Radboud University


# The influence of information technology on organizational structure

*An explorative study to the use of information technology and its effect on the organizational structure of small and medium sized enterprises*


| | |
|---|---|
| Author: | Bram Willems |
| Student number: | S4473663 |
| Supervisor: | Jannes Slomp |
| Second examiner: | Matthijs Moorkamp |

**Abstract**

Information Technology (IT) started as a 'nice to have' for organizations but quickly evolved to a 'need to have'. An organization without IT seems unthinkable in this era. In previous literature it has been shown that technology and organizational structure are related to each other. The purpose of this study was to gain insight into what effect IT can have on organizational structure in small and medium sized enterprises (SMEs) in order to gain new theoretical insights. This explorative study focuses on the effects IT can have on three elements of organizational structure: decentralization, formalization and specialization. This research used a qualitative approach and looked at two steel manufacturing SMEs.

The results of this research suggest that IT can influence structural characteristics. Interestingly, centralization seems to be a double-edged sword, meaning IT can both increase and decrease centralization in organizations. It seems that IT increases centralization in operating routines but can lead to decentralization in improvement routines. The increase of centralization in operating routines can be explained by the fact that information of the primary process can be easily collected and analyzed from a more central, broader perspective. The decentralization of improvement routines seems to be related to the fact that there is more time on the operational floor to work on improvement projects since IT takes over the coordination of the operational floor.

It seems that IT can increase formalization, since it makes it easier to communicate the right information to the right person. In addition, data from the operational floor can be communicated back to management, which can lead to improved work instructions and procedures. It is not clear how IT can influence the specialization of an organization.

This study shows how IT can influence the organizational structure and makes it clear that IT in an organization can lead to organizational change and therefore adds initial support to the literature.

*Key words:* Information Technology (IT), Continuous improvement, Decentralization, Formalization, Specialization, SME

# Table of contents

# 1. Introduction

Beginning in the 1950s, sociotechnical systems thinking had its origins in the coal mines in Great Britain (Pasmore, 2019). The sociotechnical systems thinking links the social aspect of organizations with the technological aspect. Back in the 1950s several coal mines and the miners were researched for new machinery that was going to be used in the mines. It was found that those mines that respected the employees and asked them for their opinions on the machinery were more profitable and had less accidents than the mines where this did not happen (Pasmore, 2019). In all cases the mines were using new technology but designed their work around the technology differently. This led to different organizational results. These were one of the first signs of how technology and organizations interact, and how different interactions can lead to different results.

A few decades later Porter and Millar (1985) discussed that an information revolution was going on, and that no company could escape its effects. This so-called revolution would change the way business is done by reducing the costs of processing, obtaining, and transmitting information (Porter & Millar, 1985). According to Porter and Millar (1985) the majority of the managers at that time were putting more effort and investments into technological advances. Back in those days information technology (IT) was seen as supporting rather than a key aspect of an organization. What Porter and Millar (1985) did not know at that time is that these technological advances would become interconnected, not only with each other, but also with the physical world (Tao and Zhang, 2017).

Now, organizations feel the pressure and the need for a digital transformation, seeing it as the only way to survive (Alaa & Fitzgerald, 2013). According to Legris, Ingham and Collerette (2003) organizations invest in IT for many reasons: *"pressures to cut costs, pressures to produce more without increasing costs, and simply to improve the quality of services or products in order to stay in business."* This development is leading to a new way of manufacturing. The pressure is especially hard on small and medium-sized enterprises (SMEs), whose organizations are faced with increasing demands of efficiency. According to La Rovere (1996) IT is particularly hard for SMEs to implement because of the lack of resources and knowledge about it. According to the European commission, based on staff headcount and turnover, SMEs represent 99% of the business in Europe. The European commission defines

SMEs as organizations of which the staff headcount is below 250 and the turnover is below 50 million euros.

## 1.1 Current state of research

Digitalization and IT have always been tackled as a technology-driven topic; therefore, a lot of effort has gone into the topic of engineering (Hirsch-Kreinsen, 2015). This has ensured that a lot of technical research has been carried out, leaving the social aspect of organizations behind (Hirsch-Kreinsen, 2015). But according to Heng (2014) the social aspect makes smart manufacturing a success. Deuse et al. (2015) expect the amount of automation to increase with the implementation of smart industries, but that does not mean that human work will be eliminated. According to Deuse et al. (2015) a closer collaboration between humans and machines will lead to changes in the organizational structures (Deuse et al., 2015; Kagermann et al., 2013). Because of this reason it is important that the field of research switches from a technology-driven to a socio-technical-driven perspective. It is important to see what the implications are on organizational structures itself rather than to look only at the technological possibilities.

When looking into the subject of the integration of information technology and organizations it is hard to focus on both subjects at the same time (Lakhanpal, 1994). According to Lowry (1997) it is a difficult field of research because it is easy to end up researching one of the two instead of the integration. Lowry (1997) argues that if a researcher takes away the organizational aspects the research will basically position itself in the field of computer science.

There are approaches that try to focus on both subjects. The socio-technical approach is such an approach. Socio-technical theory considers that work systems consist of two components: (1) a social component, which consists of people and organizational structures, and (2) a technical component, which consists of technology and tasks (Cheon et al., 1995; Bostrom and Heinen, 1977). The idea of the socio-technical approach is that if one of the four aspects changes, the other aspects need to adapt to those changes in order to balance the system (Housel et al., 2001). The model in figure 1 below shows that a change in one part requires a change in another part of the system, including changes in the process (Leavitt, 1965; Galliers and Baker, 1995).

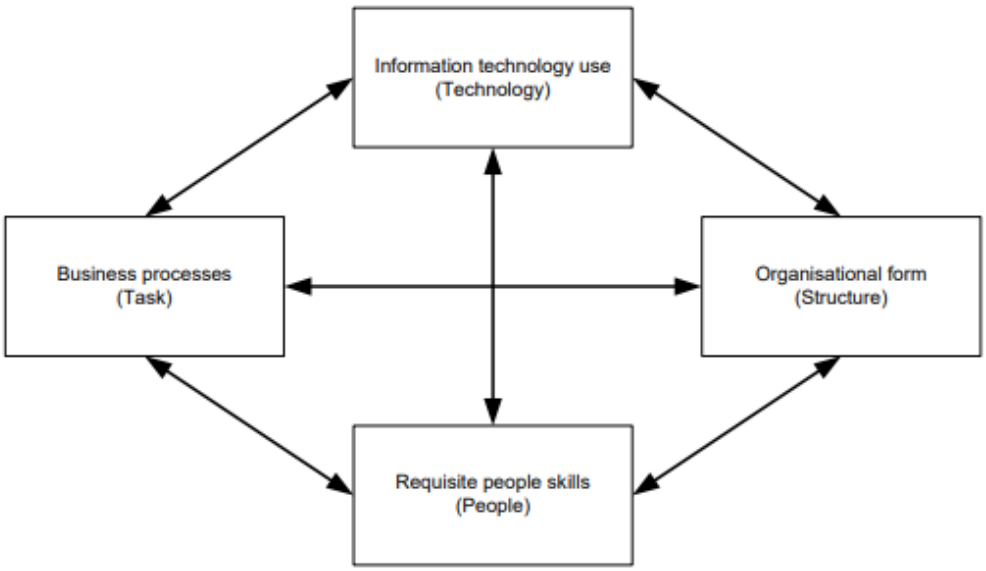



Figure 1. Leavitt's Diamond (Leavitt, 1965)

According to several researchers (Trist & Bamforth, 1951; Trist, Higgin, Murray & Pollock, 1963) the intention of a sociotechnical systems design is to enhance the collaboration between human behavior and technology. According to Pasmore (2019) this can be achieved by allowing input in the design from the people closest to the technology. In his article Pasmore (2019) argues that the social aspect of organizations has to be in line with the technological aspect of the organization in order to achieve better operational performance. He notices that *"the evolution of social systems is not keeping pace with the exponential advance of technology, let alone anticipating more pervasive changes yet to come"* (Pasmore, p.71, 2019). Pasmore (2019) makes it clear that technology can influence the way the operational floor is designed but he argues that the evolution of social systems is not keeping pace with the advance of technology. In order to understand this relationship better this thesis will focus on how information technology influences the organizational structure.

## 1.2 Research objective and question

This research will focus on the relation between technology and human components in an organizational setting to put smart manufacturing (industry 4.0) in a broader perspective. By exploring the relationship between Information Technology and structural characteristics on the operational floor this research tries to generate more knowledge about the relationship between IT and organizational characteristics within SMEs. This leads to the following research question and a global conceptual model:

*How does information technology influence the organizational structure of SMEs?*

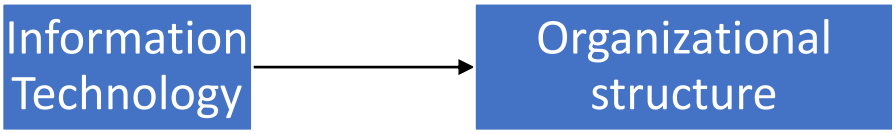



Figure 2. Global conceptual model

## 1.3 Context of the study

The HAN QRM is currently working on a project called the digital factory. This contains a digitalization of a production process in order to provide better insights in the organization's manufacturing processes. This digitalization of the process could provide better insights in the planning and control decisions. The essence is that information from the shop floor will be translated back to the planning system (ERP) in order to make better planning and control decisions. This (smart) technology can provide real-time information, but the question then arises: does this technology change the way organizations are organized? This research explores how this influences the organizational structure. This research will use the cases recommended by the project of HAN QRM. The cases used are two medium sized steel manufacturers. Both the organizations have a different organizational structure and a different maturity level of IT. By using these cases this research fills the gap in the literature and will provide insights for those organizations in practice. This thesis is an explorative study and will use two cases and compare these cases to come to new insights and will give basis to the future.

## 1.4 Relevance

According to Schuh et al. (2017) the advantage of industry 4.0 is the ability for an organization to adapt to their environment. They argue: "*the faster an organization can adapt to an event that causes change in its circumstances, the greater the benefits of the adaptation*". This shows that rapid and accurate adaptation to events can benefit the organization as a whole and technology can help with that. However, it is not clear how an organizational structure is affected by this technology. By carrying out research on the influence of IT on organizational characteristics, this research aims to generate more knowledge about IT in SMEs. The findings will contribute to current literature that is mainly focused on either technical aspects or on large organizations. This research tries to fill the gap by looking at SMEs and the influence of IT on organizational characteristics.

Other than a general contribution to the literature this research contributes to the HAN QRM project. It can also contribute to management decisions in similar SMEs. It could be valuable to know what changes new technologies could bring to their organizational design. This research could give managers more insight on this topic.

## 1.5 Layout

This research will start off with a literature review on the existing literature in chapter 2. In this chapter the definitions of the organizational characteristics and the role of IT will be given. In chapter 3 the methodology will be explained in detail and it will be described why certain choices are made regarding the cases and interviews. Besides that, an operationalization of the concepts used in the analysis will be given. In chapter 4 both cases will be analyzed according to the theories as presented in chapter 2. At the end of chapter 4 the two cases will be compared and conclusions on this will be given in chapter 5. In the end, in chapter 6, the limitations and recommendations will be discussed.

## 2. Literature review

The concept of information technology (IT) is defined differently in the course of time starting from decades ago till now. This means a lot of these definitions are old and not applicable anymore (Sriram et al., 1997). Therefore, this chapter will clear up the many different definitions, will argue what definitions will be used, and will end with the model that will be used in this research. This chapter will start of by emphasizing the relationship between IT and organizational structural characteristics. After that these two variables (structure and IT) will be broken down and described in more detail. For this the model of HAN QRM will be used as guidance. This is a maturity model and shows how organizations can evolve. This model will be substantiated with underlying theories. At the end of this chapter a model will be described that can be useful to analyze the cases with.

### 2.1 The relationship between information technology and organizations

As mentioned by Yap and Walsham (1986) the relationship between information technology and organization characteristics is not a one-way relationship but rather reciprocal. This is shown in figure 3 below. It is therefore important, yet difficult to keep the focus on both information technology and organizational aspects.

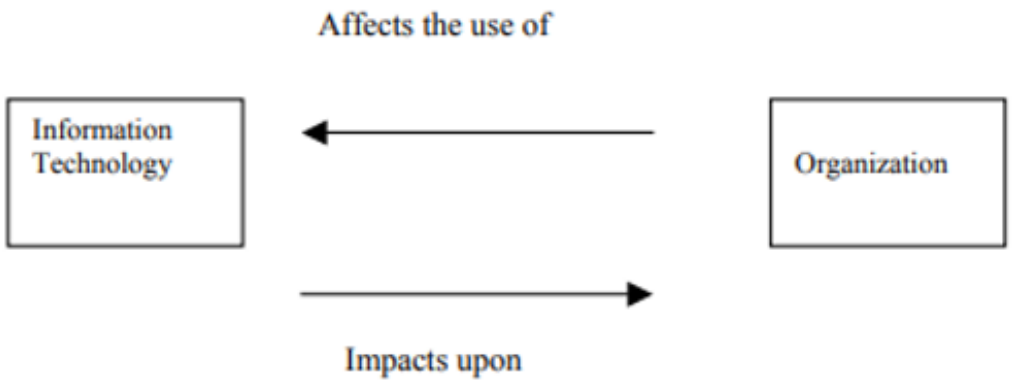



Figure 3. the reciprocal relation between information technology and organizational characteristics.

Galbraith (1977) introduced organizational design strategies in which he defined an organization as an information processing system. According to Galbraith (1977) and March and Simon (1958) the main function of an organizational design is to create the most efficient structure, processes and technologies to "*facilitate the collection, processing, exchange and distribution of information*" (Bensaou & Venkatraman, 1996). According to Galbraith (1977) an organization uses information in order to accomplish its goals. Once the tasks to accomplish

the organizational goals become more difficult, more information is needed. This information becomes more diverse or changes as the level of the task is more demanding. It also becomes more diverse or changes as the task is split between more and more people (Galbraith, 1977). Galbraith (1977) argues that there are two ways to solve this design problem. An organization can either increase its information processing capacity or reduce the need for information processing. This is in line with Ashby's (1969) 'law of requisite variety', which means that variation can only be controlled by variation. In an organizational setting this means that when an organizational unit has a high variety, their ability to control this variety should at least be as high as the variations.

According to Porter and Millar (1985) information technology can be used to be more efficient and more effective and can create a competitive advantage for organizations. Lucas and Baroudi (1994) linked information technology variables to organizational variables by the use of Leavitt's Diamond (see figure 1). Lucas and Baroudi showed that information technology impacts the work processes, communications, interorganizational relations and structural variables of an organization.

Several studies are performed to find out what the influence of IT on organizations is. Several results are found in different studies. Burn (1990) researched SMEs in Hong Kong and found out that IT strategy is related to the model of competitive advantage of Porter and Millar (1985). Porter (1984) itself says that technology can enhance the competitive forces of an organization. According to Sohal et al. (1988) the impact of IT on businesses in Australia is positively related to the organizational performance. Dewett and Jones (2001) focus more on the role that IT plays in moderating the relationship between organizational characteristics such as structure, size, learning, culture and interorganizational relationships.

This shows that a lot of studies have been performed on the relationship between IT and organizations, but they are not like-minded and have different results overall. Studies that were more focused on organizational structure like Damanpour (1991) and Kock and Lau (2001) were mainly focused on specialization, formalization and centralization.

Tao and Zhang (2017) discuss the evolution of the interaction between physical and virtual space and distinguish four stages. In their work they show how different stages can be defined to show how the virtual space (IT) with the physical space (organization) interacts. The first

stage is only based on a physical space and uses no virtual space whatsoever to base decisions on. The second stage uses information technologies but the interaction between the virtual and physical space is considered weak. The third stage is using these information technologies and there exists an interaction between the virtual and physical space. The fourth stage consists of a constant two-way connection between the physical and virtual space.

