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Readiness Assessment Framework for Transfer of Production Systems

- A Case Study

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Product and process development
Production and Logistics

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ABSTRACT

Introduction

The implementation or transfer of production systems from the developing organisation to the receiving can induce difficulties, however a connection between achieving readiness of the receiver within the context of PSD has not been investigated previously. The aim of this thesis is thus to examine PSD in a core plant environment, focusing on the transfer activity and readiness for change. The following research questions were asked:

- How can assessing readiness potentially benefit a PSD project?
- How can preparation for transfer ensure readiness of the receiving organisation?

Methodology

A case study was performed and a company was selected due to a recently performed PSD project where the company went from a tradition line-based production to digitalised cells. The thesis is within the COPE research project; thus, some emphasis is on the global aspect. This exploratory and descriptive research study both examines and describes the studied phenomenon. The case study approach enabled the identification of organisational and human factors within the PSD project. Data collection contained interviews and a literature review was performed.

Theoretical Framework

A literature review was performed which provides insights regarding a general approach to a PSD process. Furthermore, core plant role and the strategic position within the network are described. Other investigated areas are within transfer of; processes, production and knowledge as well as prerequisites for those activities. Maturity assessment models are also introduced to provide an insight on assessing an organisations current state and to establish improvement strategies. An overview of competences which are required in an Industry 4.0 context are presented. Individual and organisational effect on change are presented as well as how change can be combated.

Empirical Findings

The empirical findings provide an overlook of the current manner in which PSD projects are executed, foremost by investigating a recent PSD project. The investigated aspects were more concretely regarding the need for a readiness assessment, and readiness to transfer a PSD project from the developing to the receiving organisation. Motivation to change and change management were also identified. Lastly, replicability within the core plant context were examined.

Analysis and Discussion

Possible benefits of a readiness assessment are identified, which are creation of a holistic view, alignment of vision, standardisation need and communication among other things. Participation and assignment of responsibility are also identified as lacking within the case company which is an essential asset within a PSD project. Lastly a framework is developed which can possibly guide the PSD process in achieving readiness for change.

Conclusions and Recommendations

Multiple benefits of a readiness assessment are identified which emphasises the human and organisational aspects of a change implied by a PSD project. The technical focus identified in the case company can be combated by acknowledging soft variables and skills and by understanding the decisions behind solutions. A framework is developed for Readiness Assessment with a focus on contesting the lack of responsibility and a “we against them” attitude. The mission of the framework is to create alignment and collaboration.

Keywords: Readiness Assessment, Change Management, Production System Development

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Västerås, May of 2018

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ABBREVIATIONS

AC	Absorptive Capacity
CM	Change Management
MCM	Manufacturing Change Management
PS	Production System
PSD	Production System Development
RA	Readiness Assessment
WP	Work Package

1 INTRODUCTION

The *Background* provides the reader with an overview of the context and initial insight on the topic ahead, followed by the *Problem Formulation* which defines the issues facing manufacturing companies. Heading *Aim and Research Questions* present the precise area of research, whereas the *Delimitations* contain the scope of the thesis.

1.1 Background

As manufacturing companies could gain advantages from globalisation, synergising the geographically dispersed plants into networks was strived for (Ferdows 1997a). A manufacturing network is defined as an aggregation of plants which are located at different locations (Rudberg and Olhager 2003) and develop over a long duration of time (Vereecke et al. 2006). Thus, the focus shifted from individual plant into international manufacturing networks (Rudberg and Olhager 2003). Competitive advantage can thus be achieved by using a company's foreign plants as a source to harness a greater market share as well as higher profits. A network can facilitate the need to efficiently and time-effectively transferring ideas from development into production. The relationship between development and production functions is therefore merging and the same organisational unit can house both functions. However, dividing the resources needed to perform both functions at multiple units can be perceived as non-economical, leading to transformation of superior manufacturers into specialists (Ferdows 1997b).

Plants within an international manufacturing network have different roles to play (Demeter et al. 2017). The core plants role entails a responsibility to create new processes, products and technologies which are spread to the whole company (Ferdows 1997b). This type of plant is also referred to as a lead plant (Ferdows 1997b) or a mother plant (Vereecke et al. 2006) but is hereinafter referred to as the core plant. Which role a single plant plays, also determines which capabilities are necessary in order to perform according to that role (Demeter et al. 2017). Local skills and technical resources are used in a core plant to collect data and apply the knowledge onto developing useful products and processes (Ferdows 1997b). When a plant can utilise the capabilities in a sufficient manner, and thereby exploit or find new areas where best practice can be applied, a higher role within the network can be achieved (Demeter et al. 2017) which is the ultimate objective for a factory (Ferdows 1997b). Furthermore, the role of a core plant is to continuously communicate with centres of knowledge, customers, machinery suppliers and research laboratories. The role is also expressed by frequent initiation of innovations and being a partner of headquarters regarding developing strategic capabilities in manufacturing (Ferdows 1997b). The plant roles presented by Ferdows (1997b) showed that the core plant is the pinnacle of knowledge which Feldmann and Olhager (2013) and Demeter et al. (2017) confirmed by addressing the competence focused plants to include all three major capabilities; production, supply chain and product/process development. Thus, according to Feldmann and Olhager (2013) outperforming other plants in the manufacturing network.

Technology development, production and product development are parts of the innovation process. Although the mentioned phases of the innovation process are often performed in parallel, the activities can also be dispersed geographically and organisationally (Vandevelde and Van Dierdonck 2003). Global transfer of manufacturing processes can be necessary from a strategic viewpoint (Nonaka 1994). A transfer of technology is defined as being sent from the developer and/or user of the technology, to the receiver where the technology is implemented and used (Grant and Gregory 1997). From the early work of Cohen and Levinthal (1990) it is

suggested that the initial stages of the transfer requires feasibility between knowledge and need, and later on, strong communications between the developer and receiver. The best suitable transfer mechanism should according to Ferdows (2006) balance the properties of knowledge, that is the amount of knowledge which can be codified, with how rapidly the knowledge is changing. Bellgran and Säfsten (2010) argue that developed production systems can in a future setting constitute as a model for future development. Additionally, the knowledge which is gained through the process of development can be accessible to others. Decisions regarding the transfer must however be made according to Nonaka (1994), which can concern whether to modify and adapt the process or to altogether clone it to another facility. The adaptation of the manufacturing process can facilitate the transfer process by taking advantage of the local characteristics. For an efficient transfer, a process which is intended to be transferred could also be designed for robustness. Deflorin et al. (2012) address difference of plants regarding knowledge transfer as heterogeneity, which can be hurdles to an efficient transfer. High heterogeneity concerning location, capabilities, process and equipment can lead to greater hurdles to an efficient transfer.

The rapid changes in technology as well as other external effects puts pressure on manufacturing networks, resulting in a network that constantly need to adapt to new circumstances (Ferdows 2014). Rapid technology change can be derived from Industry 4.0 concept which contains state-of-the-art technologies such as Cyber-Physical System and Internet of Things (Qin et al. 2016). Furthermore, globalisation can increase competition for a manufacturing company as a result of new customer demands, demands for shorter lead time and lower production costs. Additionally, a production system (PS) can contribute to competitiveness for a manufacturing company. The demands derived from globalisation are therefore influencing the development of a PS (Bellgran and Säfsten 2010). However, there can be several triggers of the need to change a PS, for instance; introduction of a new product (Bellgran and Säfsten 2010; Schuh et al. 2011) or a product model, identified possibilities of improvement of the working environment or ergonomics, or a need to increase capacity. The triggers can also be external, such as change in environmental requirements, changed market demand or technology development (Bellgran and Säfsten 2010). Furthermore, change can be a compulsory demand (Alves et al. 2016) or derive from the need to introduce new production technologies (Schuh et al. 2011).

A production system development (PSD) process includes several phases, i.e. the design phase, physical building of the system as well as implementation or industrialisation. The phases are further divided into multiple activities which are performed in a iterative manner (Bellgran and Säfsten 2010; Bruch and Bellgran 2013; Wu 1994). A structured development process which defines the activities and their order is of importance. However, one of the gains from a structured method is to create understanding. Economical and personnel resources in the early phases of the development can result in paybacks of fewer disturbances and better end results. This alone does not motivate higher resource investment in the beginning of a PSD project (Bellgran and Säfsten 2010). Another issue is presented by Bruch and Bellgran (2013), when PS design information is subjected to lack of management, the impact can generate a deficiently regarding the performance of the system. This deficiency is expressed in difficulties to reach fast time to volume, cause delays, rework and waste of resources in the implementation phase. Overall, the ambition to create an effective and robust production system might be obstructed.

The implementation phase involves the realisation of the production system. The activities of physical build-up of the system and start of production is performed simultaneously. However, the success of the start-up is highly depended upon activities in the development as well as the plan and preparation for start-up (Bellgran and Säfsten 2010). The preparation can include

management engagement, education, organisation, time, resources as well as the human aspect (Karlsson 1990). Issues during start-up of production can lead to increased costs, lower the total production effectivity as well as increase time to market (Bellgran and Säfsten 2010). The issues can derive from several causes, i.e. focus on the technical solutions can lead to neglection of organisation of work and misinterpretation of the system can arise at different departments due to miscommunication. The cause can also be lack of information regarding the effects of the new system on different segments of employees or lack of management support after the transfer process (Karlsson 1990). Therefore, a prerequisite for a successful PSD project is that the production system must be regarded as an entity, which includes both the human aspects as well as technology in order to avoid the risk of suboptimation (Bellgran 1998). The terms transfer and implementation are used interchangeably in this thesis; however, they can mean different activities. A transfer is often a description of transferring for instance knowledge between two sites, whereas implementation is application of developed process. Nevertheless, as the developing organisation and receiving organisation are in this thesis viewed as two separate entities, a transfer terminology is more appropriate.

Implementation of a proposed design of a production system can be prevented by the resistant to change phenomenon, leading to a lack of embracement. Resistant to change can be derived from a fear to stop or pause the production, as well as economic constraints or a fear to fail (Alves et al. 2016). Change is handled on an individual level by going through stages of unfreezing, moving, refreezing and experienced (Lewin 1947). Individuals and organisations must thus be guided through these stages in order to create readiness and reduce the resistance to change (Holt et al. 2007).

1.2 Problem Formulation

The core plant role is expressed through development of processes, products and technologies, but also through spreading the processes and knowledge to the subsidiaries (Ferdows 1997b). The difficulties of knowledge transfer intra-firm, and on a global scale, are one of the main problems facing manufacturing network companies (Ferdows 2014). The functions in an innovation process are often dispersed, uncertainty can thus arise in both the developing as well as the receiving organisation when it comes to readiness. The developing organisation's transfer of the project and the receiving organisations commitment can also affect the readiness (O'Connor and McDermott 2004). A need for organisational change can thus emerge when transferring knowledge, even unlearning old procedures can be necessary in order to adapt to new situations (Madsen 2014). Similar issues can arise during the implementation phase of a PSD project. Alves et al. (2016) mention the resistance to change which prevents implementation. Additionally, a project can overlook the human aspects and focus on the technical attributes whereby overlooking the soft variables, hence preventing a successful PSD project (Bellgran and Säfsten 2009) or change effort (Korter 1995).

Companies that fail to identify the soft skills required for industry 4.0 are risking omitting the full potential of the digitalisation. Level of readiness in individuals as well as organisations needs to be considered in order to adapt to the new circumstances and align company strategies towards these skill requirements (Hecklau et al. 2016). Models or instrument for creating readiness exist in the academia (e.g. Armenakis et al. 1999; Jones et al. 2005; Holt et al. 2007). However, a connection of readiness for change within the context of PSD has hitherto gained little to none attention. Hence, a problem is identified regarding to develop and adapt an organisational assessment according to a specific context.

The identified topics of focusing on technology rather than soft skills and variables presents an opportunity for inquiry to gain insight of how an organisation could work with these factors. A contribution of a study of this phenomenon could therefore possibly provide a connection between PSD and organisational change. Thus, offering a connected view of the fields and the possibility to develop a framework which can perhaps support the organisation to reach successful change. Additionally, possibly introducing a standardised and applied way of working with assessing the organisation whether it is ready to receive a PSD results or a change.

1.3 Aim and Research Questions

The aim is to examine the Production System Development process in a Core Plant environment, focusing on the transfer activity and readiness for change. Following research questions are stated:

RQ1: How can assessing readiness potentially benefit a PSD project?
RQ2: How can preparation for transfer ensure readiness of the receiving organisation?

1.4 Delimitations

Although a PSD process is composed out of several phases, the focus in this thesis is on the implementation phase generally and on the transfer activity particularly. Transfer activity can be associated with a global setting, which will be briefly examined. However, the focus is on the local transfer activity which includes transfer of the project from the developing organisation to the receiving ditto where both parties are located in the same factory. As such, the emphasis is on the human and organisational factors making technical aspects secondary. Nor will this thesis contribute with specific economical insight. The PSD process framework will be elaborated to provide a basis of knowledge, the case company specific details will be excluded. The excluded details are for instance of the equipment procurement and supplier selection. Although such aspects are important in a PSD process they are not in line with the aim of this thesis. Lastly, this thesis will not investigate whether the core plant role is completely embraced by the case company.

2 METHODOLOGY

This heading contains a *Research Introduction* where the baseline for this research is explained as well as the case company selection criterions and is followed by the *Research Classification* which contains a description of the utilised research approach. The *Data Collection* describes the collection of empirical findings and theoretical framework. Lastly, *Data Analysis* describes the approach of analysing data collected data as well as the reliability and validity considered in this thesis.

2.1 Research Introduction

The aim and research questions of this thesis and the derived complexity set various demands on the selected research approach. Firstly, a company was selected which had recently undergone a comprehensive PSD project which could be examined. The experience of such a project should thereby be examined in a post-project manner which could elaborate, reflect and combine the experiences within the company. The case study approach was thus appropriate in order to obtain a deeper understanding of the phenomenon. The case company completed an extensive transformation project during autumn 2017 where the company went from a tradition line-based production to digitalised cells. Thus, the company qualified as a case company where the research questions and aim could be examined. The selected case company was also a partaker in the COPE research project, which was a prerequisite.

2.1.1 Core Plant Excellence (COPE)

In light of the core plant setting, this thesis is part of the COPE research project aiming to promote core plant excellence in the Swedish manufacturing industry. The project is a collaboration between academia and industry. Academia contributors are Jönköping University and Mälardalen University. The project initial stages involved a work package to identify the core plan role and capabilities, going through an additional four work packages, ending up in a delivery and distribution of findings to the contributors as well as publications of related scientific articles (Bruch et al. 2016).

The COPE project includes case studies, as such, this thesis contributes to the project via the case study nature and core plant setting of the case company. An additional contribution to the COPE project goals could be that this thesis attempts to identify problems in the case company, thus, adding to the research value and problem identification of the industry. The global replication aspect is also considered in this thesis, which is a part of the core plant responsibility and COPE projects aim. Lastly, as a final contribution, this thesis has the ambition to identify improvement potential in the case company's PSD structure, and thereby possibly increasing the case company's capabilities and competitiveness. Thus, including another aim of the COPE project.

2.1.2 Methodology of the Thesis

The progress of this thesis was structured in a Gantt-chart which contained weekly deliverables and goals, thereby provided a guidance of the planned progress. This format provided boundaries but could be adjusted when necessary. The planned sections of the thesis were divided according to weeks and a detailed checklist of daily deliverables was constructed. Although adjustments had to be made, the overall progress was followed according to plan. The progress was also reported to university supervisor as well as the company supervisor. Company supervisor reports were performed face-to-face as well as via telephone. The latter method was utilised specifically

for discussion regarding the developed framework as inputs from the company supervisor were of essence.

2.2 Research Classification

The initial investigation of the researched area indicated that previous research, which is in line with the aim of this thesis, was limited. To gain new insight and knowledge of a phenomenon Kothari (2004) suggest an exploratory research study. The exploratory research requires a research design which permits flexibility regarding the various aspects of a phenomenon. Exploratory research studies emphasise the formulation of a problem which is either investigated or a hypothesis is developed. The research problem is often stated in general manner but transformed into an exact form in an exploratory approach. The research problem is simply performed by a survey of concerning literature. In this thesis, an exploratory approach was utilised to investigate the targeted area. Concepts and theories developed in previous research was also the foundation of the theory, however, the specific targeted area contains limited previous research which indicated an incomplete combined knowledge base. This thesis could thereby possibly provide a contribution of novel findings.

The descriptive research study is used when describing characteristics of a situation or a group is necessary. The descriptive approach emphasises on the accuracy aspect and necessity to minimise bias simultaneously as reliability is maximised. Therefore, a clear plan must be established to assure that accurate measuring of the said phenomenon is performed. Techniques for collecting data in this research method are observations, interviews, questionnaires etc. It is difficult to categorise the research approach as often several approaches are needed in a study (Kothari 2004). In this thesis, interviews were performed in order to describe the phenomenon as well as identify explanations to its functionality. As exploratory approach is utilised to identify and examine the targeted area, the descriptive research approach was used to define the interrelations and connections of the elements.

2.2.1 Case Study Approach

The explanatory nature of the case study, asking *why* and *how* and investigating contemporary events, is commonly used in studies of organisational, business (Yin 2014) or processes interrelations focusing on a profound investigation (Kothari 2004) and contains a qualitative approach (Yin 2014; Kothari 2014). Moreover, the case study can provide a holistic perspective in a real-world setting and supports findings of contextual conditions. A case study objective is of expanding and generalising theories via data collection in form of observations, interview and/or documents, thereby attempted to identify reasons behind decisions. The case study approach is also appropriate for identifying relations of behaviour, organisational, managerial processes etc. (Yin 2014).

In the premises of collected data by literature review and associated research questions, the case study approach was selected. The research questions were stated in a how-manner which seeks to identify the reasons behind decisions and phenomenon as well as improvement potentials. The case study approach was hence deemed as valid for this thesis as there is a requirement for extensible description of a social phenomenon, which is in line with Yin (2014). As the organisation and human aspects were in focus, understanding of the relationships of the PSD project and the underlying factors was essential and could be approached from a case study setting.

2.2.2 Case Company Description

The case company consist of three factories here named, D, E and R where the D-factory is the factory that have undergone the PSD project. The D and E factories manufactures different kind of components ranging in size. Whereas the R factory manufactures sub-components and is an internal supplier at the factory site. Furthermore, the company also consists of the headquarters. The company is known to deliver high quality products, within its field.

The PSD project was originally a low cost high output project. The project was first initiated about 8 years ago but put on hold. The low cost high output project was renamed word class as it corresponded to the overall strategy of the company. The aim of the PSD project was to use a cellular layout with a complex IT system which connected the flow, instead of conveyor belts as well as a reduction in manual tasks. The IT-system includes a Factory network to which all machines and equipment are connected. The internal logistics are in form of autonomous vehicles, which also acts as buffers. In addition, the human-machine integration is simple and easy to use for operators for a shorter learning curve and simple work place changeover. For instance, signals and manuals are visualised on screens to simplify repairs and maintenance. The PSD project had several Work Package (WP): grind and furbish, assembly, measurement, working organisation, one for each supporting organisation among others. The development of the production system took one and a half year from the project go-ahead until production started in 2017. The resent PSD project concept will be implemented in the other factories as well, but with some adjustments to its content.

2.3 Data collection

Qualitative research is applied when the interest is to uncover phenomenon related to quality or kind. This is the explanation for human behaviours and their underlying reasons which can be investigated by using in-depth interviews. The interview results are strongly depending on the ability of the interviewer and are performed with the aid of pre-conceived questions (Kothari 2004). In a case study setting, interviews are performed as guided conversation (Yin 2014) and are typically combined with other methods of data collection, such as questionnaires or observations (Eisenhardt 1989). In this thesis, data was collected through interviews, thus a qualitative research approach was utilised to uncover the reasoning behind behaviours.

To compare the finding of the thesis with existing research, a theoretical data collection was performed. Eisenhardt (1989) explains that comparison of the build theory in a case study is necessary with the existing body of research, as conflicting findings forces researchers to strive for frame breaking ways of thinking. Furthermore, conflicting findings must be acknowledged as it otherwise risks reducing the confidence of the findings. Thus, to ensure a possible comparison, an elaborate theoretical data collection was completed which contained additions from multiple disciplines such as the production and process development which is within the area of research, also organisational and change management theories were investigated.

2.3.1 Theoretical Data Collection

The initial stages of the theoretical data collection consisted of a broad search mainly to gain an understanding of the examined area and the field of existing research. According to Oliver (2012) the literature review provides the reader with a context and interconnections of the researched area and other relevant subjects. Moreover, the relevance of the examined area can be investigated, if the collective body of research is performed from different aspects of the topic a deduction can be made that the examined area is of relevance. Eisenhardt (1989) explains that a broad range of literature must be considered as comparison of the theory or findings with existing literature is essential. Similarities, contradictions and their explanations are important to examine.

The focus was to assimilate literature which was published within the last ten years, preferably after 2010. However, certain definitions of for instance terminology was considered as best explained by the original source. This notion resulted in selection of literature published several decades ago and compared with recently published sources. The majority of selected, thus included scientific articles were published within last ten years. Several books were also selected which were found through Mälardalens University library where dissertations also were found. In some cases, relevant books and dissertations were not available in the catalogue of the library and was thus ordered via the library.

Research articles were found in four primarily used data bases, that is Scopus, Emerald Insight, Primo and Science Direct. The search engine Google Scholar was used secondarily to retrieve research articles not available in full text in the primary data bases. The secondary search engine was also utilised in the snowballing tasks, that is when relevant research articles was found in the references of selected literature. To produce a manageable number of hits in the search activity, search words were combined with each other. Criterions for selected articles, besides from the aforementioned, were that the research articles should indeed be scientific and preferably cited by other researchers. The latter was dismissed when research articles were published within the last year. Conference papers were automatically excluded. Additionally, selection of research articles was based on firstly reading the abstract to confirm that the data is within the scope of the thesis, secondly the articles were read fully after which some were excluded. Information regarding selected research articles were inputs in a developed Excel document, see an extraction of the document in Table 1. This thesis contains altogether approximately 90 research papers, books and dissertations in order to provide a broad perspective of the research area from multiple relevant disciplines as suggested by Eisenhardt (1989).

Data base	Keyword	Limitations	Hits	Selected	Year	Authors	Title
Scopus	“Ferdows Model"		86	1	2012	Deflorin	The lead factory concept: benefiting from efficient knowledge transfer
Google Scholar	Snowball from above				2014	Lang, Deflorin, Dietl, Lucas	The impact of complexity on Knowledge transfer in Manufacturing networks
Scopus	“Production system design” AND “manufacturing industry”	Article TITLE-ABS-KEY	9	2	2013	Bruch & Bellgran	Characteristics affecting management of design information in the production system design process
					2013	Rösiö & Bellgran	Reconfigurable production system design – theoretical and practical challenges
Emerald Insight	“Change management”	Leadership, Project management	6	1	2013	Vora	Business excellence through sustainable change management
Science Direct	“Manufacturing change management”		9	2	2016	Koch, Gritsch, Reinhart	Process design for the management of change in manufacturing; toward a manufacturing change management process
					2016	Koch, Michels, Reinhart	Context model design for a process-oriented manufacturing change management

Table 1 - Example of data searches

Table 1 contains examples of search words and combinations which were utilised in the process of research articles collection. This method was used as it provides control of the number of selected articles, as well as control regarding which search combination has been used. Thereby, the document contributed with time saved and traceability. Later in the process, the document was filled with a category of citations, that is extracts from research articles which were used in the thesis. Research article citations were used to find connections, similarities and variations within a field of research. This provided a structured manner for writing both the theoretical framework of this thesis as well as the analysis of theory with empirical findings.

