. That being said, the modular structure of the framework allows for improvement, adjustments and add-ons, in order to increase its usability. In other words, instead of taking an exclusive approach to limit the results to rigid boundaries, the framework could, with adjustments, still be used in wider areas.
- It keeps a ‘strategic FIT’ as an essential attribute, by aligning continuously the capabilities that are generated by the different coordination activities to the competitive priorities of a company, and eventually to its business strategy.
- It combines the relevant theories and integrates them with the prerequisites, as well as the mechanism to cope with the major challenges of IMN coordination.
- Finally, a constant goal has been to keep the framework as simple as possible by adopting plain, straightforward terms, as well as using visualisation to increase its practical and pedagogical character. This is because eventually, the ultimate users of
such framework i.e. the practitioners and senior managers of IMNs, would prefer to use such simple and practical solutions.
7 Conclusion

In the last chapter of this thesis, some final conclusions are drawn based on the previous chapters. The outcome of the study is also discussed in terms of the impact on both literature and practice. The chapter concludes with some suggestions for further research.

Despite its significance by being one of the two fundamental determinants of the competitiveness of an IMN (Szczejczewski et al., 2016), coordination has not been researched to the same extent as configuration. The overall aim of this research was, therefore, to develop knowledge that improves the coordination of the intra-company network of a manufacturing company.

The suggested framework (and the similar ones) can replace or be applied to any existing, unmethodical efforts of coordination, in order to: (1) clarify the responsibility and contribution of the plants in an IMN regarding their coordination role, (2) specify the coordination mechanisms that need to be conducted recurrently and pursued rigorously by coordination teams in different teams within the network, and (3) provide a direction and an awareness of the aftereffects of such activities by using continuously the strategy ‘compass’.

Considering coordination as a strategically important aspect, and embedding coordination-related mechanisms into the operational routines of an IMN, will increase the possibility of harnessing the existing potential synergy that lies in the effective management of interrelations among the plants of an IMN.

In order to succeed in IMN coordination, it is necessary to:

- Develop a strategic view on coordination, which is in line with a company’s greater long-term strategy and the characteristics of its network
- Map an IMN and delayer a large IMN into congruent, manageable sub-networks
- Construct a coordination organisation that fits a company’s context
- Clarify and communicate the autonomy of plants and their coordination roles
- Conduct coordination through the iterative use of the right mechanism

That being said, it is important to study deeply and understand the network of a company, the characteristics of its plants, its challenges and strategic priorities, so as to successfully coordinate its network. These attributes are the responsibility of the strategic management of an IMN (Szczejczewski et al., 2016, Olhager and Feldmann, 2017).
7.1 Theoretical and practical contributions of the research thesis

The focus of this research was on the coordination of IMNs, which lies in the global/international manufacturing field of research. Three research questions were formulated in order to achieve the aim of the research, which was to develop knowledge that improves the coordination of an IMN.

The first research question: ‘what are the key challenges related to the coordination of an IMN’, aimed at understanding the challenges encountered in the coordination of an IMN.

Various challenges were listed in the coordination of an IMN. These were: clarification of the plants’ level of autonomy in coordination activities, challenges regarding assigning resources to coordination activities, transfer of a company’s XPS (including culture and values), and transferring strategic production know-how between plants. Those challenges are addressed by specific parts of the proposed coordination framework.

The second question: ‘what are the necessary steps and mechanisms for improving coordination of an IMN’, focused on the necessary steps and mechanisms for improving coordination of an IMN of a manufacturing company. In answering this question, it was suggested that there should be: (1) preparatory steps that put the prerequisites of IMN coordination in place, and (2) executional mechanisms that aim at conducting the coordination. The preparatory steps provide the right requisites for conducting the executional part i.e. coordination mechanisms.

7.1.1 Theoretical contribution

The overall aim of the research presented in this thesis was to gain knowledge that improves the coordination of an IMN. This was done by performing five case studies, on different aspects, but all related to coordination. The theoretical contribution of this thesis is to the existing research on IMN management, and in particular their coordination, which still is considered to be limited (Friedli et al., 2014, Feldmann, 2011, Cheng et al., 2011, Rudberg and West, 2008).

Within the IMN-related research, there are models with which to classify the plants of an IMN from a configurational perspective. However, few studies have provided input as to how plants in an IMN could be classified based on their coordination role in the network. This research presented discussions and the proposed model for filling this gap.

In addition, this study contributes to the area of KT in an IMN context. The transfer of knowledge among multiple units of an organisation has been thoroughly researched (Bender and Fish, 2000, Ferdows, 2006, Foss and Pedersen, 2002). However, due to the significance of the transfer of knowledge for the IMNs and its practical relevance, KT between IMN plants is still of particular interest among researchers and practitioners. In this research, different types KT projects and the complex process of KT were studied.
There were proposed a model for gauging KT projects, as well as a holistic model for performing KT projects in IMN context.