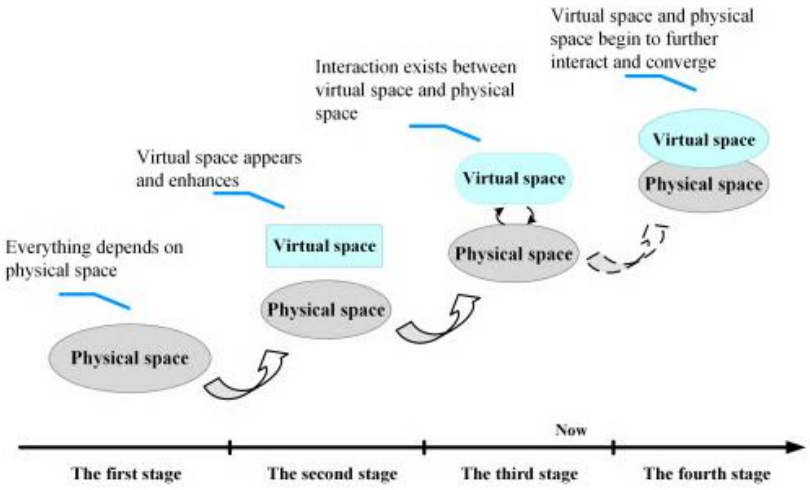



Figure 4. The evolution process of shop-floor (Tao & Zhang, 2017).

The first stage depends on the physical space completely due to the lack of effective information. This leads to low efficiency, accuracy and transparency for the shop-floor. The second stage uses more information that is gathered with the help of computer aided systems, the interaction between the physical and virtual space is weak and the data is mainly entered manually. This will lead to a virtual space that is out of sync with the physical space. The third stage uses more communication technologies, sensors and IoT. There exists an interaction between the virtual space and physical space although the two spaces are not completely in sync. The fourth stage would be a complete synchronized virtual space (Tao & Zhang, 2017).

The model of Tao and Zhang (2017) corresponds to the model that the HAN QRM introduced. The HAN model uses a taxonomy to describe how an organization scores on both IT maturity and lean improvement maturity: managerial controlled factory, digitally (supported) controlled factory and socio digital factory. The illustration below in figure 5 shows how an interaction between IT and continuous improvement is linked to a specific taxonomy. In each taxonomy as mentioned by HAN the operational structure and the improvement structure is different.

*Managerial Controlled Factory:*

Information systems have limited functionality. They are not connected. Also named Industry 2.0. Management spends substantial time on firefighting. The company is functionally organized. Improvements come from the management.

*Digitally (Supported) Controlled Factory:*

Information systems have good functionality. They are connected to a certain extent. The information exchange with the shop floor is limited: there is no real time data. Improvements are local. Also named Industry 3.0. Management experiences a gap between information coming from the systems and reality. Moving towards (semi) autonomous teams.

*Socio Digital Controlled Factory:*

Information systems are fully connected. Information is available everywhere. There is no gap between information and reality. Improvements are local as well as cross-departmental and focused on improving value streams. Semi-autonomous teams are fully responsible for parts of the value streams. Intelligent software is used for the coordination between the teams and for their links to suppliers and (external) customers. Industry 4.0. Management focuses on realizing an agile factory.

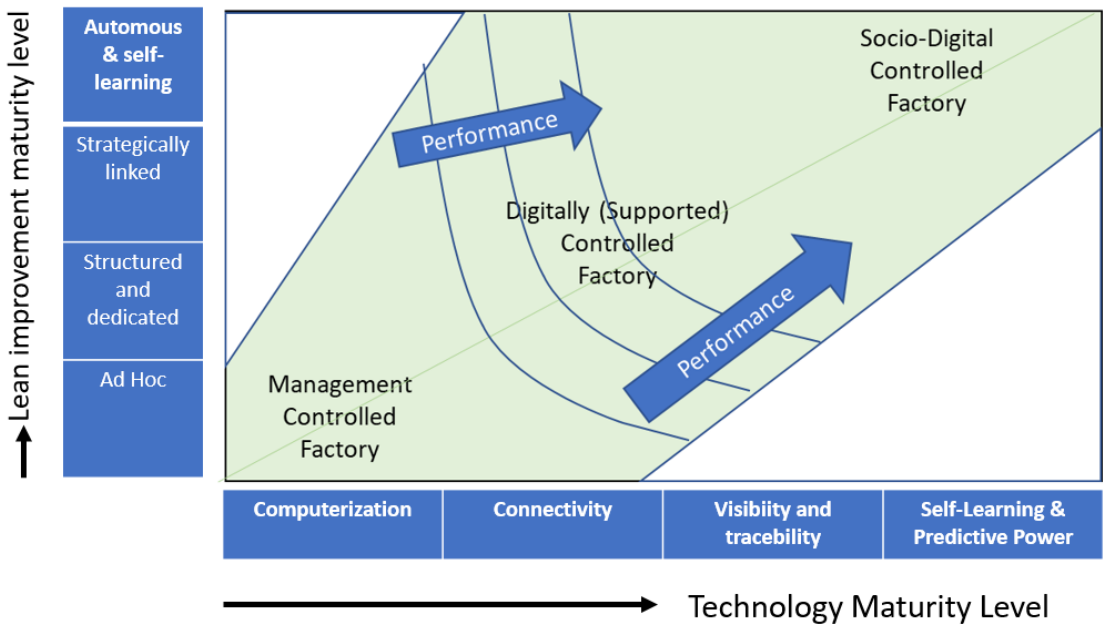



Figure 5. HAN Taxonomy

The taxonomy of the HAN correspond to the stages of Tao and Zhang (2017) and can therefore be linked to each other in order to create a foundation to analyze the cases in chapter 4.

The managerial controlled factory corresponds to the second stage of Tao and Zhang as there is only some manual connection between IT and the organization. The digitally (supported) controlled factory corresponds to the third stage of Tao and Zhang as there is more connection between the different IT systems and the physical world. In the socio digital controlled factory everything is connected and the physical and virtual world are synchronized. This corresponds to the fourth stage of Tao and Zhang (2017).

It is clear that information technology has an impact on organizations and a lot of researchers acknowledge that. The next paragraphs will discuss IT maturity and organizational structure more in-depth.

## 2.2 IT maturity

As mentioned, IT can be defined as the "*technologies dedicated to information storage, processing, and communications*" according to Ang et al. (1997). This definition of IT focuses on the hardware needed for communication, the software that processes the information and the goal of IT namely the communication itself. Sriram et al. (1997) came up with a definition that includes the personnel and resources: *"while there are many inconsistent definitions of what constitutes IT, a growing consensus argues that IT should be defined broadly to encompass hardware, software, telecommunications as well as the personnel and resources dedicated to supporting IT."*

IT has always been tackled as a technology-driven topic. Because of that, the definitions of IT are often based on its technical aspects (Hirsch-Kreinsen, 2015; Kendall, 1997). According to multiple researchers (Kendall, 1997; Huber, 1990) there are more than just technical aspects and they make the distinction between decision-aiding technologies and communication technologies.

IT has been classified in different ways in the literature. Several researchers tried to link IT to organizational structures (Kendall, 1997; Savino, 2009; Chan, 2000; Khosrow-Pour, 2014). Most researchers agree that IT and organizational structure should work together to achieve more organizational effectiveness.

Applegate et al. (2006) introduced 'Three Eras of IT Evolution'. These eras show that IT in organizations evolves in a certain way. The first era describes how the primary role of IT is a centralized intelligence and is mainly used by (IT) specialists. It mainly consists of automated

back-office activities and the implementation is mainly through independent projects. Applegate et al. (2006) argue that the justification for projects like this are based on cost savings.

The second era is described as decentralized intelligence and provides information and tools to improve decision making and increases the knowledge of the employees. In this 'era' IT is used more broadly throughout the organization and is justified by an increase in decision making quality and performance. The implementation is ad hoc.

The third era describes how the primary role of IT is about shared intelligence and uses IT to create business value and to create competitive advantage. This form of IT is used by everyone throughout the organization and it is justified to add business value. The implementation is through strategic initiatives.

The model of the HAN that was introduced at the beginning of this chapter also describes the IT maturity. In this model the researchers have four levels of technology maturity. These consist of: (1) computerization, (2) connectivity, (3) visibility and traceability and (4) self-learning and predictive power. These levels of technology maturity are based on a study rapport by Schuh et al. (2017) which is supported by literature by Porter (1989). These definitions overlap with the eras as described by Applegate et al. (2006).

### 2.2.1 Computerization

Computerization can be seen as the first step in the development to Industry 4.0 (Schuh et al., 2017). Schuh et al. describe computerization as the usage of computerized information technologies in isolation. This means that organizations could operate more precisely or reduce costs in certain parts of the process. These systems do not communicate with each other. This corresponds to the first era of Applegate et al. (2006) and is mainly focused on back office activities.

### 2.2.2 Connectivity

In the connectivity stage, the computerization will go from isolated to connected. Applications throughout the business are connected to each other and try to mirror the organization's primary processes. A full integration between the operational part of the organization and the IT systems has not happened yet (Schuh et al., 2017). This corresponds to the second era of

Applegate et al. (2006) and provides the employees with more knowledge for decision-making.

### 2.2.3 Visibility and traceability

By the use of sensors, the primary processes can be captured from beginning to end, allowing organizations to trace specific events and products in their process. This provides an up-to-date digital model of the process. In the literature this is called a digital shadow. A so-called digital shadow provides the management with an up-to-date view of the process on which they can base decisions. In this situation the management has to analyze and make decisions themselves (Schuh et al., 2017). This corresponds to the third era by Applegate et al. (2006) since it can be used by everyone, everywhere and is a strategic choice to create business value.

### 2.2.3 Self-learning & predictive power

The last stage in the technology maturity is the ability for IT to self-learn and to predict. In this stage the organization can simulate scenarios in order to predict the future as good as possible. By reducing disruptive events the organization will have a more stable process. In this last stage the organization can delegate certain decisions to the IT system. For example, how the planning should use machines in order to avoid machine failure (Schuh et al., 2017). This level goes even further than the eras of Applegate et al. (2006) because the IT is operating independently and making choices itself.

## 2.3 Improvement maturity

The IT stages, as presented in the previous paragraph are compared in the HAN model with a lean improvement maturity level. This maturity level is based on continuous improvement and consists of four levels: (1) ad hoc, (2) structured and dedicated, (3) strategically linked, and (4) autonomous and self-learning. The maturity levels can tell something about the organizational structure. These levels are based on literature of Bessant, Caffyn and Gallagher (2001). In their work they describe different levels based on how continuous improvement can evolve in an organization. The HAN used this as a basis for their framework to describe how organizations improve their lean maturity level. Below the four stages in the HAN model will be described based on Bessant et al. (2001).

### 2.3.1 Ad hoc

Ad hoc means that organizations operate at random and decide what they should do and how they should solve problems typically at the moment the decisions should be made.

Organizational strategy is based on the short term and short-term profits. Small improvements occasionally happen.

### 2.3.2 Structured and dedicated

In a structured and dedicated organization there is more formalization and more structure. Continuous improvement is introduced. This leads to a more structured approach to decision making which focuses the organization on the long term. Improvements are mainly done by the staff who have a basic understanding of continuous improvement tools.

### 2.3.3 Strategically linked

The continuous improvement is strategically linked to the strategic goals of the organization. The continuous improvements are monitored and measured against the strategy of the organization and are part of the main business.

### 2.3.4 Autonomous & self-learning

An organization is autonomous and self-learning when it has a devoted problem solving unit and is highly experimenting with continuous improvements. Besides that it is stimulating learning throughout the whole organization. An organization does this by systematic finding and solving problems and sharing the lessons learned.

## 2.4 Organizational structure characteristics

The taxonomy the HAN consists of different organizational structures; functional, working towards (semi) autonomous teams and (semi) autonomous. This paragraph will describe these different structural components according to three organizational structural characteristics: decentralization, formalization and specialization. This way it will be easier to analyze the cases. This paragraph will sharpen the definition of structure which will be used in chapter 4 to analyze the results of the case-studies.

### 2.4.1 Decentralization

This paragraph will discuss what decentralization is and what can be found in the literature about the relationship between IT and decentralization. Mintzberg (1980) defines decentralization as: "*the extent to which power over decision making in the organization is dispersed among its members"* (Mintzberg, 1980, p.326). The higher the degree of centralization the less the power is distributed among the organization. On the other hand can centralization be described as the "*extent to which decision making authority is dispersed or concentrated in an organization*" (Dewett & Jones, 2001). To measure this for the case

organizations the term decentralization will be divided into three dimensions: (1) decision-making rights, (2) responsibility, and, (3) hierarchy. These terms will be explained in this section.

Traditionally organizations are designed with a highly centralized decision-making process (Dewett & Jones, 2001). This is called the functional structure in the HAN taxonomy. In a functional organization the management makes all the decisions and the tasks are fragmented in simple tasks (Vanhaverbeke and Torremans, 1999). The socio-technical approach (de Sitter, 1998) suggests the opposite. A well-known list of socio-technical design principles, which supports the idea of self-organization, is given by Cherns (1976 and 1987). The main idea of self-organization is that the knowledge is where the tasks are performed and thus decisions should be made as close to the work-floor as possible. De Sitter (1998) describes this with the parameter separation of control and operational tasks. If this parameter is low, decentralization is high. In that case the control options will be at the shop floor (Achterbergh & Vriens, 2009). This can be linked to the (semi) autonomous team in the HAN taxonomy.

According to Vriens, Achterbergh and Gulpers (2018) a decentralized organization is considered to have a flat hierarchy. Moore and Gino (2013) found that a flat hierarchy leads to more responsibilities at the shop floor. Achterbergh et al. (2018) say that employees should be able to participate in decisions that influence their tasks in order to be able to be held responsible for those tasks.

But, the question of whether the integration of IT leads to a more centralized or a more decentralized organization has two sides. If managers receive more information from the work-floor they will have more insights of the work-floor, which reduces uncertainty and will give managers the power to make decisions (Blau, Falbe, McKinley & Tracey, 1976; Child & Partridge, 1982; Lado and Zhang, 1998). On the other hand, if the work-floor is better informed of the overall status of the organization they will be able to be more globally optimized in their work and thus will make better decisions themselves (Argyres, 1999; Fulk & Dutton, 1984; Dawson & McLoughlin, 1986; Zenger & Hesterly, 1997).

The literature shows inconsistent results and shows that IT can have two sides, it can increase centralization but it can also increase decentralization. This shows that, according to the literature, the decision-making authorities can be placed over a wider variety of hierarchical

levels in organizations (Groth, 1999; Huber, 1990; Keen, 1991). Keen (1991) argues that IT provides the possibility for organizations to centralize and decentralize at the same time. The idea is that the information is sent to the places in the organization where the decisions can best be made. In this way, instead of information always flowing to management or being decentralized amongst workers, it will be allocated to the appropriate level of the hierarchy that can best handle it. This also corresponds to the socio-technical approach and the law of requisite variety (Keen, 1991; Ashby, 1965; de Sitter, 1965).

### 2.4.2 Formalization

According to Lewin and Johnston (1996) formalization can be described as the amount of routine responses (rules, procedures and instructions) to recurring problems or opportunities that specify how employees should coordinate their actions to accomplish organizational goals (Aiken et al., 1980; Blau & McKinley, 1979; Ettlie, Bridges & O'Keefe, 1984). According to Weber (1947) formalization can be achieved by making rules, procedures and instructions. Perrow (1986) argues that formalization can help by reducing the ambiguity and creating more efficiency which are, according to Huber (1990), problems IT tries to solve as well. IT can have the benefits of formalization without the cons because it can reduce the cost of searching company procedures and standards (Dewett & Jones, 2001). When procedures are in a computer and linked to the right products and processes, they are much easier to access than, for example paper documents. This reduction in time can save administrative costs, and interruptions in the workflow, which will increase efficiency. This can lead to more formalization since it is easier to access (Dewett & Jones, 2001).