2.3.2 Empirical Data Collection

For this thesis, the primary data collection was performed via interviews. The interviews in this thesis were balanced between structured and unstructured. Kothari (2004) writes that structured interviews contains predetermined questions and techniques of recording. The interviewer is therefore confined to a rigid procedure which is predetermined prior to the interview. An unstructured interview on the other hand, does not require recordings nor a rigid order of questions, thus allowing more freedom. In this thesis, the interview question protocol acted as a guide which was followed according to necessity at each case. A balance of the interview types was also necessary as the research approach is both exploratory and descriptive and according to Kothari (2004) the unstructured interview is more suited for exploratory research study. The structured interview method is often used for the descriptive study as it provides a basis for generalisation and is more suited for an unexperienced interviewer.

Interviews were performed with 17 employees mainly from the D-factory, although a small number of interviewees were selected from the E-and R factory. The candidates were proposed by the company supervisor who also were the initiator of this thesis. The majority of the interviewees had a manager position, several project managers were also interviewed as well as technical leads, see the complete Table 2 below. Totally 17 interviews were performed between

8th of February and 28th of March of 2018. The duration of the sessions was between 40 and 60 minutes with an average of 45 minutes and all sessions were performed face-to-face on site.

Number	Position	Date
1	Local Change Manager	February 8th
2	Project Manager	February 8th
3	Change Manager	February 28th
4	Process Development & Strategy Manager	March 14th
5	Factory Manager Manufacturing E	March 15th
6	Previous Factory Manager Manufacturing E	March 16th
7	Controller Manager	March 16th
8	Process Development Manager	March 16th
9	Technical Lead	March 21th
10	Technical Lead	March 22nd
11	Maintenance Manager	March 23rd
12	Supply Chain Manager	March 23rd
13	Project Manager	March 27th
14	Business Development Manager	March 27th
15	Factory Manager Manufacturing D	March 27th
16	Project Manager & Technical Lead	March 27th
17	Factory Manager Manufacturing R	March 28th

Table 2 - Chronological order of the performed interviews

A question protocol was developed with the aid of the university tutor. The protocol contained approximately 14 first degree questions and several second-and third-degree follow-up questions, see the complete Interview Question Protocol in Appendix 1. The first-degree questions were intended to be asked in all interviews, where the second-or third degree could be disregarded depending of the initial answer. Yin (2014) advises to ask open-ended questions in a conversation manner while be guided by the question protocol. The questions should be asked without bias which encourages the interviewee to answer from individual perspective.

The questions were developed in a *how*-manner which is according to Yin (2014) less intimidating. Several advantages of two authors of the thesis were presented. During the interviews one person could manage the questions protocol, while the other could actively listen to the interviewee and find deeper meaning of statements which were followed-up. The advantage was that questions were asked which were not in the protocol but within the aim. According to Eisenhardt (1989) the strategy of assigning different roles to the investigators can benefit the case study by providing different perspectives.

In order to adapt to the different roles of the interviewees, the interview protocol was extensive containing questions for both receiver, developer as well as management perspectives. The questions were asked to identify a wide data range on each topic for all interviewees. However, in some cases there was a flexibility in the interview which allowed for a deeper investigation on specific areas to identify the underlying causes or relations. The spontaneous questions were based on the aim of the thesis and adapted to target the expertise of the interviewee. Although this method can be associated with a risk of squander essential information, it was developed based on the research questions and thus had a general perspective. Meaning, it had to be adapted to a certain degree during every interview.

According to Eisenhardt (1989) flexibility and adaption to data can be a vital part of the theory-building case study. The case company also granted access to documents. The utilisation of the documents in this thesis were limited to gain an understanding of the case company, thus not referred to. The case study was initially structured via the research questions and an interview

protocol, see Appendix I, was created in order to capture the correct data throughout the study. Thus, according to Eisenhardt (1989) preventing an overwhelming amount of data. The research questions were re-evaluated throughout the study as more data was managed and analysed. The research questions, however, did not deviate extensively from the first formulation but were merely re-focused in order to compensate for new data findings. According to Eisenhardt (1989), a shift in research questions might happen in case studies.

Prior to an interview the interviewees received information regarding the interview in an email, see the complete document in Appendix 2. Every interview occasion initiated with a description of the thesis and its aim. According to Patel and Davidson (2003) interviewees are commonly unaware of the need of the interview, thus might lack motivation, making the information regarding the purpose especially important. Preferably, information should be provided both in written form prior to the interview and in the beginning of the interview.

In several of the 17 interviews, the authors presented the preliminary framework to assess readiness to the interviewees. The final framework is presented in heading 7.4, whereas the preliminary was based on an initial idea of the authors and developed during and after circa 5-7 interviews. Presentation of the preliminary framework was performed due to two main arguments. Firstly, the authors intended to test the preliminary framework base on value and content. Secondly, the aim of this thesis proved to be too abstract for some interviewees which demanded a visualisation. This approach provided room for discussion and brainstorming regarding previous experiences of the interviewees, whereas the authors could mention attributes or content of the framework and thereby capture ideas and thoughts of the interviewees. This approach added value to the findings and to the framework itself, however, a downside was lack of consistency throughout all interviews. Preferably, the framework should have been presented during all interview which could have contributed with additional value. Reasons of why this was not performed was two-folded, several interviewees comprehended the idea of the framework and did not need a visualisation. Moreover, some interviews were wide-ranging thus the appointed time-frame was not sufficient.

Recording of each interview session was made after gaining approval from each interviewee. Two recording devises were used to assure that the interview was recorded. Yin (2014) suggest that recording an interview is associated with the omission to actively listen. However, this risk could be counteracted in this thesis by the aforementioned assigned roles. The advantages of the recording also overweighed the risk as time-demanding notetaking could be avoided thus the focus was on the interviewee. Transcript of the interviews was made by listening to the recordings and carefully writing. All content in the recordings was written, although time-consuming this process reassured that all provided information was attained. On average, each interview transcript was seven pages, which resulted in approximately 120 pages of combined transcript.

2.3.2.1 Role Description of the Interviewees

To protect the identity of the interviewees, the following reference system was developed, see Table 3.

		Typical role in PSD projects
Factory Managers	2	Sponsor
Process Developer	7	Part of the developing organisation
Receiving Organisation	2	Previous receivers
Supporting Organisation	4	Receivers or contributors to development projects
Change Management	2	Change Management responsibilities

Table 3 - Interviewee reference system

Two factory managers are referred to in the upcoming heading Empirical Findings, from the E and D factory respectively. The Process Development is an umbrella term for project managers, technical leads and process development managers which are a part of the Process Development Organisation. The receiving organisation is also an umbrella term for production managers. Here two interviewees were included, that is a newly appointed *Factory Manager Manufacturing R* and a *Previous Factory Manager Manufacturing E*. These two persons had previous experience as a receiver and was thus interviewed based on the receiving role and not the existing position. Lastly, the supporting organisation could have dissimilar roles among each other considering if they were receivers or had a responsibility in the developing organisation. Maintenance for instance were both involved in the developing tasks but were also a receiving organisation, the same was true for the Supply Chain organisation. Business Development and Control were viewed as supporting organisations, even though Business Development could contribute with inputs for the developing organisation.

2.4 Data Analysis

The case study analysis was based on seventeen interviews and their transcripts, thus containing about 120 pages of data. To achieve an overview, Phase 1 of the analysis contained printing the transcripts and reading through as a whole, see the complete analysis process in Figure 1. The analysis method utilised in this thesis is in line with Yin (2014) strategy for analysis, “the ground up” which is started with the approach of “playing with the data”. In the playing with the data, this thesis sorted the data into arrays. In the ground up phase, themes in this thesis emerged and patterns could be identified. Yin (2014) suggest that this approach is more beneficial to experienced researchers within a field as concepts are easier to identify in contrast to novices. Even if the authors were not experienced within the examined field, the amount and kind of data gathered to answer to the aim and research questions, a ground up approach was necessary to identify interrelations and intangible factors. This allowed for a discussion and preliminary themes were found. Which were as following:

- Readiness and maturity
- Organisation readiness
- Preparation for transfer
- Transfer
- Background
- Replicability
- Current state analysis

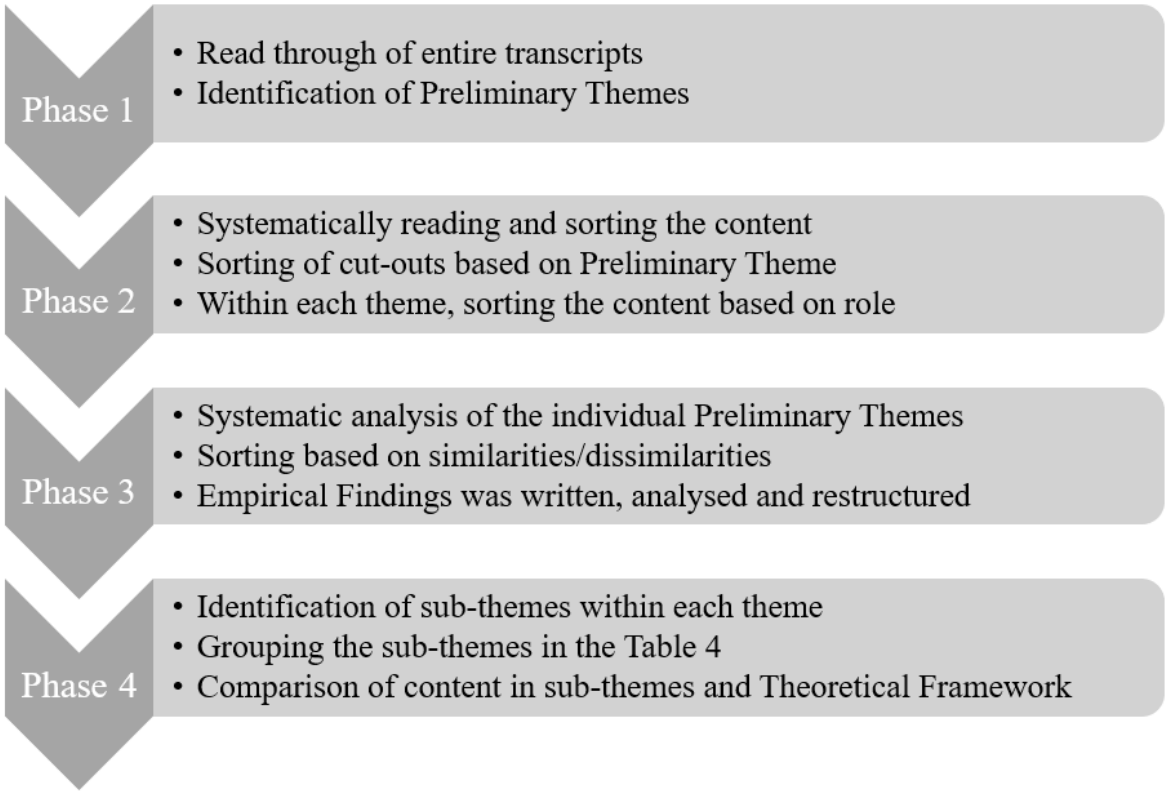

Figure 1 - Analysis process steps

These themes emerged based on the aim and research questions. In a Phase 2, the transcripts were systematically read, and the content was sorted according to themes. The sorting consisted out of cutting out sections from the transcript. The cut-outs were firstly sorted by theme, and secondly according to roles (see Table 3) within each theme. Thus, identifying both the themes, connections between the views from the roles as well as discrepancies. In Phase 3, the preliminary themes were analysed separately by sorting the content by similarities and dissimilarities. Lastly, this process resulted in the heading *Empirical Findings*, which was once more scrutinised by several read-through and discussions which resulted in re-structure and emerging of explicit themes. Eisenhardt (1989) writes that the comparison of collected data and theory is an iterative process where systematic comparisons are performed regarding theories fit with the case data.

Phase 4 consisted out of identifying sub-themes within each theme, thus identifying underlying deeper themes. The identified themes and sub-themes were grouped in a table, related to each research question, in order to specify the relations to literature as well as to the research questions. The analysis approach for case studies are usually subject to vast amounts of data according to Eisenhardt (1989) and is based more on experience of the researcher than standards (Yin 2014). Nevertheless, the analysis approach was to categorise the findings to the identified themes, thus making the analysis structured. In addition, in order to distinguish the casual relations from the formal, the finds were considered stronger if several interviewees said the same things. The complete analysis of the empirical findings and theoretical framework is found in heading 7 *Analysis and Discussion*.

While analysing the empirical findings, the thesis was enriched by divergent couplings within the data due to contributions of two authors which provided multiple perspectives. Also, the different backgrounds of the authors contributed to the thesis as data could be analysed in-depth

as the writes went through each detail of the findings and concur regarding the placement of a finding in a theme. This process allowed for discussions and reasoning which could possibly strengthen this thesis. Eisenhardt (1989) argues that multiple investigators can benefit to the study as creative potential can be enhanced by complementary insights and thereby capitalising of novel understandings and different perspectives. Moreover, convergence of investigators can increase the confidence regarding the findings.

2.4.1 Theory Building

The analysis of the collected case data with existing theory in multiple research fields resulted in a developed framework for Readiness Assessment which is found in heading *7.4 Framework for Readiness Assessment*. The development consisted of iterative comparison of case data and existing theory, which involved identifying essential finding in the sub-themes and adding to the theoretical framework with both contradicting and correlating theory. The intention of the developed framework was applicability for both case company and for external use. However, foremost utilisation of the framework was intended for a broad spectrum of manufacturing companies undergoing a radical change and transformation which affects both organisational aspects and humans within the system.

Building theory from case study is elaborated by Eisenhardt (1989) who states that theory building benefits from multiple investigators and conflicting theories. The latter compels the researcher to creative thinking and thus generate theory. Hence, theory building is relying on existing theories and empirical data but when theory of a phenomenon is limited, a case study approach is especially appropriate as the researcher is not compelled to rely solely on past theory. When existing theory is not elaborate concerning a phenomenon, case study approach can create novel theory. This was the case for this thesis, existing theory within the boundaries of the aim and research questions were not sufficient for identifying the precise applications of a readiness assessment. Thus, the existing theory was complementary to the case study findings. The developed framework was primarily based on the empirical findings. The theoretical findings were utilised to support and formulate the framework.

2.4.2 Reliability and Validity

Yin (2014) has described the validity and reliability of a case study as containing three areas: construct validity, external validity and reliability. Construct validity is considered as the most difficult to achieve in case study research due to the construct being a subject to bias of the researcher (Yin 2014) as well as difficulties in providing well-structured results due to the nature of qualitative data (Eisenhardt 1989). External validity concerns the attribute of the research to be generalised, and reliability meaning that the research can be repeated (Yin 2014).

The research approach of this thesis has focused on finding correlations between literature and case study where the latter have been thoroughly scrutinised in order to identify unbiased patterns, therefor trying to secure the construct validity by openly discussing the findings. The authors had a flexible approach to the aim and research questions of the thesis, thus adapting the thesis to findings rather than the opposite. Meaning, focusing on the novelty of the results and reframing from interpretations. The authors have identified literature that matches the empirical findings by both selecting research which concurs and contradicts the finding of the thesis. The interviews followed a structured protocol with questions that have reframed from bias intervention. Furthermore, to reframe from personal influence, the authors did not encounter any of the interviewees prior to the interviews. This approach was intentional in order to avoid bias.

A limitation of this study was the amount and type of interviewees. Regarding the amount, 17 interviews were conducted which does not provide a significant cross section of the company. The intent was to examine one factory (factory D) at the case company, but to provide a broader perspective several interviewees from other factories (factory R and E) were interviewed. Regarding the type of interviewees, several individuals from the developing organisation were interviewed, however, within the receiver and the supporting functions only a few interviews were conducted.

To secure the external validity, the resulting framework of readiness assessment is of a general nature hence providing a workable result for any company in a similar situation as that of the case company. Consequently, the authors identified relationships between the empirical findings and previous research, thereby adding to the external validity. Moreover, the details of internal processes and ways of working at the case company have not affected the result, thus not limiting the framework to internal use. However, the thesis has not included a benchmarking approach which could have validated the research additionally, nor have company internal documents been consulted. In addition, generalisation of this study could have been improved if more research methods such as observations were used. However, according to Kothari (2004) an approach to improve generalisation is to use a structured interview protocol, which was used by the authors. This too might however be compromised as the interview protocol was used flexibly.

By closely describing how the case study was conducted, both interviews as well as management of data, the authors believed that by following the same steps and rigid structure of analysis, reliability have been achieved to the greatest extent possible. The research approaches used are furthermore adding to the reliability by providing an established framework for the research approach. In addition, the interviews were recorded and transcribed which further adds to the replicability. The company supervisor selected the interviewees, thus adding a bias element to the reliability. The theoretical data collection was documented in an Excel document, thereby providing traceability regarding performance of the data collection. Replicability can be affected by the presentation of the framework to a few interviewees, although the thesis contributions were vast, an equal opportunity to all interviewees was not provided.

3 THEORETIC FRAMEWORK

Firstly, this heading provides an insight of the *Production System Development* process and highlights the important aspects of the development procedure. The phases in a PSD process are described, thus an overview can be gained. The attributes and importance of the core plant is explained in *The Core Plant Role*. Prerequisites for transfer of knowledge, production and processes are described in *Transfer within the Network*. *Maturity Assessment* provides an introduction to maturity models. *Competences for Industry 4.0* provides an overview of the necessary competences in the Industry 4.0 setting as novel requirements are necessary in this setting of manufacturing. Change has consequences on both organisational and individual level. The former is presented in *Organisational Change* and the latter in *Change Management*. Hereinafter, the organisations of maintenance, supply chain, business development and controller are referred to as supporting organisations.

3.1 Production System Development

While product development has been examined both in the industry and in the academia, the PSD process has not received the same amount of attention (Bellgran and Säfsten 2010). The interface of product and production development has been examined by multiple researchers (e.g. Vandevelde and Van Dierdonck 2003; Gedell et al. 2011; Bruch and Bellgran 2012; Säfsten et al. 2014) radical change of a PS is however less common as entirely new design of a PS is seldom performed as it is more customary to modify or redesign existing systems (Gedell et al. 2011; Bellgran and Säfsten 2010). PSD can for instance be perceived as a subactivity within product development therefore obtaining limited attention (Bruch and Bellgran 2012).

A PSD can be defined as a system which includes process development as well as other functions of a PS which are required in order to manufacture products. Furthermore, PSD requires development also of organisational capabilities, and a holistic view of subsystems as well as their elements and interrelations (Bruch and Bellgran 2014). A process development is in contrast defined as a systematic development of production objectives, such as improving or creating methods (Kurkkio et al. 2011).

A distinction is made regarding the grade of change to a PS, that is if the change is minor or major. In the minor category changes to an existing PS are made, whereas in the major category an entirely new PS is created (Bellgran and Säfsten 2010). The change is also defined as first or second degree. In the first degree of change, the core values of the system which achieves the desired performance are intact post-change (Porras and Robertsson 1992). This magnitude of change is often performed as part of the daily activities (Bellgran and Säfsten 2010). Whereas the second degree of change results in a paradigm shift due to a radical change of the system. The latter change also involves different levels of the organisation (Porras and Robertsson 1992) and is often performed in a project format (Bellgran and Säfsten 2010).

The degree of change depends on the starting point of a company and the novelty of the change. For instance, if a company is accustomed to automation, an introduction of a robot cell is a minor change. Although introducing the same technology into a company without previous experience of automation would consist of a major change (Bellgran and Säfsten 2010). Radical innovation can consist of implementing state-of the art production technology. However, the ultimate manner to create a potential competitive advantage is by developing completely unique production technology solutions (Bruch and Bellgran 2014). The triggers for change can be of internal or external factors, radical change and development are most often triggered by the

external factors. Redesign and improvements to a PS are triggered by internal factors (Bellgran and Säfsten 2010).

As the PS design process entails complexity, the progress must thereby be structured (Bellgran 1998). By this means, overall costs can decrease, the process is simplified and less time demanding. Furthermore, a structured process enables collection of experience regarding the PSD tasks, which can result in a more efficient progress during future production development (Bellgran and Säfsten 2010). Standardisation and formalisation of the design process are key factors to develop as the design phase contains collaborations with divergent functions and departments, indeed increasing the process complexity. Assigning a team with a project manager becomes an prerequisite (Vandevelde and Van Dierdonck 2003; Bruch and Bellgran 2013). The team should consist out of personnel from different functions and disciplines as the complexity of the process requires a spread of inputs (Bellgran and Säfsten 2010). Furthermore, information sharing across functions is further complicated by a high degree of differentiation between department (Vandevelde and Van Dierdonck 2003).

A structured method from development of a PS can besides from creating understanding of the process, also contribute with an understanding of how the context is affecting the development. Moreover, an understanding can be formed regarding PS performance as an effect of the development procedure (Bellgran and Säfsten 2010). Additionally, a structured production design process can benefit with information sharing as well as define roles and responsibilities (Bruch and Bellgran 2012). In practice, it is common that stage-gate models are utilised in a PSD project (Bruch and Bellgran 2014; Bruch and Bellgran 2012; Rösiö and Säfsten 2013).

The company specific context can affect the PSD project as perspectives and attitudes of personnel and management can influence the process. The individual factors of management and the developing team can affect aspects such as resource allocation as well as selection of details in the PS solution based on personal priorities or preferences. Additionally, production output can be prioritised over the development tasks. The context also includes the company approach to a holistic view, meaning if the company considers that a system is composed of both technical and human factors. Moreover, management motivation is an important factor as it includes an active participation in achieving organisational learning and change (Bellgran 1998).

3.1.1 The Production System Development Process

One of the earliest steps in the PSD process is the PS design which sets the baseline for the continuing work, meaning that following steps in the PSD process are influenced and directly dependent (Bruch and Bellgran 2013). The design step is further divided into the phases of preparatory design and detailed design (Bellgran and Säfsten 2010; Bellgran 1998), where preparatory design contains a background study and a pre-study. The detailed design stage contains designing and evaluating a conceptual production system, followed by a detailed design of the chosen production system. Each phase contains several actives with different focus areas, e.g. the background study concentrates on evaluation of the existing PS at the developing company (Bellgran and Säfsten 2010) as well as PS of other companies (Bellgran and Säfsten 2010; Bruch and Bellgran 2013). Internal or local benchmarking with the intention of collecting design information at the same factory as a PSD project is less time demanding and spontaneous than visiting an external company which requires planning and can delay the phase (Bruch and Bellgran 2013). However, best practices are developed in-house as benchmarking is limiting regarding providing best solutions to problems or to maintain a competitive edge (Lu et al. 2010). See Figure 2 for a PSD process as developed by Bellgran and Säfsten (2010). Information

acquisition by benchmarking is important as it is an opportunity to design a competitive production system solution (Bruch and Bellgran 2013).