Furthermore, this research contributes to the previous research in the general area of IMN management. It complements the work of researchers in the field of IMN management (e.g. Ferdows, 1997, Vereecke and Van Dierdonck, 2002, Feldmann and Olhager, 2013). As mentioned earlier, configuration and coordination are closely related, and both together determine the competitive capabilities of an IMN. Any attempt to improve either of those IMN management aspects could provide inputs to the other aspect.

Finally, it has been emphasised that, despite its importance, there is a lack of literature that covers coordination-related research. In particular, there are few reports on the practices related to IMN coordination (Cheng et al., 2015). This research shows how the involved companies practiced coordination in their organisations. Also, the existing studies around coordination of IMNs provide a sectional contribution on the sub-areas of coordination. The current research is distinctive, in the sense that it provides an overall perspective to coordination by proposing a framework that covers the identified challenges and approaches to overcome them.

7.1.2 Practical contribution

The results of this research encourage practitioners to re-think the ‘what’, ‘why’ and ‘how’ questions regarding coordination. By identifying some of the coordination-related challenges and, at the same time, providing practical guidelines embedded in a holistic framework, it attempted to improve coordination of networked type of manufacturing companies. The following elaborates on the practical relevance of particular parts of the framework.

An increased understanding of the benefits of delayering an IMN into relevant subnetworks, and identification of the commonalities among an IMN’s plants, reduces its management complexity. Furthermore, it facilitates the management and formation of cross-plant coordination organisations. This is an initial, important step towards the management of interrelations among an IMN’s plants. In other words, prior to any actions regarding coordination of an IMN, it is necessary to decompose a complicated IMN into manageable congruent subnetworks and to identify the interrelationships among the plants.

As mentioned earlier in the results of this research, the lack of clear guidelines on the autonomy level of plants led to disruptions in conducting inter-plant projects. Traditionally, the management of a single plant (or a few isolated plants) would not consider such aspects as a significant challenge. However, the involvement of several plants, and the increased complexity of the network as a result of increased variables (plants in different countries and contexts), generates new challenges in that regard. The introduced model regarding the autonomy of plants (Figure 26) is a suggestion to resolve such issues.
Furthermore, the successful execution of a KT project is a constant challenge in an IMN context. The results of this study provide guidelines from different perspectives, in order to increase the odds of conducting a successful KT project. First of all, the results contribute to the identification of the flows of knowledge within and into an IMN. Furthermore, the model proposed for gauging the type of KT projects (Figure 27) provides guidelines for adopting a suitable strategy. Finally, the holistic knowledge transfer model (presented in Figure 28) addresses a multitude of significant factors that need to be dealt with throughout a KT project.

Finally, the last study in this research examined three industrial companies with regard to IMN coordination. Studying and comparing how those companies coordinated their IMN provided useful information that could be used by the senior management of any IMN, because: (1) studying best-practice incorporated in real-life provides some insights to general coordination challenges and incorporated methods to confront them, and (2) studying coordination practices in a variety of companies with different challenges can provide a basis for how a particular type of IMN, with a structure or conditions close to a certain company, could be coordinated.

7.2 Research limitations

The previous section explained the contribution of the current research in demonstrating the fulfilment of the research objective: i.e. the research contributes knowledge that improves the coordination of an IMN. Nevertheless, highlighting the limitations of this study will help its readers to understand the context and terms of its application. In the case of this particular research:

- First of all, the current research is of a qualitative nature. Hence, the author’s background, previous knowledge, and mind set may have led to bias in the interpretation of the qualitative data and, therefore, the conclusions of this research. Similarly, the selection of the interviewees and respondents may have also affected the results. This was especially so in those studies with a limited number of interviewees (such as study III). That being said, multiple data sources (triangulation of data) were incorporated in order to mitigate this risk.

- Furthermore, the limited number of cases in this research, as well as the inherent limitations of the case study method itself (Gummesson, 2000), confine the generalisation of the results. Thus, generalisation of the results to other environments should be done cautiously.

- The description of the concept of ‘fit’ in strategy is still vague. In other words, it is not crystal clear how certain approaches regarding a decision area (such as centralisation) will affect an IMN. Some of the confusion comes from practical limitations, in the sense that companies usually have a certain approach that ‘fits’ their context, and which they try to make it work. It is not always feasible to change
strategy, nor to test different strategies periodically and analyse the results. This limitation is normally transferred to those studies in which limited observations on a certain case make it difficult to find the ‘ideal’ approach and its aftereffects.

- Another limitation of this study lies within its static nature. Although the aim was to take a holistic view of the collected data, the data were collected at different points in time. Nonetheless, both the environment and the companies involved have been exposed to constant change. The current study is not exceptional in this regard, and the results are not claimed to be of all-time relevance. That being said, both retrospective and real-time cases were combined to get a fairly up to date view of the phenomenon.