Pierce and Delbecq (1977) argue that highly formalized organizations tend to be more predictive because their processes are strictly based on procedures. According to Achterbergh et al. (2018) the influence of employees on their tasks will decrease if the formalization increases. There is little research done to how IT influences formalization within organizations. Since IT makes it easier to access certain procedures and easier to provide the right person with the right information it could be possible that IT increases formalization, however there is not enough research done to conclude this.

### 2.4.3 Specialization

Specialization refers to how split up different tasks are and can refer to different specialties or job types in an organization (Aiken, Bacharach & French, 1980; Hage & Aiken, 1967).

Specializations tend to create sub-optimization. If an organization is highly specialized this can reduce the abilities of the employees to understand the wider context in which they are participating (Lawrence & Lorsch, 1968). According to de Sitter (1998) a highly specialized organization splits up all the departments, sub-departments, sub-sub-departments and workspaces. In essence, the higher the specialization, the more split up tasks are and the less diverse employees jobs are (Galbraith, 2002; de Sitter, 1998). IT can help to gain this wider context by providing information to those who need it. IT can provide the employees with information about how their decisions can affect other decisions, this will give employees a better understanding over their impact and can lead to better decision-making. Without IT employees have to make decisions based on their own knowledge, and when an organization is highly specialized this knowledge lacks a wider context which can lead to decisions that are not in line with the rest of the organization (Ciborra & Lanzara, 1990).

Since IT can provide information to those who need it, it can be argued that IT can simplify tasks. Knowledge is available to everyone which could mean that tasks could be performed by more people. This could lead to more specialization when IT makes it possible to split up a difficult task into multiple simpler tasks. It could also lead to less specialization because employees possess more knowledge and can perform more difficult tasks, having their job consist of a bigger portion of the process.

### 2.4.4 Link to HAN taxonomy

When looking at figure 5 it can be seen how organizations can move from one taxonomy to another. The first taxonomy is structured in a functional way which could mean, according to Vanhaverbeke and Torremans (1999), highly centralized, highly formalized and highly specialized. The more autonomous a team will become the more decisions it will make by themselves. It is therefore expected that the operational routines will be less centralized, less formalized and less specialized.

## 2.5 Summary of theory

In this chapter the taxonomy of the HAN is described and substantiated with existent literature. This research will try to find out what the influence of IT can have on organizational structure, which consists of continuous improvement structure and organizational characteristics such as centralization, formalization and specialization. In the next chapter these concepts will be further operationalized and clear definitions will be presented that will

be used to analyze the cases. The conceptual model can be found below. This model gives an overview of the literature as discussed in this chapter and the goal of this study as discussed in chapter 1.

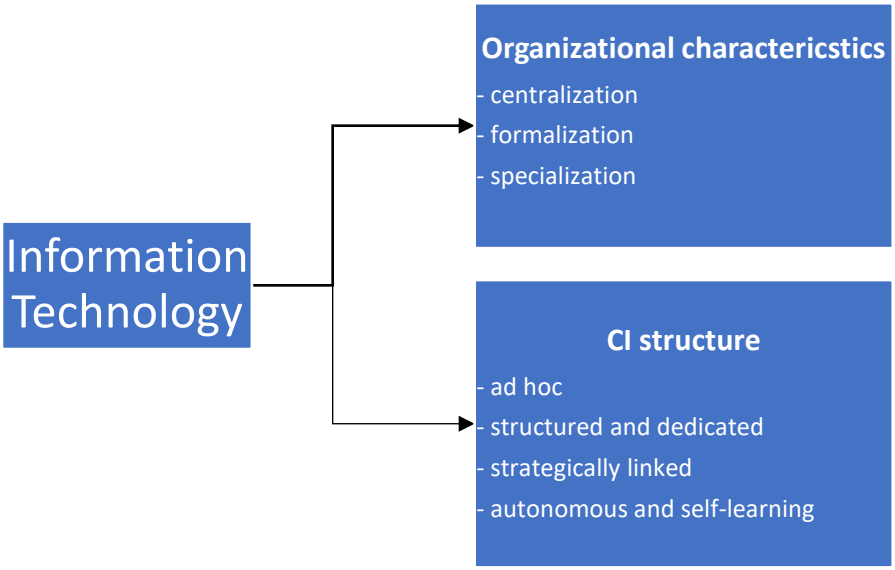



Figure 6. Conceptual model

# 3. Methodology

In this chapter the methodology used to answer the research question will be discussed. It will defend the choices made. Also, the data collection will be discussed, and an operationalization will be given to show how this data will be analyzed. Furthermore, the research ethics and the quality criteria will be explained in this chapter.

## 3.1 Qualitative research

This research addresses the effect of information technology on the organizational structure in SME organizations. According to Suri (2011) the concepts of information technology have been studied in large organizations with low variety and high-volume processes. Since it is mainly researched at large organizations the majority of the research has used quantitative methods (Jaca et al., 2014). According to Boeije (2014) qualitative research can be used to understand social phenomena in their natural context by using the experiences and perspectives of respondents. By using a qualitative approach this research is aiming to gain insight into what the influence is of information technology on the organizational structure in small and medium sized enterprises in their natural context in order to create a better image of the researched subject. In the HAN taxonomy the organizational structure is described by how continuous improvements are organized and the operations are organized (functional or semi-autonomous). It is therefore interesting to look how both improvement and operation routines can be influenced by IT. The literature study shows the gap and also provides a perspective to look at organizations. By interviewing different people in different organizations, this research aims to gain in-depth information on how information technology is used and how the case organizations are organized.

## 3.2 Explorative research

The goal of this research is to generate knowledge of the relationship between information technology and the organizational structure in a small or medium sized organization. According to Corbin and Strauss (2008) a qualitative approach can lead to additional insights during the data collection and analysis and therefore can be used to explore new contexts. Since there is no literature on this subject focused on the specific context of small and medium sized organizations, this research will use a qualitative research method and will therefore explore additional insights during the data collection and analysis. This means that this

research is primarily focused on exploring practical situations in order to generate more knowledge about this subject.

Since this is explorative research this research is iterative, meaning that the outcomes of the interviews will give new inputs to the next interviews and, if necessary other parts of this research will be reviewed. If certain topics stand out in the interviews the theory will be elaborated on these points and the interviews will be adapted accordingly. Each case is described separately, and new insights will be introduced at the beginning of the new case.

To make this explorative research more structured, this thesis introduced the pre-existing theories in chapter 2 and will operationalize the concepts that could be useful in comparing the two cases further in this chapter. This explorative research tries to provide more in-depth insight into how information technology influences the organizational structure.

In order to research the influence of IT on the organizational structure, it is important to describe the organizational structure and IT within the case organizations. In reality the organizational structure might differ from what the organizational chart describes. By interviewing employees of multiple organizational levels this structure and information structure will become clear. The interviews will be focused on different levels in the organizational hierarchy. Three different levels of employees will be interviewed: managers, planners and operators. By combining answers from the interviews of employees from multiple levels, answers are expected to be more complete and representative. The organizational structure will be described according to three structural characteristics: formalization, centralization and specialization.

## 3.3 Data collection

Each case in this research will follow the same steps and will be described in the same way to ensure consistency. First, general information about the company is collected. Second, more specific information is gathered like the organizational structure and the layout of the production process. Third, information is gathered about how the information distribution is organized. Finally, the collected data will be evaluated for each case.

The aim is to collect useful in-depth data. According to Boyce and Neale (2006) this can be done by the use of semi-structured interviews. Since the three organizational characteristics, formalization, centralization and specialization are based on how humans interact with

organizations, a qualitative approach with semi-structured interviews is used. With the use of semi-structured interviews these individual thoughts can be made clear and can be documented in a structured way (Boyce & Neale, 2006). With these interviews it is also possible to gain insight into individual thoughts, emotions and experiences by sticking to the subject (Patton, 2005). The interview questions will be made beforehand and there will be room for additional questions to go more in-depth where appropriate. By using semi-structured interviews the researcher can ask additional questions or ask for an elaboration on specific topics during the interview which will be the key to explorative research (Eriksson & Kovalainen, 2015). This will be further explained in the next section.

To increase the reliability of this research, an interview protocol (see appendix I) will be used. According to Boyce and Neale (2006) an interview protocol consists of rules that can give some guidance to the implementation and administration of interviews. The interview protocol emphasizes the importance of confidentiality towards the respondent which will be elaborated on in paragraph 3.7 (Boyce & Neale, 2006). By using an interview guide the interview will be consistent and reliable, but there will also be room for additional questions and elaboration.

Nine interviews were conducted. In each case study an operator, a planner and the manager were interviewed. In case 1 the role of the planner and team leader was one role. In case 2 these roles were separate. Therefore, case 2 had one more interview. The manager was interviewed at the beginning and end so additional questions that arose during the day could be addressed. After interviewing the three different employees, the interview findings were discussed with the interviewees, so called ‘member-checks’. This made sure that the findings in the interviews were interpreted right. The duration of the interviews varied from 25 to 75 minutes. All the interviews were fully transcribed (for the transcribed interviews see appendix II). In table 1 below the interviewees can be found with the date, function of the interviewee, and organization in order of time.

Besides interviews observations were done and documents were gathered. The factory floor was observed to see where the interviewees were referring to in their interviews. Pictures were made of how information was distributed throughout the organizations. This gives the research more background information in order to put the interview answers better into the organizational context. Other than that, the reader of this research will get a better feeling of

how both organizations looked in real-life, this allows the reader to understand the research results in a better context.

| Interviewee | Date | Organization | Function of interviewee |
|---|---|---|---|
| 1. R1 | 04-06-2019 | Case 1 | Manager |
| 2. R2 | 04-06-2019 | Case 1 | Planner/team leader |
| 3. R3 | 04-06-2019 | Case 1 | Operator |
| 4. R4 | 06-06-2019 | Case 2 | Manager |
| 5. R5 | 06-06-2019 | Case 2 | Team leader |
| 6. R6 | 06-06-2019 | Case 2 | Planner |
| 7. R7 | 06-06-2019 | Case 2 | Operator |

Table 1. research participants

## 3.4 Case study

This research will use the cases used by the research project of the HAN QRM. These cases fit this research because both the cases are small or medium sized manufacturing enterprises, which already have a specific organizational structure. However, this does not mean that these organizations are designed the same way. By looking at the IT maturity level of each organization and comparing these with the organizational structure and the continuous improvement structure, this research tries to identify the differences between the cases. By identifying these differences this research tries to find out why these differences occur and how IT could be influencing .

Furthermore, the two cases used in this research are both steel manufacturers. This means their processes are similar. Unlike their processes, their way of organizing and digitalization is not alike. Organization 2 is highly digitalized, and Organization 1 has almost no signs of digitalization.

To establish the relationship between the information technology and the organizational structure, the employees and managers will be asked to describe the organizational structure and the way of distributing information. These structures and ways of distributing information will be described and analyzed in chapter 4 for each case. See appendix I for the interview questions.

## 3.5 Data analysis

The interviews are recorded and transcribed so that the data can be analyzed. The first step is to find patterns in the interview data by means of coding. This means assigning codes to specific parts of the text, based on the literature study in chapter 2 (Vennix, 2011).

To analyze the interviews this research made use of template analysis. By using template analysis, the flexibility to analyze the interviews is high whilst the structure in the data analysis is high as well. This is desirable with an explorative approach where flexibility is needed to analyze the data (Symon & Cassell, 2012). A template analysis does not restrict the amount of code orders which enables the researcher to analyze themes according to the richness of data. This means that the actual data leads the researcher to a specific outcome which is then interpreted and reviewed with existing theories about those subjects (Thomas, 2006).

Template analysis uses a theoretical framework or perspective to look at the data, called *a priori codes*. These *a priori* themes are developed in the theory chapter and the questions are based on these themes. By reading the transcripts and assigning parts of it to the *a priori* themes first order codes arose. Each theme was highlighted in the transcript with a unique color. If parts of the transcript seemed relevant but could not be assigned to a specific theme, a new theme with a new color arose. An initial coding template arose when the *a priori* and the new themes were combined. This gives ability to add new insights during the coding process.

After the initial template was supplemented with new relevant codes the transcripts were analyzed again. Not only were the codes assigned and reassigned, the template was also adapted when new possible themes were found. By looking at recurring patterns first order codes can be linked to each other which can make higher order codes (second order codes). This way the amount of codes will be reduced, and more overview is created.

## 3.6 Operationalization

In chapter 2 the different structural characteristics were described and divided into different dimensions. Decentralization was divided into decision-making rights, responsibility and hierarchy. Formalization was divided into rules, procedures and instructions. Specialization was divided into the division of tasks and diversity of jobs for employees. Each variable will be

briefly discussed with example questions from the interview protocol and a table with the indicators will be shown.

To find out what the decision-making rights are for employees, questions will be asked such as: "*If there are disturbances, are you allowed to fix these yourself?"* and "*what are you allowed to do and what do you have to do?"* This determines ability to make decisions independently. To show what the ability is to make decisions together there will be asked questions about the collaboration between the planner and the team leader. They will also be asked if employees are allowed to suggest improvements and how this process works. Questions like: "*are you able to share your thoughts and knowledge about improvements for the organization?"* will be asked to employees. Questions like: "*for what are you blamed for?"* and "*how do you know if your work is good or not?"* and *"how do you know what you are supposed to do?"* will show the level of responsibility in terms of accountability and receiving blame for mistakes.

The previous questions will also provide insights into the hierarchy dimensions. To support these answers there will be a request for an organizational chart. It will also be asked how employees get their orders and pass them through. This will provide insights into the (same level) colleagues the employee is working with. Questions like: "*who provides you with the orders?"* and "*are you independent or dependent of other employees?"* will be asked.

To find out how formalization is present in the case organizations this research will focus on rules, instructions and procedures. By asking "*are you allowed to solve problems yourself?"* The rules that are present in the organization will come forward. Questions such as: "*how do you receive orders"* and "*what do you know of the order"* will show the procedures that are present in the organization. There will also be questions asked like: *"what happens if the planning can not be achieved?"* this will trigger the interviewee to think of real life examples that can provide more insights in procedures that are followed when something unusual happens.

To gain insight about specialization in the case organizations an organizational chart will be asked for and questions such as: "*what is your function within the organization?"* and "*what are your daily tasks?"* will be asked. These questions will be followed up by more in-depth questions to gain insights about the division of tasks and the task variety. These interviews in

combination with the organigram will provide an overview of the division of tasks and the task variety.

| Variable | Dimension | Indicator |
|---|---|---|
| **Decentralization** | Decision-making rights | Ability to make decisions together<br>Ability to make decisions independently<br>No ability to make decisions<br>Ability to suggest improvements |
| | Responsibility | Accountability<br>Receiving blame |
| | Hierarchy | Span of control<br>Amount of same level colleagues |
| **Formalization** | Rules | How to deal with problems<br>How to communicate |
| | Instructions / procedures | Documents explaining the process<br>Documents/procedures on how to deal with certain disturbances |
| **Specialization** | Division of tasks / task variety | Level of split up tasks<br>Amount of different tasks in total process |

Table 2. Indicators and dimensions per variable.