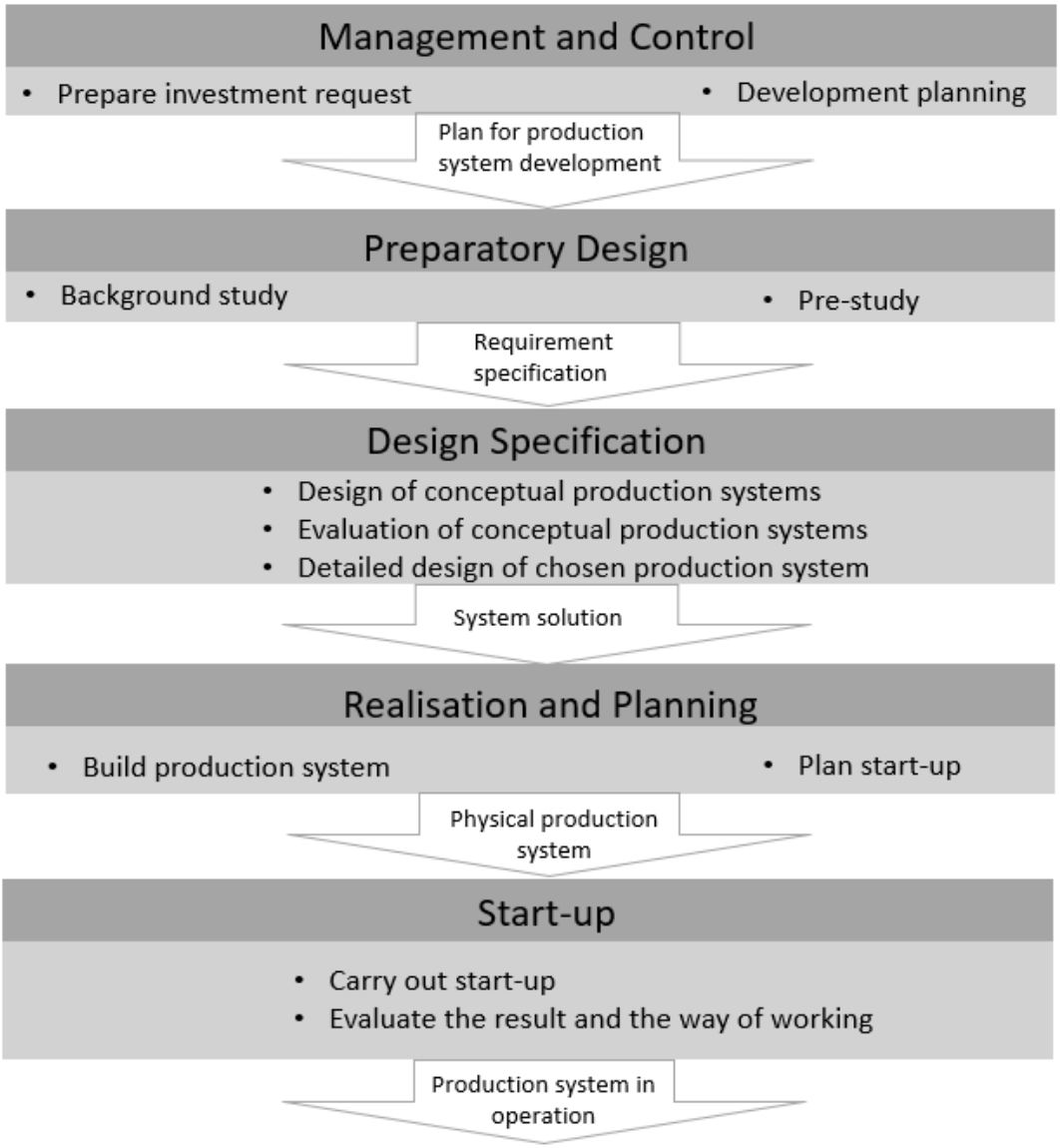

Figure 2 - PSD process modified from Bellgran and Säfsten (2010)

The background study phase is about taking advantage of gained experience and acquire a holistic view of the existing PS. A PS is dynamic, meaning that the system is continuously subjected to minor changes. Gaining a holistic and accurate view of the PS is a challenging task which requires multiple inputs. Inputs could also be of previous design projects (Bellgran and Säfsten 2010). However lack of documentation might require re-work, or risk to influence the provided information by personal backgrounds, experiences and interests (Bruch and Bellgran 2013). Documentation can also facilitate follow-ups and create a baseline for decision-making with a prerequisite that terminology is created which can be understandable by all involved functions (Bruch and Bellgran 2012).

The pre-study on the other hand is about looking forward and outward with the intention to capture the goals and strategies of the company (Bellgran and Säfsten 2010). The pre-study should concentrate on gaining inputs from relevant function in the company, which could be of market need, production volumes, appropriate technology level, personnel and stakeholders but

without actually making decisions at this stage (Bellgran 1998). The two initial phases result in a demand specification which is the basis for the following three steps in the design (Bellgran and Säfsten 2010).

The design of a conceptual PS refers to determine flows of material, information, processes and people and their interactions. Furthermore, system parameters are chosen as well as layouts and automation or technical level (Bellgran and Säfsten 2010). Generally during the design phase, interconnected activities can be carried out parallelly by different function of the organisation disregarding that all necessary design inputs are not available. This can result in issues later in the process if utilised information is incorrect which can demand rework. This issue is derived from lack of clear strategies regarding handling of preliminary information and routines regarding communication of changes. Furthermore, there is a risk that novel information dominates in the information content which can be counteracted by including representatives from different functions and can contribute with different backgrounds. It is important that novelty is understood for it to be utilised (Bruch and Bellgran 2013). Furthermore, additional aspects which could be considered in the design phase are flexibility, redesign of jobs and change of organisation design (Wu 1994). Decisions regarding the organisation must be considered, which can include the organisational structure, assigning responsibility, level of required competence and wage distribution. The level of competence includes issues of the type of competence required and the needed flexibility of the personnel (Bellgran and Säfsten 2010).

It is however common that decisions regarding organisation of work and material supply are overlooked thus not integrated into this stage of the PSD process (Bellgran and Säfsten 2010). Organisation of work contains attributes such as competence of individuals, job assignments and design, interaction of co-workers and how people interact with technology. Job goals must be formulated, controlled and followed up (Bruzelius and Skärvad 1995). It is therefore pressing that the technical system and organisation of work in conceptual design are performed parallelly. Responsibilities must for instance be assigned to the production staff or to a supporting organisation. Current organisation as well as organisation of work must thereby be challenged (Bellgran and Säfsten 2010).

The solutions generated are evaluated in an iterative process which is part of the evaluation of the conceptual production system phase. The detailed design phase is an elaboration of the selected concept (Bellgran and Säfsten 2010). The concept is at this stage a model which contains the subparts of the system as well as their interrelations (Wu 1994) which must be elaborated in detail and connected into a systems view (Bellgran and Säfsten 2010). Furthermore, information in the design phase must be managed effectively. However, gaining design information related to forming a holistic view is an especially challenging task. Nonetheless, a holistic view is of vast importance as otherwise the technical subsystem receives extensive focus. Rather a design solution should contain a broad view and therefore a vast divergence of information (Bruch and Bellgran 2013) and thus avoid suboptimation (Bellgran 1998). This can be achieved by including other function which are affected by the design of the PS, thus achieving cross-functionality (Bruch and Bellgran 2012). Furthermore, involvement of production engineering in the PSD process is essential to ensure long-term development of PS which consists of planning for future PS as well as for the current. However, daily operations can be prioritised by this function to ensure delivery of ordered products. Yet, production engineering is especially important regarding developing a core competence in PS design (Bruch and Bellgran 2014). The participation of production engineering is therefore essential as the function has impact on planning and performing the design process, thus the performance of the final solution (Bellgran 1998).

When the design process is accomplished, the PSD process enters the phase of implementation i.e. realisation and planning, which is divided into a realisation and planning sub-phases and operations. Realisation entails the physical build-up of the production which is performed simultaneously as the planning of operations. Operation includes two stages which are the start-up of production and ramp-up. There is a precedence that the operation phase is carefully planned as resources must be utilised efficiently (Bellgran and Säfsten 2010). A method to handle the operations phase is to commence temporary organisation in problematic areas in the production with a task to solve problems. Furthermore, manufacturing experience and efficient learning curve can be achieved by introducing full-speed testing programs. The befits are of increased experience and cognitive learning by both management and technical personnel. Certain capabilities must be developed in order to ensure a fast start-up, that is problems must be detected, analysed and quickly corrected, which requires efficient decision-making and routines. Additionally, dysfunctional norms in operators can arise if the production is running on a low speed for an extending period, which can be prevented by increasing the output rate early (Almgren 1999). The ramp-up period is often connected to critical events, that is disturbances affecting production, and which emphasises the need for teamwork as the combined knowledge are greater than the knowledge of individuals (Fjällström et al. 2009).

Production start-up can benefit from development of standardised documentation (Vandevelde and Van Dierdonck 2003) regarding the design information which decreases the need for interaction and clarification. However, informal interaction can be of value as a context for information sharing can benefit from divergent backgrounds and training (Bruch and Bellgran 2013). Furthermore, in this phase the support and participation of management is particularly important (Karlsson 1990) as management attitude can affect important tasks (Bellgran 1998). The process also requires that explicit responsibility is assigned regarding ownership of the operations phase. The success of the PSD process can be evaluated based on the operations phase performance, especially as this phase is based on the preceding work in the process (Bellgran and Säfsten 2010).

3.2 The Core Plant Role

The Core plant is an intermediary within the network which entails that the core plant is facilitating the knowledge transfer between the R&D and production. In the R&D department, knowledge is explored, whereas the activity of exploitation is connected to production. The core plant collaborates with R&D, thus partake in the exploitation of knowledge (Enright and Subramanian 2007) which can be spread to other facilities within the network (Simon and Näher 2008). Consequently, the core plant participates in the development of products, processes and technologies, that is the innovation of the network. Core plant is thus the knowledge creator which provides the network with solutions. The development of processes connected to production is thereby the responsibility of the core plant (Enright and Subramanian 2007).

The core plant gains and optimises manufacturing methods, which includes gathering and validating ideas for optimisation. Additional attributes of the role are; training personnel at new locations and drive continuous improvements. The network can thereby benefit from gaining knowledge developed in the core plant, that is both explicitly transferred from the core plant or implicitly incorporated into manufacturing processes (Simon and Näher 2008). Compared with a network structure without a core plant, each plant collaborates with R&D without an intermediary. This network structure does not contain strategic plant roles (Abele et al. 2008). However, alignment of products must be achieved which can be benefited from the intermediary

role contribution of knowledge, for the core plant concept to be profitable. Furthermore, the core plant concept possesses the advantage of lower adaptation costs of processes (Deflorin et al. 2012).

Synergy can be achieved by transfer of manufacturing processes to the subunits of a company network. Furthermore, transfer can aid to gain performance consistency between the subunits (Lu et al. 2010). However, trade-offs of whether to transfer production knowledge created in the core plant within the network or provide space to the plants to create local knowledge must be made. Nevertheless, knowledge transfer is connected to cost-savings regarding fewer adaptations, but the transfer activity itself is related to negative cost. Consequently, the knowledge generated in the core plant and if it is eligible for a transfer is depended upon the complexity of the production process and the heterogeneity of the plants in the network. These characteristics of knowledge regulate the extent of adaptation required post-transfer of the production processes, thus the benefits of the transfer. Furthermore, reducing complexity is particularly important as knowledge transfer can be performed more effectively (Lang et al. 2014).

The quality of the relationship of subunits can influence the knowledge transfer as it becomes more beneficial for both parties, that is the receiver and the transferrer. Furthermore, the plants within the network are most likely to retain a strong strategic role (Vereecke et al. 2006). However, coordination issues can result in a requisite for network configuration, that is if the subunits can acquire knowledge and achieve high performance without the contribution of the core plant (Lang et al. 2014).

3.3 Transfer within the Network

The transfer of knowledge and best practise has certain prerequisites which are elaborated in *Knowledge and Practice Transfer*, here different kind of knowledge is also explained. The prerequisites for process and production transfer are elaborated in *Transferability of a Process.*

3.3.1 Knowledge and Practice Transfer

As knowledge is one asset by which companies can gain competitive advantage, knowledge becomes an key resource that demands increasing amount of attention and management (Grant 1996). A prerequisite for global learning and knowledge transfer in a network is aggregation of knowledge in the subunits of a corporation (Gupta and Govindarajan 2000). Competitive advantage can be sustained by transfer of best practices intra-firm. The transfer can be related to transferring organisation of work, superior technology (Szulanski 1993) or knowledge transfer (Grant 1996). The prerequisite of knowledge transfer is however that the network is supporting the activity (Ferdows 2006) and that knowledge transfer mechanisms are developed (Lazarova and Tarique 2005).

In the belief of management, the transfer systems concerning production know-how can be informal and implicit, thus lacking structure (Ferdows 2006). Additionally, knowledge developed by subunits is often tacit as it is influenced by the local context of the subunit (Szulanski 1996). Barriers to a knowledge transfer and utilisation can also be lack of incentives and poor communication (Lazarova and Tarique 2005). Classification of production knowledge can aid managers to select suitable mechanisms for transfer. Furthermore, the necessary absorptive capacity (AC) level in a production unit must be decided upon. Moreover, the form of knowledge, whether it is tacit or codified, affects the suitable method for transfer. The transfer

is further complicated by the pace of change of knowledge, as does the interplay of form and pace. Furthermore, when the maturity level of technology is low, the corresponding knowledge form is more tacit than codifiable (Ferdows 2006).

Practice transfer is divided into the stages of initiation, implementation, ramp-up and integration, where initiation is derived from identification by the organisation of a need. The transfer of knowledge from the source and receiver is performed in the implementation stage and when the organisation is utilising the knowledge, the ramp-up stage is reached. When knowledge becomes a routine, the organisation is situated in the integration stage (Szulanski 1996). Vertical transfer implies the transfer from homogenous departments in the organisation, as from the R&D department to a factory. Whereas horizontal transfer of best practice is intra-firm as the knowledge is previously acquired in the company (Kogut and Zander 1992).

Madsen (2014) makes a distinction between accumulated experiential skills, for instance concerning a specific process, and standardised non-process specific skills which can be welding. Hopp et al. (2009) define tacit knowledge as unarticulated, meaning it is connected to senses, movement, skills, intuitions or physical experiences. Madsen (2014) describes this phenomenon as tacit knowledge, which can be difficult to capture, decontextualize and creates a difficulty to transfer and assimilate. The receivers' capabilities can be increased by training and knowledge can be transferred by handing over of documentation, face-to-face training, on-job training, videos and visits.

Parameters that the developing organisation need to consider for successful transfer projects are for instance; keeping employees at their jobs during the process, motivate employees to prepare for the transfer and to take responsibility for teaching the receivers' employees the new ways. Furthermore, transfer project characteristics such as adapting knowledge for the unfamiliar environment, possible lay-offs or personnel transfer and training programs must be handled by management (Madsen 2014). Certain tasks on the shop floor can be standardised and thereby the knowledge can be transferred. However, complexity and uncertainty of tasks might implicate that certain knowledge is hidden. Operators might not be aware of the possessed knowledge nor the collective behaviour which is required to solve a problem in the production. Thus, to fully understand the tacit knowledge observation are required (Madsen et al. 2008).

The continuous dialogue between tacit and explicit knowledge creates organisational knowledge. New knowledge is formed by individuals but to be articulated and amplified it needs the organisation. When tacit knowledge is exchanged in social and collaborative processes, it is referred to knowledge sharing (Nonaka 1994). Furthermore, organisational knowledge is created when the organisation possess the capability to create knowledge, spread the acquired knowledge throughout the company and utilise it in the development of products, services and systems (Nonaka and Takeuchi 1995).

Cohen and Levinthal (1990) explain that the relationship of the developer and receiver will affect AC due to the pre-transfer knowledge level of the receiver and its ability to require that knowledge as well as the ease of collaboration. A firm's AC is the direct ability to incorporate external information and spread it internally. Additionally, it is a way to determine the firms knowledge base, focusing on the level of knowledge of individuals. Zahra and George (2002) define AC as a dynamic capability which is related to both creation and utilisation of knowledge. This can facilitate to gain and sustain the competitive advantage. Gao et al. (2017) argues that AC should be considered as a capability rather than an asset.

Goncalves Filho and Waterson (2018) further argue that AC can be divided into potential and realised capacity. Knowledge acquisition and assimilation is found in the potential capability, whereas knowledge transformation and exploitation are within the realised capacity. The ability to manage knowledge is considered to be the role and the outcome of AC which is found in organisational routines and processes. Cohen and Levinthal (1990) means that the AC of the receiver can differ regarding abilities such as experience and knowledge of the workers, also regarding the background of the receiver. The success of communication of AC is dependent not only on the transmitting organisations knowledge but requires some expertise of the receiver as well. Dynamic capabilities are affecting organisational development, in AC it can influence how knowledge is acquired which is necessary to create other organisational capabilities such as production.

Moreover, knowledge developed in subunits in the network are more often based on diverse experience, which is more valuable but also more tacit than time-based experience. To be fully utilised, the receiver need to possess AC (Szulanski 1996). Knowledge transfer is particularly related with cost-savings when the receiving company possesses a high level of AC which results in less amount of adaptation. Also, less interdependencies between decisions regarding production can lead to integration of changes to the transferred knowledge (Lang et al. 2014). For this type of knowledge to spread to other subunits the requirements are of frequent contact which facilitates knowledge sharing (Miao et al. 2011). Several barriers to knowledge transfer exists. Firstly, knowledge characteristics such as if the knowledge is unproven, secondly, where the knowledge is originated from, as credibility and lack of motivation can affect the transfer. The transfer is also depended on the knowledge receiver, as lack of motivation and AC risk to affect the transfer. Lastly a hurdle to transfer is the context characteristics of the organisation which might be a risk factor, for instance an arduous relationship (Szulanski 1996).

3.3.2 Transferability of a Process

Transferability of a process is the ability of the process to be adapted, transmitted and assimilated to the receiver, which is performed cost- and time efficiently. Knowledge which is necessary within the transfer activity determines the transferability. Barriers to transfer can be lack of managerial know-how at the receiver, lack of infrastructure, governmental requirements, climate etc. Robustness is the sensitivity of a process to the mentioned or other factors; the system is robust when it can be transferred without adaptation to fit conditions and environments which it was not intended for. The process can thus be cloned which can lead to avoidance of adaptation costs (Grant and Gregory 1997).

If a process can be cloned, the assessment of appropriateness is not necessary and does not require knowledge of the receiver. Such robustness is however difficult to achieve in practise and the process might be robust to certain variables but sensitive to others (Grant and Gregory 1997). Adaptation of a manufacturing process can be evaluated regarding its suitability with local conditions, also called appropriateness. A robust process does not require adaptability in order to conform to local requirement, however some factors might be robust, and some must be adapted (Nonaka 1994). Nevertheless, most manufacturing processes cannot reach a level of robustness and transferability which is necessary for a complete mobility (Madsen et al. 2008).

Replication of production lines is an important capability to attain in production companies within a network. This need is derived from the dispersion of companies within the network as well increasingly connected, and the need to be able to respond to shifting performance objectives (Wæhrens et al. 2012). Replication is the process that an organisation partakes to copy an existing success in production into another location. Thereby the organisation strives to

emulate the previous achievement by creating new production lines in the image of another (Winter 2010). However, the complexity of production involves multiple practices and technologies, their interconnection is the prerequisite for operational efficiency. Thereby making replication a challenging task which requires corporate transfer capabilities (Ferdows 1997b).

3.4 Maturity Assessment

The maturity assessment concept derives from the Software Engineering Institute of Carnegie-Mellon University, when Capability Maturity Model was implemented to improve software development, the concept has however spread and adapted to multiple disciplines (Maier et al 2012). Within IT management for instance, organisation can gain an improvement regarding position as change solutions can be identified (Becker et al. 2009). In a maturity model, essential characteristics of an organisation at a level are described. Such a model is descriptive in its nature (Maier et al. 2012) and can be utilised as a tool to assess or improve (Wendler 2012; Becker et al. 2009) organisation or processes (Maier et al. 2012). The current situation of an organisation can be assessed, and a suitable improvement strategy can be identified by the support of a maturity model (Becker et al. 2009; Mullaly 2014). Even though the advantages are contained in the means of managing and improving organisational capabilities, a maturity model is often developed once again due to similarities in structure but differences in content (Cohen and Levinthal 1990).

Organisational maturity, within the context of project management, is defined as an organisational preparation for implementation of a portfolio of projects (single projects and programs) in a consistent manner, with the emphasis on efficiency and effectiveness. Programs entail a number of projects which are connected by their scope. Organisational project maturity can thus be assessed based on the level of preparation for implementation. A project is in itself a temporary organisation rather than a unique and temporary series of tasks within the framework of the organisation, thus means by which organisational strategic objectives can be realised. The management of a project sets demands regarding stakeholder management, human resources and knowledge management. The emphasis for a successful project is managing the implementation process, the temporary organisation and achievement of beneficial changes. As the context of each organisation differs, a maturity assessment model is difficult to create which is suitable for all organisations. A potential method is an evaluation-based assessment which is provided in Figure 3 where each area contains multiple criterions for evaluation. For instance, *the definition of the project results*, can contain; scope definition regarding the project outcomes, viability of the beforementioned, and decisions making regarding the desired outcome (Görög 2016)

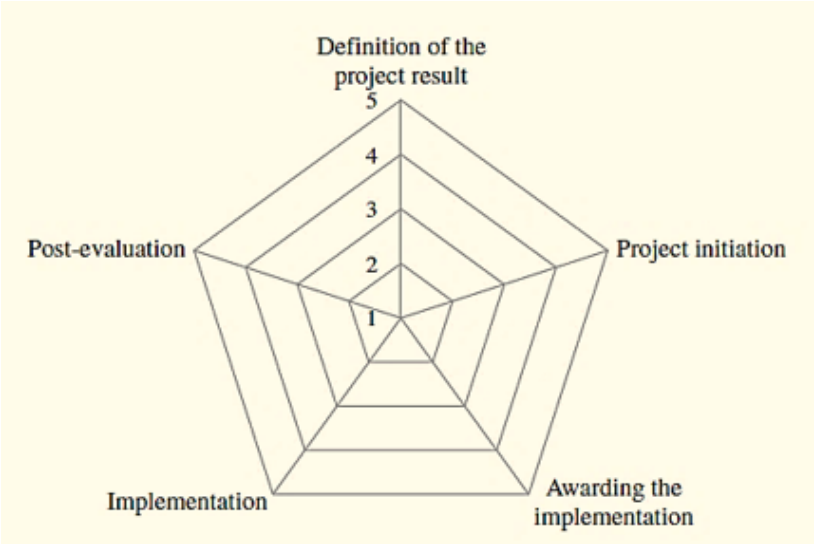

Figure 3 - Project maturity assessment model modified from Görög (2016)

According to Mullaly (2014) in order to provide value, project maturity modls must achieve a balance between the simplicity of questions and complexity of the model to accompany the broad and complex project management role. The existing maturity models does however not achieve this balance. Thus, the relevance to be utilised is not accomplished. In order to provide value, project maturity models must improve regarding; flexibility in structure, adaptability of application and responsiveness in interpretation. Furthermore, guidance concerning organisational improvements require a flexible and contextual framework which can be adapted to several types of projects, potential practises and processes. Additionally, the contextual influences of the mentioned factors should be recognised.

