The social job characteristics of the future

"How do social job characteristics change due to Smart Industry?"

Programme:	MSc Business Administration
Track:	Human Resource Management
Student Name:	D.J. (Dave) Hoffmann
Student number:	S1878530
Student E-mail:	d.j.hoffmann@student.utwente.nl
1st supervisor:	Prof. dr. T. (Tanya) Bondarouk
2nd supervisor:	M.M.P. (Milou) Habraken PhD.
Date:	09-10-2018

Preface

Two years ago I joined the research group Smart Industry & Human capital. This research group is part of Saxion University of Applied Science in Enschede. This research group builds knowledge in relation to Smart Industry and labour. I had the chance to work on several cases and to participate in a couple of researches related to Smart Industry. Approximately one year ago this same research group gave me the opportunity to conduct a master research which contributes to their expertise. Earlier during my bachelor thesis I focussed on job design in relation to the attractiveness of work for young ICT employees. Thereafter in the classes of Human Resources and Technology Design job design was also an important topic. I find job design a very interesting topic, so I had the desire to combine Smart Industry and job design in my master thesis. Luckily this desire this was possible. During the research more and more papers about Smart Industry were published. Smart Industry is a relatively new phenomenon that was mentioned for the first time in 2014. I enjoyed my time learning about Smart Industry and it was nice to see the literature about Smart Industry growing during the research process.

I would like to thank the research group Smart Industry and Human Capital for their support while writing this thesis. In particular, I would like to thank Stephan Corporaal for supporting me during this thesis process. I also would like to thank Tanya Bondarouk and Milou Habraken from the University of Twente for their pleasant supervision.

I also would like to thank Bram Blokhuis in special since we studied together for six years. We managed to balance education and fun in a perfect way. Also my girlfriend Zjoske Leenders deserves a very special thank you since she supported me a lot during this thesis process.

I believe that this study can contribute to the existing literature on Smart Industry and job design, even though the study is rather explorative. Some clear results have been found among the cases. For me the main message of this study is that in a Smart Industry context makes that humans are more forced to use their human social skills.

Dave Hoffmann
October, 2018

Abstract

New and smart technologies are getting more affordable for all sizes of companies. These smart technologies are changing the society and the economy in a fast pace, the main challenge for companies is to become fit for the future within this Smart Industry. This study focuses on understanding the impact of the Smart Industry context on the social characteristics of job design. Four cases have been researched in a qualitative approach. The insights of this research can be used in the redesign of jobs to prevent negative effects on the related work outcomes to become fit for the future. Since the social characteristics explain a lot of variance in positive work outcomes the combination of Smart Industry and job design will be an interesting topic in the challenge to make companies future fit. This research shows some interesting findings in contribution to make organizations future fit. When it comes to the task interdependence a shift from process-based (multidisciplinary) collaboration to project/team-based collaboration has been found. This asks for different interactions among the colleagues, in departments and also demands a different role of the manager. In regards to the interaction outside the organization the interaction with the suppliers, customers and others increases. When it comes to feedback from others it became clear that data plays an important role in the feedback cycle. The importance of social support is being stressed by the interviewees since tech workers are specialists these days and depend on each other's knowledge. Companies have to bear in mind that constant interaction and support is needed to perform in the new industrial reality.

Table of contents

1. Introduction

New technologies are becoming both increasingly affordable and user friendly. This allows these technologies to penetrate not only in the daily reality of larger organizations but also in the daily reality of small and medium-sized enterprises (SMEs) (Corporaal, Vos, van Riemsdijk & De Vries, 2018). This far-reaching digitalization is changing the society and the economy in a fast pace, the main challenge for companies is to become fit for the future (Keijzer in Smart Industry, 2018). The technical innovations that happen nowadays are often categorized as Smart Industries (Smart Industry, 2014). The phenomenon 'Smart Industry' is often described in different ways among different areas across the world. For example, in the Netherlands it is described as 'Smart Industry', in Germany it is described as 'Industry 4.0' and in the United States as 'Smart Manufacturing'. According to Brynjolfsson and McAfee (2014) machines in this fourth industrial revolution do not only have the job to produce a massive amount of items in a fast way, but also have to meet the specific needs of customers. This means that production lines have to be programmed to switch between different specifications. Schwab (2017) Stated that this technological revolution radical changes the nature of work, business models and the methods of organizing companies.

To become fit for the future small changes will not be enough, to play a role in the future organizations need to transform in one or more of the Smart Industry areas (Smart Industry, 2018). Smart Industry (2018) mentions eight Smart Industry areas divided in three categories. These three categories are manufacturing technology, digitalization and a network-centric approach. The first, manufacturing technologies, is related to new production techniques such as 3D printing, robotics and printed electronics. The techniques are low cost and are insensitive for failures. The second, digitalization, is related to phenomena such as sensor technology, the internet of things and big data. With this technology it is possible for machines to interact and learn from all the data. The third, network centric, makes that everything is connected to each other. This gives the chance for customers and companies to interact. The eight categories regarding to Smart Industry (2018) are Flexible Manufacturing, Smart Products, Servitization, Digital Factory, Connected Factories, Sustainable Factories, Smart Working and Advanced manufacturing. The action agenda Smart Industry (2016, p. 37) warns for two important things in regards to employees *"Jobs in new areas ask for new skills of the employee"* and *"Ensuring and informing of a level of knowledge of employees is necessary"*. When jobs fundamentally change the nature of the job design characteristics may also change. This will be discussed next.

Smart Industry brings a couple of important changes in technology that together lead to fundamental changes in how companies operate, how they compete and how employers design work (Bosch, 2016; Smart Industry, 2015). Smart Industry causes a lot of technological opportunities in work and this changes a lot in the design of jobs (Bosch, 2016; Habraken & Bondarouk, 2017). Humphrey Narghang and Morgeson (2007) found that job design affects the behaviour, attitude, role perception and well-being of an employee. This effect is mediated by the psychological state (experienced meaningfulness, responsibility and knowledge of results). To remain fit for the future it is important to be able to enhance well-designed jobs. When technology impacts the job characteristics it is important to know how it changes and how to cope with the change. Over time there has been a lot of research on job characteristics. The job characteristics are a part of job design in which the components of work are modelled to explain their effects on the job holder (Rusch & Harold, 1971). In the last two decades many researchers investigated the phenomenon job characteristics in-depth and some expanded

the existing literature (Parker, Wall & Cordery, 2001; Morgeson & Campion, 2003; Grant, 2007; Humphrey, Nahrgang & Morgeson, 2007; Grant & Parker, 2009; Oldham & Hackman, 2010; Parker, 2014). Grant (2007) for example added the relational perspective to the traditional job design theory. Grant & Parker (2009) further explored the relational part of job design and examined on the proactive perspective beyond job design. Humphrey, Nahrgang and Morgeson (2007) expanded the classic job characteristics model with additional motivational characteristics, social characteristics and work context characteristics. Humphrey et al. (2007) stress the importance of job design by the finding that the combination of job design characteristics explain 43% of the variance in an individual's behaviour.

There already has been some research on the effect of Smart Industry on job design. Bosch (2016) researched the impact of Smart Industry on the motivational factors of job design. She found out that skill variety and feedback on the job increased by the effects of Smart Industry. This is caused by automation and the data that is produced by the sensors used in Smart Industry. She also found that technologies make tasks more complex and the data sources affects the feedback. So, looking at the motivational factors of job design changes have been found. Of all job design areas the motivational characteristics do explain most of the variance in work outcomes: 34% in organizational commitment, 34% in job satisfaction, 26% in role perception, 25% in performance and 2% in turnover (Humphrey et al., 2007). Beside that the social characteristics are very important in job design and explain 40% in organizational commitment, 25% in turnover intentions, 18% in role perception outcomes, 17% in job satisfaction and 9% of the variance in performance. When you compare that to the work context characteristics (that explains 16% of the stress and 4% of the job satisfaction) the social characteristics can be an interesting topic when it comes to well-designed jobs and making organizations future proof. Several researchers already predicted changes in the social characteristics of job design due to the Smart Industry technologies. Corporaal et al. (2018) stated that working in a Smart Industry context will lead to other ways of collaboration and more contact between disciplines due to the complex technology and need for different knowledge. Multi-disciplinary teams will become more common. Wang, Wan, Zhang and Zhang (2015) mentioned the use of sensor technology and data generation will change the way we give and receive feedback. Johns and Gratton (2013) in addition state that the way we socially communicate will fundamentally change by the use of digital communication technologies. These outcomes indicate that it is plausible that Smart Industry effects changes in the social job design characteristics. It is important to gain insight in these changes so companies can adapt to enhance well-designed jobs and take advantage of the positive work outcomes.

This study aims to contribute to the knowledge companies need to have to become fit for the future. Since the way we work will change and changes in the composition of work in the near future are not to avoid this study will contribute knowledge to an urgent practical ongoing phenomenon. The findings of this study are the first steps that can be used for getting companies future proof. By understanding the effects of Smart Industry on the social job characteristics this study will help companies to make choices in the redesign of their jobs to prevent negative outcomes on the related work outcomes. Different scholars agree that the social job design characteristics will be influenced by Smart Industry (e.g. Corporaal et al., 2018; Johns & Gratton, 2013; Zhang & Zhang, 2015). The expectation is that the collaboration becomes more multi-disciplinary, the feedback becomes different and the way we communicate becomes more digital. These aspects are also key factors in the social job characteristics. This makes it interesting to understand what changes will take place. When this becomes clear organisations will have the insights to redesign jobs to influence the related

work outcomes (organizational commitment, turnover intentions, role perception outcomes, job satisfaction and performance). Beside the insights of Bosch (2016) the other category of job design characteristics who explain a big part of the variance in the related work outcomes will be explored. This will provide a better understanding of Smart Industry, the effects on job design and in turn the effects on the related work outcomes. This study has an explorative character due to the intention to understand the influence of Smart Industry on the social job characteristics. The main research question of this study is:

'What is the influence of the Smart Industry context on the social characteristics of job design?'

This paper consists of five chapters including the introduction above. The next chapter will be devoted to the theoretical framework in which the theory of job design, Smart Industry and technology will be future elaborated. In the third chapter the methodological aspects of this study will be presented. The findings will be displayed in the fourth chapter. In the fifth, and in the final chapter there will be the a discussion and conclusion where the limitations, practical implications, suggestions for future research and conclusion will be discussed.