- Finally, the majority of the data were collected from a contract manufacturing type of company. Once again, great care should be taken when using the results outside of the context of this study.

Some other limitations of this study arise from IMN coordination being a broad research area and so some areas were not covered in this research. Some suggestions for complementary future research are addressed in the next section.

7.3 Prospective research

The results of this study contain discussions on the coordination of IMNs, including a framework composed of preparatory steps and coordination mechanisms for its actual implementation. During the research project, some possible paths for future research were discovered.

First of all, as mentioned earlier, it is recommended that other cases are studied in order to increase the external validity by performing further cross-case analysis and so improving the results. This can lead to further development of the framework by testing it in other case environments.

Another interesting area related to the coordination of an IMN is to study different strategies regarding the allocation of resources to coordination activities, and their consequences, in different types of companies. As mentioned previously, not every strategy fits a certain company, and so tailoring a coordination strategy to the exact environment in which it is applied will increase the likelihood of its success.

Another possible research path is to study the interface between plant level and network level. Considering the tight connection of those distinctive (but interrelated) levels, then understanding the relation of those two layers will provide valuable knowledge, as suggested by Cheng et al. (2015). Such research may improve the choice of strategic decisions, on plant or network levels, both with regards to building competitive advantage as well as the reallocation of resources in IMNs.
Finally, as humans are inseparable elements of organisations, a potentially useful path of research is to study the role of people in the coordination of IMNs. Little is known about the roles of people in certain types of plants in an IMN. This is a natural follow-on from the discussions on coordination roles for the plants in an IMN. Clarifying and categorising the coordination roles of people in plants is a fundamental step towards overcoming the organisational and resource-related challenges related to coordination.

7.4 Final summaries

To sum up, multi-plant manufacturing companies may, unconsciously and upon immediate need, carry out some coordination activities. However, the lack of a holistic and strategic view on IMN coordination, combined with a short-term perspective on coordination, might hinder companies from achieving the true potential of their networks. A strategic perspective on coordination provides a direction for the coordination activities within an IMN, enabling the achievement of competitive advantages that help a company to outperform its competitors. Manufacturing companies that operate a geographically-dispersed network of production plants can, apart from the competitive advantages obtained from their plants, can achieve competitive advantages from the interactions of the plants in their network. Proficient coordination an IMN aims to achieve this: i.e. to manage the flows and interrelations between the plants within an IMN, in order to enable them work better together and produce results greater than the sum of each individual plant's results.

Last but not least, although the current study put much emphasis on the significance of network activities and coordination, the performance of plants should not be sacrificed for the sake of their network contribution. In other words, first and foremost, each plant should be able to perform at an acceptable level in accordance to the business strategy, thereby ensuring the plant’s profitability. At the next level, the plant, based on its level of competence and its coordination role in the network, may contribute to the network. As explained by Colotla et al. (2003), it is a combination of capabilities, both at plant and network levels that allows a company to enter zones of competitiveness that are otherwise impossible to reach.
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Abstract

Due to globalization, many companies have established or acquired production plants worldwide in order to capture the market opportunities that lay beyond their national borders. This has resulted in the emergence of international manufacturing networks (IMNs), which consist of multiple, interdependent production plants with different characteristics within a single organization.

Coordination of such networks consisting of multiple plants in different countries is not a simple management task. That is why some companies struggle with it, and turn their global production into a function that hinders their agility and performance; while others turn it into a formidable advantage. Coordination of an IMN requires a company to link and integrate its plants to support its strategic business objectives. A proficient coordination of activities, across multiple plants of an international manufacturing company, leads to competitive advantages.

Despite its significance, the coordination aspect of IMN management has not been studied sufficiently. Operations leaders in today’s complex manufacturing world require a common language, tailored tools and frameworks for the management of their network. The research area of international manufacturing lacks empirical evidence of how industrial companies are (or could be) coordinated. Therefore, the overall aim of this research is to develop knowledge that improves the coordination of an IMN.

The data in this study were acquired from case studies carried out on the IMNs of four global manufacturing companies where the majority of data was gathered from a global contract manufacturer headquartered in Sweden. The findings reveal a set of challenges, which influence the coordination of an IMN as one of the main aspects of its management.

In order to improve IMN coordination, a framework has been developed from the results of the studies performed in this research project, as well as the results of previous research related to IMN management. It is composed of two distinctive parts: (1) preparatory steps, and (2) executional mechanisms.

The first part of the framework discusses, and provides an insight into, the strategic relevance of coordination, the establishment of an autonomy balance among plants in an IMN, and mapping an IMN. The second part of the framework contains three mechanisms for conducting coordination in an IMN.