3.5 Competences for Industry 4.0

The digital revolution, industry 4.0 or internet of things, contains not only computers and robots but digitalisation of processes as well. Meaning, the industry 4.0 productions system contains interconnected equipment which are of artificial intelligence character with visual aids for operators, requiring less human interaction, also known as the cyber-physical system (Lee et al. 2015). Pinzone et al. (2018) identified the disruptive attributes of industry 4.0 to include an increase in digital connectivity, human-machine collaboration and visualisation via digital aid. Furthermore, digitalisation can entail cataclysmic changes in processes and technology, often within a short time period which also embodies adoption of digital competence (Hecklau et al. 2016; Pfeiffer 2015). Thus, industry 4.0 will affect humans since new skills are required and both opportunities as well as challenges will arise. That is, new types of jobs are created that move away from monotone tasks and will potentially require more skills from the employees (WEF 2016), the operators undertake a planning workforce position (Pfeiffer 2015). In other words: *"[…]as technology races ahead low-skill workers will reallocate to task that are non-susceptible to computerisation – i.e. tasks requiring creative and social intelligence. For workers to win the race, however, they will have to acquire creative and social skills."*(Frey and Osborne 2017, p.269). The required skills are often defined within the hard requirements, i.e. technical skills (Pfeiffer 2015; WEF 2016) rather than the soft, but the requirements for soft skills are increasing both for operators as well as for engineers (Pfeiffer 2015).

The hard requirements are for instance technology and methodology understanding and IT-skills such as virtual tools (Pfeiffer 2015). The soft skills, on the other hand, are such as self-

management, self-organisation (Hecklau et al. 2016), communication/social skill, problem-solving abilities (Hecklau et al. 2016; WEF 2016), project management as well as visualising complexity (Hecklau et al. 2016). In addition, there are challenges such as employee's ability to cope with organisational change and increased requirements for complex processes (Hecklau et al. 2016; WEF 2016). Although the aforementioned skill criterions are of interest for an industry 4.0 manufacturer, there has been more focus on the hard skills requirements rather than the soft skills which are a vital part of the future manufacturing system (WEF 2016; Pfeiffer 2015). Meaning that requirements on a new It-system must be communicated from employees to the developers, understood by the designers and from a managerial point of view, assess if management is ready for change. In addition, participating in organisational or technology development includes employees as well as management in the initial stages of the developing process which utilises the participants experience. In order to incorporate the social aspects of a PSD project, integration initiatives such as virtual representations of the production system can be used by the developing organisation (Gregori et al. 2017). When it comes to training and vocational education, there is an increase for such aspects in industry 4.0 (WEF 2016) as well as benchmarking and mentor programs that supports new employees in adapting to the working environment (Pfeiffer 2015).

Several authors identify that new skills and jobs will be required for industry 4.0 (Hecklau et al. 2016; Pfeiffer 2015; Gregori et al. 2017; Frey and Osborne 2017; WEF 2016). However, limited attention has been focused on finding general solutions to this issue, as visualised by Gregori et al. (2017) who made an assessment of the human-focused production layout in order to counteract health and safety issue, focusing on physical affects.

Hecklau et al. (2016) presents a model for assessing employees in an industry 4.0 setting. The assessment showed competence gaps, thus, is an instrument to find educational or training opportunities. However, in order to gain the best possible fit, each company needs to weigh the abilities to match the manufacturing companies' needs. The skill categories defined for the assessment tool is a set of identified competencies required for industry 4.0 according to academia.

3.6 Organisational Change

With radical production system transformations, Porras and Robertsson (1992) explains that the organisation needs to be changed as well. The transformation includes both processes, ways of working and humans, these aspects might have less focus than the more tangible technical issues and innovations. In addition, although an organisational change is imminent, lack of motivation can affect the success of the change. Emphasising the core of organisational change; "*Organisational change-that is, improvements in organisational functioning – requires change in behaviour of individual organisational members*" (p.728).

Radical change of an organisation can be defined as a change of greater magnitude, including market innovations or company performance improvement on premises of market demands or cost decrease, for instance. Naturally, organisational transformation can derive from technical innovation which in turn can stem from both innovation or a market opportunity. However, a correlation between innovation and market needs to be made. Furthermore, cross-functionality is a prerequisite for innovation in a transformation by finding abilities in organisational structures that cannot be found from an individual's point of view (O'Connor and McDermott 2004). The organisational aspects of a transformation are concretised as being employee participation, organisational attributes such as procedures and structures, cultural traits, and continuous

improvement. In addition, adapting to a transformation is an individual characteristic (Holt et al. 2007).

The transformation project team commonly consist of individuals that are placed in the project throughout the whole duration and are thus motivated and invested in the project. The organisation usually contributes with resources to develop the skill of the team members. The team can consist of champions that have a crucial role in a transformation project (O'Connor and McDermott 2004). Champions are the drivers of the innovation team as they fuel the project with energy, they do however require leadership in order to maintain within the project direction (Markham and Aiman-Smith 2001). It might be challenging for employees to accept change due to an insufficient level of readiness. The level of readiness for individuals are dependent on the change context, change process as well as the self-readiness for the change, this being different for each individual and resistance to change can emerge. Readiness levels can be raised by ensuring that individuals believe in the change. Also required is management support of the change and that the support is established. Furthermore, beneficial traits of the change must be shown on individual and organisational level (Holt et al. 2007).

There are several areas in academia regarding management of manufacturing change. Manufacturing change management (MCM) is defined as "*organizing and controlling the process of making alterations in manufacturing, including all measures to avoid or frontload and efficiently plan, select, implement and control manufacturing changes*" (Koch et al. 2016a, p. 11). Processes for MCM additionally should provide a project with defined gates as well as incorporating causes for change to the factory. MCM focuses on the manufacturing change (Koch et al. 2016a) whereas engineering change and engineering change management is impacting products, explicitly: *"Engineering change refers to making alterations to a product and engineering change management to the organising and controlling of this process."* (Jarratt et al. 2010, p.105).

By combining the process attributes of the product and manufacturing change concepts, differences can be found and a common process for managing change can be made. The processes for engineering change management have a greater focus on the early phases of the process, hence laying a foundation for change by addressing the exploratory phases identifying the need and finding solutions. MCM, on the contrary, utilises detailed implementation preparations to achieve manufacturing readiness and smooth transition as well as focusing on continuous operation. Focusing on MCM it is clear that the proactive nature of the process is lacking, hence a joint process is of interest. Moreover, a survey and complementary interviews indicated that companies have a higher level of defined processes for the later stages of MCM, that is problem solving, preparing or initiating implementation. However, having a stated process might not fulfil the requirements for effectiveness of MCM (Koch et al. 2016a). The details of the requirements are shown in Table 4.

MCM Effectiveness (Aspects)	**Detailed requirements (examples)**
Holistic view	Systemic view Interfaces (to e.g. other departments)
Transparency and traceability	Transparent approach Clear responsibilities
Practicability and applicability	Enterprise-independent applicability Simplicity of method
Process orientation	Coordination of activities and stakeholders Information flow and communication support
Proactivity	Change identification Early change approval
Problem solving and analytic capabilities	Cause and impact analysis, change classification Solution finding and consideration of production system properties
Knowledge management	Achieving and tracing information Control of success and lessons learned

Table 4 - MCM effectiveness, modified from Koch et al. (2016a)

The frequent changes and increasing complexity of the manufacturing system implies a need for structured and detailed design of the process. The industry provides insight that each of the MCM aspects are important in a change process. Academia, however have so far exposed the *holistic view* and *problem solving and analytic capabilities* strongly. While *practicability and applicability*, *process orientation*, *proactivity and knowledge management* lacked some exposure. Whereas *transparency & traceability* was the least exposed. Nevertheless, the industry could benefit from a rigid change process when applying manufacturing changes (Koch et al. 2016a).

3.7 Change Management

The reason for change can be summaries by drivers of external factors (market demands/changes) where the goal is to transform the organisation (Kotter 1995; Oakland and Tanner 2007). However, commonly ending up in failures (Jørgensen et al. 2009; Kotter 1995). Considering change, Kotter (1995) provided a framework which is a mentioned in several works on change management (CM) (e.g. Bordum 2010; Vora 2013; Jørgensen et al. 2009) by introducing an eight-step model to transform an organisation, thus providing the basis of change management.

By *creating a sense of urgency*, the change can gain momentum in the early phases of the change initiative. That is, the ability to have motivated leaders, i.e. managers, that are able to find means to inspire change, thus engaging the organisation for change. The perceived simplicity of a change initiative might cause this, the first stage, to be underestimated in terms of importance and therefore insufficient time is spent on this step. The second step provides further insight on the importance of a *guiding coalition* which includes managers and change organisation personnel. This group commonly act separately from the company's established structure. Referring back to step 1, urgency can provide incentives for a guiding coalition. Moreover, the coalition should be lead and supported by a key line manager rather than a staff executive. Thus, underestimating the importance of teamwork and not reaching enough momentum for the change (Kotter 1995).

By *creating a vision*, the coalition can gain more success in the change effort, thus stage three is reached. Although the initial vision is an unfocused visual creation the change coalition develops the vision and a tangible strategy over time. The vision should be simple, comprehensible and preferably, should be able to be explained within five minutes and generate interest and understanding. *Communicating the vision* to the whole organisation is the forth step. To reach a

successful communication strategy the requirements for declaring a change are managers that act according to the change as well as joining the change vision to quarterly evaluations of division managers. Additionally, the company's intranet and internal newspapers can be used for vivid presentations of the vison. Introducing vision and change discussions in management meetings and aimed vocational educations in line with the change effort, facilitates vison spreading (Kotter 1995).

Once the change has gained personnel mass, there is a risk that obstacles occur and thereby hindering the change effort. *Combating the obstacles* as the fifth step, includes recognition of self-commitment from employees regarding the change and incentives to act and contribute within the change. But more importantly, management commitment that is harmonized with the change. By *creating short-term goals,* the sixth step can be accomplished. That is, actively assigning goals that ensure that momentum is kept throughout the change effort. These wins can consist of personnel rewards or short-term goals such as performance improvements. In addition, the short-term goals create a sense of urgency which is vigorous in a change effort (Kotter 1995). The seventh step is an extension of step six, although short-term goals are helpful a *premature declaration of success* can lead to a loss in change momentum. Meaning, even if a change has been implemented, the change need energy until its rooted and well established in the organisation. This can take five to ten years. The leaders have a central role in keeping the momentum, addressing the change effort by attending to noncoherent processes, employee alignment and opportune hires. In this stage, consideration of change resistance should be a focus as such resistance can grow and benefit of a premature declaration. Moreover, if step one through six have not gained enough attention, the declaration of success is likely to be premature. The eighth and final step, *creating the corporate culture* is derived from two success components. Firstly, Identifying the change successes on an individual level contributes to an understanding that the change was not mastered exclusively by management but by the employees as well. Secondly, the top management descendant should be pertinent with the change effort. Meaning, if the new management does not incorporate the new organisation it is likely that the organisation reverts to the old ways (Kotter 1995).

Although CM has a developed framework, in industry there is an ad-hoc attitude towards CM as managers are trying to learn how to incorporate CM trough experience rather than educational programs and with that, managerial support in CM might be lacking (Shanley 2007; Jørgensen et al. 2009). However, some research has been done to find systematic and standardised ways of working with CM (Bordum 2010; Jørgensen et al. 2009; Shanley 2007; Vora 2013). First, a definition of the CM process is of interest. Oakland and Tanner (2007) identified two major components of organisational change: readiness for change and implementing change. Readiness, as the initial step, might be lacking in the organisation due to a focus on a hasty implementation, training, and projects rather than managerial support and strategy alignment. In order to reach readiness there should be a focus on goals and measurements, thus enabling convergence of individuals towards readiness. Implementation, in extension, should embrace the individuals will to work in the system, thus attending to structuring work and processes and applying roles thoughtfully. In addition, a holistic view of the change process can be hard to attain due to day-to-day missions. Consequently, could benefit from an external resource (Oakland and Tanner, 2007).

By consulting the winners of CM, i.e. companies that are considered successful in at least 80 percent of organisational change efforts, an aim at soft factors can be seen (Jørgensen et al. 2009). The soft factors are; attitudes, culture (Jørgensen et al. 2009; Vora 2013; Kotter 1995) and understanding complexity (Jørgensen et al. 2009; Kotter 1995) The soft factors are considered

to be the most difficult to combat in an organisation change (Jørgensen et al. 2009; Vora 2013). Furthermore, managerial support from higher management is a major contributor (Jørgensen et al. 2009) to a successful change (Shanley 2007). Even including the president or chairman (Kotter, 1995). The receiving organisation's manager need the managerial support in order to apply resources and to prioritise. Also, the receiving manager requires training to understand what the change, and what being a change manager means (Shanley 2007).

In the preparation phase of an organisational change the soft factors should be considered in order to identify a plan for the project. Early detection of soft factors is a prerequisite for a successful change, thus combating change resistance (Jørgensen et al. 2009). Looking at successful cases of change management as well as literature the following can be said. Firstly, by adding a lesson learn element to a project it is possible to create and history database of previous project, thereby creating a learning opportunity for future projects and consequently be able to identify soft aspects that were successful or overlooked (Jørgensen et al. 2009). Secondly, an assessment of the current state should be performed (Vora 2013) incorporating the soft part but nonetheless the technical expectations as well, vis-á-vis the hard parts. The required changes will also be communicated throughout the organisation (Jørgensen et al. 2009; Vora 2013), preferably via illustrations of the vision (Kotter 1995). Thirdly, the complexity of the change can be combated by planning (Bordum 2010; Jørgensen et al. 2009) and accepting the risk of adjustments in the project (Jørgensen et al. 2009) but planning should not substitute a vision (Kotter 1995; Bordum 2010).

The vision is the driver of the project which gives energy to the change and is, furthermore, a representation of the strategy, its goals (Bordum 2010) and should be understood by a majority, but preferably all of the affected organisation's individual. If the vision is dispersed throughout the organisation, the willingness for change is likely to rise and individuals are more inclined to make sacrifices for the good of the change (Kotter 1995). Lastly, the work of a change manager does not end at implementation as continuous momentum needs to be supported for a change to stick until the new culture and attitudes are rooted and well settled for regular day-to-day operations (Jørgensen et al. 2009; Kotter 1995; Vora 2013). The problems in this phase can be traced back to the initial three stages, if the vision, intensity level or collaboration is not strong enough, there is a risk of declaring the project accomplished to early (Kotter 1995). Regarding change responsibility, CM might not be a separate organisation but rather the ability of the manager affected by the change, such as middle managers attending to operations (Shanley 2007).

4 EMPIRICAL FINDINGS

Firstly, a brief introduction of the recent PSD project is provided, followed by a description of the roles in a PSD project to give an overview of the project and organisational structure. A motivation to change can differ throughout the organisations, this is elaborated along with how readiness was assessed in the case company's recent PSD project and that alignment and a holistic view regarding a change is often lacking. Furthermore, the transfer activity and a PSD project implication for the organisations are described. Lastly, the core plant context is elaborated in relation to transferability and replication.

4.1 Introduction to the Case Company Project

The recent PSD project meant that the case company did not only implement new and advanced technology but a new organisation as well. Although the novel production system is based on simplicity, employees experienced that the digital change was difficult to embrace. Furthermore, due to lack of training and system thinking, process understanding was not fully developed when production started. The receiving organisations had different priorities and readiness throughout the project, and most importantly, the readiness differed when the project was handed over to the receiving organisations. In order to gain an insight and understanding of how the case company achieved readiness for change, the majority of the focus is on the recent PSD project. However, the SAP implementation is also highlighted to a limited degree to provide more insight into the organisations relation to change.

4.2 Roles in a PSD Project

A PSD project is generally driven by a project leader and a project team. Nevertheless, some projects are solely driven by the process development organisation as information sharing regarding the project is not permitted. The factory manager is responsible for developing a needs assessment for investment projects and deliver it to the project team. The factory manager and the project leader are appointed as sponsors for the project. The dignity of a project related to investment amount and complexity determines which position is appropriate to appoint to a sponsor role. It can be a line manager or a production manager. The project leader must also estimate needed resources for the project which are delivered to the factory manager. The pre-study can be initiated when resources are allocated. Follow-up is performed in a steering committee which contains the project leader, sponsor and different levels of receivers, such as line managers. A gate model is followed and after the pre-study is accomplished a decision regarding continuation of the project to initiation phase. The project team can either consist of the same personnel or new members are appointed. The sponsor is however the same throughout a project and can also be a receiver. The production manager is responsible to ensure that investments of equipment is in line with the strategical plan and can therefore prioritise which projects to initiate.

4.2.1 Project process

The development projects at the company follows a standardised project workbook with the following phases: Pre-study, initiation, delivery, and post project, respectively. Each phase ends with a gate. In the pre-study phase the aim is to find solutions, evaluate the solutions and decide on witch solution that will be proceeded. Initiation phase means that the solution is developed, suppliers are evaluated and selected. Procurement of machines, equipment and tools are done in the delivery phase.

4.2.2 Receiving Organisations

A receiving organisation is defined as a customer to the developing project and can ensure that specific demands can be retained. The Maintenance organisation can be viewed as an operation department or a supporting organisation. The organisation itself defines it as a receiver. Supply Chain manager was a receiver of the project but had employees involved in the project as well. In general, most organisations can be classified as a receiving organisation, which is true for; supply chain, maintenance and production. However, most of the receiving organisations appoint employees to participate in the development organisation as well. The employees participate in WP.

4.2.3 Supporting Organisations

The role of Business Development is before a project is initiated and demands are stated regarding future processes. The function supplies the process organisation with inputs regarding future customer demands which are obtained through experience, via sales and customer contacts. Customers also visit the case company and performs audits of the business, thereby formulating demands and identifies risks. The involvement of business development is however limited to interviews by the process development organisation, later in a project the tasks can be of aiding the project with analysing cost and aid the controller organisation. Controller organisation are involved in a process development project in the pre-study to assess the benefits of the investment and deliver a profitability assessment.

4.2.4 Change Management Function

“Change management” was the name of one WP during the recent PSD project, which aim it was to relocate people from production as the new production concept requires a lower degree of human resources. The task was thereby focused on mapping out the competences which were needed in the new production system. The person responsible was connected to the HR department. A Local Change Manager is also referred to in the upcoming headings. The role of the person was during the preparation and implementation of SAP, a business system. These inputs are related to the PSD project as both implementation occurred parallelly.

4.3 Assessing Readiness

A process developer argues that readiness is something which is noticed and understood in interaction with individuals. Another process developer defines readiness as technical experience of similar technology as well as the organisational ability to receive, that is if the receiving organisation is able to receive the technology or if a reorganisation is necessary. In which case preparations must be made and this becomes a foundation on which readiness can be assessed. A readiness assessment could according to a supporting organisation manager, be beneficial as a managerial aid which can possibly induce certainty. Thus, managers would not have to rely on a “gut feeling” as it is difficult to translate signals from the own organisation regarding whether individuals are ready to receive a change. A factory manager´s definition of an RA is that the organisation is ready to receive technology which requires competence. For instance, the organisation is familiar with change of technology regarding replacement of an old machine with innovative technology. However, the change in the recent PSD project also involves Industry 4.0 and digitalisation which demands more from the operators. A supporting organisation manager defines RA as readiness of an organisation or individual to embrace innovative technology and organisation of work.

The transfer was successful from one supporting organisation's perspective considering the project's slim budget and short time span as restrictions. The project also had a vast number of stakeholders which further complicated the tasks. Disregarding of the obstacles, the project was delivered on time. The success of the transfer was due to right persons with appropriate attributes were in place to receive. One supporting organisation perceives that the recent PSD project was successful in regard to their own preparation, and communication. The organisation's resources were active in the PSD project and reported back to the manager. The organisation creates their own in the KPI which must be achieved to reach readiness to receive a transfer. The recent PSD project was successful since much have been done in terms of preparations and a high level of knowledge was achieved. Three process developers agree that the transfer activity from the developing to the receiving organisation was not completely successful. The developing organisation considered readiness which was competence building of the operators and involvement of people. Some parts of the recent PSD project were received faster than others but that no one was in place to receive during the transfer. The receiving organisation was solely ready to receive machines. The transfer of technology was performed as planned, however the rest of the transfer was rather unsuccessful. The receiver did not state demands on the receiving activity, and the process of transfer is not clearly defined. This can be a part of the reason for a poor transfer, not only in the recent PSD project but generally as well.

A supporting organisation manager argued that readiness could be achieved in the recent PSD project by insuring that processes and competence in their organisation concerning for instance IT were developed. Competence is regarded as especially important. One supporting organisation manager explains that their organisation did not assessed their readiness in the recent PSD project. The process development organisation distributed information regarding the progress of the project, but possible effects to the supply chain organisation is their own responsibility to frame. The supporting organisation did however not evaluate how the recent project would affect their organisation. A hindsight is therefore that the organisation should have discussed among themselves, required presentations from the process development organisation and more particularly taken both time and responsibility toward readiness. The organisation would also need to report to the process development organisation of their own progress toward readiness and formulate which actions that was taken toward this aim. Readiness can also be assessed by measuring the readiness of individuals in the organisation, which was performed in the SAP implementation, where competence and motivation toward change was assessed.

There is consensus in the process development organisation as well as according to one receiver that no official current state analysis nor gap analysis was performed for the recent PSD project. The receiver adds, a gap analysis would have been an improvement as the amount of problems which occur after every project might have been less. A process developer state that their organisation tried to identify acceptable levels of automation competence by consulting the suppliers. As the recent PSD project included high-level digitalisation and Industry 4.0, a RA should therefore include an assessment of knowledge in a current state paired with a desirable knowledge level in a gap analysis. Currently a gap analyses is performed related to the operators but should also be performed of all supporting organisations. It is important to execute in a pre-study. There would also be value in re-assessing the receivers current state thought the project as the pre-study was executed several years before the competence analysis was made. A current state analysis could give insight on knowledge levels. However, knowledge level does not equal to readiness to receive and education does not equal to understanding. A process developer about readiness:

> *"About 10 years ago we developed a machine with no set up, we managed to get it working without any set up. […] It was the first fully automated operation with robots and everything. I was on a*

meeting with another line, which is close by, and told them about this. They said that I lied. They could not accept the possibility, they could not comprehend this. Then, the readiness level is very low. And you have to lift them, when they don't even believe in this. Imagine if one would implement the same technology there, it would have been a long way to go."