In the table below a summarized version of the theory as described in chapter 2 is presented. This table tries to combine the theory of Tao and Zhang (2017) with the less scientific substantiated taxonomy of the HAN. This way the taxonomy used by HAN has a better scientific base in order to use it further in this research. As shown in figure 5 the different maturity levels do not correspond exactly with a specific stage; there is some overlap. Therefore, this table can only be used as guidance to analyze the cases.

| Taxonomy (stage) | Managerial controlled factory (2nd stage) | Digitally (supported) controlled factory (3rd stage) | Socio digital controlled factory (4th stage) |
|---|---|---|---|
| **IT role*** | Automated back-office activities | Provide information and tools to improve decision-making and knowledge worker performance | Shared intelligence to add business value |
| **Virtual space vs physical space** | Manual connection | Some automatic connections, out of sync | Completely synchronized |
| **Structure** | Functional | Working towards (semi) autonomous teams | (semi) autonomous teams |
| **Improvements** | Management | More locally | Both local and cross departmental |
| *IT roles from Applegate et al. (2006) | | | |

Table 3. Summary of HAN QRM taxonomy and their characteristics

## 3.7 Research ethics

Research ethics are an important part of conducting proper research. Researchers have to make decisions in their research that come with ethical dilemmas (Guillemin & Gillam, 2004). In this paragraph, choices in this research will be elaborated on in order to guarantee the confidentiality of information that will be received by participants in this research. The research will be done according to the points of ethical considerations in management research by Bryman and Bell (2007).

Before every interview the respondent will be informed about the purpose of this research and there will be an explanation on why their information is relevant. It will be stated at the

beginning of each interview that answering the interview questions is completely voluntary and it will be made clear that respondents can stop the interview at any given moment. At the start of each interview the respondents will be asked if they agree with the recording of the interview. Also, the respondents will be assured that the answers given will stay anonymous and that names will be deleted from the transcripts. The respondents will be able to receive a copy of the interview transcript and the research results to ensure full transparency. When the research is finished, each organization will remain anonymous and the interview transcriptions will not be publicized. There will be no direct relation between the researcher and the researched, which makes this research independent.

## 3.8 Quality criteria

In general there are four quality criteria: dependability, credibility, transferability and confirmability. This paragraph will discuss how these four criteria will be ensured in this research.

According to Shenton (2004) a dependable study would be able to be repeated and conclude approximately the same results. To ensure the dependability in this research, the process of the research is described and the data will be systematically analyzed. The model, as presented in chapter 2, will be used as perspective to look at the data. Besides that, all the data and models that have been used can be found in this document.

Credibility means that the results in this research are trustworthy, and for qualitative research this means the phenomenon is described properly (Shenton, 2004). This research is focused on two organizations that have identical manufacturing processes of which one organization uses almost no IT in their primary process(case 1) and the other organization uses a lot of IT in its primary process (case 2). By the use of these organizations this study will be able to describe the phenomenon in detail and will be able to compare the data from identical organizations which have a different way of organizing and a other IT usage. This makes it possible to research the effect of IT on the organizational structure in a similar setting. In addition, by using member-checks the findings in the interviews represent the reality as experienced by the interviewees.

The transferability can be compared with the generalizability, which means the ability to apply the results of this research to a larger population. For qualitative research this can be difficult

since it uses data which is context dependent (Shenton, 2004). To be able to generalize the results of this research the case organizations will be described in detail so the contextual aspects will be clear. In addition, this research will use two cases and will use existing definitions of the concepts to be used which will make it easier to see the contributions to a larger population.

The confirmability can be referred to as researcher bias, it is the ability of the researcher to stay objective towards the data (Shenton, 2004). The data should not be influenced by the researcher but should be a correct representation of the information given by the respondents (Shenton, 2004). The confirmability will be respected by a detailed described research process and research ethics.

# 4. Data analysis

In this chapter the cases will be viewed from the HAN perspective. This means the cases will be analyzed and the IT maturity and CI maturity will be discussed. Other than that the level of decentralization, formalization and specialization will be discussed. First the organization will be described, and an organizational chart will be drawn. This information is based on the interviews and the background information provided by observations and documents.

After this, the organizational chart will be explained in more depth using the interview answers. This will provide in-depth insights of the IT maturity level, CI maturity level, the decentralization, the specialization and the formalization. This will be done by discussing the answers of the interviews.

In this analysis the organization will be described according to the taxonomies and structural characteristics as described in chapter 2.

## 4.1 Case Organization 1

Organization 1 is a metal working company which focuses on both big and small projects, and they consider themselves as the mid segment of metal working. They are too big to do only one-piece orders and too small to do repetitive orders. They say the key for their business is a mix between variance and volume. Organization 1 has their own process which starts with metal plates of which they build for products such as parts for construction. Their primary process consists of laser cutting, pressing, welding, bending and assembly.

Organization 1 has a very old information system and works with paper sheets. Organization 1 is curious on how they could improve their information system and therefore chose to join the HAN QRM project.

### 4.1.1 General overview organization

The primary process at Organization 1 starts at the sales department. The sales department sells orders to customers. Once they sell their orders, they communicate this with the planning. The planning department then makes the planning for the week and in more detail for each day. After that, the engineers/programmers create the programs for the machines the operators work with. Next, the operators begin the manufacturing of the products. Every product needs the same type of operations to be performed. This means the products always start with the laser cutting or with pressing. Then the product moves to the press and the

product gets the bends it needs. After the press the different compartments will be welded together. After every manufacturing operation is done, all the compartments will be assembled, and the product will move to either the expedition or the warehouse where it will move to expedition later. The primary process is visualized in figure 7 below.

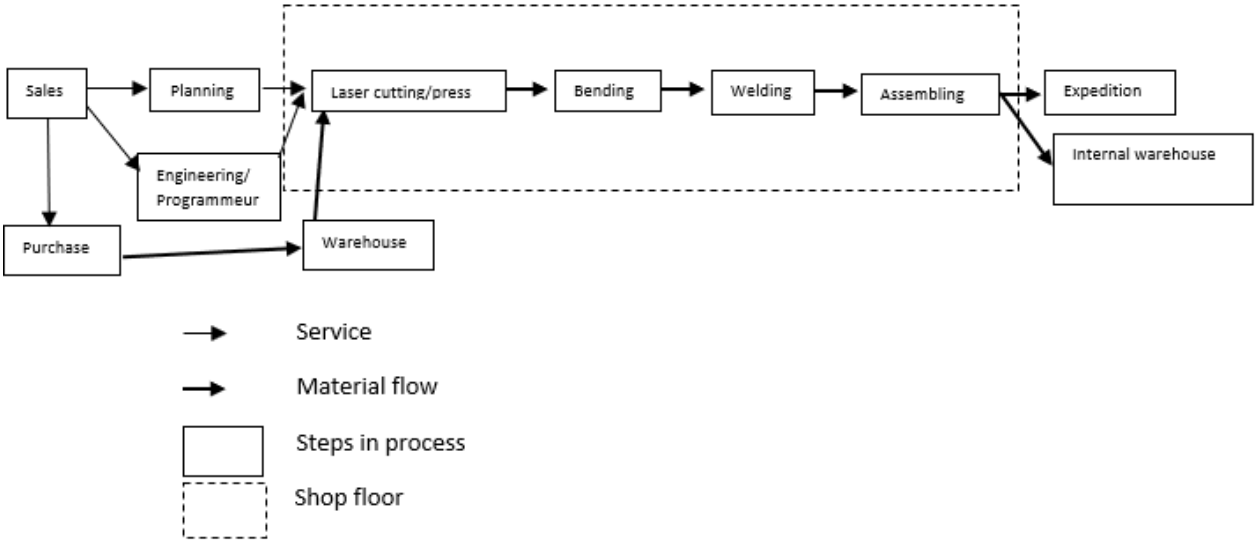
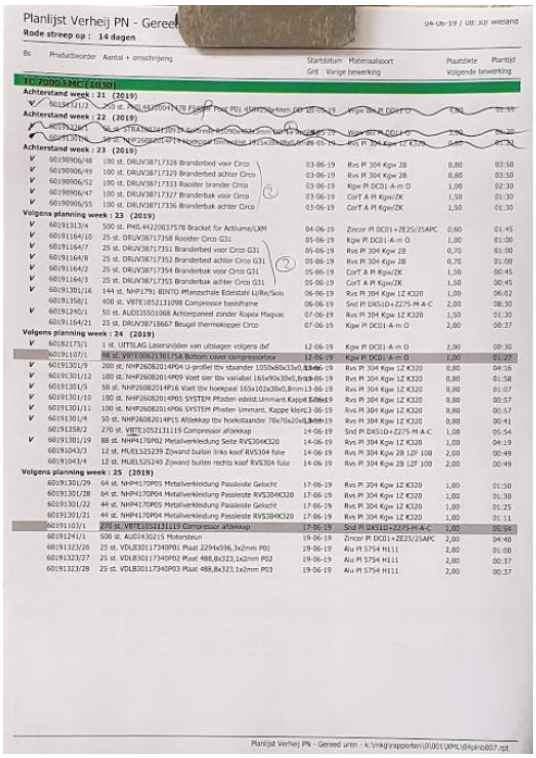



Figure 7. The primary process of Organization 1

### 4.1.2 IT maturity

In Organization 1 there is an absence of IT. The information needed for the primary process is distributed by paper. See image 1. This is a picture of a plan list that operators use to perform their tasks. These lists are distributed in so-called 'buckets' (see image 2). The planners make these lists via their ERP system and it is communicated by paper. The way Organization 1 uses IT corresponds the best with the computerization stage as presented in chapter 2. They use computerized programs, but the programs operate in isolation and are not connected with each other. When looking at the HAN model, organization 1 is in de-computerization phase, it is using back-office automation but the systems are not connected with each other and information is distributed by paper.


Planlijst Verheij PN - Gereed

Rode streep op : 14 dagen

Image 1. Plan list Organization 1

Image 2. How plan lists are distributed in ‘buckets’ throughout the shop floor

### 4.1.3 Virtual space vs physical space

It seems that Organization 1 does not use much IT and the IT they use for their planning does not seem to be in line with the reality. According to the interviewees this is due to two reasons:

1) The estimated time for production does not always equal the actual time for production. This is due the fact that there is no administration of the number of hours spent on an operation. According to the manager: "*the programming time gives a different value than the pre-calculation time. That is not linked to each other*."
2) The order acceptance is based on euros instead of machine capacity. This makes the planning sometimes unreliable. According to the planner this can happen when the client delivers parts of their own. This means the end product will be less valuable, because there will be no euros spent on material. Nonetheless this does not mean that the hours required for the product will be that much less.

### 4.1.4 CI maturity level

It became clear during the interviews that it is hard for employees of Organization 1 to give suggestions of improvements. As the work prepper said: *"I do not think there is an improvement loop right now. If things are going wrong, we all say we should do it differently the next time but other than that nothing happens."* and: *"it is too busy to sit with someone for half an hour to talk about improvements".* This shows that the employees have no room in their schedule to suggest improvements. Most improvements come from the manager and the staff. Also, the planner said that the problems that occur on the shop floor are not processed digitally. "*The remarks that are written down on the plan list end up in the trashcan because we do not have it digitally".*

The manager seems to be working on several projects to improve the process at organization 1. *"We are currently working on an improvement process to simplify the process in order to cut the costs".* This, in combination with the fact that the remarks on the plan list end up in the trashcan, makes it seem that organization 1 is focused on firefighting on the operation floor. They solve problems as they come by using pen and paper and do not administrate those problems. The manager seems to work on more structural and strategic improvements. The focus seems to lie on the short term which corresponds to the 'ad hoc' stage of the HAN model.

### 4.1.5 Decentralization

#### *Decision-making rights*

The operators are consulted at the beginning of the day about the day plan. The planner told in the interview that he discusses the plan with the operators and takes their opinion to finish

or edit the plan. He also said he needs to confirm this with the managers before the final planning is distributed. This shows that the operators have some say in the planning. It seems that the operators needs to be consulted because of the lack of digital communication and data.

As mentioned before, Organization 1 does not use IT to distribute information across the primary process. For the distribution of the planning they use paper sheets with all the orders on it for that day. The operators receive this list and with their expertise they are allowed to cluster items together in a way that makes the most sense. This can also be seen on the plan list (image 1). The operator clustered orders, with a pen, on the plan list. This was also acknowledged by the manager during the interview. When asked what the operator can decide himself the manager answered: "*the details, easy combinations of different kinds of material. Products that he can easily add in the same run, so it is finished. And with some machines it is easy to cluster products because they have the same size, those are the things the operator themselves can decide.*"

In the case of Organization 1 the operators have the authority (variability) to change the sequence in which they will produce the orders. Operators always need to consult these changes in sequence with their team leader which is in direct contact with the planner. This is, according to the planner, because there has to be a balance between delivery time and efficiency. The operators are consulted for the efficiency but the planner has to make sure the products are delivered on time.

There are situations where the planning needs to be revised. This happens when errors occur or when rush orders come in. When the planning needs to be revised in these cases the manager makes the decisions. When the manager is not present at Organization 1 the planner takes his role and revises the planning. He does this by going around on the shop-floor to change the plan manually on the paper sheet.

### *Responsibility*

At Organization 1 the factory floor is responsible for producing the right goods in the right way. This depends on whether or not the planner did a good job. There are a few reasons why this does not always go right at Organization 1. It seems that sometimes the planner forgets to mention certain dimensions of products, this means that the operators use wrong dimensions or stop working and have to wait for the planner to correct it. As the planner said:

"*if something is not specified on the paper the operators will come to us and we will look into it right away. Most of the time we just use a pen to correct in on the plan list. This can lead to machines having to stand still.*"

It can also happen that a customer has contacted the manager or the sales department and has a rush order for Organization 1 to fulfill. This then becomes clear when the work prepper and the manager discuss the daily planning. The manager can overrule the work prepper and can change the planning. Other than that, the work prepper in collaboration with the operators is responsible for the daily planning and the most efficient use of the capacity of the machines.

### *Hierarchy*

The process at Organization 1 starts at the sales department. The sales department sells orders to customers. Once they sell their orders they communicate this with the planning department via an ERP system. The planning department then makes the planning for the week and for each day. After that the engineers / programmers create the programs for the machines the operators work with. The planning is communicated with the operators via the team leader which gives the operator a picklist, which is printed on a piece of paper. On this paper the operator can find all the information he needs to fulfill orders for each day. For daily planning the operators themselves can chose the order in which they want to produce their orders. For instance the operators can themselves look at the different orders and cluster the orders that have the same, or some of the same, specifications together so it is easier to work with.

At Organization 1 the manager makes most decisions based on the planning. Although the manager officially makes the decisions, he consults the whole team first. The planner makes a weekly planning and the work prepper discusses this planning with the operator and makes a concept daily planning after consulting on this with the operators. After the concept daily planning is made, the work prepper will discuss this with the manager, and he will either confirm the planning or edit it based on new orders that came in. The planning department consists of two planners (2 FTE) at organization 1.

In the interview with the planner it became clear that the priority of orders is decided by the manager in collaboration with the factory floor. The planner said: "*the priorities (of the*

*planning) are not given by us. The priorities are always given by the manager in collaboration with the factory floor."*

As discussed before the manager always decides whether or not a rush order will get priority. Besides that, the operators and the work prepper seem to make the plans and the manager only steps in when there are sudden changes to make in the plans.

### 4.1.6 Formalization

#### *Rules*

When interviewing the planner some basic rules came up that are used on the factory floor. For example, when things go wrong or when some information is missing the operator will write it down on the plan list and will inform the planner of the problem. The planner will then correct the plan form. This can either go by printing a new plan form or by correcting it in pen on the existing plan list. The planner said: "*We will take a look at the factory floor when there is missing something on the drawing and correct it. We will also take a look when they (operators) are producing a large series, to check if everything is correct (..) if something is not correct, they will also write that down on the worksheet".*

For the planning department there is a rule that the order acceptance is 80%. This way there will always be room for rush and extra orders that will come in. According to the manager this is because in this way there is more leeway considering the delivery time to customers. Other than that changes in the planning are always discussed with the management.

#### *Procedures*

The amount of procedures in Organization 1 seems low. The procedure is that the work prepper gets the weekly planning from the planning department and will discuss this with the operators to make a daily planning. After he consulted the operators he will need to discuss this concept planning with the management during a planning meeting which will then either agree with the planning or edit the planning. This shows there is room for discussion for the daily plan and there is no such thing as a procedure where the daily plan is based on. The planning is mainly based on knowledge of the operators and the work prepper.