2. Theoretical framework

2.1 Technological changes

Changes in work due to technology is not something that only happened today. Kagermann, Helbig, Hellinger and Wahlster (2013) summarized all four industrial revolutions. The first industrial revolutions took place at the end of the eighteenth century. The introduction of the steam and water machine changed the industry completely. In that time, there was a huge resistance against this industrial change, but when the effects became visible the conclusion was that it improved the working conditions of the employees and that the fear was unfounded (Mokyr,1990). The second industrial revolution took place around the 1870's by the introduction of mass production, electrification and the division of labour. In this period assembly lines were introduced to optimize the mass production and meet the demand of mass customization (Allen, 2009). The third revolution is known as the computer revolution around the 1960's. Machines became programmable and computerized automation started. Self-service was being introduced and administrative and calculation tasks were able to be automated by computers (Gordon in Brynjolfsson & Mcafee, 2016). Mokyr, Vickers and Ziebarth (2015) stated that at the beginning of every industrial revolution mankind feared the reduction of employment, but history shows that some job disappeared and others increased. Nowadays there is a fourth industrial revolution going on called Smart Industry (Smart Industry, 2014). Smart Industry is an amalgamation of techniques which makes smarter manufacturing and new business models possible (Smart Industry, 2016). History does not answer the future, but we can learn from the past revolutions. Mokyr (1990) for example mentioned that there was huge resistance against the steam machine since it would cause an unknown situation and Mokyr et al. (2015) confirmed this for other revolutions. At the moment the media and also scientific literature elaborates on the extent jobs change or disappear (e.g. Frey & Osborne, 2015), but in the past these revolutions have worked out well for the working conditions and the employment (Mokyr et al., 2015; Mokyr, 1990). History shows that these industrial revolutions cannot be stopped. If companies do not embrace smart industry right now, it might be too late.

Smart Industry

"Smart Industries are industries that have a high degree of flexibility in production, in terms of product needs (specifications, quality, design), volume (what is needed), timing (when it is needed), resource efficiency and cost (what is required), being able to (fine)tune to customer needs and make use of the entire supply chain for value creation. It is enabled by a network-centric approach, making use of the value of information, driven by ICT and the latest available proven manufacturing techniques" (Smart Industry, 2014, p.17). This is the definition of Smart Industries that was officially conceptualized by Team Smart Industry. This definition was also one of the first times that this phenomenon was cited in the Netherlands (Habraken & Bondarouk, 2017). Smart Industry (2018, p. 9) defines Smart Industry in a broader way: *"Smart Industry is about future-proof industrial & product systems; these are smart and interconnected and make use of Cyber Physical Systems"*. Regarding of Smart Industry (2018) manufacturing technologies, digitalization and network-centric technologies are the main categories of Smart Industry. This is in line with their earlier conceptualization of Smart Industry from 2016. In Table 1 an overview can be found of the three Smart Industry categories.

Table 1: An overview of the three Smart Industry categories

Smart Industry area	Explanation
Digitalization	"*Digitalization of information and communication among all value chain partners and at all levels in the production process"* (Smart Industry, 2018, p. 9).
Manufacturing technologies	"*Granular, flexible, and intelligent manufacturing technologies, adjustable on the fly to meet highly specific end-user demands"* (Smart Industry, 2018, p. 9).
Network-centric	*"High-quality, network-centric communication between organizations, humans and systems, in the entire value network, including the products or services used by the end-users"* (Smart Industry, 2018, p. 9).

Digitalization is about the use of sensors and high tech ICT exchange systems to register and head the production process (Smart Industry, 2016). Digitalization could also be related to (big) data sources, since the internet of things and the companies itself feature a huge amount of data. Smart Industry (2018) adds that digitalization also involves digitalized communication and information transfers. Manufacturing technologies contain the new ways of manufacturing that is available at the moment and in the future (Smart Industry, 2016). Key aspects of these new manufacturing technologies are that they are intelligent, adjustable and are able to adapt to customer specific needs (Smart Industry, 2018). Examples of these new technologies are: 3D printing and industrial robotics (Smart Industry 2015; 2016; 2018). The benefits of these technologies are that this makes the production process cheaper and that it makes mass customization possible (Brynjolfsson & Mcafee, 2016; Smart Industry 2015; 2016; 2018). Network-centric technologies are about the connection of technologies which enhance better collaboration and to smoothen the production process (Smart Industry, 2016). This can be also an inside network-centric connection and an external network-centric connection with the customer (Smart Industry, 2018). This approach makes it possible to break the traditional value chain and make the production process a value network (Smart Industry, 2015). Habraken and Bondarouk (2017) developed a Smart Industry framework and described four key developments based on interviews. Digitized, connected, equipped and informed. These four aspects are partially in line with the pillars described above.

Smart Industry (2016) predicts that these changes in the industry will lead to six main developments. The first, high value information, aims on the increase of information that companies can use to improve their products. The second, customer intimacy, is about custom work that can be delivered by the more flexible mass production process and the options a customer can participate in the production process. The third, value chain participation, refers to the ability of customers and suppliers to collaborate in the process and the ability to tune the product perfectly towards their needs. The fourth, flexibilization, indicates that the production process is becoming more flexible, this improves the customer intimacy and a lower cost price. The fifth, improving quality, is about the huge amount of data that is available to improve the product. The sixth and last, automation, indicates the high quality and high rate of production which results in cost saving. Smart Industry (2018) revised their work in 2018. They now defined eight important Smart Industry areas within the three categories. The eight areas are displayed in Table 2.

Table 2: an overview of the eight Smart Industry area's regarding to Smart Industry (2018)

Smart Industry area	Explanation
Advanced Manufacturing	An advanced factory produces faultless products with a high frequency. Not only automation is possible, but also manufacturing with no defects. When this is achieved the next step is mass customization.
Flexible Manufacturing	In a flexible manufacturing factory, it is the ambition to produce different kind of complex products with the same team of people. The programming time is zero, there will be no start-up time and no losses.
Smart Products	Ultra user friendly, attractive, intelligent, customer specific products with minimized lifetime costs.
Servitization	Product manufactures become service providers. Examples are leasing, maintained and remote control. Techniques like 5G, Internet of things and artificial intelligence can contribute to this development.
Digital Factory	All the different parts in the factories will be connected seamless. Virtual reality, augmented reality, artificial intelligence, algorithms and sensors will play an important role.
Connected Factories	Connected factories are businesses who are digitally connected. It will be possible to exchange a large amount of data with the aim to reduce costs and use it for researches,
Sustainable Factories	Factories will minimize the consumption of materials and energy to be as efficient as possible. Also refurbished and recycles materials are common sense.
Smart Working	The aim is to be an enjoyable workspace for both young and old employees. Technology has the job to help an employee in his work. The effects of this technologies are to be more productive, maintain their health, making jobs more enjoyable and more rewarding.

As part of their research, Habraken and Bondarouk (2017) mapped the expected impact of Smart Industry. In their framework the impact of Smart Industry is visualized on eight aspects, these are: relations (with the customers and suppliers), optimisation, reshoring, jobs, value proposition, production process, products and other processes (maintenance, logistics, design and administration).

When reflecting on the stated technological changes and the predicted changes, it becomes clear that Smart Industry is not a topic that is researched thoroughly. When it comes to the definition of Smart Industry, the definition of Smart Industry (2018, p.9) is the most complete definition. The definition of Smart Industry (2014) was the starting point of a new wave in the theory, but this particular subject is sensitive for change. The definition of Smart Industry (2018) has taken into account new technologies and the contemporary context we are dealing with today. For this study it is important to have such points (the pillars/areas) of reference to connect the changes in the social job characteristics due to the changes in Smart Industry times. Smart Industry (2018) updated these pillars mentioned in Smart Industry (2014) with the knowledge of today. The updated description of Smart Industry (2018) will provide the starting point for the conceptualization of Smart Industry within this paper. Smart

Industry brings a lot of changes in technologies we use in industries. This makes that production processes will change and that people will have to adapt to these technological changes. This will mean something for job design. The combination of Smart Industry and job design will be made in paragraph 2.3. Hereafter job design and the social characteristics will be explored.

2.2 Job design

Hackman and Oldham (1980) defined job design as a set of opportunities and constraints that are structured into assigned responsibilities and tasks that affect how an employee accomplishes and experiences work. Hackman and Oldham (1976) empirically studied the design of work and tested their model on 658 respondents from seven companies. They started this research since job redesign became a more important strategic topic and less is known about the effectiveness of redesign. The results of this study support that their model is valid. According to Hackman and Oldham's model (1976), working conditions and the core job dimensions (skill variety, task identity, task significance, autonomy and feedback) should be well-designed to positively affect the psychological state (experienced meaningfulness, experienced responsibility and of the work and knowledge of the actual results of the work activates) this in turn leads to internal motivation, (job) satisfaction and work effectiveness. This is in line with the insights of Challenger, Leach, Stride and Clegg (2012). Since they state that job design is an important instrument when it comes to increasing productivity a performance. Humphrey et al. (2007) stress the importance of job design by the stating that the combination of job design characteristics explain 43% of the variance in an individual worker's behaviour. The model of Hackman and Oldham (1976) is still inspiration for more recent job design studies, such as Grant (2007), Humphrey et al. (2007) and Grant and Parker (2009). Research that build further on the findings of Hackman et al. (1976) tried to extent the model with other characteristics which influence positive outcomes. To illustrate, Humphrey et al. (2007) extended the JDC model of Hackman and Oldham with additional motivational characteristics, work context characteristics (physical demands, work conditions and ergonomics) and social characteristics (Interdependence, feedback from others, social support and interaction outside the organization).

Job design characteristics

There have been a lot of reviews on the existing job design theories. Parker and Wall (2001) reviewed the literature in relation to job design characteristics and concluded that the effects and the needs in regards to design of the characteristics differ in different cases. Humphrey et al. (2007) meta studied and analysed the job characteristics and came up with a in depth overview of all the existing literature. The model of Humphrey et al. (2007) contains three job design characteristics: motivational, social and work context characteristics. These characteristics have influence on work outcomes. The work outcomes in the model of Humphrey et al. (2007) are behavioural, attitudinal, role perception and well-being outcomes. This relation is mediated by the critical psychological state. This critical psychological state contains the experienced meaningfulness, experienced responsibility and the knowledge of results. Humphrey et al. (2007) proofed the importance of social job design characteristics in their meta-analysis. The research of Humphrey et al. (2007) resulted in a model that contains twenty-one characteristics, four of these characteristics were related to social aspects. The results of this study show that there is a significant association between the employees'

attitude and the social characteristics. It became clear that the social characteristics in this study explained some unique variance in (1) 24% in turnover intentions, (2) 17% in job satisfaction, (3) 9% in the subjective performance and (4) 40% in the organizational commitment. The relation or link of social characteristics and observer rated performance was not demonstrated. The results of the study of Humphrey et al. (2007) show that the social characteristics are not only playing a role on the background. Oldham and Hackman (2010) revised their earlier work in 2010 and concluded that social characteristics became more important over time. Grant and Parker (2009) indicate that the impact of technology and changes in the social perspective in work context also impact the social characteristics which are leading to positive work outcomes. The last couple of decades, the use of teams increased within organizations (Ilgen, 1999). This increase in teamwork may be related to the growing interest in the social characteristics of job design, since Humphrey et al. (2007) for example elaborate on this under the title interdependence.