According to the factory manager, in huge technology leaps, as in a PSD or SAP, the challenge is of preparing the personnel for the change as they have excellent knowledge of the current system but lack competence in IT. Preparation for this gap is therefore difficult to comprehend. On the other hand, the project selected the best applicants to participate in the developing tasks which meant that some individuals were left out. These individuals needed to be relocated to a factory without digitalisation. The competences required ten to twenty years ago does not fit today, change is happening very fast.

A receiver explains, a current state analysis is generally performed in the pre-study phase. A baseline is set by looking at the current state of today, competences, technology and examine each stakeholder's views. In the recent PSD project, it was clear in the pre-study that the digitalisation would require more of the operators in terms of competences. The projects are generally adapted to the current state analysis to a varying degree. The resources are set from the start, during the project there are management team forums and check-off meetings where resources can be re-distributed if there is a delay. The meetings occur at least once a month and decisions are made rapidly. A manufacturing manager is usually a sponsor for several projects and cannot focus on the details in every project. Therefore, it would be preferable to spread the projects to several sponsors that work close to the end user. In the end, they will live with the new system.

The current state analysis can be a good way to create alignment, consensus, and an openness between the stakeholders, a factory manager explains, analysis of the projects current state generally is carried out with a set of known parameters including planned actions and which actions need to be added. The analysis supports prioritising and it is a forum for discussions. The analysis is performed several times during the project. However, the current state analysis is focused on technical parameters and the project advancement is generally not changed based on the analysis. In the best cases, issues are counteracted, in other cases, the project team realises that an issue is unsolvable, or the project plan is backtracked which might affect the gates. For example, in the recent PSD project, the ambition was to have one supplier for all robot cells, but no supplier wanted to take that risk. There was a massive workload which should be performed within a relatively short time frame. Therefore, the procurement issues extended the project with a few months.

4.4 Alignment and a Holistic View

In the recent PSD project, a process developer states, the focus was on the technical readiness. Technology readiness can for instance be achieved by working closely with the equipment suppliers, however, the result of the transfer showed that readiness was not completely achieved at the receiver. Competence building of operators was also focused on, a process developer continues, but creating a holistic view of the system was overlooked. A receiver adds that it is vital to ensure readiness as aspects of e.g. quality and competence. The technology is easy to focus on, the soft variables and a holistic view is difficult to identify in order to understand if readiness is achieved. The risk is that small overviews of soft variables can escalate and create wide-ranging faults later. According to a process developer, the technology in the recent PSD project was simple and the processes were easy to learn. The problematic aspect was understanding the interconnection of the cells. The automation concept was new also for the

process development organisation, and for other organisations within the company as well. Thus, readiness also lacked in the process development organisation as the holistic understanding was not entirely reached. To gain a holistic view, a process developer states, would require an understanding of the decision making behind the design of the production cells and the processes. A supporting organisation manager adds that the ambition is to gain a holistic perspective where the organisation of work is included and especially important.

According to several process developers, assessment of readiness connected to the soft variables are generally overlooked and difficult to handle as the competence in the development organisation is technically oriented. Readiness of an automated system sets other demands than a regular PSD project as it is difficult to concretises soft variables, as explained below:

> *"To just trust the system is one matter, the pallet will arrive in one hour even though no one is retrieving it."*

A supporting organisation manager explains, there was a lack of synchronisation between the process development organisation and the supporting organisation in terms of goals. The goals for the supporting organisation was not in the project initially, and was not clearly stated, which complicated the process. This supporting organisation did not perform assessment of the current state, future planning requirements, competences, nor general requirements. However, the process development team did a substantial investigation in the pre-study, but the project was initiated quickly by management, thus, left little time to prepare and include the supporting organisation. The manager gained information via two participators of their progress in the developing process. However, as the manager lacked a holistic view of the recent PSD project and project goals, the dialog suffered. The lack of understanding is thus related to not being part of the steering committee where uncertainties can be discussed. The manager also describes the following:

> *"Everyone else had an uphill to climb, knowledge of the technical parts was not gained when the project started. Then the other questions are difficult to ask as they become tiny in comparison to the fantastic technical topics."*

The citation describe that the process development organisation had an idea phase when the technical parts of the project were approached, the supporting organisations were however not involved. However, the manager perceives that the process development organisation has embraced this oversight and improved since the recent PSD project. According to a factory manager, it was obvious during the recent PSD project transfer that higher management of one supporting organisation was not involved nor informed of the implications PSD had for that organisation. When supporting organisations have a low maturity, most of all management, the outcome can be devastating. Which is explained by the factory manager as following:

> *"If management does not understand and prioritise to do differently, then people will work in exactly the same manner with something entirely new. So here I saw a major gap."*

Generally, in PSD initiative, a receiver explains, the organisations need to be involved earlier to make adaptions and gain an overview regarding the interconnections of the separate part within the project. The receiving organisation might thus identify possible solutions to problems if knowledge is gained early in the project and production issues might be avoided. A factory manager states that informing personnel and creating understanding of the change and its consequences was underestimated during the recent PSD project. This was obvious after the transfer as individuals lacked a system view which resulted in returning to old procedures. Furthermore, conflicts could arise between the receiving and the developing organisation due to deficiencies in communication and documentation. This resulted in different interpretations of

the project. The factory manager explains that the project is set up with sponsors and receivers whom are connected to the project and its stakeholders. They are included in the early phases of the project. However, this does not mean that the information is spread through the organisation. This is where the organisation is lacking, the structure is present, but the persons involved must integrate. Furthermore, a receiver mentions that if the scope has changed communication becomes even more important.

It is furthermore important, according to a receiver, to work together early on in order to identify risks for e.g. quality and competence. These aspects have previously been overlooked prior to the transfer. The transfer process might become smoother if the receiving and the developing organisation had worked together. Moreover, both early involvement of the operators and supporting organisations is pressed upon. If a RA is not preformed prior to a transfer, the consequences can be of deficiencies in the dialog which can lead to unalignment of expectations. Furthermore, a factory manager argues that the RA could serve as a communication aid where the developing and receiving organisations can develop a common terminology as well as gain alignment. Additionally, although supporting organisations were involved in the project, the difficulty arose regarding alignment of vision.

A business developing manager state that it is important to integrate customer demands into the structure of PSD projects in a cross functional manner. RA in the context of a supporting organisation manager is considered as understanding of customer demands and the consequences they imply for the organisation to strive for, which demands flexibility in the production. This also means that the supporting organisation needs a clear integration to the process development organisation where they can contribute with inputs regarding current and future customer demands.

4.5 Motivation to Change

According to a process developer, the magnitude nor the need of the change was understood in the recent PSD project, it was only considered as a huge task. The receiving organisation did not do enough when it comes to understanding the magnitude of the change. There were reorganisations which meant that managers were replaced, so they were not included in the project and did not comprehend that a transfer was imminent. They did not have the time to think about what is coming next, or how they will be affected. In addition, the focus was on the daily operations. Which is exemplified by the following:

> *"[…] almost like there was just going to be a button to press and go ahead with the new system once it was in place"*

A great deal of individuals could not understand the effects of the recent change nor the benefits of it, a process developer states. A receiver further argues that a RA should provide room for reflection where advantages of the project can be identified. This could provide an effortless structure for how a receiver could convince the rest of the organisation regarding benefits of the change. Furthermore, the importance of involvement of the management is major factor and the RA could clarify "*What's in it for me*" on a management level. Motivation of the receiver is generally essential to evaluate. If the engagement in the receiver is lacking, then the receiver will not spread motivation nor information regarding the change within their own organisation. The receiver must thus believe in the change in order to spread information. The receiver further explains that a RA can therefore aid in the evaluation of motivation and the commitment to the change. One of the major issues in a project is the resistance that occurs in a collision of the developer and the receiver. This collision can be avoided if the parties have agreed in an early

stage of the project. Moreover, a RA could facilitate personal reflection and what is expected from an individual as well as the attitude toward the project and willingness to change.

An approach to maintain motivation in the organisation is raised by one supporting organisation manager. The manager suspended a vast amount of time by having meeting with the PSD project team during the recent project. The turbulence derived from implementation did not reach the organisation. This is explained as following:

> *"We have a lot of warmth in our organisation. I usually say to the others that it is time to enter into the warmth."*

A factory manager raises the lack of commitment to change and discontentment as a factor which is more noticeable as the organisation of work is changed and the teams are smaller. Anxiety regarding change can be prevented by transparency, however the shared information can also lead to misinterpretations and turbulence. Thus, a balance is needed between the amount of information to share and when to do so. One supporting organisation manager state that the willingness to change is an individual attribute. Ordinarily in the supporting organisation, change is introduced by involving the organisation in a longer time period plan of pending change which has proven to be an effective approach. But it is also a difficult balance and maintaining the change willingness in the organisation and not to subject the organisation to a high level of change which risks lowering the willingness.

Motivation determines the level of readiness and is a prerequisite to success of the transfer and implementation according to a process developer. Lack of motivation is identified by the process developers as common attribute generally in PSD projects and can for instance derive from initiation of a project on a high organisational level with risk of leading to a lack of support from the receiver. A sense of ownership was therefore missing as someone else was driving the project. During the recent PSD project, a lack of motivation, understanding and competence occurred in the receiving organisation, specifically in management, which can be caused by insufficient leadership and can lead to a lack of commitment and ownership. However, one supporting organisation had great engagement in the recent project which was obvious by appointment of resources and pursuing own matters. The motivation was initiated from the organisation itself as demands were raised which were followed up by investing human resources in the project. The organisation's processes were defined by the organisation, meaning that the organisation seized their responsibility.

4.5.1 Responsibility Distribution

Several process developers argue that clear responsibility must be assigned to the receiver, which has been lacking both in general PSD projects in the recent project. The organisation is lacking a receiver focus. To actively making sure that the receiver is involved is however not prioritised as the daily tasks which includes personnel responsibilities are focused on. A project risks therefore to be viewed as an added burden. Active participation from the receiving organisations must be in place, that activities are preformed but also supported by the management. Instead, resources in form of operators or technicians are assigned to the project which is a misunderstanding of the receiving organisations responsibilities. Rather, an ownership must be embraced which could prevent a gap in the transfer. The process development organisation included operators in the development process, but the management from the receiver was not directly included in the project which could be a possible shortcoming. A process developer argues that the motivation can also derive from the receiver, concerning the attitude toward a project and is exemplified as following:

"They regard it as a necessary evil to appoint an operator to a project, but it is an investment. The operators must feel that they are special to be selected and can be part of something new."

Prerequisites for the preparation needs to be considered, as when production starts adjustments and development of organisation of work is complex to develop, a receiver state. Production engineering should possess responsibility of the technology, and the production managers for the organisational readiness. Responsibility issues are however not clearly defined in the project handbook according both several process developers and a supporting organisation manager. The project handbook contains routines of the other phases leading up to the transfer, such as acceptance of equipment etc. but when the process development organisation is ready for a transfer of the project, the activities which must be prepared by the receiver are not defined. Basically, the receiving organisation gains new equipment which is ready for production but the planes, change-over routines, competence building and so forth are not developed prior to the transfer. Meaning, the developing organisation are concentrating on their tasks, but the receiving organisation overlooks to prepare for the transfer. This misalignment is explained by one process developer as a lack of explicitness that the post project phase is owned by the receiver.

A process developer explains that the effects of lack of responsibility can lead to a misdirection of causes to problems after transfer. It is also important to assign responsibilities to people that possess the ability to create engagement and can follow-up the progress. Even though the responsibility is distributed, it does not ensure that it is grasped fully, a process developer states. This is exemplified by the following statement from a process developer:

"Competence, motivation and responsibility in the production management is something which was underestimated. Therefore, a situation occurred last summer. Technology became a scapegoat but when we investigated this closer the actual problem was staff shortage."

According to a process developer, the receiver was prepared for transfer by working with operators and industrial engineering in the project until the equipment was at the factory. The project should however have involved operators, industrial engineering and production manager to a larger extent. These issues were brought to light when there were issues this summer. It turned out that individuals had variations in knowledge levels and lacked an understanding. After the transfer all shortcoming became obvious. It is therefore necessary to assess readiness early in the project. The process development organisation has been successful in identifying and selecting, implementing and transferring a solution. After the transfer it is often realised that the receiving organisation is not ready. A process developer also adds that organisational aspect was brought up in the pre-study but disregarded as it was viewed as the responsibility of the management.

A project can generally implicate an extended change, the process development organisation can thus identify which aspects are overlooked and assign responsibility by raising the issues. It is for everyone's best interest to achieve clarity a supporting organisation manager states. A supporting organisation manager adds, even though readiness is the organisations own responsibility, they require support from the process development organisation as they are the expert on the change and can develop what kind of activities are necessary in order to achieve readiness. An assessment should also provide information of why the change is pending, and how much cost is expected to be saved. Additional information is also needed regarding the expectation of benefits and resources to create an overview of the demands on the receiver. Unnecessary frustration was a result of not participate in the development, with a lack of acceptance to solutions were the background was not explained, and implied that the organisation

needed to be reconfigured which is time consuming. This is explained as following by the supporting organisation manager:

> *"We need to learn not to go around and await that the project delivers a solution, rather decide to be more active in the beginning with the preparations"*

Additionally, a process developer explains that it was problematic to gain the attention of the receiver as the production had to maintain their output, however their participation is important in the project. As explained below:

> *"In some regard, everything which is not directly associated with production is not prioritised and this leads to a huge suffering in the end."*

> *"It is difficult to have a receiver who is responsible for a lot of things. We want a clear receiver who owns the equipment and can put time into the development of working procedures and receive knowledge from the operators as well."*

A receiver states that it is common that the receiving and developing organisation has an *"we and them"* attitude. A factory manager states that the collaboration between the receiving and developing organisation is not always successful. A contributing factor might have been the turn-around of people which came with new perspectives into the project. In a smaller part of the project, one person from the receiving organisation was involved during the transfer which was a great asset, but that person was alone in the matter. A receiver explains that the receiving organisation can often expect and await to obtain a complete solution which is delivered by the developing organisation. This way of reasoning is however incorrect as the receiver must participate in the developing activities. A closer collaboration must therefore be created where the receiver can gain an understanding of the benefits of the change. Participation can also benefit post-project phase. If the receiver is participating in the project, possible issues can be identified earlier and resources to solved them can be demanded. All resources are gone after a transfer which implies that the problem-solving is depended upon the receiving organisations abilities. The consequences can thereby be of breakdowns after the transfer.

From a supporting organisation point of view, customer demands, and trends should be generally considered in the early phases of the PSD project. However, as a reference or consulting body concerning market and future processes the mandate should be broader within the project. A supporting organisation manager concurs, earlier involvement could have prevented organisation related issues, this would be before the technical specifications are set. In addition, clarity from the process development organisation is needed, which provides not only the technology and equipment but also the organisational parts, which concerns for instance operative competences needed in the organisation. There was for instance no individual responsible for IT initially, when there should have been. However, according to a process developer, certain PSD projects are kept unofficial due to higher management demands. Thus, the developing organisation are not allowed to share information with other organisations within the company.

A factory manager points out that an organisation immaturity was demonstrated by the supporting organisation as the representative which was supposed to partake in the recent PSD project was not replaced when that resource disappeared. This represents a lack of commitment to the project. The situation could have been prevented by a more efficient preparation which included information of the reorganisation.

According to several process developers, assessing readiness could result in a shorter ramp-up as well as fact and cost-effective start-up with fewer mistakes as the organisation would be

prepared on how to handle issues. The risk of deficiency in readiness is that when all equipment is installed and working, the start-up of production is initiated even if competence is lacking. The persons which were involved in the projects earlier phases becomes more important and must contribute more. It is therefore important to involve more people earlier. Organisation of work could be prepared earlier as well as a sort of organisational evaluation which could concern methods to resolve issues of competence loss, vacations or absence.

Several process developers explain the consequences of transfer without achieving readiness. The developing organisation must sustain the project under a longer period than planned as the developing organisation possess the necessary competence. Meaning that the receiver lacks the competence to take over the project, which is possibly derived from a lack of motivation. The receiver need to have the process involvement under a period after the transfer. This prevents competes building in the receiving organisation as the time to learn by solving problems is not performed by those who are supposed to run the production. A pressure to produce as fast as possible after the transfer might be the underlying cause. A factory manager states that a pilot project was made where process development organisation as well as supporting organisations and operators remained in the project after transfer. In this post-project phase, effectivity was measured, and deviations handled during a three-month period. This approach is believed to be a preferable approach in every PSD project. The disadvantages are however that resources from the developing organisation are prevented to initiate a new project.

Lack of managerial support was also raised by a change manager. Change management had a dedicated WP with three participators in the recent PSD project, however, no one from management was includes in the WP during the whole project. One manager participated during a period, but when that person disappeared from the project, so did the engagement. The effects were that the remaining representatives lacked mandate to realise change. The WP had an assortment of delivered material, but the receiver did not pursue them. Management support and understanding is raised by another change manager who was connected to SAP implementation project. In this project the change manager aimed at raising awareness in management regarding the change and the implication the change would have for the organisation of work.

4.6 Change effects on the Organisation

Change can cause a need for a reorganisation according to a process developer. As the organisation of work is different, a need for a reorganisation is raised in order to ensure and maximise effectivity. A factory manager explains that a reorganisation was an effect from the recent PSD project regarding the production responsibilities. Pre PSD, the receiving organisation consisted out of managers who worked in shifts and had personnel responsibilities. The production responsibilities fell on the line manager who had a cost focus. The two manager roles were unaligned considering a holistic view of the production. The receiver was thus not prepared to obtain and create necessary understanding of technology and process, nor to evaluate requirement of knowledge of the operators or working methods. A reorganisation was thus made during the fall of 2017 where the focus was on having line responsibility with an emphasis on process. The working method prior to PSD is explained further by a receiver who states that shift managers were difficult to include in projects as they worked unregularly in shifts. One line could have five shift managers and to achieve alike motivation of five people is difficult. The difficulty also connected to identify who is the receiver. Post PSD the structure is clearer, and one person is responsible per line.

One supporting organisation participated in the recent project from when the technical specifications were determined until the ramp-up phase, according to the supporting organisation manager. The manager states that a self-assessment of the organisation was made. As exemplified by the manager:

> *"One cannot commit five technicians without it affecting the organisation. In hindsight, it was worth it. […] If we hadn't committed our resources, this had not been done, we have a project organisation, a process development light if you will"*

The organisational strategy incorporated for instance co-ordination of educational programs for personnel as well as a way of working with ramp-up. The aforementioned strategies would not be executed if the supporting organisation was inactive.

4.7 Structured Way to Assess Readiness

A process developer claims that a structured way of assessing readiness is necessary, which can include prerequisites to create competence, motivation, and time to both learn and create motivation. Competence building can be easy if the organisation is aware that it is needed. However, difficulties can arise when awareness is not attained, readiness assessment can be a solution for this type of issues. According to a receiver, there is a lack of standardisation regarding assessing readiness, and it is often depended upon the complexity of the project. When it comes to the human and organisational parts for transfer preparations, one factory manager points out that there are no defined processes or standards, it is up to the person initiating the change. Thus, the project can change depending on the manager focus. A process developer further explains that the understanding of the general PSD process must be achieved, otherwise the ramp-up period risks prolonging. A structured way of assessing readiness, where the major workload is early in the project, can ensure that the change is paired with competence to successfully transfer the project. To assess transfer readiness a receiver states, there should be a vital few KPIs.

A factory manager and a receiver also agree that RA is beneficial to be performed early in a project and should require different outputs at different stages. The factory manager continues that at the idea-phase and in the pre-study, readiness concerning the maturity of the technology should be regarded. Later in the project, readiness of competence building, and training should be considered. In the opinion of a receiver, if the transfer is acknowledged early on, then it becomes an organic part of the project and mythology of transfer can decrease. Meaning, all parts of the transfer can be prepared, i.e. every part of the receiving organisation is well-settled when the transfer is occurring, the details of post-project phase are developed. However, if the RA is planned to occur near the transfer, the process can become more time-demanding until all parts of the organisation can develop an understanding. However, projects which are of a small variety, with clear delivery goals might not need a RA. Rather, RA is more vital in large projects which are prolonged over a period of time as motivation must be sustained and it becomes more important to make sure that all factors are considered. Nevertheless, readiness assessment is required in every project, states a process developer, as it is important to assess readiness even for small project which results in changes of organisation of work. A factory manager requests a RA method which can be applied in extensive projects, which requires a familiarity with the method. This could be achieved by having a basic level in the method where competence about the RA procedure is built. However, the assessment must be performed continuously according to a process developer, and the issue of readiness must gain more attention regarding for instance the activities which must be performed toward achieving readiness. A RA could be appropriate

before passing a Gate where readiness could be assessed regarding if everything is ready for a next Gate.

A RA can according to a process developer provide an overview of the total progress of the project as well as provide where and when resources must be assigned. The time perspective could be reflected upon together with the developer, a receiver states, which could benefit the planning of how and when a receiver can involve the organisation as well as the supporting functions. Furthermore, the development of routines and working methods could be initiated earlier than post transfer. The RA should therefore occur before the transfer as resources are removed post-transfer, leading to increased difficulties in making improvement or changes as the focus is on ramp-up.

According to process developers, another issue which must be confronted with a RA is the difficulty to keep it relevant and up to date, especially if the amount of information is too vast. A RA could be simple, such as a checklist which contains necessary attributes for how an assessment can be performed. On a global scale, RA could ensure that everyone does the same things and that it is the basis for every project. It is also important that the RA is performed in a manner which does not require a high-level administration and provides a value added to a project. Assessing readiness should take time as is involves people who must be understood. However, the RA must be included in project meetings and into the project itself. A process developer argues for a RA which can include technology readiness, and whether the organisation is ready for such technology in general. A grading could also be made of the supporting organisation regarding the readiness to receive. A high level of complexity in a new system would then require a high level of activities to achieve readiness. The difficult aspect for a RA is that the process development organisation cannot state demands on the receiver regarding readiness. One supporting organisation manager raises the need to benchmark other companies and examine how they work toward achieving readiness. This derives from the low personnel turn-over which can create isolation. Furthermore, business developer tasks could be of transferring information regarding customer demands from their organisation to the development organisation. The process of transferring information must however be performed in a more structured manner into the developing process.

4.8 Human Factors and Competences

Another process developer explains that the area of responsibility for the project was to offer the operators education via procurement from suppliers. These training opportunities consisted of going to the supplier and testing the equipment. The project provides a structure and decisions on which individuals that should be included in the education. It was both operators as well as the organisation's personnel. The operators were at the supplier in the early stages of the project, it is a prerequisite for learning. A process developer further explains:

> *"What I think it is important is that we get that competence in the early stages of an investment project because it makes the ramp-up phase easier […] It is the receiving organisations responsibility to make sure that operators have the right competence."*

Education programs can be of a general nature, a receiver explained. Several of the individuals had been working at the same position for eight years, the change manager explains. One requirement was to find a new working position for all the individuals, therefore a validation of skills was made, which caused unrest. Especially individuals that did not grasp the digital system or experienced difficulties to adapt to change. The validation aimed to find the best fit for each individual and to show what competences were needed in the organisation. A communication

plan was established within change management WP to prepare the individuals. However, supporting organisations were not included in the preparations and recruitment procedures.