The actual work that the operators do is mainly based on the expertise of the operators themselves. They get a drawing from the planning department and the planning itself and they will know what to do and how to cluster these different orders. For some orders there are work instructions (see Image 3).

When problems occur it is hard for organization 1 to communicate this quick to all operators. When the daily plan needs a revision the planner has to change all the plan sheets by hand throughout the operation floor. In those scenarios the machines have to stand still for a while.

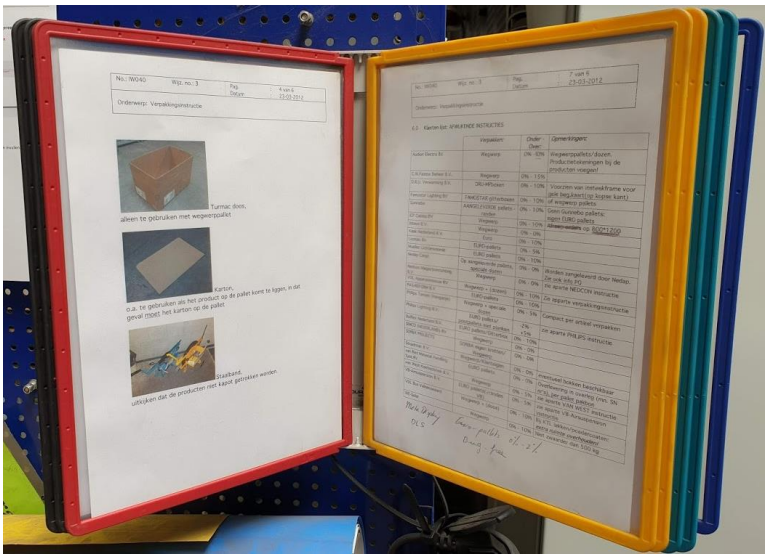


Image 3. Work instructions for operators.

### 4.1.7 Specialization

The specialization in Organization 1 became clear when the organizational chart and the daily planning was explained during the interviews. In this daily plan the names of similar employees are assigned to different tasks. This showed that multiple employees were able to do all tasks. Most employees were able to do at least 3 of the 4 tasks of the primary process. This shows that the specialization is low in Organization 1 and most employees have knowledge about the whole process. When asked about this the most tasks could be performed by most employees although there were some tasks that required different machines which required more expertise.

In the table below a summary of the different structural variables can be found for Organization 1.

| Variable | Dimension | Indicator |
|---|---|---|
| **Decentralization** | Decision-making rights | The factory floor can make decisions based on the primary process, planning decisions always need to go by the manager. |
| | Responsibility | The factory floor is responsible for the most efficient capacity of the machines and for good quality products. |
| | Hierarchy | The work prepper decides together with the operators what the daily plan should be. There need to be a balance between order delivery time and efficiency. The plan always needs to be agreed by the manager. |
| **Formalization** | Rules | There are some basic rules for when things go wrong. But mainly operators are free to fill in the daily planning. |
| | Instructions and procedures | There are some work instructions and the daily planning is made by the work prepper by consulting the operators and the management. |
| **Specialization** | Division of tasks / task variety | The primary process consists of four steps and most operators can do three or more of these tasks. This makes the primary process not highly specialized. |

Table 4. Summary of structural characteristics for Organization 1.

### 4.1.8 Summary Organization 1

In order to fill in the table that was presented in chapter 2 it had to be made clear what the role of IT is in Organization 1. This includes how the integration is between the virtual and physical space and how improvements are done at the organization. It seems that Organization 1 only uses IT for some back-office automatizing. It was also shown that this IT system is not in line with the reality which causes the planning to be incorrect. Errors have to be corrected by pen by hand which costs Organization 1 time. Other than that, the different structural characteristics are described below for Organization 1. The results of the analysis are summarized in table 5 below.

| Stage | The second stage | The third stage | The fourth stage |
|---|---|---|---|
| **Taxonomy** | Managerial controlled factory | Digitally (supported) controlled factory | Socio digital controlled factory |
| **It role*** | The back-office has automated activities (use of an ERP system) | | |
| **Virtual space vs physical space** | There is a manual connection between the virtual space (back office automation) and the physical space (factory floor). The planning is communicated by paper and changes are done manually by pen. | | |
| **Structure** | | Organization 1 seems to work as a team. They discuss the planning together and the factory floor has a saying in when to produce what and how. | |
| **Improvements** | Management takes most decisions on improvements, no initiative is taken by operators but it is also not encouraged. | | |
| *IT roles from (Applegate et al., 2006) | | | |

Table 5. Summary of HAN QRM taxonomy and their characteristics

It seems that organization 1 leans toward being a management controlled factory. The information systems have limited functionality and are not connected. The operation floor is mainly firefighting and the strategic improvements mainly come from the management. Although the operational routines seems to be decentralized and the operators are somewhat free to fill in their daily tasks (with approvement from the management). The improvement routines on the other hand seem to be more centralized.

## 4.2 Case Organization 2

During case Organization 1 it became clear that more focus should be on the exact flow of information throughout different systems to be able to define the IT role better. In this way the IT connections are better mapped and the IT maturity can be better substantiated. Because of this, case Organization 2 defined their information flow process in more detail as can be seen further in this chapter (figure 9).

Organization 2 is a metal working company which focuses on both big and small projects. Organization 2 has their own process from semi-raw materials (steel plates) to the complete assembly of their products. For example, they make doors, fronts, ventilation grilles, and explosion panels. During this process the raw materials go past various operations such as laser cutting, milling, welding, coating, deburring, bending and internal and external assembly.

Over the past years Organization 2 invested in new information systems and is highly digitalized, this makes Organization 2 a good case for this research. In this analysis the organization will be linked to the taxonomies that are mentioned in chapter 2 and the organizational characteristics will be described. By doing this for both cases this research will gain in-depth insight into the effect of information systems on the control structure.

### 4.2.1 General overview organization

The primary process at Organization 2 starts at the sales department. The sales department sells orders to external companies. Once they sell their orders, they communicate this via their ERP system to the planning, engineering and inventory management. The planning department makes sure the products are manufactured on time and in the right order. The engineering department creates the details for each product and creates the computer programming for the machines needed to make the products. The purchase department

makes sure there are enough materials to make the products. From here on the materials are grabbed from the warehouse and the production begins.

The production always starts with plates of steel which are cut by the laser cutting machine. The metal plates are cut in different shapes which all form different components of the end product. After the laser cutting the different components are deburred and move on to the press brakes. Some components, if needed, are then welded together and then all components move to the coating area where the products get a paint coat in the color requested by the customer. From here on there are two different choices for transport. Sometimes Organization 2 assembles the product internally and then it moves to the expedition. Other times Organization 2 transports the product to the location and assembles the product at that location.

Not all products that Organization 2 makes consist of only metal plates, some of their products have aluminum components. There are two types of aluminum components Organization 2 uses: aluminum grates and aluminum frames. They are both sawed into shape and then the grates are welded together and the frames are milled so they can be assembled together later on. After the welding and the milling the grates and frames move on to the paint coating where they merge again with the metal plate work. In figure 8 a visual overview of the production process is given.

The process is highly differentiated which means that every step in the process is done by another operator. The process is also highly functionally concentrated, this means that the process consists of several steps that every product passes through. The process steps are split up, meaning that process step 2 continues with the product that was made in process step 1. The products are all identifiable with a code (see appendix) so the operator clicks his next "order" on the computer and searches for the product based on the code he receives and continues with this. The process steps follow each other as shown in figure 8.

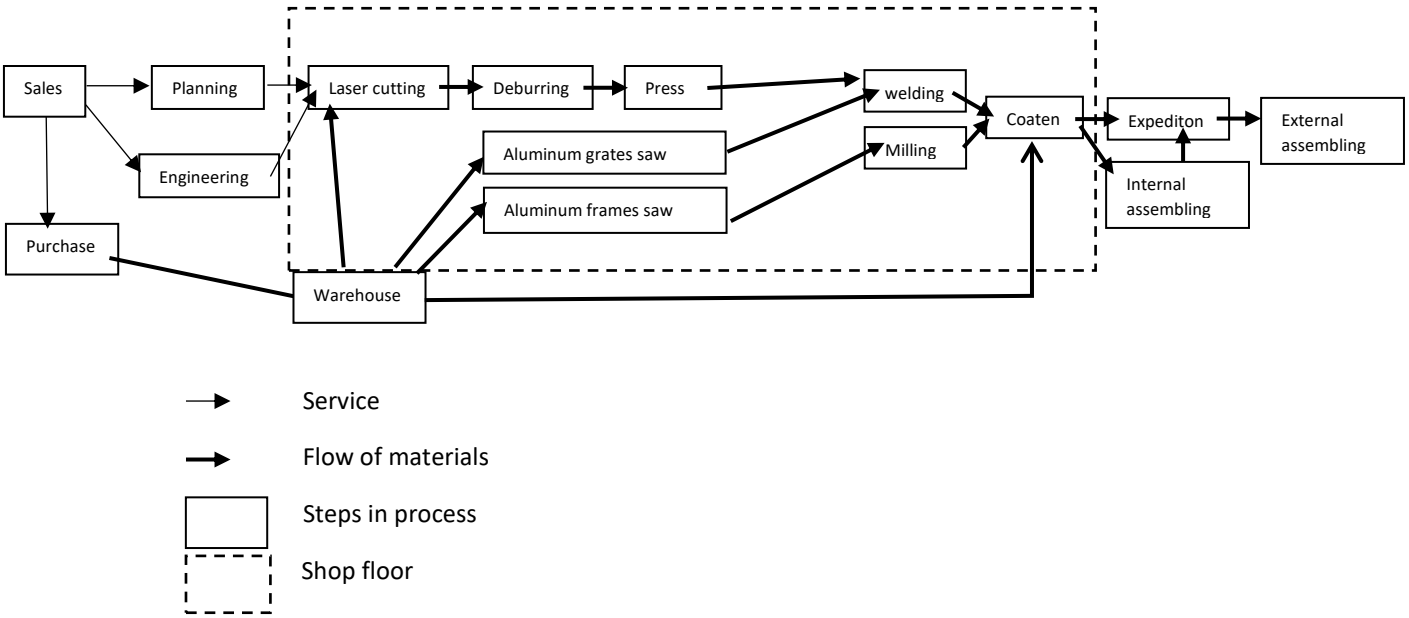


Figure 8. Primary process Organization 2

### 4.2.2 IT maturity

According to the manager, the whole back office is automated. Also, the design and engineering is automated with generic building blocks: *"we digitalized the engineering to save time, now we use generic building blocks which we can steer on parameters, this saves us time."*

The manager said that they use their own software, named iCentre, to distribute the needed files from the office throughout the factory. *"iCentre supports deciding what route the product will take throughout the factory based on the information that is put in".* The manager was then asked if iCentre and the physical world are in sequence. The manager said that the digital world and the physical world do not line up completely. Thus, there is no complete fit between their IT system and reality.

Every workstation on the shop floor has a computer with a scanner (see image 4). This shows the operator their current task and the operations he or she needs to do. By simply pressing next the previous order will be sent to the next workstation. The orders are all numbered with either a barcode or a code in the material itself (see image 5 and 6). By pressing next the order number will pop up so the operator will know what material to get and where to get it (see image 7).

In figure 8 the connections between the different information systems are visualized. This shows that all the IT systems are somehow connected with each other. Other than that organization 2 traces its products throughout the process. This is done by scanning barcode by operators at their workstations. Since this is not a fully automated process it can be argued

that organization 2 is between the connectivity stage and the visibility and traceability stage. This corresponds to the second era of Applegate et al. (2006) since their IT system is providing information and tools to the operators.

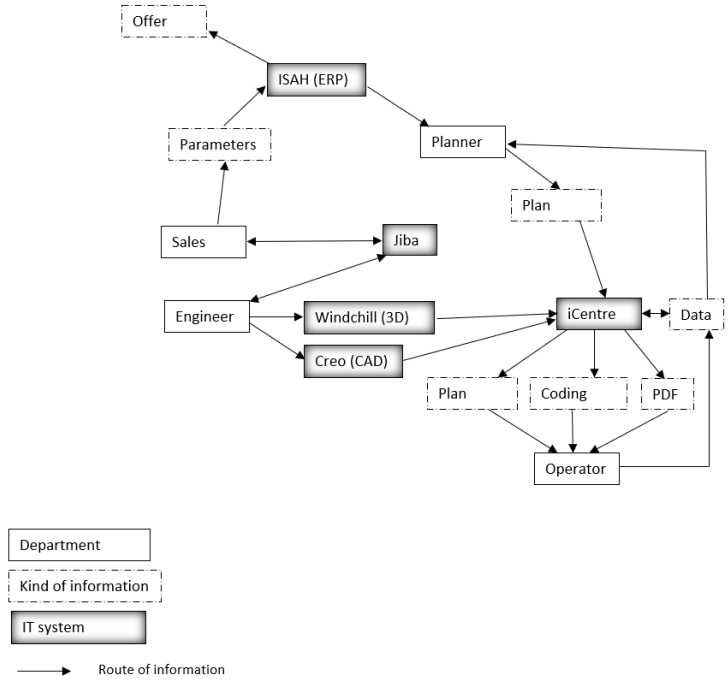



Figure 9. Information systems in Organization 2

Image 4. Each workstation has its own computer with scanner.

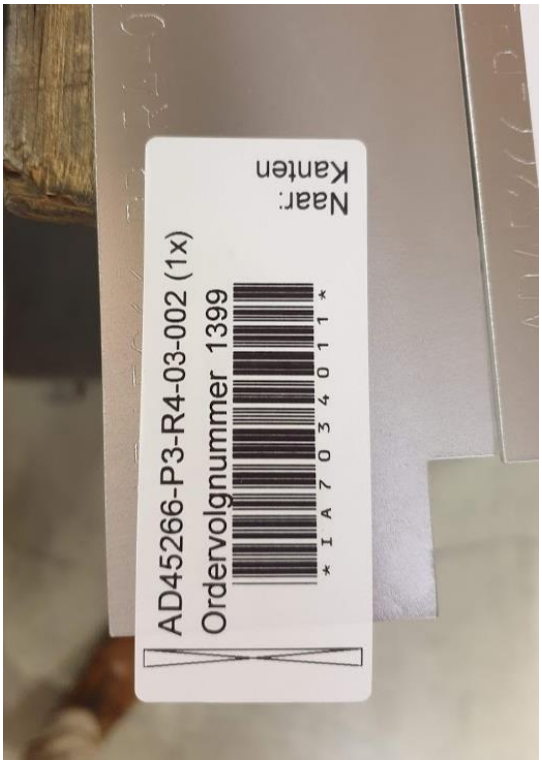



Image 5. Barcode on product.


Image 6. Product number on product.