Earlier prominent research on job design did not indicate the importance of certain social job characteristics within job design (Hackman & Oldham, 1975; 1976; 1980). Others found a relation of certain social characteristics on outcomes such as the satisfaction of employees (Hackman & Lawler, 1971; Turner & Lawrence, 1965). The word certain is used since the terms used to describe these characteristics differ from the terms Humphrey et al. (2007) for example used. Turner and Lawrence (1965) for example elaborate on required and optional interaction on and off the job. Hackman and Lawler (1971) for example describe the importance of fulfilling the needs for interpersonal interaction and making friendships on the job. More recent research stresses the importance of the social characteristics more often.

Reflecting on the above, there can be concluded that there are different point of views when it comes to the inclusion of social characteristics in relation to job design. Some research did include certain social characteristics and other did not. The names of the characteristics differ, the categorization of the characteristics differs and other effects are found. However, all the scholars agree that well-designed jobs are beneficial for the individual and the organization. The social characteristics discussed by Humphrey et al. (2007) will be discussed below.

The social characteristics Humphrey et al. (2007)

Scholars who researched social characteristics in job design often give descriptions of this phenomenon with terms like social interaction, interpersonal contact and contact with colleagues (Hackman & Lawler, 1971; Humphrey et al., 2007; Oldman & Hackman, 2010; Turner & Lawrence, 1965). Grand & Parker (2009 p.9) state that the social characteristics of work are related to: *"the interpersonal interactions and relationships that are embedded in and influenced by the jobs, roles, and tasks that employees perform and enact."*. Hereafter an overview of the social job design characteristics of Humphrey et al. (2007) will be given.

Task interdependence

The first social characteristic, task interdependence, can be described as the extent work activities are contingent on others (Humphrey et al., 2007). Humphrey et al. (2007, p. 1336) composed an in-depth definition of task interdependence: *"Task interdependence is the degree to which an employee's job is connected with other jobs, such that employees rely on each other to complete tasks; initiated interdependence occurs when work flows from the focal employee to others, and received interdependence occurs when the focal employee's job is affected by others' jobs* (Kiggundu, 1981, 1983; Thompson, 1967; Wageman, 2001)*".* Hackman and Lawler (1971) earlier mentioned this aspect as 'dealing with others'. The

research of Humphrey et al. (2007) focused on the interdependence in tasks among colleagues within the company and not on all the interdependencies an individual could have. This is different from the definition that Hackman and Lawler (1971) chose for dealing with others. Their definition was focused on the interdependencies with people from both inside and outside the company. Researches differ in outcomes and the effects of interdependence on positive psychological states (Champion, Papper, & Medsker, 1996; Stewart & Barrick, 2000). There are four perspectives that explain the relationship of interdependence on positive psychological aspects (The opponent process perspective, the type-contingent perspective, the disposition-contingent and context-contingent perspective). The main message from the different perspectives are that the positive outcomes of the social characteristics are contingent on for example context, employees tasks and preferences (Duffy, Shaw & Stark, 2000; van der Vegt & Janssen, 2003; de Jong, van der Vegt & Molleman, 2007; MacDuffy, 2007).

Feedback from others

The second social characteristic in the model of Humphrey et al. (2007) is feedback from others. Humphrey et al. (2007, p. 1336) defined this as: *"Feedback from others is the degree to which employees receive information from supervisors, co-workers, customers, clients, or others about their performance* (Hackman & Lawler, 1971; Hackman & Oldham, 1980)". This characteristic relates to the extent an organization provides an employee with information of their job performance. Hackman and Oldham (1976) described a motivational aspect feedback from the job. This aspect differs from feedback from others, since feedback from others is related to the broad interpersonal aspect of feedback. Feedback from the job only relates to the feedback that is directly given from the work itself. Kluger and DeNisi (1996) researched the effects of feedback and they concluded that the positive effects of feedback in common are more likely to be achieved when the feedback is more focussed on the tasks itself.

Social support

The third social characteristic, social support, is defined by Humphrey et al. (2007, p. 1336) as: "*Social support is the degree to which employees receive assistance from supervisors and co-workers* (Karasek, 1979; Karasek & Theorell, 1990)". Regarding to others this also includes the opportunities to make friends at work (Sims et al. 1976). A stream of research in the zero's agreed to the statement that the ability to perform in work is affected by the access to social support (Morgeson & Humphrey, 2006; Spreitzer, Sutcliffe, Dutton, Sonenshein, & Grant, 2005). In these researches, four perspectives about social support have been elaborated. These perspectives are the demand control support model, the job demands resources model, the social undermining perspective and organizational support theory. The first, the demand control model (Karasek & Theorell, 1990), was first developed to examine the demands of control of an individual and the relation to burnout complaints and suggests that the outcomes mixed (Grant & Parker, 2009). The second, the job demands resources model (Bakker & Demerouti, 2007), which also relies on the effects of social support on dimensions of burnout came with rather positive outcomes. The third, the social undermining perspective (Duffy, Ganster & Pagon, 2002), claims that the source of the social support plays an important effect in the outcomes of this support (Duffy et al., 2002). The fourth, organizational support theory (Rhoades & Eisenberger, 2002), states that organizations who threat employees favourable can achieve positive outcomes (Rhoades & Eisenberger, 2002).

Interaction outside the organization

The fourth social characteristic, interaction outside the organization describes the extent a job requires communication with people extern from the company (Humphrey et al. 2007). Humphrey et al. (2007, p. 1336) defined interaction outside the organization as: *"Interaction outside the organization is the degree to which employees communicate with people beyond the boundaries of the organization, such as distributors, suppliers, clients, or customers* (Morgeson & Humphrey, 2006; Tschan, Semmer, & Inversin, 2004)*".* These people could be for example customers or suppliers. Stone and Gueutal (1985) defined this aspect as 'serves the public'. This fourth aspect describes the link between an individual within the organization towards external people outside the organization. Regarding to Grant and Parker (2009) there is a split in theory about the effects of interaction outside the organization. There are two streams. The first stream suggests that too much interaction outside the organization could cause mental health problems. The other suggests that this interaction works positive on performance (Zapf, Seifert, Schmutte, Mertini & Holz, 2001; Grant, 2008).

Above the background of the social characteristics has been discussed. The majority of the scholars agree about the positive impact of that social characteristics when managed in a proper way. The positive effects will be found in the work outcomes such as behavioural, attitudinal, role perception and well-being outcomes. Regarding to Humphrey et al. (2007) this effect is mediated by the critical psychological state mentioned above. Some scholars warn for any negative effects on some characteristics when stimulated too much. Most important are the positive influences that the social characteristics can have on turnover intentions, job commitment, subjective performance and organizational commitment. These influences imply the importance being aware of the existence and composure of the social job characteristics. Since Smart Industry contains components related to digitalization of communication, far-reaching automation of manufacturing and a network-centric information transfer there will be a chance that this brings changes in the extent and the way social characteristics are present in a job. It is important to gain insight in these potential changes since well-designed jobs are beneficial for the organization. In the next paragraph the consequences of Smart Industry on the social characteristics will be discussed.

2.3 The consequences of Smart Industry on social characteristics

Since the Smart Industry brings a lot of technical improvements and opportunities (Brynjolfsson & McAfee, 2014) it automatically comes with chances to innovate and improve in business models (Bauerhansl, Homepel & Vogel-Heuser, 2014; Kagermann, 2017; Kagermann et al., 2013; Schwab, 2017). When production factories apply smart technologies, virtual and physical systems are able to work together in a flexible and global way of manufacturing. This change makes it possible to innovate in the field of operations and absolute customization. Due to this, manufacturing cost will be lower than in a manual customize production process. This in combination with the speed and agility, in which organization need to transform their business to the rapidly changing demands of the customer, brings a lot of new chances and challenges (Smart Industry, 2014). Who is going to communicate with the customer when the customers' demands are changing and the techniques are getting more complex? What does this mean for the internal collaboration, the feedback mechanisms and the social support? Schwab (2017) implies that the change in technologies and business models changes the entire system within the countries, companies and societies. This revolution changes the activities we do, how we do these activities and

also who performs these activities (Schwab, 2017). In regards to Schwab (2017), the changing environment causes a shift in the social paradigm that changes the way we work, communicate, express inform and also how we entertain ourselves. Parker (2014) states that relatively simple jobs will remain in for example the production industry and the knowledge intensive jobs will also increase. She states the gap between well-designed and poorly-designed jobs becomes bigger when work involves technology. In other words, the content and nature of work is expected to dramatically change with the involvement of the new smart technologies.

Job characteristics in Smart Industry

The first social job design characteristic, interdependence, relies on working together within the organization with others (Grant & Parker, 2009). Working together could fundamentally change since people are becoming more and more free in the choice of place and time they work. Also the ways people communicate with each other changes by the use of communication technologies (Johns & Gratton, 2013), this could influence the way interdependence is perceived. Beside the change in communication the technological companies desire employees to work in multidisciplinary teams since product are becoming more complex and more different knowledge is needed (Corporaal, Alons & Vos, 2015). The second social job design characteristic, feedback from others, which is about the feedback from others on the performance of the employee could be affected by the new ways of communication and the complexity of jobs. Parker (2014) and Corporaal et al. (2018) stated that jobs are becoming more complex since the easy parts of jobs can be automated. What does this mean for the people who are already within the organization, who have to adapt to a new level and the feedback on their performance? In smart factories in industry 4.0 it occurs that employees get their feedback straight from the data that is generated by the technology due to for example data (Wang et al., 2015). Expectations are that is that the sources from which feedback is being received will be different than before. In times of Smart Industry, direct feedback from data could be a source which is not described in traditional literature. This is based on how Smart Industry (2018) defines digitalization. They state that the processes, data and communication on all levels are digitized in a far-reaching way in times of Smart Industries. The third social job design characteristic, social support, relies on for example the support of colleagues and supervisors (Grant & Parker, 2009). The expectation is that social support will change since the ways people interact is also changing. Johns and Gratton (2013) for example stated that the way we interact with each other is changing due to the technological influences. This does not only affect social support but also the other three social characteristics, since within the social characteristics communication is a fundamental aspect. Social support relies on the context and the personal preferences of an employee, this in combination with the increasing complexity and changes in communication could have impact on this social characteristic in job design. Also the increase of collaboration with machines, for example described by Davenport and Kirby (2016), could have an effect on the support. The fourth and last social job design characteristic, interaction outside the organization, is the extent to which an employee has contacts outside the borders of an organization (Grant & Parker, 2009). Since administrative tasks are likely to be automated, (Frey & Osborne, 2013; Gordon, 2016) the way we communicate is fundamentally changing (Johns & Gratton, 2013) and the customer demands more specific products (Smart Industry 2016) this is an aspect that is really likely to be changed within the Smart Industry context. The automated tasks, the specific demands of the customer and the new ways of communication may cause that employees are stimulated to use their social intelligence to interact outside the boundaries of the company.