There was a need to get managers to support the competence and education programs. One of the change manager´s deliveries was to develop a material which summarised the necessary competences for the recent PSD project. A process developer explains, list of competences that was needed for the machines and equipment was performed:

> *"The list was pretty good. The problem was that it was not implemented fully, because production did not receive it, they did not understand why they needed to work with that. So, there was a gap there. They created education plans and what training was needed but it was never implemented"*

Define types of education and knowledge requirement is however not the same as being prepared but it is a good start, a process developer claims. Also, management did not take responsibility to follow up the education programs and check that the desired competences were achieved. A change manager emphasises the human aspect of change. Changing to the digital system is difficult when there are individuals that have very little computer experience. The receiving organisation got the information but lacked in education. Communicating the upcoming change might give little effect. For instance, explaining how the persons education works in the system gives an understanding of the role. Meaning, it was clear what to do but not why.

A training system for practical training is needed, according to the change manager, in order for the individuals to develop their skills, this was not available in the recent PSD project. The newly developed production system implies other expectations regarding change management. The expectations on the individuals are to understand not only the digital transformation but the new equipment as well. Individuals needed to improve their computer skill which was a demanding part of the change. A factory manager concurs, it is necessary to be prepared before the equipment arrives. However, the level of competence is not always reached to gain the equipment's full potential. In a previous PSD project, the involvement of technicians, operators, and other stakeholders made the tests and educational packages better.

Priorities can also be an issue according to a change manager. There were an unreadiness in some of the factories due to lack of education prioritising concerning SAP. However, when the education goals are reached, it is important not to stagnate. The change management tasks need continuous work, there is always going to be change. Furthermore, individuals are reluctant to change as the old system is safe and known, finding ones driving force is crucial for managing the change.

4.9 Replicability of a PSD project

One process developer mentions the importance of working with lessons learned. The recent PSD project was a transfer of a former project from which good and bad practises are found. The goods practises were replicated to the PSD project. The lessons learned procedure is mandatory following a project as well as consulting the lessons learned result in the pre-study phase. Concerning external replication, a presentation on best practise for technical solutions, decision processes and discussions is shown to the network representatives from the subsidiary factory. However, the representatives only attend the development phase to a small extent. This is due to the fact that the process development staff cannot add time to external factories. The case company does not have an organisation for intra-firm collaboration. The subsidiary representatives come to the case company to inspect the technology and the underlying

documentation, however, some of the representatives only inspect the technology. Thus, they risk repeating the mistakes.

A process developer explains that the subsidiaries have a high interest in the recent PSD project. Possible field of application of the developed technology can thus be identified. The equipment and its documentation, such as drawings and materiel, is carefully set up via processes in the development phase. A copy of the developed system will however not be possible as the equipment will not fit other production lines. The digital parts might be the same, such as the idea on data management and process monitoring and the overall function of the production system. The process will most likely differ as well. The transfer preparation is incorporated in the process developers work. However, the internal transfer is more of a concept copy as the production is built around on common strategic goals. Learning from the previous projects is a natural part of the process. However, a change manager explains, the subsidiaries factories can access the lessons learned as well as standard documents for competence assessment. Hence, the subsidiaries can use the competence documents to see which competences are required in a PSD such as performed in the factory.

From a receiver point of view one project is an accurate representation when transfer would not be of interest. The projects scope was misaligned as well as the technology. On top of that, decisions were made on a higher level of the organisation. A good example, on the other hand, is a curing machine for which some of the project successes have been communicated to the subsidiaries as well as companies buying the same machine. The curing machine was prepared for global replication from the start. In the recent PSD project there are simple machines with complementing technology that is likely to be replicated.

4.9.1 The Core Plant Role and Replicability

The core plant responsibility, a factory manager explains, is that tests are performed in the case company then replicated globally. That is why manufacturing development centre is located in the case company. Furthermore, due to the replicability responsibility the case company has a lower efficiency and capacity as well as a larger workforce which is needed to manage development and new technology that will be replicated. At one point an estimate was made on how many employees were working with core plant questions, it turned out that this balanced out the workforce compared to other factories in the process development department. The replicability is decided upon depending whether a project is successful or not. One example is SAP, which started at the case company with a lot of issues but is now replicated to the other factories without the same issues. A good level of technical readiness is needed in order to purchase a new machine, the technology has to be ready before it can be released, otherwise negative consequences might occur. The manufacturing development centre need to have good governance for the *"good enough"* state.

One of the subsidiaries have a huge advantage, another factory manager explains, which is access to an open space for the new production line. In this way, it is possible for that factory to start the new production line before shutting down the old one or use them parallelly. Also, the factory manager has shared information to the subsidiary on ongoing projects. The lessons learned from the recent PSD project can be replicated internally and the project magnitude have made the project very complex. In addition, the biggest challenge was to remove the old line before testing the new line. The new line was implemented and started quickly.

In a local context, the factory manager continuous, there have been a replication of details such as lower buffers that shows shortcomings in the flow and decoupled assembly. In addition, the automated production line that can manage a stop of up to one and a half hour, the stops are of critical nature, without lowering the output will be replicated internally as well. In this flow, autonomous vehicles are the buffer. In the old production line, every autonomous flow had its own rules, the new flow has homogeneous processes to realise standardisation. The aforementioned project had about 85% technology, robots and systems but a limited degree of the human aspect, the focus is on processes and to stream line the factory. In addition, the processes should look as similar as possible to one another, but the focus ahead is to work with humans and the individuals in the system. The idea is that, the number of machines one can operate, corresponds to a higher wage. In this way, resources can be moved from one place to another with ease.

The case company is more expensive than its subsidiaries in China and England, the supporting organisation manager explains, this is due to the core plant role that involves testing new things, spreading knowledge and teach other plants. The best individuals and machines are sent to the sister factories, thus, making their products cheaper. This is exemplified by the following:

> *"I'm not surprised that we are more expensive than the others. But we do that for them and we accept that role."*

Internal replication is made between the factories at the case company site, if the concept works locally, it can be replicated intra-firm. One supporting organisation manager explains, the replication is limited to the supporting organisation's tasks, the subsidiary can access the organisation's program. However, subsidiaries want to invent their own practises. In addition, the subsidiaries are not always interested in help but rather to learn about mistakes such as implementing SAP at the same time as a PSD.

5 ANALYSIS AND DISCUSSION

The first heading, *Potential Benefits of Assessing Readiness*, provides an understanding of why an assessment is needed in a PSD project. The second heading, *Responsibility Effects on Change Efforts* presents evidence on the responsibility aspect of a change. Thirdly, the *Replication* heading deals with how the replication activity should be addressed. The mentioned headings are answering the first research question. Finally, the heading *Framework for Readiness Assessment* presents a model based on the findings which is to be used by the developing organisation when working with change and PSD projects. The last heading contains the answer for the second research question.

5.1 Potential Benefits of Assessing Readiness

Within this heading a description of focus on *Technical Competence Readiness* is analysed and necessity of a holistic view is presented. *Preparation for Change* present an analysis regarding the findings concerning the transfer activity.

5.1.1 Technical Competence Readiness

Consensus is reached in the empirical findings regarding that the focus of the recent PSD project was mainly technical with accompanying competence building (process developer; change manager; factory manager; receiver). Readiness is defined as technical experience and an assessment of the technical readiness should be performed prior to transfer, which can be achieved by collaboration with equipment suppliers. However, this approach was deemed not completely successful. Consequently, the soft variables are not prioritised which could be explained by the technical expertise and focus in the developing organisation. The difficulty to concretises the soft variables is also perceived as more obvious in PSD projects which incorporates automation (process developer). Companies that successfully implement change focused on the soft variables; attitudes, culture (Jørgensen et al. 2009; Kotter 1995; Vora 2013) and understanding complexity (Jørgensen et al. 2009; Kotter 1995). It is clear from the empirical findings that a technical focus was prioritised, the company is aware of the importance of the soft variables which is in line with the theoretical findings. Therefore, a focus on soft variables should be taken in to consideration to a greater extent for a successful PSD project.

An effect of technology focus by both process developers and receivers in the recent PSD project is that a holistic view is omitted, thus prohibit achieving readiness. A holistic view of the project can be created by an understanding of design decision (process developer). Furthermore, the complexity of an automated system entails the need of specific competences as well as the need to understand the importance of the soft variables. Even when the individual processes of the production are simple, the interconnectedness must be understood (process developer) as well as the ambition to gain a holistic view regarding the organisation of work (supporting organisation manager). Otherwise, the consequences post-transfer can be that the receiving organisation can regress to old procedures, to spread information can thus reassure that change understanding is achieved (factory manager). The implemented change need continuous work to become a part of the organisation, this can take several years after the change have been transferred. Moreover, change efforts need a communication strategy in order to be successful, which includes internal communication systems as well as evaluation of employees according to the strategy (Kotter 1995).

The design phase must therefore include the organisational structure, assigning of responsibility as well as a required level of competence. The competence requirement should moreover include which kind of competence is needed. Most importantly is that the technical system and organisation of work are executed simultaneously in the PSD design (Bellgran and Säfsten 2010). The conceptual design should contain the subparts of the system and their interrelationships (Wu 1994) and connect this in a holistic view (Bellgran and Säfsten 2010). A holistic view is important to achieve to minimise the risk of emphasising the technical subsystems (Bruch and Bellgran 2013) thus avoid suboptimation (Bellgran 1998). However, a holistic view can be difficult to reach due to daily operations (Oakland and Tanner 2007). Production engineering inputs are essential to ensure long-term development, but daily operations are often prioritised (Bruch and Bellgran 2014). Foremost, it is important to gain a holistic view especially in complexed projects such as in PSD. The empirical findings show that understanding is needed regarding; the design decisions, importance of soft variables, competences needed, interconnections of processes, organisation of work and information spread regarding change. This is considered important as otherwise, a risk of regression to old procedures is imminent. These are therefore the variables that must be included in a RA.

The technical orientation of the recent PSD project was interrelated to competence building of the operators (process developer). Similar findings are made in the receiving organisation where technical competence building is focused on (receiver). The organisation should be ready to receive technology and its required competences (factory manager; process developer; supporting organisation manager) and organisation of work, thereby the receiving organisation should develop related processes (supporting organisation manager). In the setting of Industry 4.0, competence building is often focused on developing technical skills rather than the soft skills where the latter is deemed as more essential in the future manufacturing setting (Pfeiffer 2015; WEF 2016). Requirement for soft skills, such as self-management (Hecklau et al. 2016), problem-solving abilities (Hecklau et al. 2016; WEF 2016) and visualising complexity (Hecklau et al. 2016), are increasing for both operators and engineers (Pfeiffer 2015). Visual aid can provide a holistic view and an understanding of the new layout, however if readiness is not achieved, reaching understanding can be difficult (process developer). Understanding can also imply the need to comprehend the underlying reasons to perform tasks in a certain manner (change manager) as well as preclude misunderstandings (supporting organisation manager). Furthermore, experience and competence building are essential in both technical personnel as well as in management to assure fast start-up. The capabilities include detection and analysis of problems and correct countermeasures which also require decision making and routines (Almgren 1999). Based on this, the authors argue that the abovementioned soft skills which are related to organisation of work and processes must be contextualised to gain a holistic view which can be provided by the RA. Nevertheless, the case company should weigh the factors according to their project strategy and goals. As soft skills become increasingly important in the future manufacturing setting, these skills demand more attention.

Ferdows (2006) argues that when technology is new the corresponding maturity level is low which implies that knowledge associated with the technology is more tacit than codifiable. Bellgran (1998) further states that in a pre-study, inputs should be from all relevant functions in the company, where technology is only one part. Moreover, Bruzelius and Skärvad (1995) highlight the organisation of work as an important aspect of PSD, that is competence of individuals, job assignments and design, interaction of co-workers as well as individual's interaction with technology. Bellgran and Säfsen (2010) also argues that organisation of work is often overlooked in the design stage of PSD projects. Wu (1994), argues that the design phase should moreover include aspect such as flexibility, and change of organisation design. The

authors highlight that an awareness regarding the tacit knowledge which is related with new technology must be achieved. This can be considered as important as this adds to the complexity of PSD projects therefore it becomes even more essential to evaluate how the technology will affect the organisation of work. As the knowledge is tacit, spreading the knowledge internally can be difficult as the knowledge is tough to codify. Hopp et al. (2009) explain that tacit knowledge is unarticulated, meaning it is connected to senses, movement, skills, intuitions or physical experiences. Furthermore Madsen (2014) argues that tacit knowledge is difficult to capture and decontextualize.

To achieve a structured PSD process regarding readiness progress, the gate model which is currently applied at the company could also incorporate a RA. Thereby, RA can be performed before passing into the next gate of the project and assuring that the plan for preparation is followed (process developer). Different outcomes should be delivered via RA at different stages in the gate model, for instance to focus on technical readiness in the idea-stage (factory manager). An assessment regarding readiness should include motivation, competence and time to learn. The motivation specifically can determine the level of transfer readiness which can be a prerequisite to a successful transfer (process developer). However, it can be argued that organisation preparation need to be considered initially as well. According to a , when a change triggers a need for reorganisation, the receiver should be made aware of the fact and preparations should be made accordingly. Jørgensen et al. (2009) claims that soft variables focus in the early stages of change is a prerequisite for achieving a willingness to change. Kotter (1995) argues that a sense of urgency for the change is necessary in the early stages of the project, thus engaging and inspiring the organisation for change must be prioritised and this requires motivated leaders.

As the case company follows a Gate model and it is the current structure of a PSD project, the authors argue that the RA is more likely to be used if it is incorporated into the current project structure. A factory manager suggest that different issues should be considered in the RA according to deliverables at each gate. However, the authors are inclined toward the arguments of Kotter (1995) who argues that change can gain momentum in the early phases and the emphasis should be on inspiring change. Nevertheless, efforts are usually not spent on this issue due to underestimation of its importance.

5.1.2 Preparation for Change

The change which is related to Industry 4.0 can be associated with Porras and Robertsson (1992) argument that second-degree changes can impose a paradigm shift which according to Bruch and Bellgran (2014), can contribute to a competitive advantage if unique production solutions are created. However, radical change is seldom performed regarding a PS (Gedell et al 2011; Bellgran and Säfsen 2010). Nevertheless, when it does occur, the magnitude of change must be understood and prioritised over daily activities (process developer). In the change management area, it is clear that little success has been accomplished in industry regarding change management, i.e. organisational change, in the last decades. Failed organisational change attempts are still common (Jørgensen et al. 2009; Kotter 1995).

One of the supporting organisations prepared the organisation via educational programs and standards for ramp-up which was initiated internally (supporting organisation manager). PSD project with a high level of digitalisation, such as Industry 4.0 initiatives, requires additional competence of the operators (factory manager; supporting organisation manager). The CM related WP consisted of an evaluation of staff competence to accompany the change focusing on relocation of the operators lacking the attribute to adapt to change, such as the increased

digitalisation in the working environment. Thereby creating unrest for some individuals (change manager). This issue is corresponding to Hecklau et al (2016); Pfeiffer (2015); WEF (2016); Frey and Osborne (2017) who argue that new competences are required for Industry 4.0. For instance, Frey and Osborne (2017) addresses the issue of relocation of workers as a consequence of the digitalisation. But this applies, according to Madsen (2014) to any transfer project as learning a new system can necessitate unlearning the old system. Which is also mentioned by a factory manager, that preparation for this gap is difficult to achieve. Moreover, the organisation is not prepared to handle the gap as changes are occurring at a rapid speed. Hecklau et al. (2016) also identified competence gaps regarding an assessment of Industry 4.0 and suggest that every company should decide which capabilities are necessary in their own context. A decrease of monotone jobs, as explained by WEF (2016), demands a skilful workforce. A possible way to perform a gap analysis is by utilising a maturity model as it provides an evaluation of the current state (Maier et al. 2012) of the organisation and can be used to improve (Wendler 2012; Becker et al. 2009) organisation and processes (Maier et al. 2012). Within the setting of the project maturity models, the existing models does not provide value (Mullaly 2014). The authors suggest that a competence assessment model such as presented by Hecklau et al. (2016) can be utilised by a company when performing PSD to identify gaps in competence.

A RA can benefit with development of common terminology as well as alignment between the developing and receiving organisation and consensus and openness between stakeholders (factory manager). A prerequisite for MCM effectiveness is a transparent approach (Koch et al. 2016a). It is important to create early alignment as goals for individual organisations can be set (supporting organisation manager). Strategy alignment in change management can be unprioritized, as readiness for implementation of change is focused on (Oakland and Tanner 2017). Alignment can also be created in the design phase by including relevant and broad inputs from the different functions of the organisation (Bruch and Bellgran 2013), thus achieving cross-functionality (Bruch and Bellgran 2012). Which is a prerequisite for innovation in a transformation as abilities within the organisation can be exploited and cannot be found in one individual alone (O'Connor and McDermott 2004). The vision which can represent the goals of the change (Bordum 2010) must be understood by a majority, but preferably by the whole, organisation (Kotter 1995). To create an alignment of vision, reflection could also be performed on an individual level regarding the expectations, attitude or willingness to change and advantages of performing a certain project. Thus, the receiver could gain motivation and forward it to the rest of the organisation. A reflection performed together with the developer could also result in a better understanding of how to prepare and plan for future activities such as organisation of work and routines. The importance of communication can also be related to providing recent information, especially if the scope has changes (receiver). Alignment creation requires cross-functionality which must be highlighted in the RA. This is identified as a limitation in the case company organisation which further implicates the importance of early alignment within the RA. A RA should thus contain; creation of common terminology, consensus, openness, strategy alignment, cross-functionality, and understanding of the vision.

Differences regarding the vision of a project can occur due to lack of communication and documentation (factory manager). Documentation can facilitate the PSD process by simplifying follow-ups and create a baseline for decision. However, it is important to create a common terminology throughout the functions (Bruch and Bellgran 2012). Transferring information between departments must also be performed in a structured manner. For instance, information from developing organisation regarding a need for a reorganisation or supporting organisations inputs to the developing organisation (supporting organisation manager). Sharing information between different function is complicated as the degree of differentiation between departments

is high (Vandevelde and Van Dierdonck 2003). But the complexity can be benefited from a structured design process. Thereby, assigning roles and responsibilities can be simplified (Bruch and Bellgran 2012). The risks of lack of documentation can lead to a necessity to re-do work which has been influenced by personal backgrounds, experiences or interests. To re-do work can also be necessary if changes are not communicated. This is derived from a lack of clear strategies and routines regarding handling of information (Brunch and Bellgran 2013).

Unaligned expectations can occur due to deficiencies in dialog and to late performance of RA, or even resistance between the developing and receiving organisation. This can be combated by an agreement in an early PSD project phase. Furthermore, achieving unanimous understanding can be time-consuming if the RA is performed adjacent to the transfer (receiver). Or as Bellgran and Säfsten (2010) describe, the PSD design requires input from multiple functions and disciplines. Thus, the authors argue that including sponsors and receivers is not sufficient to ensure that information is spread in the organisation. The RA must contain a clear communication strategy regarding information sharing but perhaps most importantly, a strategy of how to communicate changes between departments. According to Kotter (1995) communication is about managers acting in line with the change as well as follow-ups are made that individuals work towards the change goals. According to a change manager a communication plan was established with the intention to prepare individuals for change which did not include the supporting organisations. In contrast, Bordum (2010) suggests that the vision can be a driving factor of change, which represents the strategy. Additionally, Kotter (1995) adds, that the vision should be dispersed throughout the organisation, thus, increasing the willingness to change as well as making sacrifices on an individual level. According to the authors, the benefits of an RA are identified as a communication forum promoting collaboration between the developing organisation and the contributing function within an organisation.

The focus of a PSD project is highly depended on the individuals responsible for initiating the change. The amount of attention regarding the human and organisational parts thus varied as standardisation is lacking (factory manager). Standardisation of RA can ensure that it is included in every project and providing a common ground and an area of discussion during meetings. The project phases are thoroughly elaborated; however, organisational readiness of the receiver and preparation activities are not defined nor standardised. The consequence of which is competence building, and routines are not prepared prior to the transfer (process developer). Due to complexity of a PSD project, standardisation is key for success (Bellgran 1998) and can benefit with cost reduction, simplification of the project and time effectiveness (Bellgran and Säfsen 2010). Standardisation and formalisation are vastly important factors as the PSD process is complex and it needs contributions from multiple functions and departments (Vandevelde and Van Dierdonck 2003; Bruch and Bellgran 2013). The context also includes organisations attitude toward a holistic view, that is, is the human factors included in the system, or is the focus mainly on technology (Bellgran 1998). As the findings points out repeatedly, a structured way to assess readiness is lacking with its multiple consequences which are escalating downstream in the PSD process. Which is also specified by a receiver, neglection of soft variables can cause wide-ranging faults later in the project, but technology is easy to focus on. The authors also argue that RA is a possible solution to combat the lack of standardisation regarding organisational and human readiness aspects within a PSD project. It is suggested that a RA framework can be utilised regularly, firstly, before entering the next gate but perhaps more importantly, as a vital component in meetings to create discussions.

Readiness should be assessed during a pre-study (process developer; receiver), where a comparison of existing aspects is compared with the future or desired state which are the intended

results of the PSD project (process developer). By performing this, an understanding can be achieved regarding where a company's current state is positioned in comparison to the future state in order to achieve alignment and a structured plan to reach the future state. A change manager suggest that the receiving organisation must be re-assessed regarding its current state continuously in the project. Also, according to a factory manager, a current state analysis is performed but the main focus is on the technology with accompanied planned actions. The authors argue that the technical focus should not be included in the RA as the developing organisation is accustomed to work with the technical attributes and their expertise is highly technical. Hence, including technical attributes would not provide value to the case company. The findings point out that it is important to assess and re-assess readiness which further strengthens the argument that the RA should be a continuous process.

The developing organisation offers educational opportunities which are acquired via procurement. Nevertheless, receiving organisation must reassure that the competence level is accurate and reached. However, even though the transfer of technology reaches its potential, the transfer as a whole can be unsuccessful. The developing organisation preparation for change consist of including the receiver, that is the operators and production engineering in the design phase. However, this does not ensure a consistent competence level in individuals, post-transfer can indicate that the receiving organisation was not ready to receive (process developer). The transfer systems are perceived from the viewpoint of management as informal and implicit, which result in a lack of structure (Ferdows 2006). Lack of incentives and poor communication can also be a barrier to transfer and utilisation of knowledge (Lazarova and Trarique 2005). An interaction with individuals post-transfer shows that there is a lack of understanding regarding the effects of change, which indicates that an even higher level of interaction is required (process developer). Level of readiness can be increased by management support which can ensure the individuals believe in the change. It is important to present benefits of a change on both individual and organisational level (Holt 2007). Transfer of knowledge can be affected if the knowledge is unproven, if the source lack credibility, but can also be affected by the lack of motivation, knowledge or absorptive capacity (AC) of the receiver (Szulanski 1996). When a change results in a reorganisation of work, it necessitates that counteracting measures are taken in the early phases in the PSD project (process developer), such as in the pre-study, to ensure readiness to receive (process developer; receiver).