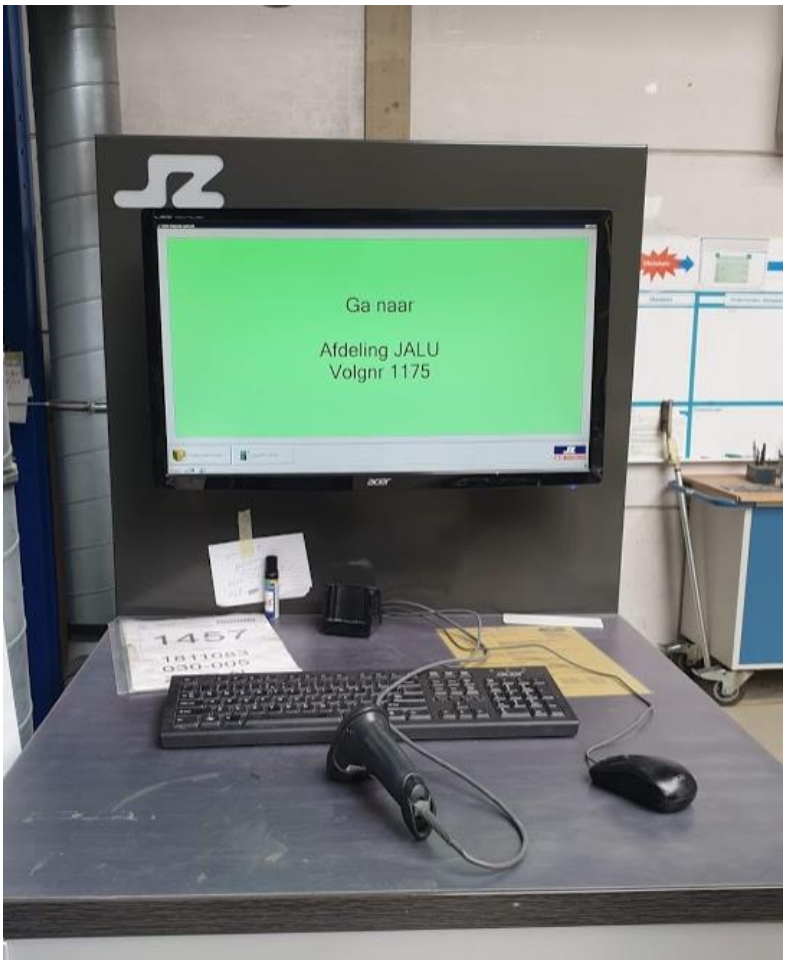



Image 7. Directions given to operator.

### 4.2.3 Virtual space vs physical space

It seems that Organization 2 uses IT systems to communicate throughout the organization. The planning department uses an ERP system, the engineering department uses a 3D modeling system and it all communicates with each other via their own internally made iCentre. With iCentre, the organization communicates between departments and with the shop floor. An overview of all the information systems is given in figure 9. In this overview it can be seen how information flows from system to system and between whom. However, the IT they use do not completely represent the reality, as the manager told in the interview. This became more clear when the planner said: "*I need to check (manually) if the hours that are worked on an order are correct and what the status is (…) then I check what the deviations are on the process.*" This shows that the planner needs to check manually if there are any disturbances in the process.

Planner: "*It is hard to know exactly when orders are done, our order prices range from 100 euro to 300.000 euro. With those dynamic differences it is hard to predict when an order should be done."*

The interaction between the virtual and physical space is manual. The operator scans a barcode and presses start on his computer. This sends information to iCentre, this way iCentre knows where the product is and for how long. After the operator is done with his task, he scans the next product and this automatically moves the product digitally to the next machine. This became clear when the manager said: "*when you press start the clock starts ticking and when you press stop it moves to the next machine."*

### 4.2.4 CI maturity level

It became clear in the interviews that the improvements in Organization 2 do not come from the operators. As the manager says: *"If we talk about improvements, the employees (operators) do not take initiative. If we come up with improvements, they will follow but they will not come up with their own improvements."* It also became clear that the manager was not encouraging it at the moment: "*to answer your question about what we do to improve that: simply nothing."*. Nonetheless it should be noticed that the team leaders seem to work on projects and improvements besides their job to oversee the process. This shows that the improvements are located more to the process but do not involve the operators themselves. It seems that because of IT there is less direct contact needed between the operators and the management to coordinate the process.

It became clear that the team leader is working on continuous improvement from the lean perspective. The team leader named several projects he and the manager were working on. These were projects concerning the product itself but also the sequence of the process and how that could be improved. As they said: "*we are just trying to continuously improve".* Although the operators are not involved in the continuous improvements this shows that a basic understanding of continuous improvement is present at the organization. which means it can be argued that organization 2 is in the strategically linked stage. This means that continuous improvement is part of the main business and linked to the organizational goals.

### 4.2.5 Decentralization

*Decision-making rights*

Organization 2 is using their own information system to distribute information throughout the organization. The manager said that they use their own software, named iCentre, to distribute the needed files from the office throughout the factory. *"iCentre supports the decision of what route the product will take throughout the factory based on the information that is put in."*

The lower level employees at Organization 2 have almost no degree of decision-making rights. This became clear in the interview with the manager when he said: "*(…) the operator just presses the 'next' button on the computer and he sees his next order. We removed the date of this product, it can be a product for the day after tomorrow but also a product that should've been finished already. But we chose to delete the date because that man just needs to weld, and he will not weld faster or differently when he sees the date. So, it doesn't bother people. They only suffer when they stop because the supply is stagnant, and we then have to put them in other workplaces."* This demonstrates that the IT system facilitates a shop floor where the operators have no variance and no decision-rights, they only press next and do what the IT system tells them to do.

This got confirmed in a later interview with an operator when he said: "*the information I receive is ordered on material thickness, what kind of material is needed, and start date; I cannot influence this*". If the order deviates from the standard and iCentre cannot make a decision, the decisions are made by the work preppers. In some rare occasions some of the operators are able to make the decision of on which machine they will produce an order. As the operator said: "*based on my knowledge and the information I receive through iCentre I sometimes need to make the decision of whether I will produce the order on the new or the old machine".*

Rush orders are planned by the work prepper and the operators will not even notice if the order they are producing is a rush order or a normal order. This became clear when the planner said: "*the employees do not see a date they just press next to see their next order; they will not know whether an order is a rush order or a normal order.*" The work prepper decides when the rush orders are done but according to the manager the work prepper will be told to do this and "*it is actually the customer who decides it"*. The operator confirmed this, stating: "*Rush orders happen in the background. Then I must have caught something by accident (to*

*know) that certain orders were brought forward and might know, but normally I am just blind to it".* The IT system takes away the transparency and decision-making for rush orders which is stated to create stress for the operators.

### *Responsibility*

When looking at decentralization it is important to know what the responsibilities of the employees are. This determines whether or not employees will be blamed or are responsible for their actions in their jobs.

At Organization 2 it seemed that employees are not directly responsible for the planning but only for the process. This became clear when the manager said: "*If we look at the planning and if the operators receive the blame for that then they have no idea what the planning is. Because it is censored they cannot be held accountable for that".* Thus, the operators are blind to the planning and not held accountable for it. However, the operator said that he was accountable for the quality of the products and the manager confirmed this by saying: *"they will not receive blame for the planning but only for the process".*

During the interview it became clear that Organization 2 used to show the due dates of the products to their operators on the screens. This made it very stressful for some of the operators. The manager and the operator described a situation from the past, where: "*at first the deadlines for the products were visible for the operators, this caused stress for him (the operator) because he felt like he was behind schedule, even when it was clear that it wasn't his fault".* After they censored the deadline the operators apparently experienced less stress. The IT system played a big role in this. Before the switch, the IT system gave the operator more information than he was held responsible for.

### *Hierarchy*

At Organization 2 there are clearly two different entities to be distinguished. First, there is the planning and work preparation entities such as the sales, planning and engineering department. The purchase department is an automatic system that orders materials based on the products to be made. They control what, how and when products have to be made. The second entity is the process group, this group consists of operators and team leaders.

As described before, the orders come in through the sales department and move on to the planning and engineering department. Organization 2 has one planner (1 FTE). The planner makes the planning based on the delivery date. The engineering department creates the

technical details for each product. This information is transferred to the operators who are only making the products according to the details they receive from the engineering and the planning department. The operator receives this information via a computer which is attached to the machine the operator is working with. By pressing on 'next order' the operator sees the information to fulfill the order and the previous order will be report ready and sent to the next step in the process. The operator does not see the precise delivery date, he only sees the sequence of which the orders should be made. For the operator the IT system is a 'black box'.

The interview with the planner showed that the planner used to have little to no influence on the orders that were sold by the sales department. The planner stated that it was a very stressful period because the sales department promised customers a delivery date which did not suit the planning. The planner was responsible for the planning and this made it seem like he did not do his work well. Organization 2 changed this and now the planning and the sales department work closer together in order to only sell products that fits the planning. In the end, the sales and planning department together decide the amount of products and what products the operators should make, and the planning department controls the order of which these products should be made by the operators. The operators themselves have no influence on this. The planner makes these decisions based on the information provided by the customer and information of previous projects. The customer provides the planner with a delivery date and product specifications. Based on the delivery date and product specifications the planner calculates, also using knowledge of previous projects, when the manufacturing should begin. Based on this start date the planner puts the order in a specific spot in the list in the system which will then show up on the operators' computer.

Sometimes there are rush orders at Organization 2. These orders need to be completed as soon as possible. The interviews showed that most of the time the order will just be put in the next spot on the list so the operators will start with the order after their current order is finished. Sometimes the urgency is high and the operators have to stop with their current work in progress and start on the rush order. When this is the case the planner communicates this with the team leader at the shop floor and this team leader makes sure the operators start with the rush order.

The engineering department decide how the products should be made and with what materials. They decide the technical details of how each product should be made and they

program the machines the operators work with to make the product. Thus, the operator has no influence on the technical details of the product either.

The sales department has a direct control relationship with the planning department and with the purchase department. The purchase department is an automatic system which orders products based on the orders that are put into the ERP system.

The decision-making rights, responsibility and hierarchy highlight that the organization is very centralized. A few people are making the decisions and the operators just need to follow and press 'next'. The people that make the decisions are the planner, who decides when and what will be produced, the engineer, who decides how it will be produced, and the team leaders, when disturbances occur. It can thus be concluded that Organization 2 has a very centralized structure.

### 4.2.6 Formalization

#### *Rules*

It seems that the information system at Organization 2 is making decisions for the operators. All workspaces have a scanner and a computer which is linked to the information system. This system shows the operators their current tasks and how to do these tasks.

When disturbances arise, the operators must inform their supervisor. They do this by filling in a form on their computer which they can link to the 3D drawing of the product. According to the manager: "*We use a form to make notes for the employees when there are disturbances".* For example, when operators notice that a hole is missing in a beam, they have to make a digital note of itin iCentre. The manager said: "*for example if something is missing, then the operator makes a note on the digital drawing of the product to point out where and what is missing".* Other than that, the mistake is told to the team leader, and the team leader makes the decisions to solve the disturbance. This was confirmed by the operator: *"if a disturbance occurs I will always tell it to the team chef".*

The capacity of the factory is controlled by rules. According to the planner, the factory floor has a certain capacity and technically speaking the planning can exceed this capacity, however according to the manager there is a rule that they will not plan more than the capacity.

The planning department keeps in touch with the shop floor team leaders with a weekly consultation about the planning: *"I have weekly production consultations. Here the weekly*

*planning is discussed and if somethings are not ready solutions will be discussed".* The planning information is only available for the team leaders, the operators do not know the planning and are not present at these meetings, they will only see their current task and cannot see the due date of it.

#### *Procedures*

The amount of procedures in Organization 2 is high. The factory is based on clear procedures. The manager said *"If you look at the workfloor, for the employees it is a black box, they just grab what they are told to (by iCentre) and give it on to the next"*. The employees are provided by the IT system with all the information they need to fulfill their part of the process. The only information the IT system provides the operators with, is the information they need for their specific task. As the manager says: "*they can only see the information they need and nothing more than that".* The IT system tells the operator exactly what needs to be done with products and on what machine. It seems that the IT system coordinates the work on the operational floor. It does this by showing the operator what material to use, what operations to be done and how. All this information is gathered and combined from different other systems filled by engineers, planners and work preppers.

The amount of formalization is very high. Organization 2 tries to explain to their operators exactly how and when to do what. This is done by rules on how to act when disturbances occur but also by the means of procedures. The procedures are mainly work instructions that are present throughout the whole shop floor by the means of computer screens. These screens show the operator exactly what he or she has to do. IT helps organization 2 to supply the right information to the right person. It can thus be concluded that Organization 2 has a high degree of formalization.

### 4.2.7 Specialization

The specialization in Organization 2 became clear when the organizational chart was explained. The process consists of 8 steps (see figure 8). All these 8 steps are done by different operators and according to the manager and the operator there are not many employees that can do multiple handlings. The manager said: "*at this moment the amount of people that can do multiple jobs is very limited".*

According to the operator this number used to be higher. When he was asked whether or not employees can fill in more positions on the shop floor he said: "*No, that is limited at the moment, but that is due to the leave of a number of employees".*

This shows that the specialization is very high in Organization 2. This has led to sub-optimization in Organization 2. There are a few problems in Organization 2 of which one is that people are not employable in multiple jobs and that there is a disbalance between the different departments. This became clear when the planner said: *"What is becoming more present is, indeed, we are no longer in balance with all departments".*

The team leader has made a skill matrix that shows every employee and their skills. These skills are shown in four levels (25%, 50%, 75%, 100%). The manager said: "*if you are in the 75% you can teach someone else the skill".* This shows that organization 2 is currently working to have more all-round employees but that education and training is necessary in order to do certain tasks.

In the table below a summary of the different structural variables can be found for Organization 2.

| **Variable** | **Dimension** | **Indicator** |
|---|---|---|
| **Decentralization** | Decision-making rights | Decision-making rights are located high in the organization, most decisions are made by the planner and team leaders. Operators only follow. |
| | Responsibility | Operators are not held accountable for the planning but for the quality they produce. |
| | Hierarchy | The planner decides what and when the operators do, the engineers decide how and the team leaders are there to tell operators what to do when disturbances happen or rush orders come in. |
| **Formalization** | Rules | Operators follow the information system and when there are disturbances they tell their team leader. |

| | | |
|---|---|---|
| | Instructions and procedures | The information system is full of useful information for the operators and provides them only with the information they need. |
| **Specialization** | Division of tasks / task variety | The organization is highly specialized every task is done by someone else and (most) employees are not able to do something else. |

Table 6. Summary of structural characteristics for Organization 2.

### 4.2.8 Summary Organization 2

In order to fill in the table that was presented in chapter 2 it had to be clear what the role of IT is in Organization 2. How the integration is between the virtual and physical space and how improvements are done at the organization. Other than that, the different structural characteristics are described for Organization 2. The results of the analysis are summarized in table 7 below.

| **Stage** | **The second stage** | **The third stage** | **The fourth stage** |
|---|---|---|---|
| **Taxonomy** | Managerial controlled factory. | Digitally (supported) controlled factory. | Socio digital controlled factory. |
| **It role*** | | The IT system in Organization 2 provides the operators with information to do their work and to make their work easier. | |
| **Virtual space vs physical space** | | Some automatic connections but it does not represent the real world and needs to be adjusted manually. | |
| **Structure** | The structure is highly specialized, highly formalized | | |

| | | | |
|---|---|---|---|
| | and has highly centralized decision-making. | | |
| **Improvements** | | Management and team chefs take most decisions on improvements, no initiative is taken by operators but it is also not encouraged. | |
| *IT roles from (Applegate et al., 2006) | | | |

Table 7. Summary of HAN QRM taxonomy and their characteristics

It seems that organization 2 leans to a digitally (supported) factory. The information systems are connected. The operational routines seems to be centralized and the operators just do what they are told. The improvement routines on the other hand seem to be more decentralized. The improvements are more local, although no initiatives are taken by operators. In addition, since most of the information has to be put in manually the management still experiences a gap between information coming from the systems and the reality. The formalization is high, the right information is send directly to the right operator. The structure seems to be very specialized since there are little all-round workers, it is hard to link this to the IT for now.

## 4.3 Case comparison

This thesis aimed to explore the relationship between IT and organizational structure of SMEs. It is valuable to compare two organizations in the same industry in order to isolate the factors to be analyzed as much as possible. In the previous sections the two case organizations were analyzed based on documents, observations and interviews. This section will compare the results of those sections in order to see if there are differences or similarities between the two cases.

The analysis was done by trying to put most details in the table as presented in chapter 2. While analyzing the cases it seemed to be very hard to fit a case into just one column. This shows that the taxonomies, as presented by the HAN, are ideals and cannot always represent the reality.

First the IT maturity and integration between the virtual and physical space will be defined for both cases and then the individual characteristic such as CI maturity will be discussed along with some practical examples. This will give basis for further research on this topic, which will be discussed in chapter 6.