Beside communication, Corporaal et al. (2018) indicate that tech workers have more contact with clients due to more specific, personalised and complex orders. This is in line with Habraken and Bondarouk (2017), who indicate that Smart Industry has influence on the relations with suppliers and customers. Expectations are that the interaction with people outside the organization and task interdependence will increase. Technical specialists who have high knowledge about the product and the process could be involved in sales and the optimization of the production process. This is based on the claims of Smart Industry (2014) and the statements of Brynjolfsson and Mcafee (2016) that Smart Industry will also bring opportunities to better respond to specific needs of customers. Specific needs require specific knowledge.

Overall, there can be concluded that technology is rapidly developing and that these developments are likely to causes changes in the composition of jobs. The expectation is that Smart Industry will make the workspace more complex and this will asks for more disciplines to work together this may cause changes in for example the task interdependence. The expectation is that this will cause changes in the social characteristics. Beside that the expectation is that communication becomes more digital and the way we communicate this may cause changes in for example the task interdependence and/or social support. Feedback in turn is expected to be generated by machines and this may cause changes in the social characteristics feedback. In other words, Smart Industry is highly likely to influence the social characteristics. In Table 3 an overview can be found of the expected changes in the social characteristics based on the literature above. Understanding the changes caused by Smart Industry on the social characteristics will provide knowledge to take into account when Smart Industry penetrates the daily reality of an organisation. This knowledge will help to make choices when one decides to redesign jobs affected by Smart Industry. More understanding of the change in social characteristics will help to make proper choices in the redesign of work and prevent negative influence on the related work outcomes.

Table 3: A systematic overview of the expected changes in the social characteristics of jobs

Social characteristic	***Expected change in regards to the literature***
Task interdependence	- Employees become more independent in the time and place they work. This may influence the task interdependence - The employees communicate is digitalizing. This may influence the interaction in the workspace - Multidisciplinary teams are more often applied since more complex knowledge is needed. This may influence the type and sort of interaction employees have
Feedback from others	- Digitalization may influence the way people receive feedback from others - Direct feedback from the job is getting more detailed by the use of data and technologies. This may influence the frequency and subject in relation to feedback from others - Data may play a bigger role in the aspect feedback from others
Social support	- The expectations are that people will interact differently due to the digitalized communication, multidisciplinary teams and new interdependencies - The sources of support may differ. It may be that support will be found in technologies
Interaction outside the organization	- The way people communicate is changing. This may affect the interaction outside the organization - Customers have more and more specific needs. This may increase and change the interaction outside the organization

	- The automation of administration and other additional tasks could bring opportunities to spend time differently. It could provide an employee more time to interact with the customer - Knowledge is getting more complex. This may cause that the experts will advise the customers on specific parts of the technology

The analytical model is model is displayed in figure 1. This arrow in the model indicates the influence of Smart Industry on the social characteristics of Humphrey et al. (2007) that we expect to be there. This analytical model displays the Smart Industry context which is likely to cause changes in the design of jobs and specifically the social job characteristics. Based on the literature above the expectations are that all the social aspects will be influenced by Smart Industry. The aim of this study is to identify changes in the social characteristics being caused by the Smart Industry effects. In the next chapter the methodological approach of this study will be discussed.

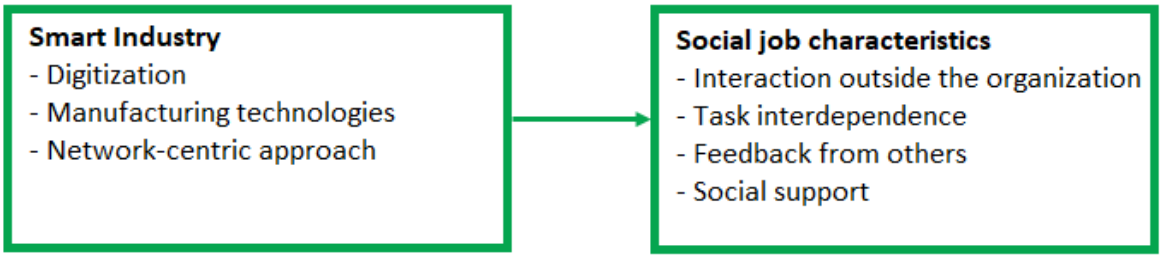

Figure 1: Analytical framework

3. Methodology

3.1 Research design and method

This study makes a combination of Smart Industry context and the social characteristics of job design to understand the effects of Smart Industry on the social job design characteristics. Therefore, this study has an explorative character since the current existing literature cannot provide a clear explanation of the effects of Smart Industry on the social characteristics. The effects are not clear yet. Shields and Rangarajan (2013) confirm this to be a reason for exploratory research. They state that exploratory research can be effective when a phenomenon is not studied clearly and there is a lack of understanding. When conducting an explorative research a researcher is ought to be willing to change the direction of the research as a result of revelation of new data and insights (Saunders, Lewis & Thornhill, 2012). The aim of this study is to obtain insight in these effects of Smart Industry on the Social characteristics to in turn provide practical insights of phenomena which can be taken take into account when redesigning a job. As mentioned above the direction of the explorative research can change by the results. This is also applicable for this research, since the only thing we know is that Smart Industry will change something in job design. We do not know what the effects will be, what parts will be influenced and we also don't know if the changes will be positive or negative for the related work outcomes. An explorative research provides this research the chance to evolve and adapt to the findings. In short this method gave the chance to approach this research open-minded. Interviewees are asked about changes in regards to each social aspect and the relation between this change and Smart Industry. In regards to the sample, the decision is made to focus on a small set of companies which meet the Smart Industry aspects discussed in the theoretical framework and operationalized in Table 2. In this study the 'everyday work situation' of employees and especially the social characteristics of the employees was examined by the use of in-depth interviews. To explore the influence of Smart Industry on the social job design characteristics it is important to have the possibility to ask in-depth questions to identify for example the context or ask for clarification of given answers. These in-depth interviews had a semi-structured character. A semi-structured interview gives the possibility to be flexible in the interview protocol (Bryman & Bell, 2015). The added value of this structure for this study is that specific in-depth questions could be asked. Employees on two hierarchical levels were interviewed. First, the employee which directly contributes to the core business. These people use the (production) technology, which is used to create the product or service, so they can reflect on the change of social characteristics. Second, the supervisors of these people were interviewed. These supervisors have a broader view on the division of tasks. This choice is made to achieve a more complete perspective out of the two viewpoints. Since the term Smart Industry was introduced in 2014 and one of the desires is to look into chances of the social characteristics there is aimed to interview people who can reflect on this change over time. Also observations of the production process are used to determine the context of the interviews. The observations where in the form of guided tours and videos of the machines.

3.2 Operationalization

To define and operationalize the areas of Smart Industry, the Smart Industry report of 2018 is used for the definitions. An overview can be found in Table 4. This information helped to

structure the changes in the social aspects and connect them to operationalized Smart Industry technologies.

To conceptualize the social characteristics and Smart Industry different studies have been used. An overview of the definitions and the examples of the different constructs are displayed in Table 5. This information helps to structure the changes in work and connect them to the operationalization of the social characteristics.

Table 4: The definitions and operationalization of Smart Industry Context.

Construct and the definition	***Operational examples***
1. Digitalization Formulated by Smart Industry (2018, p.9): *"Digitalization of information and communication among all value chain partners and at all levels in the production process."*	● Digitalization of process information ● Digitalization of product-information ● Digitalization of communication ● The use of the internet of things ● The use of big data
2. Manufacturing technologies Formulated by Smart Industry (2018, p.9): *"High-quality, network-centric communication between organizations, humans and systems, in the entire value network, including the products or services used by the end-users."*	● (New) industry changing technologies, such as: ○ Far-reaching robotica ○ 3D printing ○ Sensors
3. Network-centric approach Formulated by Smart Industry (2018, p.9): "*Granular, flexible, and intelligent manufacturing technologies, adjustable on the fly to meet highly specific end-user demands."*	● A network in which the end-user and company are connected ● A network in which the different technologies within the company are connected

Table 5: The definitions and operationalization of the social characteristics of job design.

Construct and the definition	***Operational examples***
1. Interaction outside the organization Formulated by Humphrey et al. (2007, p. 1336): "*Interaction outside the organization is the degree to which employees communicate with people beyond the boundaries of the organization, such as distributors, suppliers, clients, or customers* (Morgeson & Humphrey, 2006; Tschan, Semmer, & Inversin, 2004)".	● Communication with suppliers ● Communication with clients ● Communication with customers ● Communication with distributors ● Communication with other people beyond the boundaries of the organization

2. Task interdependence Formulated by Humphrey et al. (2007, p. 1336): "*Task interdependence is the degree to which an employee's job is connected with other jobs, such that employees rely on each other to complete tasks; initiated interdependence occurs when work flows from the focal employee to others, and received interdependence occurs when the focal employee's job is affected by others' jobs* (Kiggundu, 1981, 1983; Thompson, 1967; Wageman, 2001)".	● Collaboration with employees from inside the company ● Crossing work process from the focal employee to others ● The impact of the other focal employee on the work of another.
3. Feedback from others Formulated by Humphrey et al. (2007, p. 1336): "*Feedback from others is the degree to which employees receive information from supervisors, co-workers, customers, clients, or others about their performance* (Hackman & Lawler, 1971; Hackman & Oldham, 1980)".	● Feedback on performance from supervisors ● Feedback on performance from customers ● Feedback on performance from clients ● Feedback on performance from others
4. Social support Formulated by Humphrey et al. (2007, p. 1336): "*Social support is the degree to which employees receive assistance from supervisors and coworkers* (Karasek, 1979; Karasek & Theorell, 1990)".	● Assistance from coworkers ● Assistance from supervisors

3.3 Selection of cases

The method used to select the cases is purposeful sampling. Purposeful sampling is a method which is of added value when a researcher studies a particular group (Dooley, 2001). A purposeful sample approach has the advantage that a researcher can choose cases and respondents who fit the criteria needed in the research. In this study the characteristics that these cases have in common are the fact that the organisations use Smart Industry technologies in their production process. Within the research purposefully selected cases and respondents who work with Smart Industry technology. This is due to the fact that this research aims to understand changes due to these Smart Industry technologies. Cases in which there are no Smart Industry technologies involved are not of adding value to answer the research question.