The success of the start-up and ramp-up is linked to the preceding work in the PSD process. Meaning that if the implementation is successful, then the process is well structured (Bellgran and Säfsten 2010). The empirical findings are however unanimous that the implementation, that is the transfer from the developing to the receiving organisation, was unsuccessful. Thereby, a deduction can be argued that the PSD process itself is flawed based on several reasons. Educational efforts alone do not ensure an even distribution of change knowledge nor accurate competence. In addition, the results points to an underachieving regarding the competence level which is noticeable post-transfer, and which might be caused by an undefined structure to identify readiness. Furthermore, the necessity of reorganisation of work requires early evaluation as it affects readiness to receive. This must therefore be included in the RA.

An additional issue is provided by a factory manager, equipment might not reach full potential due to lack of sufficient competence. The change management responsibility, according to Jørgensen et al. (2009); Kotter (1995) and Vora (2013) only begins with implementation of the change but must be sustained until it becomes rooted in organisation or culture. A change manager provides insight regarding this issue, it is important not to stagnate after reaching educational goals. Kotter (1995) also argues that if the vision, intensity level or collaboration are

too weak, the project can be ended before gaining momentum. Although Kotter focuses on long term change, the arguments that change must be sustained are considered by the authors as valid in PSD projects as well. Motivation for change do indeed need to be sustained throughout the PSD process as showed by the findings.

The transfer activity must also be highlighted early in the PSD project to become an established part of the process. By acknowledging the transfer, the receiving organisation can be prepared to receive (receiver). The design stage of the PSD process sets the baseline for descending process steps. Meaning that the following steps are influenced and directly depended on the activities performed in the design phase (Bruch and Bellgran 2013). Competence building of the receiver can be limited due to lack of preparation for change, as the process developers must remain in the project post transfer. Thereby creating an environment where problem solving is performed by the process developers, thus opportunities to learn are wasted. The underlying reason might be the pressure to reach desired capacity (process developer). Temporary organisation with a problem-solving orientation is an option to handle operations phase (Almgren 1999) which can provide a combined knowledge (Fjällström et al. 2009). However, a RA can benefit a faster ramp-up, as well as cost effective start-up with less degree of mistakes. The benefits also could include remedies for handling issues as organisation of work can be prepared in early stages of PSD, also remedies for handling issues occurring in the organisation itself (process developer). According to the authors, it is believed to be of essence that the acknowledgement of the transfer activity is performed early in the PSD project, thus in the RA. However, the transfer activity within the RA should be evaluated in an iterative manner to assure that new information or decisions are incorporated in the preparation to receive.

RA is viewed to be essential in PSD projects which are extended over a long period as it is necessary to sustain motivation and to ensure that all vital parts of a project are included. Projects with clear delivery goals might not need a RA (receiver). However, a familiarity and comfort with RA can be created during the small projects thereby increasing the possibility to correctly perform RA in complex projects (factory manager). An overview of the progress should also be provided in RA to ensure that resources are appointed when they are necessary (receiver). The RA should contain a relevant and appropriate level of information which can enable ease of updating. RA should furthermore have fitness for use (process developer) and a low level of administration (process developer; receiver). The authors argue that vital parts of the project are essentially a context related issue. As the authors has limited insight into the project handbook of the case company as well as into the industry itself recommendations of this nature is not sensible to provide. However, the authors agree with the empirical findings that familiarity and comfort can be created in the RA by initially using the RA for smaller projects. As stated previously, the RA is recommended to be used regularly during meetings as well as before entering gates. It is also previously stated that communication and documentation are important for spreading information and creating alignment. An overview of the RA progress is therefore of significance.

5.2 Responsibility Effects on Change Efforts

Within this heading the importance of *Active and Assigned Responsibility* is elaborated as well as the role of *Active Participation*. *Managerial Support* is recognised as an important prerequisite for handling change Lastly, *Organisational Readiness* is identified as an important part of the PSD project.

5.2.1 Active and Assigned Responsibility

Organisational readiness can be perceived as a management responsibility, thus disregarded in the case company PSD project. Moreover, clear responsibility assignments are needed but are lacking in the project structure (process developer). Assigning responsibility should be included in the design phase of PSD (Bellgran and Säfsen 2010). The consequence of lacking a responsibility assignment can be of misinterpretation of root causes to problems. However, responsibility in the receiving organisation can be underestimated. Assigned responsibility is not equivalent to understanding the extent of the role as motivation is an important factor which facilitates engagement creation. For instance, maintenance organisation ramverresponsibility, thus elaborated their own processes as well as appointed the own resources to the PSD project. The maintenance organisation formulated and pursued important interests related to the PSD project (process developer). However, there is a misalignment concerning the maintenance organisation´s role in a PSD project which can lead to decreased mandate (supporting organisation manager). The receiving manager should have the ability of a change manager, thus taking responsibility of a change (Shanley 2007). As technical systems and organisation of work should be performed simultaneously, responsibilities must be assigned to both receiving and supporting organisation (Bellgran and Säfsten 2010). Nevertheless, some projects are solely driven by the developing organisation as information sharing regarding the project is not permitted (process developer).

There is a lack of expressed demands from the receiver regarding the transfer activity, thus the activity is not clearly defined (process developer; supporting organisation manager). This is a general issue concerning all PSD projects as the receiving organisation discount to prepare for the transfer and does not seize ownership of this activity. This issue might descend from a lack of standardisation that the post project phase is assigned to the receiver (process developer). Production engineering is however an especially important role in the design phase to develop core competences (Bruch and Bellgran 2014). Explicit responsibility is essential to assign regarding ownership of the operations phase (Bellgran and Säfsen 2010).

Assessing readiness is viewed as the responsibility of organisations (supporting organisation manager). However, the findings suggest that this is performed in one organisation, which is clearly pointing out that responsibility is not grasped. Therefore, it is suggested that the organisations should perform a RA but most importantly align their efforts to reach change by working toward a mutual vision. An RA could therefore be a forum to exchange information. The RA must therefore contain clearly defined responsibilities especially regarding the transfer activity. By aligning the efforts of both the developing and receiving organisation a definition of the transfer activity can be achieved. The RA can possibly provide a continuous evolution regarding if the assigned responsibility is actually seized.

5.2.2 Active Participation

Production management must be encouraged to actively partake and support activities in the PSD project (process developer). Participation of production engineering is essential for planning and performing the design as it has consequences for the performance of final solution (Bellgran 1998). Assigning operators to participate in the developing work is a misunderstanding of receiving organisations responsibilities and can be an effect of lack of receiver focus in the organisation (process developer). Participation in the PSD is also necessary to gain information and understand underlying decision, this can create an acceptance of solutions. This can be ensured by actively seeking inclusion which is ultimately the organisations own responsibility

(supporting organisation manager). Moreover, it is important to collaborate early in a PSD project for two reasons; identification of risks and effortless transfer (receiver; supporting organisation manager). Involving the management is essential and with a RA further elaboration of the benefits of a PSD can be made (receiver). Management motivation is important to achieve participation in achieving organisational learning and change (Bellgran 1998).

A *we against them* attitude is also identified, that is a lack of a comprehensive view of the developing activities and a lack of involvement of the receiver in the developing tasks. A PSD solution can be awaited without the need to involve the receiving organisation in the developing process. This must be prevented by active participation of the receiver in the PSD project which can also create an understanding of the change benefits as well as of the post-project phase (receiver). The collaboration of the developing and receiving organisation is not successful, nor is the information spread throughout the functions prosperous. The latter can lead to misunderstanding of priorities, when the management does not embrace the change the organisation risk to stagnate (factory manager). Management change embracement is a prerequisite for a successful change (Kotter 1995). An onerous relationship can cause a barrier in the knowledge transfer context (Szulanski 1996) and will affect the AC and the pre-transfer knowledge level of the receiver (Cohen and Levinthal 1990). There is an ad hoc attitude toward change management in industry, whereas educational programs should be prioritised in order to facilitate change management framework (Jørgensen et al. 2009; Shanley 2007).

As the developing and receiving organisations has limited collaboration where management of the receiving organisation does not participate actively in the PSD activities, it can be argued that the implementation phase of the project is rather a transfer activity. That is, the developed PSD design is actually the work of developing organisation while the receiving organisation awaits a solution. This can thus be classified as a horizontal transfer provided by Kogut and Zander (1992), that is acquired knowledge and best practice intra-firm is transferred to another department within the company. Which can be interpreted by the authors, that the receiving and developing organisations are separate units in the PSD project. Even though the developing organisation is striving for an assessment of receiver readiness it is believed that RA should be performed by both organisations. Therefore, the RA framework includes both organisations. It is intended that the RA is a collaborative framework which promotes involvement, as lack of participation is believed to be the root cause of issues within the transfer.

Production management should seize ownership of organisational readiness (process developer). An additional aspect is to prolong the process developers' involvement in post-transfer (factory manager). The prolonged involvement can be considered as mandatory as the lack of receiver presence and competence post-transfer can demand the continued involvement of the developing organisation. Which can be perceived as lack of motivation on an individual level (process developer). Discontentment and anxiety related to a change in the organisation can also be prevented by transparency in the PSD project (factory manager). Thus, an identified finding is a lack of commitment and ownership from the receiver. Or as a process developer formulates, lack of competence can risk leading to commitment and ownership issues. Furthermore, a factory manager explains that a lack of commitment can also be displayed by not replacing loss of personnel in a PSD project.

Lack of commitment and ownership can derive from initiation of a PSD project from outside of the immediate receiving organisation, which can lead to decreased support from the receiving to the developing organisation. That is, when the steering committee and the sponsor are external (process developer) and a lack of understanding of the project is a possible consequence as

concerns cannot be raised (supporting organisation manager). Perspective and attitudes of personnel and management can influence the PSD project. The affected areas can be resource allocation and selection of details in the PSD solution (Bellgran 1998). However, appointing resources from the receiving organisation, such as operators to a PSD project, can be a way in which management express their commitment. Nevertheless, the attitude and motivation of receiving organisations management can disperse to the operators, if the project is viewed as a necessary evil, the appointed operators might lack motivation themselves (process developer). The motivation of the receiving organisation and the believe in change must thereby be evaluated (receiver; factory manager). The approach of the maintenance organisation is involvement by the manager thus maintaining motivation of the organisations own project team in the PSD project (supporting organisation manager). A crucial part of a transformation project is championing as these persons maintain motivation throughout the project (Markham & Aiman-Smith 2001). A finding is thus, that appointment of operators can be a subterfuge for management involvement in a PSD project. That is, by appointing an operator, the receiving organisation can be perceived as involved but no actual commitment is made.

5.2.3 Managerial Support

The empirical findings show that change managers lacked management support from the receiving organisation or higher management regarding competence building educational programs. Managerial responsibility was not seized regarding follow-up if necessary competence was achieved (change manager). A possible explanation that is, that the receiving manager also needs managerial support to assign resources and to prioritise in change management work. Furthermore, the receiving manager requires training to fully understand their role in change management (Shanley 2007). A supporting organisation manager further explains that support from the developing organisation, that is the change experts, is needed regarding achieving readiness. Lack of management leadership can cause a decrease of motivation and understanding in the receiving organisation. Even when operators are included in the PSD project, a lack of management presence is viewed as a shortcoming (process developer). Support and participation of management in particularly important in the transfer phase (Karlsson 1990) as management attitude can affect important activities (Bellgran 1998). Higher management support is essential for a successful change (Jørgensen et al. 2009; Kotter 1995). A RA should therefore highlight the value of managerial support of the change activities.

5.2.4 Organisational Readiness

Current organisation and organisation of work must be challenged in the design phase (Bellgran and Säfsten 2010). An organisation assessment is deemed necessary and is initiated by the organisation itself which can be based on previous project failures. Organisational preparation can thus reassure that a project can achieve success (supporting organisation manager). To compare, as one supporting organisation made an assessment another did not, the results of the success rate can be deemed as related to an organisation assessment. A process developer also implies that a change can cause a need for reorganisation of work to ensure maximised efficiency of the change. The reorganisation of work is thus a finding as evaluation of the need is not evaluated from all receiving organisations.

The organisation must be structured to be able to receive a change, thus lack of structure for handling this task can be the root cause for an unsuccessful transfer. This phenomenon is explained by a process developer, as the receiving organisation was structured in multiple shift managers, a holistic view nor a commitment to receive was attained. As there were multiple

managers, no clear commitment nor responsibility can be assigned to a specific person (process developer). The responsibility of the receiving manager is to understand the change and the role of change management (Shanley 2007). A reorganisation was made post-project (process developer) which can be argued is a deficiency as an evaluation of the organisational capabilities to receive a change should be performed in the early phases in PSD project.

The receiver must possess absorptive capacity for fully utilise the transferred knowledge (Szulanski 1996). A high level of AC is related with cost savings as less adaptation has to be made (Lang et al. 2014). Although this is described from a network transfer point of view, it is believed to be accurate also intra-organisation as the receiving organisation has limited participation in the developing work. As the receiving organisation in the case company is often waiting for a solution, a deduction can be made that a solution is risking being new for the receiver and therefore adaptions must be made. Which could possibly be prevented by active participation in the PSD process. Cohen and Levinthal (1990) argue that the success of communication in AC is dependent upon both the developer and the receiver of the knowledge. The AC is also necessary for creation of capabilities regarding organisation and production.

5.3 Replication

Intra-Network Collaboration of the case company is presented as well as *Preparation for Replication* which are performed in PSD projects. Lastly, *Core Plant Responsibility* findings are analysed.

5.3.1 Intra-Network Collaboration

A close collaboration exists within the network. The developing organisation can act an external resource to factories within the network only to a limited degree, as a clear structure to partake in the core plant responsibilities are not established (process developer). Transferring best practices intra-firm can gain competitive advantage (Gupta and Govindrajan 2000) but a prerequisite for knowledge transfer is that the network can support this activity (Ferdows 2006) and develop mechanisms for transfer (Lazarova and Tarique 2005). External replication is thereby expressed by sharing of documentation, e.g. lessons learned, as well as decision process for technical solutions (process developer). However, knowledge developed in the factories is often tacit and influenced by the local context (Szulanski 1996) thus difficult to transfer (Madsen 2014; Hopp et al. 2009) as certain knowledge can be hidden (Madsen 2008). The network representatives participate in the PSD project to a limited degree, thus focusing mainly on technical solutions, thereby risk re-creating the same mistakes (process developer). The factories in the network can be interested in lessons learned to avoid making failures (supporting organisation manager). An understanding of the interrelation of competence and technology can thereby be absent.

5.3.2 Preparation for Replication

The developing organisation prepare the PSD project for replication by careful documentation (change manager; process developer). Although the replication is not always clearly emphasised (change manager). However, exact replication might not be possible as each factory within the network has various prerequisites and strategies or a misalignment of scope. Local replication is thereby more plausible than global (process developer). The ability to adapt, transmit and assimilate a process decides whether a process is legible to be transferred or replicated, thus if the process is robust (Grant and Gregory 1997). Robustness is however difficult to achieve as

some factors might be robust but not all (Nonaka 1994). Replication is however an important ability within a network (Wæhrens et al. 2012) but requires corporate capabilities (Ferdows 1997b).

For local replication, lessons learned from previous PSD projects are utilised, where successful practices are replicated both internally as well as used as a framework for impending developing projects. Lessons learned is a mandatory task both concerning consulting in the pre-study phase as well as performing after-the-fact (process developer). Organisation of work is replicated locally, as well as processes (factory manager).

5.3.3 Core Plant Responsibility

The case company factory and the Manufacturing Development Centre is located close to each other; therefore, the role of the factory involves testing the technology and development (factory manager) and spreading knowledge, thereby teaching other factories (supporting organisation manager). Which is in line with the definition of a core plant, that is; the intermediary between R&D and production, participating in the innovation, thus the knowledge creator within the network (Enright and Subramanian 2007). The responsibility of the role entails gathering and validating ideas of optimisation, training personnel and drive continuous improvements (Simon and Näher 2008). Due to this responsibility, the factory has a large workforce but a lower degree of efficiency and capacity. For instance, the case company factory has a higher amount of process developer employees than other factories in the network. As this factory can be considered as a test facility, replication to others is only decided if the test is successful (factory manager). Thus, an argument can be made that resources are spent in the case company factory which other in the network can benefit from with a prerequisite that the project is tested successfully. The network can also benefit to gain a solution where the growing pains of first implementation are excluded.

A factory manager also explains that factories within the network has more beneficial preconditions regarding preparation for a transfer. A supporting organisation manager further elaborates that this is the reason that the case company factory is more expensive in comparison to others within the network. Individuals and machines are furthermore send to other factories, thus making their products less expensive. Lang et al. (2014) argue that even though knowledge transfer is connected to cost-savings, the transfer activity is connected to negative cost.

5.4 Framework for Readiness Assessment

In the previous PSD projects, readiness to receive was not prioritised. It is obvious, based on the findings in the previous headings, that a need for RA is pressing for a tranquil implementation of a PSD project. Boldly stated, it even might be a prerequisite for a transfer from a developing organisation to the receiving. In this heading, the content which could be included in a RA are presented.

The framework is intended to act as a guide in the various setting of change, such as in a PSD project, but not limited to a specific setting. The framework is rather a guide to utilise in any change initiative. Accordingly, the content of the framework is formulated in an open manner to invite for discussion. The findings have indicated that the receiving and developing organisation are decoupled in a project, therefore there is not a clear alignment of vision with multiple consequences; responsibility is not assigned, there is no clear structure for assessing readiness, limited preparation for change is executed, motivation and understanding is lacking and so forth. The fact that the organisations are decoupled in change initiatives is identified to be the root cause behind a majority of issues presented in the findings. The framework is therefore constructed to inspire discussions and creating an involving format as this is identified as a missing component of the current project structure. The content is formulated in a question format to achieve self-reflection on all levels of the hierarchy, thus including all participants of the change.

5.4.1 Working with the Framework

The authors argue that soft variables should be considered in each step of the developing work, consequently also in each area of the RA. This is also the reasoning behind that the RA should not have different content regardless of gate. The authors argue that there is a risk that the case company would regress to old ways of working, thus having a technical focus if the organisation is not accustomed to considering and focus on the soft variables. Therefore, it is recommended that the case company develops an experience by working with the RA in its current form, when the RA is a part of the culture it can be conformed to the gate stages.

The framework might not be a stand-alone document. For it to be incorporated into a company culture, it is necessary to fully understand the benefits of an RA and the consequences of performing a transfer without assessing readiness of the receiver. The framework itself does not provide the explanation of the mentioned factors, which is an identified limitation. To successfully utilise the framework, the authors suggest that an initial phase might be of creating an understanding within the organisation of the importance of a RA and thereby the framework. This would however press upon the embracement within management that the RA is essential for a successful PSD or other projects which implicates change.

As the framework is promoting organisational collaboration the questions are formulated in a manner which requires participation from both the developing organisation and receiving organisations. Thereby inviting to collaboration within the project. Figure 4 shows the basis of the framework and is intended to be used to create an overview of the organisations progress toward change. The questions in Figure 4 are formulated to be leading and open for discussion, thus preventing a simple yes or no answer. Thereby, the recipient need to reflect and openly discuss the questions which can possibly create a sense of motivation, responsibility and inclusiveness.

Figures 5 through 8 are complements to the framework (Figure 4) as they provide more elaborate suggestions regarding the content of the framework. However, these are merely suggestions as the authors have limited insight to the case company organisation. Such framework is absent in academia, thus specific content needs to be developed within the context of the case company. Nevertheless, the guidance of the suggested content can be utilised for instance before entering a gate but also as early on in the project as possible. The framework is intended to be used together with all affected organisations during regular meetings.

Nevertheless, some projects are initiated within the developing organisation which does not permit involvement of other functions. Thus, the framework must be adapted to be utilised solely by the developing organisation. In this case, the framework is recommended to be used as a guidance to reflect regarding to the content of how each point or question should be approached and how to prepare the receiving organisation when the project reached the official state. The framework becomes a reflective document where the developing organisation can acknowledge and assure that the human and organisational aspects are not overlooked.

The triangle within the framework, see Figure 4, is a representation of the possible need to re-evaluate changes in the project which can implicate a requirement to deeply re-assess the effects of the change of scope. This is method to reach acknowledge flexibility which a project might require. The framework should be used iteratively, if the vision, collaboration or intensity level is to weak, the project risk to be considered as finished in connection with implementation. The triangle should be the initiating and ending question in every meeting to ensure that every organisation works toward the same goal, that is that the scope of the change is followed.

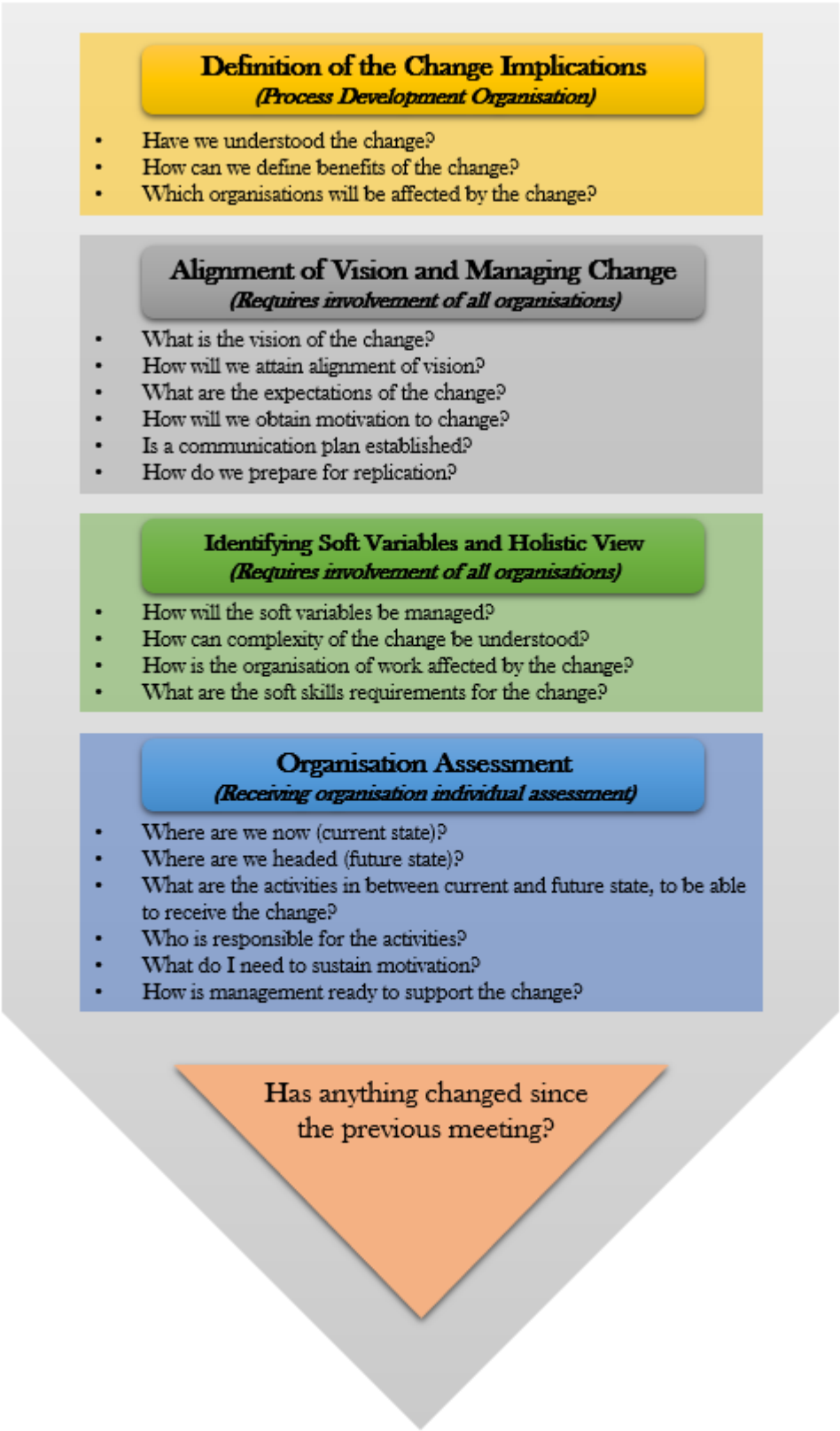

Figure 4 - Framework for Readiness Assessment

5.4.1.1 Definition of Change Implications

The developing organisation, as the experts on the pending change, should firstly understand the change implications as well as the change itself. Therefore, the yellow section of the framework and accompanying Figure 5 is dedicated to the developing organisation. This part of the framework is intended to define the change, understand its benefits and completely understand the change itself, which is deemed as necessary in order to efficiently spread information to the other organisations. In this way, the developing organisation creates an initial idea of for example which actives should be performed by the other organisations in order to be align with the change. The yellow section should be performed solely by the developing organisation when entering or initiating a new change project. The authors believe that the developing organisation provides a definition and possible activities for the change. However, the other organisations need to reflect and adapt the provided information to their own organisation, thereby taking responsibility for the change. The latter is performed by the aid of the following sections (Figure 6 – 8).