When looking at Organization 1 it seems to have little to no IT on the shop floor. The back office is using some IT to do their planning and drawings (ERP system) for the products but to give this information to the shop floor they print it out on paper and changes are mainly done manually by pen. According to the IT maturity level organization 1 is in the computerization stage.

The IT role and integration between the virtual and physical space seems high in Organization 2. The IT system in Organization 2 provides the operators with the information to do their work and only their work. This makes it easier for the operators to do their work. They are not shown any other information regarding the planning or the progress of their colleagues. According to the operators this makes them less stressed and they only have to worry about the process step they are performing at that moment. There are some automatic connections between IT systems but there is no full synergy between the virtual and physical world. Since this is not a fully automated process it can be argued that organization 2 is between the connectivity stage and the visibility and traceability stage.

At Organization 1 it became clear that the team leaders, or as they were called in Organization 1, work preppers, were only coordinating the shop floor according to the planning. The planning sometimes is not correct and has to be rectified. If there are mistakes in the planning this has to be discovered during the work process and has to be manually corrected, which happens mainly by pen on the plan list itself. These remarks on the plan lists end up in the trashcan and are not administrated whatsoever. Therefore, the team leader's job is mainly the coordination of the process instead of improving the process; the team leader stated that he has no time for improvements at all. Improvements are located at the top management only in Organization 1 and seem to be focused on the short term, which corresponds to the 'ad hoc' stage of the HAN model.

During the interviews with Organization 2 it became clear that the operators did not come up with improvements for the organization. But it did come up that the team leaders were

working on improvements which shows that improvements at Organization 2 are made at the shop floor. Team leaders were continuously trying to improve the process and the product. This corresponds to the strategically linked stage. This is something that did not come up at Organization 1. At Organization 1 the improvements come from the management only and are thus located at the top of the organization. A reason for this could be that Organization 2 has more IT that can take over the coordination of the shop floor. This is also shown by the number of FTEs needed for the planning at both organizations. At organization 1 there are two planners and at organization 2 there is only 1 planner. This shows that, even when organization 2 is a bigger organization they need less FTE to make the daily plan. The IT at Organization 2 shows the operator exactly what he or she has to do and in what way. This way the team leaders do not have to only be coordinating the shop floor, meaning that they have time to work on projects such as improving the shop floor. This demonstrates that IT can have different effects on centralization. Organization 1 is an example of a lack of IT. This lack of IT results in no digital communication and data that goes from the operational floor to the management. This results in operational routines being decentralized in organization 1, but also leads to centralization for improvement routines in organization 1. At organization 2 the IT is giving feedback to management which improves the coordination between departments. This led, in the case of organization 2, to centralized operational routines. However, since IT takes over the coordination at organization 2 it seems that the team leader has more time for improvements. Thus, the improvement routines seem to be more decentralized at organization 2.

What can also be analyzed by these observations is the difference between Organization 2 and 1 by the means of IT maturity level and continuous improvement maturity level. When using the HAN taxonomy, it can be argued that organization 1 is a management controlled factory and organization 2 is more of a digitally (supported) factory. These correspond to the stages as mentioned by Tao and Zhang (2017). This shows an interesting difference when looking at the differences in organizational structure and improvements which will now be discussed further.

When looking at the structural characteristics of Organization 1 it appears that the individuals in Organization 1 tend to work more as a team rather than split up tasks done by different individuals. The factory floor has the ability to make decisions on the daily plan. The operators

are consulted for the daily plan of which they have say. Besides that, they decide how they cluster different products based on materials or size. This is based primarily on their knowledge and expertise. This also makes them responsible for the most efficient use of the machines and the quality of the products they make. In contrast to that, organization 2 tend to have a high centralization. Decisions are made at the top and operators just do what they are told. The IT system makes it able for planners and engineers to improve and make decisions since the operators feed the system with data (process time and mistakes are registered in the system). But this could also explain why most operators in organization 2 are not employable in multiple workspaces. Organization 1 let their operators think about clustering and the daily plan themselves. This could stimulate them to learn more skills.

The formalization is low in Organization 1. There are some basic rules and meetings, but decisions are mainly based on knowledge and expertise. The lack of IT could explain why there is an absence of formalization. There is no medium to spread the information, besides paper. There are some work instructions and the daily planning always follows the same route: the work prepper consults the planning with operators and discusses this with the management. In organization 2 the formalization is high. Everything the operators have to do is directly targeted to them via the IT system. This could explain why formalization is high in organization 2 because it is easier to communicate the right information to the right person.

The specialization in Organization 1 is not very high, most of the employees can do three or more tasks of the primary process which consists of four main steps. The absence of IT makes the teams work more together and discuss the clustering and daily plan together, this could stimulate learning. The tasks within Organization 2 are split up, which makes the specialization of the primary process high. It became clear that there were not a lot of employees who could do multiple tasks of the primary process. It was not clear how IT was influencing this. Although it could be the fact that operators only do what they are told and are not stimulated to suggest improvements on either the daily tasks or long term ideas.

# 5. Conclusion

It has been argued that the use of information technology in organizations has an effect on the organizational structure. This is mentioned by several authors (Galbraith, 1977, Leavitt, 1965; March and Simon, 1958; Yap and Walsham, 1986; Van Eijnatten, 1993; de Sitter, 1998; Hyer et al., 1999). Organizational theories such as the socio-technical approach argue that the human side of organizations should be aligned with the technical side of organizations. This thesis formed around a project by HAN which is based on the digital (controlled) factory project. The research tried to gain insight into how information technology influences organizational structure in a SME setting.

It is therefore interesting to see how a digitalized organization (Organization 2) differs from a non-digitalized organization (Organization 1) in order to see how IT can influence the way of how organizations structure themselves. It also shows what IT can take over from the organizational structure.

This research focused on the research question: *"How does information technology influence the organizational structure of SMEs?"* In order to answer this research question, a digital and a non-digitalized SME organization in the same industry were analyzed based on their organizational structure and their IT maturity level as well as their CI maturity level as mentioned in the model presented by HAN. This research question will be answered by drawing conclusion on the data analyses of those organizations. The thought process that leads to those conclusions will be described.

The digitalized organization's operation routines are highly centralized. The planning decisions are not made on the shop floor but at the planning department. This can be explained by the fact that all tasks are administrated and the time to do a task is known at the planning department. This administration is done by the computers and scanners that are at each workstation on the shop floor. The operator presses next for the next order and the system will administrate the time and process of the previous order. This data can then be used by the planning department to plan the orders in such a way that the expertise of the operator is no longer needed. The planner seems to be provided with enough data to make balancing decisions.

In the non-digitalized organization, it became clear that the planner had to consult the operators for the daily planning. The centralization of the operating routines in Organization 1 is therefore lower than in Organization 2. This can be explained by the fact that there is little to no administration for the products that the operators make in Organization 1. Thus, the planner has no data to base the planning on which makes it necessary to consult with the operators to make a planning.

It seems that the improvement routines in organization 2 are located at the operation floor. It also seems that the IT system can take over the coordination at organization 2. This gives the team leaders more time to work on continuous improvement projects. When looking at organization 1 the team leaders and the planners are mainly firefighting on the operational floor. This is mainly due to the lack of data and digital communication. Because of this, the planners and team leader spend most of their time firefighting and fixing daily problems instead of working on improvement projects. The improvement routines seem to be centralized and are done by the management. This shows the implementation of IT can both centralize as decentralize at the same time when looking at different aspects of the organizational structure.

At Organization 1 the formalization is low. Because there is no IT system throughout the shop floor it is more difficult to communicate changes in the planning. Changes in the planning due to mistakes or rush orders are done by pen on the plan list that is printed out. This has to be done manually. This means that the planner has to go around and change the already printed plan lists around the shop floor. Sometimes this takes time and the machines will stand still. Organization 1 seems to be more dependent on the expertise of their operators rather than work instructions and procedures, this is explained by the fact that it is harder to distribute and access these instructions and procedures when there is no digital process. The work instructions that are available to the operators are printed out (see image 3). This means that it takes time for the operators to find the right work instruction, which could make it less accessible.

The formalization in Organization 2 is high. The information system tells the operators exactly what to do and how to do it. They are provided with the right measurements and instructions on how to proceed. They are not bothered by information they do not need. For example, rush orders are not noticed by the operators, they appear like any other order. The operators

are also responsible for some administrative tasks. Most administrative tasks are easily done by pressing 'next' or scanning a barcode. When there are mistakes the operators need to put this in the IT system. This gives the planner and the engineers data on the process to be able to improve the planning.

In these cases, it is noticeable that the use of IT can increase formalization. This can be explained by the fact that IT can improve accessibility for work instructions and the communication of work instructions. This is in line with what Dewett and Jones (2001) argue: that IT can have the benefits of formalization without the cons as it can reduce the cost of searching for company procedures and standards. IT can also improve the data moving from the shop floor to the engineers and the planning department as seen in organization 2. By this feedback loop the shop floor can increase the knowledge of the process by the planning and engineer department. With that information they can formalize tasks more and better, in such a way that the process is explained better in order to prevent mistakes. This matches with what Dewett and Jones (2001) say about IT: that it can increase efficiency by reducing time, saving administration costs, and reducing interruptions in the workflow. This is also shown by the fact that organization 2 communicates changes without the operators knowing it. This allows them to continue working without interruptions. This reduces the time and administration costs for organization 2.

At Organization 1 the work is not as individual. Most employees can do multiple tasks of the main process. Organization 1 seems to be more dependent on the expertise of their operators. This could be due to the lack of IT. Operators do not use work instructions but figure out the work themselves. This could be the reason that operators have to think more about their tasks instead of simply doing what they are told at a specific moment. At Organization 2 the work is split up in small tasks and most employees only do one task. This could be due to the fact that the IT system explains in detail what, when and how to do certain tasks. It does appear that organization 2 is trying to educate more of their people. Apparently, there used to be more all-round operators, however this has diminished due to personnel changes. This shows that the IT system in organization 2 is not able to provide a non-skilled worker with enough information to perform the task. There is still experience and skill needed for the jobs. Upon analysis, it appears that the organization utilizing more IT is more specialized than the other. Regardless, it is difficult at this moment to substantiate connecting this to the IT.

It is now clear what the effect of IT on organizational structure can have in SMEs. It seems that IT can provide the possibility for an organization to centralize and decentralize at the same time. On the one hand it can centralize the operational routines, but on the other hand it can decentralize the improvement routines. It also seems that IT can increase the ability to spread instructions and procedures to the right person at the right time. This means that it could lead to more formalization. Aside from that, it can create a feedback loop from the operational floor to the management. With more data, work instructions and procedures can be improved which leads to more formalization. It did not become clear in this study if IT has an effect on specialization.

# 6. Discussion and recommendations

This study has looked into the effect IT can have on structural characteristics in SMEs by looking at the level of IT maturity and the structural characteristics of two cases. This is done by in-depth interviews with employees from different hierarchical standpoints and by doing observations through the shop floor. Interviews were held with managers, planners, team leaders and operators. By exploring this subject this study aimed to contribute to the research around IT and the effect on organizations which could help organizations at implementing new IT systems for their organizations. As mentioned by Yap and Walsham (1986) the relationship between information technology and organization characteristics is not a one-way relationship but rather reciprocal and thus organizations should take into account that their organization might change when they implement new IT systems. This study provides insight into what might happen to the organizational structure when new IT systems will be implemented. This chapter will discuss the limitations of this study and its theoretical and practical relevance.

## 6.1 Limitations

This research was prone to a few influential limitations. This section will discuss these limitations and their effects on the research.

By using qualitative research, the research tried to explore the influence of IT and its effect on organizations. This is an appropriate method for explorative research, but when analyzing the results it became clear that it is hard to score the organizations on organizational characteristics based solely on interviews, documentation and observations. It was also difficult to then compare the results of two cases based on a qualitative approach. Where for explorational purposes it proved as a good method, it was an inferior method for a case comparison.

Given that it is an explorative study some minor changes were done in the interview approach after the first interviews. This led to there being more information on the second case than the first, especially on how information is distributed. On the one hand, this is a limitation, but it also increased the credibility by asking further than just the initial interview protocol.

The transferability of this research is limited since this study focused only on two cases. This is not only a low number of cases but the cases are also very specific, namely steel manufactures and SMEs. Therefore, the generalization of the results is difficult, since it is a

very specific case study. However, by describing the cases and results in detail and providing context by the use of pictures, the results could be transferred to certain areas where the results could be relevant to use. For example, manufacturing SMEs could make use of the results as presented in this research.

The research started in the beginning of 2019 with a different research question. The interview questions are based on the initial research question which was later changed to the current research question. Due to several circumstances this research was delayed and therefore it was made impossible to redo the interviews due to the lack of time. This means that some of the interview questions are redundant and there were subjects would could have used more focus. The interview questions could have been better in line with the current research question.

## 6.2 Implications

This study found that IT could influence the structural characteristics of an organization. It therefore generated knowledge of IT influence on SMEs. It was shown that IT could lead to more centralization in operating routines and more decentralization in improvement routines. It seems that IT can take over the coordination of the operational floor, leading to more time for team leaders to work on improvement projects.

In the literature there is no consensus on the effect of IT on centralization. Keen (1991) argues that IT provides the possibility for organizations to centralize and decentralize at the same time. The idea is that the information is sent to the places in the organization where the decisions can best be made. This corresponds to what has been seen in case organization 2 where the operators are provided with only the information they need. This research is a good case to show how IT can influence centralization in both ways.

Apart from that, the research showed that more IT could lead to more formalization. IT can distribute information quicker, more accurately, and more accessibly. As seen in Organization 2, the right information was spread to the right workstation via computers. This includes, for example, sudden changes and information to carry out the tasks. This adds to the already existing research, for example by Dewett and Jones (2001).

Lastly, this research showed no direct results on the influence of IT on specialization. However, it did become clear that the more digitalized organization had a higher specialization. This is

in line with the literature. Without IT employees have to make decisions based on their own knowledge. When an organization is highly specialized this knowledge lacks a wider context which can lead to decisions that are not in line with the rest of the organization (Ciborra & Lanzara, 1990). In organization 1 the organization is not as specialized and decisions are based on knowledge, whereas in organization 2 the organization is highly specialized and decisions are based on the IT system.

## 6.3 Theoretical recommendations

This research explored the effect of IT on structural characteristics in SMEs and provided some insight on the effect of IT on these characteristics. As stated, this research was focused on a very specific and small case study. Therefore, it is hard to generalize the results to other industries. This makes it interesting to see if the results will be the same in other cases.

This research also focused on a small aspect that could influence the structural characteristics. As seen in Leavitts (1965) Diamond there are many variables that influence each other. It is therefore interesting to see what has the biggest impact on structural characteristics and why. Future research could focus on more variables that could influence structural characteristics. This would give a more complete picture of different variables that could influence organizational structure.

This study focused mainly on two opposite cases in the same industry. This study was able to draw conclusions based on a case comparison: a case organization with a lot of IT and a case organization without IT. By doing this, interesting differences were found in organizational characteristics. A new study could compare these results at another organization with a lot of IT to see if the results as shown in this research are present in more organizations. This will make the results more reliable and useful for managers and researchers. Such a study could also be done in a quantitative way where many organizations are asked about their level of IT and their organizational characteristics. This could either confirm this research's results or give new insights to the research field.

## 6.4 Practical recommendations

The insights on IT that this research provides can be valuable for managers in practice. As mentioned in chapter 1, organizations feel the pressure on themselves and feel that a digital transformation will be the only way to survive (Alaa & Fitzgerald, 2013). Organizations are therefore investing in IT systems a lot. According to scholars such as Yap and Walsham (1986)

there has to be synergy between IT and the organization. This means that while investing in IT, systems managers should focus on how to properly implement it for the unique organization.