To select the cases, two sources for suiTable companies were being used. The first source are the connections of the research group Smart Industry & Human Capital at Saxion. This study group connected me with two suiTable Smart Industry companies (companies who already work with Smart Industry technologies) from their network. The second source is the Smart Industry network. Regarding to Smart Industry (2018) this network consists of companies which are ready for the future of Smart Industry and contribute to the knowledge development particularly in the Netherlands. This Network consists of about 100 companies (Smart Industry, 2018). To ensure consistency among the cases, only companies that operate in the manufacturing industry were approached. Among the approached companies there are differences in the size, years of experience in Smart Industries and the kind of Smart Industry Technologies applied in their process.

Out of the twenty-one approached companies seven confirmed to participate in the research. Thereafter, every company was visited to discuss the opportunities in relation to this study and to assess to what extent they are influenced by Smart Industry. This first consult is not included in Table 7. After this first consult, the conclusion had been made that four of the seven companies where suiTable for this study. The main criteria used for assessing these companies are the integration of Smart Industry in their process and the amount of people available for interviews.

3.4 Introduction to the cases

An overview of the cases can be found in Table 6. After the introduction of cases the companies are kept anonymous to ensure privacy and secure company specific details. Eaton Industries Netherlands has a workforce of approximately 700 employees working in Hengelo. The worldwide workforce is around 96.000. Eaton Global is an American company which operates on every continent in the world. The branch in the Netherlands focusses on power management solutions. Their production process contains high-end welding robots and fully automated machines and also their products they produce become smarter by applying digitalization and network-centric technologies. Recently a big part of the manufacturing technologies is renewed.

Hellebrekers Technieken is a Dutch company with branches in the Netherlands and Belgium. This company has a total workforce of 200 employees. For this research only the subsidiary in Nunspeet is approached. Hellebrekers operates in different industries: infrastructure, sports and industries. For this research the component that focuses on industries is included. The products of the company involve Smart Industry technologies related to digitalization, a network-centric approach and smart manufacturing. The production process involves mainly digitalization and a network-centric approach.

Hollander Techniek is a Dutch company that operates on a national level. Their workforce is around 100 people who operate from four locations in the Netherlands. For this research people from Almelo and Apeldoorn have been interviewed. This company focuses on the adjustment of standardized robots for customers' specific needs. The products of the company involve Smart Industry technologies related to digitalization, a network-centric approach and smart manufacturing. The production process involves mainly digitalization and a network-centric approach.

Bronkhorst is a company that operates from their branch in Ruurlo with an employment of approximately 600 employees. They deliver high-tech products involving sensor technology all over the world. The products and the process of the company involves Smart Industry technologies related to digitalization and a network-centric approach. Recently a project started involving smart technologies, this project is about an investigation of the technological possibilities in regards to the production process.

Table 6: An overview of the cases with information about their Smart Industry focus, size and other relevant information

Company	Size	Smart Industy Participation	Smart Industry focus	Additional relevant inforation

Eaton Industries *A worldwide progressive manufacture of power management solutions*	96.000 worldwide and 700 employees in Hengelo	Research group SMI & HC	Production process and products	Recently introduced 'Smart Grit'. This technique exchanges data from products between different devices
Hellebrekers Technieken *Progressive manufacture and programmer of technical installations*	200 employees	Smart Industry Network	Production process and products	Made the business choice to focus more on the complete smart solutions rather than small simple solutions
Hollander Techniek *Reconstructor and programmer of standard robots for specific customer needs*	100 employees	Smart Industry Network	Products	Developed from a regular installation company to a high-tech advisory and robot installer
Bronkhorst *Manufacture of Mass Flow Meters using sensor technology*	600 employees	Research group SMI & HC	Mostly products	Fast growing high-tech company with focus on sensors. Cobots will be introduced soon

3.5 Data collection

For the data analysis a semi-structured analysis is applied. A semi-structured interview allows the researcher to ask follow-up questions related to what an interviewee answers. However, the specific topics that will be discuss are formulated in advance (Edwards & Holland, 2013). Within each company, three or four semi-structured interviews are conducted. Crouch and McKenzie (2006) state that having a small sample size in an explorative study is no problem when you interview the right people. Since the aim of this study is to research the influence of Smart Industry on the social characteristics the interviewees are selected by the extent they come into contact with the Smart Industry Technologies within a technical environment. Therefore, cases are carefully selected as mentioned in paragraph 3.3. All the interviews were conducted in a face-to-face setting with one interviewee and one interviewer. Before the actual interviews were conducted public documents were analysed and an acquaintance consult was scheduled in which information about the context of the organization, the potential interviewees work and the influence of Smart Industry was gathered. This acquaintance consult helped to select cases. The actual data is collected among two category of interviewees. The first category contains executive employees who work with Smart Industry technologies in their daily work. These interviewees in this category had different functions, for example product engineer, software engineer and product tech worker. This variety gave the opportunity to gather general similarities. The second category was composed of employees with a managerial or coordinating function, for example (project) managers. These people have could provide a more board view and can put the answers of the executive

employees into perspective. Also the managerial interviewees worked with Smart Industry technologies. The suitability of the potential interviewees was assessed by asking questions in the acquaintance consult. These questions aimed to gather information about the composition of the potential interviewees' job.

The interview protocol can be found in the appendix 1. The semi-structured interview consisted of four main topics and these topics a two general questions. The interview objective was to gain knowledge about the impact of Smart Industry on the social job design characteristics. The topics used are related to the social job design characteristics described in the literature. The two general question were aimed to identify change over time in relation to that particular social job design topic and the role of Smart Industry in that change. After these two main questions, follow-up techniques were used to gain clarity in the change and Smart Industry techniques related. Table 7 provides and overview of the companies, the functions of the interviewee and the time totally spend interviewing within a company.

Beside the interviews the researcher had the chance to make observations within three of the four cases. Within the other case the HR manager showed me pictures in the orientation conversation. If possible information videos of the machines are used to obtain knowledge.

Table 7: Overview of the companies, functions and length of interviews

Company and description	**Functions interviewed**	**Time**
Eaton Industries	• Production Manager *Manages the production department, works with input of data and is responsible for the manufacturing machines.* • Engineering Manager *Manages the engineering department, works with input of data and is responsible for the product innovations.* • Product Engineer *Engineers products for the customer, customers often ask for smart solutions. Works closely together with other disciplines.* • Production Tech Worker *Works with smart manufacturing on a welding robot. Gets input by data. Has multidisciplinary contact with R&D and others.*	3:01
Hellebrekers Technieken	• Production/Engineering Manager *Manages the production and engineering department and is responsible for all the innovations within the manufacturing and engineering.* • Project Engineer *Engineers smart solutions for the customer. This employee has a sort of foreman role and performs some managerial tasks. Also works with smart manufacturing robotics, data and cloud solutions. Works in a multidisciplinary team.* • Software Engineer *Develops the software for the robots, cloud software and makes sure every relevant device is connected. This engineer also advices customers. Works in a multidisciplinary team.*	2:05

Hollander Techniek	• Project Manager *Manages project teams and has interactions with the customer or brings others with specific knowledge in contact with the customer.* • Robot Engineer *Reconstructing and programming of smart robots. This engineer works in a multidisciplinary team to make sure devices and robots are connected. Uses data to improve the product.* • Software Engineer *Engineers the software of the smart robots. This engineer has knowledge of the smart manufacturing and uses data to optimize the product. Has to work with other disciplines to achieve the best solution.*	2:17
Bronkhorst	• Production Manager *Manages the production department of Bronkhorst. This manager has a coaching role towards his team and currently aims for better adoption of data and smart manufacturing.* • Sensor Tech Worker *Has a foreman role within the department of sensor technology? He is busy with manufacturing high-tech sensors and also aims for improvement. Data plays a very important role in this process. Also works with smart manufacturing technologies such as 3D printing.* • Tooling Engineer *Manufactures high-tech sensors. Is also involved in the development of the sensors. Data plays a very important role in this process. Also works with smart manufacturing technologies such as 3D printing.*	2:23
Total		**9:46**

All the interviews were recorded with a voice recorder. These recorded interviews were translated in verbatim transcripts.

3.6 Data analysis

For the data analysis several steps of analysis are conducted. This analysis adopted the method Dooley (2001) describes in his book. Five steps are taken into account. These steps are: transcribing, the first orientation on codes, open coding, axial coding and selective coding. The first step of the analysis was to transcribe the interviews. For privacy reasons the identity of the interviewees was not included in this study. The interviews are transcribed in word. In total the recordings consisted of nine hours and forty-six minutes. The transcription phase took approximately four hours per one hour of recording, so in total this phase took approximately forty hours. The sum of the word count of all the transcriptions is 52.161 words and the total page count of the transcripts is 92 pages. Second, the first abstract codes were designed. These codes were mainly based on the social job characteristics and their components. In Table 8 an overview can be found of these codes and every quote is explained with an example.

Table 8: An overview of the first abstract codes within the coding process

Code	Example Quote
Interaction outside the organization – suppliers	"You have to meet with different suppliers, you have to make agreements and communicate the boundaries." – R1
Interaction outside the organization – customer	"Do you know the V-model? That's the way how we work. In every phase there is a verification step. In that step we also involve the customer." – R6
Interaction outside the organization – other	"We don't have data analysts for example. If we need one, we ask a colleague who knows some guys in that field. He makes some contact for us. More experienced tech workers have these contacts." – R5
Task interdependence - inside	"An interaction between the production and engineering happens often. In practice you see that R&D and engineering make something new. On paper it looks perfect, but is it doable in practice?" – R8
Task interdependence – crossing work process	"Yes, when something has to be glued is goes to the department down the stairs. They have the glue and the expertise to do everything with glue. Everything related with glue goes there." – R9
Task interdependence – impact work one on another	"People are getting more specific knowledge of certain parts, but they don't realise the impact of their work on another phase. They don't know that the next department is not able to do their work because a screw is on the wrong place." – R7
Feedback from others - supervisor	"Now we focus more on the whole process. Back in the days I had more technical knowledge, now I focus more on guiding the process." – R2
Feedback from others – customers	"Feedback of the customers is of high value. Because of this feedback we made a huge transition towards a more professional company." – R4
Feedback from others – other	"How we give feedback to each other? We will give each other feedback during the stand-ups or during the sprint review." – R5
Social support – coworkers	"It is very important that you work together. In the past we saw things going wrong because people tried to invent things, but these thing were already tried." – R7
Social support - supervisor	"First you have to go to your supervisor when it comes to support. It is necessary that he wants the same. Thereafter you look for an engineer to work it out." – R9
Social support - other	"When engineers have questions they ask these directly to the company who makes the components." – R2
Digitalization	"Internet is a huge source of information. We keep an eye on what happens in the world." – R3
Smart Manufacturing	"If you look in the production line we have a welding robot, automatic press brake. The only thing is that you have to put the product in the machine." – R10
Network-centric	"When we grow we focussed more on the MES connection between the ERP and the machines. Then you find out that that it is impossible to do everything on different machines. Now you have 20 machines and 20 different solutions." – R3

Third, interesting parts were labelled with these codes in the open coding phase. In this phase also new codes arise. New codes arise because some quotes didn't fit in the initial codes or such topics were common. These codes can be found in Table 9. Every new code is explained with an example quote.