Definition of the Change Implications

Have we understood the change?

- Are the details of the change understood, as well as the overall effects of the change. It is important to understand the change down to the smallest parts, if the developing organisation does not understand the change effects neither will the other organisations.

How can we define benefits of the change?

- What are the benefits of the change?
- Define the reasons why the change is needed
- How can we communicate those in order to create motivation to participate?
- Benefits must be understood by higher management, receiving/supporting organisation managers and operators. The benefits must thus be formulated in suited terminology

Which organisations will be affected by the change?

- Define the organisations which will be affected by the change. Might be necessary to evaluate if the developing organisation itself has understood the implications of the change in order to efficiently communicate the change to others
- When and how will we spread information. Generally, more information sharing is equivalent to a better outcome of the change
- Define what is expected from the receiving/supporting organisations, that is what kind of activities are necessary to be aligned with the change. For instance, is the organisational structure suited for the change

Figure 5 - Definition of the Change Implications

5.4.1.2 Alignment of Vision and Managing Change

The grey section, see Figure 6, is intended for ensuring that the organisations are aligned regarding the vision and must thus be performed jointly by all affected organisations. This section provides room for open discussion regarding the change, where specific issues which are commonly overlooked can be discussed, such as expectations of the change and developing a communication strategy. This section also provides room to emphasise the aspects of motivation in a change effort which is considered as important both in the beginning and throughout the entire change progress. The authors highlight that this section is of essence regarding jointly reflect and discuss the mentioned topics as well as promote continuous individual reflection. The joint discussion can provide a context for vision and the change, which can combat misalignment. It is suggested that this section is must be performed thoroughly in the beginning of a change initiative. Furthermore, the section should be revisited regularly during meetings to assure that the alignment of vision and motivation are sustained. Both alignment and motivation are pressed upon by theoretical and empirical findings, thus must be highly prioritised.

Alignment of Vision and Managing Change

What is the vision of the change?

- The vision represents the goals and strategies of the change and should not be substituted by a change plan
- Discussing the vision can ensure that common understanding is reached
- The vision should be simple, short and precise

How will we attain alignment of vision?

- Agreement must be obtained regarding the vision throughout all affected organisations. The vision must be understood by all personnel which requires spreading the vision to all, thus creating organisational synchronisation. How will we ensure that this is performed?
- Create an alignment by developing common terminology and cross-functionality
- Alignment of vision can be sustained by communication and documentation
- Create early alignment, thus create space to set organisation-specific goals as well as an overview of the pending change. A collision between the developing and receiving organisation can be avoided by an early agreement
- Strategy and vision alignment must be prioritised

What are the expectations of the change?

- The organisations should provide their point of view of what they expect from the change in terms of for example; efforts, priorities, outcome, organisation of work, required support from the developing organisation and inputs from the receiver
- How will the change be prioritised and incorporated into the daily activities

How will we obtain motivation to change?

- Change requires motivated leaders thereby ensuring transfer readiness and the success of the transfer activity. Motivated leaders can inspire, engage and convince their organisation regarding benefits of change. Create a sense of urgency regarding change. Convince the receiver management of the change benefits
- Resistance to change can be avoided by incorporating all organisations in the developing work
- Find and assign champions. Champions are a vital part of the change as they bring energy and are ready to make sacrifices that benefit the change. Champions can be anyone, manager or operator, that motivate and drives the change. Champions can possess the ability to create engagement
- Motivation must not be underestimated

What do we need to sustain motivation?

- Understanding of underlying reasons of performing tasks in a certain manner
- How do I participate in the change, individual reflection regarding; expectations, attitude and willingness to change
- How will I motivate my organisation, this too requires personal reflection. It is important that management seizes this responsibility in order to motivate the organisation

How should we established a communication plan?

- Develop a communication strategy regarding information sharing in general and how to communicate changes within the project specifically, to avoid conflicts due to different interpretation of the change
- Communication can be of intranet, internal newspapers and vison alignment in management/employee evaluations
- Define how design solutions are communicated in order to create an understanding
- How will we integrate? The developing organisation must provide information to affected organisations, and receive reports on the progress from the organisations. How will this be managed?
- Transparency regarding information sharing and consensus must be highlighted

How do we prepare for replication?

- Ensure that all organisations work toward the possibility of replication
- Careful documentation of the framework activities might provide the possibility to replicate the change progress which includes other aspects than technical attributes

Figure 6 - Alignment of Vision

5.4.1.3 Identifying Soft Variables and Holistic View

The green section, that is Figure 7, emphasises soft variables and skills which are usually overlooked in a change effort, but are essential in order to create a holistic view. By overlooking soft skills and variables and solely focusing on technical aspects of a change, a holistic view will not be achieved. This section is important to perform jointly in a cross-functional manner in order to identify the correct soft variables and skills which is a difficult task to achieve without a collaborative initiative. This section should be performed in the beginning of a change initiative, but most importantly, it should be performed continuously to assure that adjustments to the scope or technology triggers a re-evaluation of the soft skills and variables.

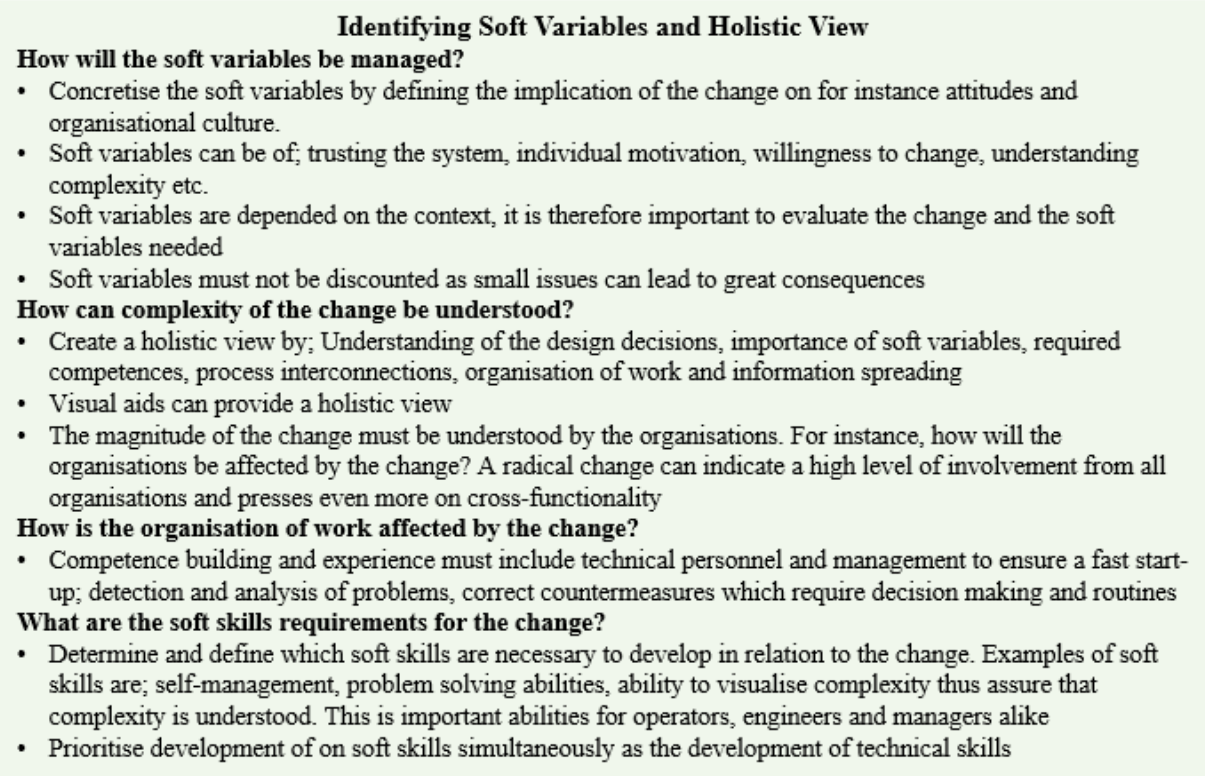

Figure 7 - Identifying Soft Variables and Holistic View

5.4.1.4 Organisation Assessment

The blue section, see Figure 8, represents an assessment which should be performed by the individual organisations. As the organisations should partake in the previous steps, that is in the grey and green sections, change effects and understanding is achieved. The organisation can thus re-assess the current organisational structure and assess which activities are necessary to perform in order to reach readiness to receive. This involves active participation, responsibility assignment and most importantly seize ownership regarding organisational readiness and of the transfer activity. In this section, the authors highlight that transfer readiness is an ability which must be achieved by the receiving organisation itself, thus this section is dedicated to the receiving organisation. It is recommended that the receiving organisations perform these activities continuously with the inputs from previous sections. The progress from the individual organisations to reach readiness must be reported to the developing organisation as well as to other organisations to achieve synchronisation and alignment. Although the developing organisation is not involved in this step per se, the reports from the receiving organisations should provide an indication whether readiness is achieved.

Organisation Assessment

Where are we now (current state)?

- An organisational self-assessment must be performed in order to evaluate if redesigning the organisation and/or reorganisation of work is necessary due to the change

Where are we headed (future state)?

- Simultaneous execution of planning of organisation of work and technical systems
- Organisation of work includes; development of related processes, individual competence, job-assignment and design, interaction of co-workers, and individual's interactions with technology
- Organisations must be prepared to receive; therefore, the transfer activity must be acknowledged early in the change initiative. Is the organisation prepared regarding countermeasures for possible problems and if new information and decisions are incorporated into the receiving activity. Thus defining the transfer activity itself

What are the activities in between current and future state, to be able to receive the change?

- Competence assessment model could possibly be utilised which is based on the context of the company
- Appropriate competence level must be reached, acknowledgement that the knowledge can be tacit which increases the difficulty to codify and spread it within the organisation
- Important that the receiving organisation participates in the change progress to be able to understand what is needed for receiving the change and understand decisions behind solutions and activities. Organisations should actively seek inclusion and participation into the change initiative
- Establish a strategy for prioritising change even if the daily operations are important
- Seize ownership of organisational readiness and the transfer activity

Who is responsible for the activities?

- Assigning responsibility, actively partake and pursue issues relevant for the organisation. Re-evaluate if responsibility is seized.
- Reflection together with the developing organisation to create understanding of implication of the change regarding; organisation of work and routines

How is management ready to support the change?

- Management support is necessary to increase the readiness level by ensuring that individuals believe in the change, thus present the benefits of change on an individual and organisational level
- It is important that management participates in the change progress as information and understanding can be gained, as well as facilitation of discussion regarding the organisation specific topics

Figure 8 - Organisation Assessment

In conclusion, the framework is design to increase collaboration and responsibility assignment, which are identified to be the root causes to an unsuccessful transfer. The framework does not provide quantitative measuring, it is rather an aid to understand if the other organisations are ready to receive the change by discussions and an iterative reflection on the change topics. The framework can become a guide for the developing organisation to identify if the activities needed

for change have been performed and thereby, if the other organisations are ready to receive the transfer. The provided framework, although collaborative in nature, can be used by developing organisation to check if the other organisations have reached readiness within the sections thus providing a sort of measurement for readiness. For instance, when the receiving organisation have taken ownership of the organisational change efforts, they can be considered ready in that aspect.

6 CONCLUSIONS AND RECOMMENDATIONS

This thesis performed a case study in an intent to attempt theory building. However only one case company has been examined in the pursuit to answer the aim: To examine Production System Development in a Core Plant environment, focusing on the transfer activity and readiness for change. The aim was divide into more comprehensible research questions;

RQ1: How can assessing readiness potentially benefit a PSD project?
RQ2: How can readiness of a receiving organisation be prepared and analysed?

To answer RQ1, the case study finding is that the case company mainly focused on the technical aspects in the latest PSD project, thus a system or a holistic view was lacking. That is, to fully understand how the design decisions can contribute to a creation of a holistic view as well as interconnectedness of processes. According to the theoretical findings, a holistic view is important, and the technical systems should not merely be focused on. Rather, soft skills and variables are considered as most important to facilitate change. In a design phase of a PSD project, the development of technical systems should be accompanied by a simultaneous development of organisation of work. This was however not the case in the empirical findings as preparation for change was lacking. The change implication was not communicated throughout the whole organisation leading to, lack of alignment regarding the vision and understanding of the magnitude of the change. Theoretical findings emphasise the importance of communication strategies in order to be successful in change efforts. This stresses the underlying issues and the imminent need for a RA, especially as the empirical findings highlight that the transfer activity was not successful. Thereby implying that the structure of the PSD projects is not entirely complete.

One of the major identified finding in the case study is the lack of managerial commitment and ownership of the transfer activity. Therefore, active participation with assigned responsibility is pressed upon. A consequence of which, managerial support is impaired. This is in line with theoretical findings that explicit responsibility is essential to assign in a PSD project. Furthermore, change management responsibility must be understood. Also, a need to evaluate is identified regarding if organisation of work as well as the organisation itself is ready to comply with the changes prior to the transfer. A *we against them* attitude was also found in the case study, which aims to be contested in the RA framework. The answer to the RQ1 is thus that the benefits of a RA can be incorporation of human and organisational aspects into the PSD process. Thereby combating the various issues presented by the case company and achieve improved results of a transfer activity.

To answer RQ2 a RA framework was developed which is based on both theoretical and empirical findings. The mission of the framework is to promote alignment of change vision and strengthen collaboration within PSD projects. Moreover, encouraging managers to actively take responsibility for the organisational change, partake in PSD activities as well as provide support for both the project as well as their own organisation. The developed RA framework is created to be of general nature, thus not specific for the case company. To create a specific RA this would require a profound understanding of a company's structures such as; processes, ways of working, project management, organisational structures, etc. Moreover, for an understanding and validation of how a RA could be integrated into the PSD process, testing the framework at the company in real projects with the end-users would be required.

The qualitative nature of the RA variables prevents accurate and objective estimation or measurement. It is therefore suggested that in addition to the framework developed in this thesis, the case company can investigate if a model such as provided by Görög (2016) or Hecklau et al (2016) is deemed necessary. Although providing an overview of the RA, the authors believe that this can risk generating additional administration. A trade-off must therefore be made between the ease of use and level of details in deliverables. This is furthermore in line with theoretical findings that the simplicity of the content and the complexity of the model must be handled in order to provide value. A framework of this sort must thereby be flexible and within a context. Foremost, the developing organisation is recommended to develop skills to use the framework and act as a leading example for the other functions within the case company. It might be essential for the developing organisation to adapt the content within the framework according to different kinds of projects and organisational structures, which requires continuedly working with and adjusting the framework.

The structure provided by the RA framework can possibly benefit the case company with their core plant responsibility. As the core plant role of the case company implicates testing, validation, development and knowledge spreading, the effects are a lower capacity and efficiency at the own factory. It becomes more essential that the PSD process is well structured and can assure readiness for a rapid and economical start-up. The findings indicate that the shortcomings in the transfer from the developing to the receiving organisation points to a deficiency in the design process of the PSD. Thus, the RA can be a starting point to gain awareness of this issue within the company with the possible benefit of more structured PSD projects and thereby be a paragon within the network.

Although this thesis does not provide a clear theory building, it can be a guide for future work both for the case company as well as future research. This thesis contributes with an identified need for future research as a need of estimating or assessing readiness for transfer was recognised within this context. Proceedings to assess readiness is lacking in the academic field and is not completely recognised within the industry. A recommendation is thus made; research is required to understand this complex task and to make the connections of the qualitative aspects which have been researched in the organisational field into the field of production development. This thesis was thus an attempt to make the connections between change management and PSD.

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7 APPENDICES

7.1 Appendix 1 – Interview Question Protocol

Intervjuprotokoll

1. Namn och position
2. Vad har du för koppling till produktionsutvecklingsprojekt (Stora projekt, tid/pengar. Ex. World Class i D-byggnaden)
    a. Vilka var dina arbetsuppgifter i det projektet (för anpassning av frågorna)

Mognadhetsbedömning

3. Hur skulle du definiera ”mognadgetsbedömning” (sätt i sammanhang, ge ett intro)
    a. Vilka faktorer skulle behöva ingå i en sådan bedömning och varför
    b. Varför skulle det vara viktigt att göra en mognadgetsbedömning inom projekt
    c. Skulle det behövas i varje projekt (m.a.p core plant ansvaret)
    d. Finns det specifika projekt där en mognadshetsbedömning är särskilt viktig

4. Har du kännedom om mognadhetsmatrisen som finns utvecklad
    a. Användes den i det senaste projektet
        i. Varför/varför inte/vilken utsträckning
    b. Hur fungerar det att arbeta enligt den
    c. Vilka är dess för/-nackdelar
    d. Hur skulle den kunna förbättras
        i. Vilka potential ser du i att använda den (tid, resurser, prioriteringar)

5. Gjordes det någon mognadhetsbedömning i det senaste projektet
    a. I vilket skede i projektprocessen genfördes mognadhetsbedömningen i det senaste projektet
    b. Om de inte skedde, varför inte
        i. Hur påverkades projektet av att det inte genomfördes
        ii. Tror du att utfallet hade varit annorlunda om den hade genomförts
            i. På vilket sätt
    c. Varför var det viktigt att genomföra den i det skedet
    d. Fanns det behov att ha mognadhetsbedömningen i flera faser i projektmallen
        i. I så fall i vilka faser (före/efter vad)

Mottagarbedömning

6. Hur bedömdes mottagarens nuläge (Organisation, kunskapsnivå, teknik osv)
    a. I vilken fas av projektet genomfördes detta
    b. Vilken mognadhetsgrad ville man uppnå inom olika faser i projekten
        i. Var det någon skillnad på mognadhetsgrad i de olika faserna, vilka skillnader
    c. Vad tittades efter specifikt (mätetal etc.)
    d. *Hur anpassades projektet efter analysen av nuläget* (resurser, tid, vilka prioriteringar)
        i. Vilka konkreta åtgärder gjordes
        ii. Varför var dessa åtgärder viktiga

iii. Hade nulägesanalysen behövt vara mer utförlig, på vilket sätt
iv. Vad hade du velat förbättra

7. *Hur förberedes den mottagande organisationen med avseende på implementering!!!*
    i. *Hur spreds informationen till mottagaren*
    ii. *Vilka mätetal, resurser, tid, prioriteringar, organisation, kunskapsnivå, teknik*
    iii. *Ser du någon förbättringspotential i förberedningen*
    b. I vilket skede i projektprocessen genomfördes förberedningen
    c. Om detta ej genomförs, varför inte
    d. Är det vanligt att titta på de mänskliga aspekterna som berör mottagande

8. Hur jobbade ni för att uppnå tillräcklig mognadsgrad i den mottagande organisationen
    a. Hur fördelas resurserna inom projekt

9. Hur bedöms det att mognadsgraden är uppnådd
    a. Hur sätter ni mål för vad som bedöms vara uppnådd mognad
    b. Vilka metoder används
    c. Vilka parametrar mäts/kontrolleras (KPI/genomförda utbildningar, etc)
    d. Utvärderas mottagaren kontinuerligt om målen är uppnådda
        i. Hur/Varför/varför inte
        ii. Vilket värde genereras av en sådan utvärdering

Överföring

10. Gick överföringen enligt plan i det senaste projektet
    a. Hur väl stämde det överens med Budget, resurser och tid
    b. Blev det några avvikelser om ja, av vilka anledningar
    c. Vad gick bra och varför
        i. Vilka var de kritiska anledningarna

11. Uppstod det några problem i överföringen
    a. Vad var anledningen
    b. Vad skulle kunna gjorts för att undvika problemen

12. Hur skulle mognadhetsbedömning/matris kunna bidra till framgång i överföringen (ex kortare ramp-up, resurser, tid, prioriteringar)

13. Hur skulle mognadhetsbedömning kunna bidra till framgångsrik replikering (förklara skillnad replikering/implementering)
    c. Ur Internt/Lokalt perspektiv och ur Externt/Globalt perspektiv

Övrigt

14. Hur skulle du vilja att företaget jobbade med mognadhetsbedömning
15. Har du något att tillägga om mognadhetsbedömning, förberedning, överföring eller generellt

7.2 Appendix 2 – Information provided to the interviewees

Information kring examensarbetet:

Examensarbetet avser att undersöka hur transformeringsprojekt kan replikeras, närmare bestämt hur den mottagande organisationen kan analyseras gällande dess mognadsgrad för mottagandet. Vidare är det av intresse att ta reda på hur den insamlade informationen om mognadsgraden kan användas och/eller anpassas inom projektmodellen.

Intervjuerna kommer bli en del av ett examensarbete på masternivå på Mälardalens Högskolan, i Civilingenjörsprogrammet med inriktning på innovativ produktion och logistik. Examensarbetet kommer bli publicerat på en webbaserad databas, DiVa, och kommer inte innehålla personnamn utan endast arbetstitel.

För vidare frågor och funderingar, kontakta:

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