This research shows that IT could lead to more centralization for operating routines and more decentralization for improvement routines. This could be valuable for managers that want to increase their CI maturity.

In addition, it seems that IT leads to higher formalization. For organizations without IT, like organization 1, it is important to keep these things in mind, since investments in IT could create the need for changes in organizational characteristics. Aside from that, it is also shown in case organization 2 that IT can take over the coordination of the shop floor which leads to more time for improvement projects for the team leaders. Among other things, this can benefit managers whom want to have more improvement projects but are limited by their current capacity.

As mentioned before this research is carried out in a specific context with only two cases. This does not mean that the results as presented in this research cannot be used by other types of organizations. This study is explorative and explored two cases and their IT use. Because observations were done and pictures were presented in this research, it makes it easier for readers to understand the context. The understanding of the research results in this specific context makes the research more valuable for readers. Thus, other organizations could learn from what is found in those two cases and place parts of this research in their own context.

# References


Achterbergh, J., & Vriens, D. (2009). *Organizations: social systems conducting experiments.* Beidelberg, Berlin: Springer Verlag.

Aiken, M., Bacharach, S. B., & French, J. L. (1980). Organizational structure, work process, and proposal making in administrative bureaucracies. *Academy of Management Journal*, 23, 631–652.

Alaa, G., & Fitzgerald, G. (2013). RE-CONCEPTUALIZING AGILE INFORMATION SYSTEMS DEVELOPMENT USING COMPLEX ADAPTIVE SYSTEMS THEORY. *Emergence: Complexity & Organization*, *15*(3).

Ang, J., & Koh, S. (1997). Exploring the relationships between user information satisfaction and job satisfaction. *International Journal of Information Management*, *17*(3), 169-177.

Applegate, L. M., Austin, R. D., & McFarlan, F. W. (2006). *Corporate information strategy and management*. McGraw-Hill/Irwin Custom Publishing.

Argyres, N. S. (1999). The impact of information technology on coordination: Evidence from the B-2 "Stealth" bomber. *Organization Science*, *10*(2), 162-180.

Ashby, W. R. (1969). Self-regulation and requisite variety. *Systems thinking*, 105-124.

Baroudi, J., & Lucas Jr, H. C. (1994). The role of information technology in organization design. *Journal of Management Information Systems*, *10*(4), 9-23.

Bell, E., & Bryman, A. (2007). The ethics of management research: an exploratory content analysis. *British journal of management*, *18*(1), 63-77.

Bensaou, M., & Venkatraman, N. (1996). Inter-organizational relationships and information technology: A conceptual synthesis and a research framework. *European Journal of Information Systems*, *5*(2), 84-91.

Bessant, J., Caffyn, S., & Gallagher, M. (2001). An evolutionary model of continuous improvement behaviour. *Technovation*, *21*(2), 67-77.

Blau, J. R., & McKinley, W. (1979). Idea, complexity, and innovation. *Administrative Science Quarterly*, *24*, 200–219

Blau, P. M., Falbe, C. M., McKinley, W., & Tracy, P. K. (1976). Technology and organization in manufacturing. *Administrative science quarterly*, 20-40.

Boeije, H. (2014). *Analyseren in Kwalitatief Onderzoek: Denken en Doen*. Den Haag: Boom Uitgevers.

Bostrom, R. P., & Heinen, J. S. (1977). MIS problems and failures: A socio-technical perspective. Part I: The causes. *MIS quarterly*, 17-32.

Boyce, C., & Neale, P. (2006). *Conducting in-depth interviews: A guide for designing and conducting in-depth interviews for evaluation input.*

Burn, J. M. (1990). *The Strategic Use Of IT In Hong Kong Organizations: An Analysis Of Applications In Small To Medium Sized Organizations*, Proceedings Of International Conference On IT.

Butera F (Ed.) (1990). *Technological Development And Improvement Of Living And Working Conditions: Options For The Future*. European Foundation For The Improvement Of Living And Working Conditions, Kogan Page London.

Chan, S. L. (2000). Information technology in business processes. *Business Process Management Journal*, *6*(3), 224-237.

Cheon, M. J., Grover, V., & Teng, J. T. (1995). Theoretical perspectives on the outsourcing of information systems. *Journal of information Technology*, *10*(4), 209-219.

Cherns, A. (1976). The principles of sociotechnical design. *Human relations*, *29*(8), 783-792.

Cherns, A. (1987). Principles of sociotechnical design revisted. *Human relations*, *40*(3), 153-161.

Child, J., Child, J., & Partridge, B. (1982). *Lost managers: Supervisors in industry and society* (Vol. 1). CUP Archive.

Ciborra, C., & Lanzara, G. G. (1990). Designing dynamic artifacts: computer systems as formative contexts. In P. Galiardi (Ed.), *Symbols and artifacts*. Berlin: De Gruyter

Corbin, J., & Strauss, A. (2008). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks: Sage Publications, Inc.

Damanpour, F. (1991) Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators, *Academy of Management Journal*, 334(3) 555-590.

Davenport, T. H., & Short, J. E. (1990). The new industrial engineering: information technology and business process redesign.

Dawson, P., & McLoughlin, I. (1986). Computer technology and the redefinition of supervision: a study of the effects of computerization on railway freight supervisors. *Journal of management studies*, *23*(1), 116-132.

De Sitter, L. U. (1998). *Synergetisch produceren.* Uitgeverij Van Gorcum.

de Sitter, L., den Hertog, J., & Dankbaar, B. (1997). From Complex Organizations with Simple Jobs to Simple Organizations with Complex Jobs. *Human Relations*, 50(5), 497-534.

Deuse, J., Weisner, K., Hengstebeck, A., & Busch, F. (2015). Gestaltung von Produktionssystemen im Kontext von Industrie 4.0. In *Zukunft der Arbeit in Industrie 4.0* (pp. 99-109). Springer Vieweg, Berlin, Heidelberg.

Dewett, T., & Jones, G. R. (2001). The role of information technology in the organization: a review, model, and assessment. *Journal of management*, *27*(3), 313-346.

Eriksson, P., & Kovalainen, A. (2015). *Qualitative methods in business research: A practical guide to social research.* Sage.

Ettlie, J. E., Bridges, W. P., & O'Keefe, R. D. (1984). Organizational strategy and structural differences for radical versus incremental innovations. *Management Science, 30*, 682–695.

Ettlie, J. E., Bridges, W. P., & O'Keefe, R. D. (1984). Organizational strategy and structural differences for radical versus incremental innovations. *Management Science, 30*, 682–695.

Fulk, J., & Dutton, W. (1984). VIDEOCONFERENCING AS AN ORGANIZATIONAL INFORMATION-SYSTEM-ASSESSING THE ROLE OF ELECTRONIC MEETINGS. *Systems Objectives Solutions*, *4*(2), 105-118.

Galbraith, J.R. (1973), *Designing Complex Organizations,* Addison-Wesley, Reading, MA.

Galliers, R. D., & Baker, B. S. H. (1995). An approach to business process reengineering: the contribution of socio-technical and soft OR concepts. *INFOR: Information Systems and Operational Research*, *33*(4), 263-278.

Groth, L. (1999). *Future organizational design: the scope for the IT-based enterprise*.

Guillemin, M., & Gillam, L. (2004). Ethics, reflexivity, and "ethically important moments" in research. *Qualitative inquiry, 10*(2), 261-280.

Hage, J., & Aiken, M. (1967). Program change and organizational properties: a comparative analysis. *American Journal of Sociology, 72*, 503–519.

Hammer, C. and Champy, J. (1993), *Reengineering the Corporation – A Manifesto for Business Revolution*, Nicholas Brealey.

Heng, S. (2014). Industry 4.0: Upgrading of Germany's Industrial Capabilities on the Horizon. *Available at SSRN 2656608*.

Hirsch-Kreinsen, H. (2015). Entwicklungsperspektiven von Produktionsarbeit. In *Zukunft der Arbeit in Industrie 4.0* (pp. 89-98). Springer Vieweg, Berlin, Heidelberg.

Housel, T., El Sawy, O., Zhong, J., & Rodgers, W. (2001). Measuring the return on knowledge embedded in information technology. *ICIS 2001 Proceedings*, 12.

Huber, G. P. (1990). A theory of the effects of advanced information technologies on organizational design, intelligence, and decision making. *Academy of management review*, *15*(1), 47-71.

Huijgen, F., & Pot, F. D. (1995). *Verklaren en ontwerpen van produktieprocessen: het debat over arbeidsprocesbenadering en sociotechniek.* SISWO: Instituut voor maatschappijwetenschappen.

Hyer, N. L., Brown, K. A., & Zimmerman, S. (1999). A soio-technical systems approach to cell design: case study and analysis. *Journal of operations management, 17*(2), 179-203.

Jaca, C., Viles, E., Jurburg, D., & Tanco, M. (2014). Do companies with greater deployment of participation systems use Visual Management more extensively? An exploratory study. *International Journal of Production Research, 52*(6), 1755-1770.

Joergensen K. M. (1999) Information Technology And Change In Danish Organizations. - Results From A Survey, *DRUID Working Paper* No. 98-8

Johnston, W. J., & Lewin, J. E. (1996). Organizational buying behavior: Toward an integrative framework. *Journal of Business research*, *35*(1), 1-15.

Kagermann, H., Helbig, J., Hellinger, A., & Wahlster, W. (2013). *Recommendations for implementing the strategic initiative INDUSTRIE 4.0: Securing the future of German manufacturing industry; final report of the Industrie 4.0 Working Group*. Forschungsunion.

Keen P. (1991). *Every Manager's Guide To Information Technology*, Harvard Business School Press, Boston, MA.

Kendall, K. E. (1997). The significance of information systems research on emerging technologies: seven information technologies that promise to improve managerial effectiveness. *Decision Sciences*, *28*(4), 775-792.

Khosrow-Pour, M. (Ed.). (2014). *Inventive approaches for technology integration and information resources management*. IGI Global.

Kock, N., & Lau, F. (2001). Information systems action research: serving two demanding masters. *Information Technology & People*, *14*(1).

La Rovere, R. L. (1996). IT diffusion in small and medium-sized enterprises: Elements for policy definition. *Information Technology for Development*, *7*(4), 169-181.

Lado, A. A., & Zhang, M. J. (1998). Expert systems, knowledge development and utilization, and sustained competitive advantage: A resource-based model. *Journal of management*, *24*(4), 489-509.

Lakhanpal, B. (1994). Assessing the factors related to microcomputer usage by middle managers. *International Journal of Information Management*, *14*(1), 39-50.

Lawrence, P., & Lorsch, J. (1968). *Organization and environment*. Homewood IL: Irwin.

Leavitt, H.L. (1965), "*Applied organizational change in industry: structural, technological and humanistic approaches*", in Marc, J.G. (Ed.), Handbook of Organization, Rand McNally, Chicago, IL, pp. 1144-1170.

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & management*, *40*(3), 191-204.

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & management*, *40*(3), 191-204.

Loeffen, J. M. (1997). *Informele afstemming in productieorganisaties: een sociotechnische blik op informatievoorziening.* Eindhoven: Technische Universiteit Eindhoven.

Lowry, J.R. (1997), "*The life cycle of shopping centers*", *Business Horizons*, Vol. 40, pp. 77-86.

March, J. G., & Simon, H. A. (1958). Organizations.

Mintzberg, H. (1980). Structure in 5's: A Synthesis of the Research on Organization Design. *Management Science*, 26(3), 322-341.

Pasmore, W., Winby, S., Mohrman, S. A., & Vanasse, R. (2019). Reflections: sociotechnical systems design and organization change. *Journal of Change Management*, 19(2), 67-85.

Patton, M. Q. (2005). Qualitative research. *Encyclopedia of statistics in behavioral science*.

Perrow, C. (1986). *Complex organizations: a critical essay* (3rd ed). New York NY: Random House.

Pierce, J. L., & Delbecq, A. L. (1977). Organization structure, individual attitudes and innovation. *Academy of management review*, *2*(1), 27-37.

Porter, M. (1984) *Competitive Advantage*. Free Press.

Porter, M. E. (1989). From competitive advantage to corporate strategy. In *Readings in strategic management* (pp. 234-255). Palgrave, London.

Porter, M. E., & Millar, V. E. (1985). How information gives you competitive advantage.

Porter, M. E., & Millar, V. E. (1985). How information gives you competitive advantage.

Savino, D. M. (2009). The role of technology as an enabler in job redesign. *Journal of technology management & innovation*, *4*(3), 14-23.

Schuh, G., Anderl, R., Gausemeier J., ten Hompel, M., Wahlster, W. (Eds.): Industrie 4.0 Maturity Index. Managing the Digital Transformation of Companies (acatech STUDY), Munich: Herbert Utz Verlag 2017.

Schwarz, G. M. (2002). Organizational hierarchy adaptation and information technology. *Information and Organization*, *12*(3), 153-182.

Shenton, A. (2004). Strategies for Ensuring Trustworthiness in Qualitative Research Projects. *Educations for Information*, 22(2), 63-75.

Sohal, A.S & Lionel, N.G., (1988) The Role And Impact Of Information Technology In Australian, *Business Journal Of Information Technology* 13, 201-211.

Sriram, K., Pai, K. S., Boyd, M. R., & Ravindranath, V. (1997). Evidence for generation of oxidative stress in brain by MPTP: in vitro and in vivo studies in mice. *Brain research*, *749*(1), 44-52.

Suri, R. (2011). *Beyond Lean: It's about time!* Madison: University of Winconsin-Madison.

Susanto, H., Leu, F. Y., Rosiyadi, D., & Chen, C. K. (2019, March). Revealing Storage and Speed Transmission Emerging Technology of Big Data. In *International Conference on Advanced Information Networking and Applications* (pp. 571-583). Springer, Cham.

Symon, G., & Cassell, C. (2012). *Qualitative organizational research: core methods and current challanges.* Sage.

Tao, F., & Zhang, M. (2017). Digital twin shop-floor: a new shop-floor paradigm towards smart manufacturing. *Ieee Access*, *5*, 20418-20427.

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27*(2), 237-246.

Thong, J.Y.L. & C.S. Yap, (1995). CEO Characteristics, Organizational Characteristics And Information Technology Adoption In Small Businesses. *Omega International Journal Of Management Science*, 1995. 23(4): P. 429-442.

Trist, E. L., & Bamforth, K. W. (1951). Some social and psychological consequences of the longwall method of coal-getting: An examination of the psychological situation and defences of a work group in relation to the social structure and technological content of the work system. *Human relations*, *4*(1), 3-38.

Trist, E. L., Higgin, G. W., Murray, H., & Pollock, A. B. (2013). *Organizational Choice (RLE: Organizations): Capabilities of Groups at the Coal Face Under Changing Technologies*. Routledge.

Valida, A. C., Leng, A. C., Kasiran, M. K., Hashim, S & Suradi, Z., (1994). *A Survey Of Information Technology Utilization Among Business Organizations In Malaysia*, Proceedings Of International Conference On IT, KL: Malaysia.Vol. 19 (4), 535-559.

Van Eijnatten, F. M. (1993). The paradigm that changed the work place.

Vanhaverbeke, W., & Torremans, H. (1999). Organizational structure in process-based organizations. *Knowledge and Process Management*, 6(1), 41-52.

Vennix, J. (2011). *Theorie en Praktijk van Empirisch Onderzoek*. Harlow: Pearson Education Limited.

Vriens, D., Achterbergh, J., & Gulpers, L. (2018). Virtuous Structures. *Journal of Business Ethics*, 150(3), 671-609.

Weber, M. (1947). *The theory of social and economic organization*. New York: Oxford University Press.

Yap, C. S., & Walsham, G. (1986). A survey of information technology in the UK service sector. *Information & management*, *10*(5), 267-274.

Zenger, T. R., & Hesterly, W. S. (1997). The disaggregation of corporations: Selective intervention, high-powered incentives, and molecular units. *Organization Science*, *8*(3), 209-222.