Table 9: An overview of new codes that came up during the coding process

Code	Example Quote
Interaction outside the organization – suppliers - knowledge	"Sometimes we ask the supplier to look at it. Trumpf is for example the expert on some parts of the technology. When we need that kind of specialistic knowledge we call them."- R10
Interaction outside the organization – customer – knowledge	"When a tech worker talks to the suppliers it is about the technical knowledge; The bits and the bites for example." – R2
Interaction outside the organization – customer – advice/service	"We aim to deliver a total service. We guide our customers and we try to unburden them." – R4
Interaction outside the organization – customer – data	"We place Smart Grit solutions into the bigger medium voltage switches. Power can been read on a distance and we are able to analyse if it's within the boundaries."- R12
Interaction outside the organization – other - knowledge	"We already know that it is not possible to be a specialist in all fields. We also consult our partners for certain parts if we lack knowledge …… We also do this with our, let's say, competitors and colleagues. Sometimes our engineers are being used by a competitor because they have knowledge about certain software." – R4
Task interdependence – inside - teams	"The name of our team is Smart Industry. We did this on purpose because we have to deal with that every day." – R4
Task interdependence – inside - multidisciplinary	"Within the teams but also with other disciplines. When it comes to the syria line they often have contact with someone of work preparation and planning." – R11
Task interdependence – inside – digital communication	"I Think that the PROCON screen, who tells something about the production process, is important. It is also important when it comes to communication with the order managers. They also know how far projects are. In the past they walked by on the shop floor." – R10
Task interdependence – impact work one on another - Technology	"That is a critical machine. You are dependent of so many factors, also the examination of the machine and the parts itself." – R13
Task interdependence – crossing work process – specialism	"Yes. We always need each other in the MES projects. They do the development of the general part and we build the implementation parts." – R2
Feedback from others – supervisor - Data	"Some competences in the feedback cycle are more abstract, but to rate that I use information that comes out of our system." – R10
Feedback from others – customers - Data	"Yes we do something with the data of the customers. That is our strong side. We can alarm many things to the customer. We can see when and why a production line has stopped working. All the data is gathered in a database." – R3

Feedback from others - other	"The feedback is more specific do to the technology." – R13
Social support – supervisor - role	The project manager guides the project and the manager keeps an eye on the performance. You don't hear him if everything goes all right." – R3
Social support – other - outside	"When you want something new with your robot and the setting have to be changed you need some knowledge. We had a class two years ago and the man who gave us the information was not reachable. In the end we came up with another solution from outside the organisation." – R8
Digitalization – data	"Digitalization was really limited before, but now you see more and more paperless offices. They don't work with papers, but do everything digital." – R4
Network-centric - customer	"We are able to log into the systems of the customer to look into their data." – R3

In the fourth phase the codes are compared to each other and merged if needed. This Axial coding phase was conducted several times to ensure consistent coding. Some codes were merged completely because it contained the same message, but other codes were merged partially. In Table 10 examples can be found of the merging process.

Table 10: Examples of mergers that were made during the axial coding phase

Code one	**Code two**	**Final quote**	**Reason**
Interaction outside the organization – customer – advice and service	*Interaction outside the organization – customer – knowledge*	*Interaction outside the organization – customer - Increase*	It became clear that the technical people who advice the customers have this role because they have increasingly specific knowledge. They also mention that this contact is increasing.
Interaction outside the organization – customer – data	*Feedback from others – customers - Data*	*Feedback from others – customers - Data*	These two code indicate the same phenomena because the interviewees mentioned that the data transfers with the customers used as a feedback tool.
Feedback from others - other	Data	*Feedback from others – other – by data*	This is an example of a technology that was labelled often and a new code that raised of a combination of an aspect and a technology. Sentences were ladled double and duplicates were merged.
Task interdependence – inside – teams	*Task interdependence – inside - multidisciplinary*	*Task interdependence – inside – multidisciplinary teams*	In this example code one and code two still exist in some cases but it became clear that a combination of both was also possible, so a new code was formulated.

The fifth and last phase of the data analysis the qualitative data is categorized in different categories. The coding structure contained 31 labels at his peak and after the fifth phase 18 labels. During the data analysis, the current status of the social job characteristics in both companies were identified and changes due to Smart Industry are found. Also the tasks of the employees were analysed and compared to the tasks of the tasks of employees of the other company. This is important since the jobs are not always comparable and differences need to be taken into account for generating proper conclusions.

3.7 Reliability and validity

Dooley (2001) stresses the importance of a well thought research method to ensure the validity and reliability. Some choices have been made in regards to these aspects.

in every interview the definitions have been given of the social and Smart Industry characteristics to ensure the internal validity. To contribute to the internal validity of the research an extensive literature research has been conducted to clarify the different definitions of the variables. Beside the interview protocol that was being used and the research method has been tested twice to improve the protocol and its questions. This test brought insights on time and the clarification of some topics. The time spend for the interview was one hour because of agenda's, but the test gave the opportunity to manage time in regards to the topic. In regards to the clarification of topics some needed more explanation, this is taken into account in the actual interviews.

In relation to the external validity the research some choices have been made. In a qualitative research the exact outcomes will not be generalizable but patterns within the outcomes of the research can be (Bleijenbergh, 2015). An outcome of the research could be that employees increasingly use a certain digital communication technique to interact with each other. This doesn't mean that this specific technique is used within every company, but it may be that the digital communication also increases within other companies. In the research we purposely chose not to influence the interviewees with much information before the actual interviews. Information have been given about the purpose of the interview and the method, but information about the actual variables have been omitted. This is to avoid reactivity which could potentially affect the external validity (Dooley, 2001). To increase the generalizability of the outcomes the choice has been made to research multiple cases with the joint characteristics of Smart Industry and a production environment.

When it comes to reliability it is important to pay attention to the imputability of the research (Bleijenbergh, 2015). All the subjects within the interviews are kept the same during the interview process to avoid a negative influence of maturation and instrument change to contribute to the reliability. In this study we tried to avoid selection bias by visiting the company before the actual interviews to discuss the type of employees that are needed in the research. This avoids differences between the cases that could potentially affect the research results. Beside that an interview protocol was being used and the research method has been tested twice to improve the protocol and its questions. During these tests the clarity of the topics, duration and follow-up techniques are tested. It turned out that some topics needed more explanation to steer the interviewee in the right direction. Actions have been taken to add more definition to the protocol. In regards to the time the aim was to conduct the interview within an hour because of agreements with the companies. It turned out that some topics took more time than others. This is taken into account during the actual interviews.

4. Results

The results displayed below are based on the experience of executive tech workers who work with Smart Industry technology in their daily job and their supervisors. The supervisors are also in touch with the technology, but the difference is that they have a broader view on their team. This different views give more insight in choices of the organization to place other outcomes in context. The choice has been made to present the results as of all companies together. This is because most of the cases only contained three interviewees This makes that these outcomes per case are more likely to be influenced by single cases. At the end of every paragraph a Table can be found with details on company level.

Smart Industry

The results on Smart Industry will be discussed by the use of the three Smart Industry areas explained and operationalized in the earlier chapters. Digitalization, smart manufacturing and a network-centric approach. The goal of the researching the use of Smart Industry technologies is to find differences and similarities between companies on the use of Smart Industry technologies. In the conclusive part of this research this can be combined with the results of job design to find coherent phenomena. When it comes to digitalization the results of this study indicate that the companies are increasingly using communication techniques. Some face to face meetings are now a days arranged via skype and communication towards the shop floor is also getting digitized with smart devices and digital messages. Beside that the use of relatively old digital communication technique, e-mail, is also still increasing. An interviewee from Company D explained how the communication with the shop floor works within their company:

> "I Think that the PROCON screen, who tells something about the production process, is important. It is also important when it comes to communication with the order managers. They also know how far projects are. In the past they walked by on the shop floor." – R10

The information transfers are getting digitized more often. Companies are working with paperless offices and this means that documents are increasingly shared in the cloud. In addition to this it became clear that all the companies gather information for a database. The companies for example gather information related to up-time, performance, heath of the machine and power usage. Most of the interviewees say that the information in this database is accessible for analysis, but the members of company C mention that the full potential is not used yet. They state that the gathered data can be of high value in their job but that they do not have access to the right data. They state that they can use this data to predict maintenance or to find problems in a certain batch but that this is not applied yet.

> *"On a product we applied some chemistry. For example, helium is a thin sort of gas. We use this theory and we expect that this will happen in practice, but in practice it doesn't seem to work. We sold three orders and they all came back. It would be nice if we bundle these measurements to prevent this in the future." – R8*

When it comes to smart manufacturing this study found that all the cases apply smart manufacturing technologies in some extent. The use differs from small parts in the production process to an extensive use of smart technologies within the complete production process.

The smart manufacturing technologies differ from 3D printing to smart automation and sensor technology. In two of the companies an intelligent manufacturing process is happening. In these production lines only the input has to be set by human. One of these two companies produces all the products in this intelligent manufacturing line, the other company also produces deviant products by hand. In the other two companies only some parts are smart. They use technologies that make use of sensor technology, 3D printing of parts and for example a glue robot. They state that it is hard to make an intelligent production lines since they build many customer specific products who differ in size and specifications. An employee of company D tells about their intelligent manufacturing. In the interview it became clear that products with all measurements can edited by the machines:

"If you look in the production line we have a welding robot, automatic press brake. The only thing is that you have to put the product in the machine." – R10

When it comes to the network-centric approach interviewees mention that they all have certain connections between systems within the organization. They mentioned connections between for example the manufacturing machines and a database and a connect between the systems of the company and their customer. In three of the four cases they mentioned to have connections with systems of their customers.

"We are able to log into the systems of the customer to look into their data." – R3

Table 11: overview results in regards to the Smart Industry areas

Smart Industry	***Company A***	***Company B***	***Company C***	***Company D***
Digitalization	The communication within the company is increasingly digitalized by the use of for example additional applications. The information transfers are digitalized with for example online platforms. The data transfers with the end-users' products are also digitalized by the use of sensor technology. The manufacturing information is bundled in a analysable database	The communication within the company is increasingly digitalized by the use of for example additional applications. The information transfers are digitalized with for example online platforms. The data transfers with the end-users' products are also digitalized by the use of sensor technology. The manufacturing information is bundled in a analysable database	The communication within the company is increasingly digitalized for example additional applications. The information transfers are digitalized by the use of company specific applications. The manufacturing information is bundled in an analysable database. Regarding to the respondents	The communication within the company is increasingly digitalized. The manufacturing information transfers are digitalized. The data transfers with the end-users' products are also digitalized but not always accessible for the tech workers. The internal information is bundled in a analysable database
Manufacturing technologies	The manufacturing technologies are flexible enough to meet customers' demands, they are flexible and intelligent enough to adapt to different products, also a considerably amount of products	The end product this company makes are the robots that feature intelligent technologies, but the needs of the customers are too different to fully automate the production process.	Robot arms are going to be applied to the production process since full automation is not possible with the technologies available. This has to do with the divergent needs of customers. Sensors are being	In general, the manufacturing technologies are flexible enough to meet customers' demands, they are flexible and intelligent enough to adapt to different products. Negligible amount of

	with specific requests are manufactured outside the production line	The adjustments they make are to complex and divergent to apply full automation	used to increase quality. 3D printing is being used to print parts of the products	products are manufactured outside the production line
Network-centric approach	Internal systems are connected and in some situations it is possible to gather information directly from the customer. The systems are connected when possible. This depends on the needs of the customer	Internal and external (customer) systems are connected. A tech worker is able to log into the system internal and external systems anytime and anywhere. These systems are connected and transfer information	The measurement systems are connected to a database in which all measured data is collected. This measurement system is being used for development and maintenance when problems occur. There is only an internal connection between systems	Internal and external (customer) systems are connected to gather information. The external systems are not always accessible for the tech workers. Tech workers use screens with real time information from the production process

Interaction outside the organisation

Within the characteristic 'interaction outside the organization' the interviewees noted three changes that can be linked to Smart Industry and its technologies. Changes have been found within three aspects. These aspects are: contact with suppliers, contact with customers and contact with other people beyond the boundaries of the organization.

In relation to the first change, contact with suppliers, almost all interviewees from all companies agree to the fact that Smart Industry changed the contact with suppliers completely. Regarding to the interviewees, the extent that tech workers have contact with the suppliers increased due to Smart Industry. An explanation for this shift is that the tech workers process the supplied product and have the technical knowledge to discuss deviations on the supplied product. The interviewees mention to have contact with the suppliers about for example technical measurements and adjustments. The Smart Industry context brings new and complex (manufacturing) technologies which makes that one cannot have all the knowledge. Employees are becoming specialists in their piece of work. An interviewee working in company C says:

"Most contact with the suppliers is about technical aspects, recently we contacted the supplier. The supplied products were not properly adjusted. The technical measurements are pretty critical" – R9

Interviewees from all companies mentioned a change linked to the contact with suppliers related to knowledge. Beside the increase in contact with the supplier, tech workers mention to have increasingly contact about technical knowledge related to the use of the supplied products, the machines and the software. A tech worker from company D mentioned that his knowledge on programming is not that good and that the supplier helps him with applying the right measurements on the machine. Interviewees indicate that this is due to the complex technologies caused by Smart Industry. The purchased products are often designed in collaboration with the supplier and the customer since the customer knows exactly what technical aspects they prefer. An interviewee working in Company D mentioned:

"Sometimes we contact the supplier of the machine. The supplier can give us the specialist knowledge we need" – R10

In regards to the second change, contact with customers, most interviewees agree that the contact with the customer increased due to Smart Industry. The interviewees mention a shift from being passive to the customer to help the customer with their specific needs. The employees from interviewed companies mentioned that they also have an advisory role today. This advisory role is something that has to do with all the specific knowledge needed to create a customer specific product. Most of the time customers do not know the possibilities of the technologies. Beside this advisory role, interviewees mentioned that they develop products in collaboration with the customers. There seems to be constant interaction between the customer and the supplier to deliver a customized product. An interviewee of company B mentioned that he is an expert on cloud solutions and that he develops and advised in this discipline. Some interviewees indicate that they make a product for internal use. They say that they do not have any contact with the end user outside the organisation, but they are in constant contact with the internal customer which operates from inside the boundaries of the organisation. An interviewee from company A stated:

"I am not the translator between the tech workers and the customer anymore, we try to bring the tech workers as close as possible to the customer. These are the people who know how to make the product and they are the right people to consult the customer about their needs." – R2

The tech workers contact with other people from outside the organization increased. Beside knowledge retrieval from the suppliers they also see an increase in the contact with other specialists from outside the company. When companies do not have certain knowledge within their boundaries, they consult other specialists to gather the knowledge needed. An example is an adjustment company C wanted to make in the settings of their machine. The only problem was that they did not have this knowledge anymore. Also the manufacture of the machine lost this knowledge. They found another way outside the boundaries of the company. Interviewees mention that they also consult for example competitors and knowledge institutions on their own. An interviewee of company B says:

"We already know that it is not possible to be a specialist in all fields. We also consult our partners for certain parts if we lack knowledge …… We also do this with our, let's say, competitors and colleagues. Sometimes our engineers are being used by a competitor because they have knowledge about certain software." – R4

Table 12: Overview of the results per aspect of interaction outside the organization per company

Interaction outside the organization	***Company A***	***Company B***	***Company C***	***Company D***
Communication with suppliers	Tech workers have increasingly contact with the suppliers. The tech workers have contact about technical aspects when they cannot	Tech workers have increasingly contact with the suppliers. The tech workers have contact about specific technical product knowledge	A shift has been found in the extent tech workers have contact with the suppliers when they cannot manage it with knowledge from	The employees have increasingly contact with the suppliers when they cannot manage it with knowledge from inside the company

	manage it with knowledge from inside the company. They also contact suppliers for technical knowledge about defects and adjustments. The tech workers contact them on their own	when they cannot manage it with knowledge from inside the company. Think of defects, measurements or questions for adjustments. The tech workers contact them on their own	inside the company They have increasingly contact and this is mainly about technical aspects, knowledge and support. Think of defects, measurements or questions for adjustments. The tech workers are free to contact them on their own	This contact is mainly about technical issues. Think of defects and questions for adjustments. The contact goes mainly via the manager
Communication with customers	Increasingly direct contact with the costumer. The tech workers seem to have contact about technological aspects and also a bigger advisory role. The tech workers are consulted about their specialization. This is completely different than before when they only had an production role	Increasingly direct contact with the costumer. The tech workers seem to have contact about technological aspects and also a bigger advisory role. The tech workers are consulted about their specialization. This is completely different than before when the only had a production role	The interviewees only have contact with internal customers	The interviewees only have direct contact with internal customers, but digitalization made it possible that they receive data from their customers
Communication with other people beyond the boundaries of the organization	Due to the rapidly changing and the complexity of technology increasingly expertise is needed from outside the company since the company is small and is not able to have all the knowledge	Due to the rapidly changing and the complexity of technology increasingly expertise is needed from outside the company. Also competitors are involved in this. They have agreements	Due to the rapidly changing and the complexity of technology increasingly expertise is needed from outside the company since the knowledge itself is too expensive to collect it in-house	One employee mentioned that he has increasingly interaction with and transfers knowledge to other than before, due to the complexity of technologies. He could not find some specific knowledge inside the company

Task interdependence

When it comes to the results regarding to task interdependence, a transition is found within two aspects. The two aspects that have been changed are the collaboration within the organisation and crossing work process from a focal employee to another.

In relation to the first change, the collaboration within the organisation, interviewees mentioned a shift from working individualistic to collaboration in teams. Within half of the organisations, the teams are described as multidisciplinary and within the others this is apart from each other. This means that the employees work in teams, but that they also have increasingly multidisciplinary contact in comparison with the past. The interviewees indicate that this has to do with the projects that they have to work on nowadays. These projects ask for different knowledge from different disciplines. One interviewee also mentioned that working with Smart Industry lead to an increase of multidisciplinary contact since it bundles different processes and departments, which includes different contacts. For example, an interviewee of company D mentioned that he has daily contact with work preparation, engineering and materials.

Beside the increase of contact with other disciplines also the knowledge in the technical discipline gets fragmented. Interviewees indicate that it is impossible to be a technical expert on every part of the technical process. They mention that the complexity of technology is increasing and that this asks for specialists. The relationship with Smart Industry was well explained by an employees of company B and C.

"You definitely need to work with other disciplines to meet the contemporary requirements of the customer" – R4

"The Smart Industry technologies are getting profound to have knowledge of every specialistic component of all the technologies." –R7

Beside the transition to team collaboration and working with other disciplines, another change in collaboration have been found. A transition to far-reaching digitalization of data, information and communication have been noticed. Companies increasingly use digital tools to exchange information. For example, within participating company, every production tech worker has his own screen with data indicators gathered from the manufacturing process. This piece of technology is also being used to communicate with colleagues and supervisors. An employee of company D describes it as follows:

"The PROCON screen tells you about the production process and it also tells you where parts of the installation are. When it comes to communication this device is used to communicate with the order managers. Back in the days they walked by." – R10

The other main aspect in relation to task interdependence that has been changed is the fact that within company the degree of the dependency on each other's specialism has been increased. Like mentioned above it is impossible to have knowledge of all the technologies needed in a product and the technologies are integrated in each other. This means that the success of an individual depends on the availability and collaboration of other knowledge within the organization. An interviewee of company A mentions that they always need different specialisms when the develop MES applications. This can be related to the aspect of task interdependence defined as crossing work-processes. These work processes that are related to the same outcome are becoming increasingly integrated in each other. An employee of Company B gives the following explanation:

"Everybody has his own knowledge. I have the knowledge of data pitcher and I do not have any knowledge about normal industrial robots, but I have the knowledge of vison and camera detection. A colleague of mine has knowledge of cooling systems, I also have some knowledge about that but it does not fit me at al. As you can see everybody got his own knowledge. When the teams are grouped for projects the knowledge an individual has is taken into account" – R6

Beside these two main changes in task interdependence, one result only was only explicitly mentioned within company D: the increasing dependency on technology. The interviewees from this company mentioned that the manufacturing technology has critically impact on the work of another. For example, when the welding robot stops working it has big influence on the other steps in the production process.

Table 13: An overview of the findings per aspect of task interdependence per company

Task interdependence	Company A	Company B	Company C	Company D
Collaboration with employees from inside the company	Another type of contact because of a shift from a process to multidisciplinary teams due to increasingly complex technologies and the need for different types of expertise to create a product and to meet customers specific needs	Another type of contact because of a shift from a process to multidisciplinary teams due to increasingly complex technologies and the need for different types of expertise to create a product and to meet customers specific needs	A shift from process to teamwork and due to complex technology increasingly multidisciplinary contact. Different knowledge Is needed in different places	increasingly digitalization in the communication and information transfers. This is due to digitalization and network-centric connections. People receive instructions on LCD screens.
Crossing work process from focal employee to others	increasingly dependency on each other's knowledge due to the complexity of technologies. One is not able to have all the knowledge so tech workers have to collect missing pieces of knowledge	increasingly dependency on each other's knowledge due to the complexity of technologies. One is not able to have all the knowledge so tech workers have to collect missing pieces of knowledge	increasingly dependency on each other's knowledge due to the complexity of technologies. One is not able to have all the knowledge so tech workers have to collect missing pieces of knowledge	Still a traditional manufacturing line.
The impact of the other focal employee on the work of another	Changed from process to collaboration. Before people worked in a production process in which they gave a product from one to another, now they work in teams a work together on the product as a whole	Changed from process to collaboration. Before people worked in a production process in which they gave a product from one to another, now they work in teams a work together on the product as a whole	Changed from process to collaboration. Before people worked in a production process in which they gave a product from one to another, now they work in teams a work together on the product as a whole	The Smart Industry manufacturing technologies are critical links in the production process. People are dependent on the uptime of the machines

Feedback from others

Several changes were found within the social job characteristic feedback from others. These changes have been found in the feedback from the supervisor, feedback from customers and feedback from others.

The interviewees noticed that the role of the supervisor in relation to feedback changed. This change can be defined as a transition from feedback on technical aspects to feedback on the process. This change can be dedicated to the complexity of the technologies and the various knowledge that is needed. All the technologies are too complex to master for a supervisor. Previously, the supervisor was a technical expert. An interviewee from company A mentions that it is important to share knowledge to minimize the gap and prevent mistakes. The supervisor now focusses on the coaching and guidance of the process. A statement of a company B's supervisor substantiated the finding above, this was an answer on a question in regards to:

"In the past my job was oriented on the substantive knowledge, nowadays I am increasingly focussing on guiding the process" – R2

In relation to this shift a change is found from a rather individual approach to a team approach. This is in line with the change mentioned before in relation to collaboration inside the company. Since teamwork asks for different feedback mechanisms regarding to the interviewees. An interviewee of company B stated:

"Nowadays we are reviewed on the performance we deliver together" – R5

In relation to the characteristic, feedback from others, the results showcase that data plays an important role within the feedback loops of companies. Several applications of data are mentioned. Data from customers is an important aspect that is mentioned a lot. Interviewees mentioned that they use the data from its customers to improve, adjust or repair their product. An interviewee of company B mentioned that they can for example analyse the temperature a power usage on a distance. This is being used to prevent failures. An interviewee of Company B explained how they use data in relation with a network-centric approach to solve customer problems from distance:

"We are able to log into the machines of a customer when a malfunction occurs. Often we can directly find the problem, but sometimes this is not possible. In that case we use the data to detect the problem" - R6

Beside the data collected from companies, the companies use collected to give feedback on others. From both a colleague and supervisor perspective. It also happens that people are exposed to data of a product that they currently work on. The people working in company D can see real-time data from the production process such as failures and performance measurements. This raises the question if this is a phenomenon in the field of the social characteristics or maybe a change in the field of the motivational characteristic feedback from the job. This question will be discussed in chapter five. The following quote of an interviewee from company C explains some context in the use of data in regards to feedback:

"At the moment we have tooling that is modified in the wrong way. In the data we noticed something changed in the measurements. We send this feedback to R&D. They have to adjust these measurements" – R8

Table 14: An overview of the findings per aspect of feedback from others per company

Feedback from others	**Company A**	**Company B**	**Company C**	**Company D**
Feedback on performance from supervisors	Due to the shift from individualistic work to teams, the role of the supervisor changed from giving feedback on the technical aspects to feedback on the process	Due to the shift from individualistic work to teams the role of the supervisor changed from giving feedback on the technical aspects to feedback on the process	No relatable changes were found	Data plays increasingly important role in the feedback loop. This data arises from the smart digitized manufacturing process which is integrated by network-centric technologies

Feedback on performance from customer/clients	Tech workers from this company can log in on the manufacturing process of the customer. By analysing the data they provide support and upgrades	Tech workers from this company can log in on the manufacturing process of the customer. By analysing the data they provide support and upgrades	No relatable changes have been found	No relatable changes have been found
Feedback on performance from others	Stand-ups are used as an additional feedback method	Stand-ups are used as an additional feedback method	Data is used within the production process to gain direct feedback or to use it as fundament for feedback to others. Standups are used as an additional feedback method	Data is used within the production process to gain direct feedback or to use it as fundament for feedback to others. Stand-ups are used as an additional feedback method

Social support

When it comes to the results regarding to social support the assistance from co-workers becomes different, the assistance from supervisors becomes different and a surprising result is that organisations increasingly look for support from outside the company. The last was already mentioned in 4.1.

In paragraph 4.2 there is stated that the interviewees mention that they become increasingly dependent on each other's knowledge due to the complex Smart Industry environment. This can be linked to the social support. Because of this dependence the interviewees state that it gets increasingly important to support each other and share knowledge. The interviewees describe that the teams consist of several specialists. In this study we found that the Smart Industry context increasingly ask for social support related to knowledge. A company A's interviewee describes how this support works in practice:

> *"Smart Industry asks for new techniques, complex techniques. Much will be asked from employees when a company applies these techniques and only two or three people mastered those techniques" – R1*

The type of support supervisors provide is already elaborated a bit in paragraph 2.2.3. The support supervisors give obviously depend on for example the type of collaboration mechanisms. In this study we found a shift from individualistic or process-based collaboration towards teamwork. The interviewees mentioned that the type of support a supervisor provides is different than before. This means that in the Smart Industry context where is worked in teams the supervisor has a different supporting role than in a non-Smart Industry context. The type of support in turn shifts from technical support to support on the team process. A supervisor from company A mentions that he brings experts in contact on technical subjects and he also mentions that he was that technical expert in the past. This is due to the increasingly complex technologies. Two quotes of a Company B's interviewee describe this situation:

> "The project manager guides the projects and the manager keeps an eye on this. When everything goes well you will not hear the manager" – R3

"We work in SCRUM-teams. This is totally not hierarchical, I do not know who is my manager to be honest" – R5

When it comes to the social support from others and in this case the social support of authorities from outside the organisation they can be divided into two sources of support. The first source of social support from outside the company is the support and the knowledge deliverance of suppliers. The complex products and technologies people work with are developing just as fast as the Smart Industry context itself. This means that employees need to be aware of all the new future, options and opportunities supplied products and technologies have. This is mentioned by interviewees from all the companies that were visited in relation to this study. The second source of social support from outside the company is even more remarkable. Within company A and B the interviewees mentioned that they sometimes look for knowledge within the boundaries of the competitive scope. This does not mean that they headhunt other companies' tech workers. This means that knowledge is shared and employees share their expertise and that this knowledge is being applied on the product of the competitor. This way of working is explained by an interviewee of company B:

"We also exchange knowledge between competitors. My engineers are also deployed in the projects of competitors because they do have a certain piece of knowledge they don't have. Competitors just ask them for the piece of knowledge they do not have. We also do that the other way around." – R4

Table 15: An overview of the findings per aspect of social support per company

Social support	**Company A**	**Company B**	**Company C**	**Company D**
Assistance from coworkers	Since another depends on some specific knowledge of the other there is more need for assistance from co-workers	Since the workplace is getting more complex (technological wise) and specific knowledge is divided but needed in a single product people increasingly look for assistance	To achieve the highest quality every specialist is being used for their strength. This means increasingly assistance among co-workers to create a product	Experts of certain technologies are more often involved in different processes other than their core processes due the knowledge they have
Assistance from supervisors	A supervisor is not able to support all technical issues because the technology is getting too complex. The supervisor has a facilitating role to enhance better collaboration	A supervisor is not able to support all technical issues because the technology is getting too complex for him alone. The supervisor has a facilitating role. They also set up knowledge meetings with others from outside the company	A supervisor is not able to support all technical issues because the technology is getting too complex. The supervisor has a facilitating role to enhance better collaboration. The supervisor does not have daily contact with the engineers an techniques	No relatable changes have been found
Assistance from others	Employees are looking for support from outside the company when they cannot find the knowledge inside the	Tech workers are looking for support from outside the company when they cannot find the knowledge inside the	Employees are looking for support from outside the company when they cannot find the knowledge inside the	Employees are looking for support from outside the company when they cannot find the knowledge inside the

	company. They look for knowledge if a customer has specific needs	company. In this case also the competitors are involved	company. They mainly look for technical knowledge about new technologies	company. They mainly look for technical knowledge from mainly suppliers

5. Discussion and conclusion

Smart Industry

When it comes to digitalization it becomes clear that all the companies have certain digitized information transfers and increasingly communication by digital technologies. An example of digitalized information transfers are linked machines and databases. An example of the digital communication are video meetings. These changes are also described in the documents of Smart Industry (2016; 2018). The results indicate that company A and B also use technologies in the field of connected factories. As displayed in Table 11 they are able gather information from the production process of the company straight out of the systems of the customer. This means that factories are connected and digitized data is transferred with a network-centric approach (Smart Industry, 2018). It turned out that company C and D do not make use of such technology. This may explain why no change has been found in the way and amount of feedback from the customer within company C and D. Instead, in company A and B a change has been found due to the digital connection of the company and the customer and this data transfer.

All companies use smart technologies when it comes to smart manufacturing, but company A and D use smart manufacturing technologies which are intelligent enough to process different products with different measurements. Within company D this is somewhat further than the rest. Company A for example also produces some customized products by hand. This could be linked to a finding that within company D the employees are highly dependent on the manufacturing technology. The interviewees mention that they are very dependent on the technology. Interviewees from other companies mention that they are dependent on the knowledge of others. This is very different from the dependency there is found within company D.

Interaction outside the organization

The results on interaction outside the organization indicate that the complexity of the Smart Industry technologies asks for technical specialists who communicate with the customers and suppliers to build together customer specific solutions .close interaction with stakeholders from outside the organization is key in Smart Industry times. This is in line with the statement of Schwab (2017) who stated that the Smart Industry change the activities we do and how we do these activities. The activities changed by the fact that tech workers now have a more advisory role towards the customer. Before the tech workers did not have that much contact outside the organization, the focus was primarily on the production process. The way how tech workers perform production activities changed since tech workers work in teams more often. Customers are looking for customer specific solutions (Smart Industry, 2016). This asks for different and more specialistic knowledge and collaboration of experts in teams to meet the customers' desires. These often multidisciplinary teams were already addressed in the research of Corporaal et al. (2018). They stress the importance to prepare tech workers for the work in multidisciplinary environments since the Smart Industry products are becoming more complex and increasingly and knowledge from multiple disciplines is a prerequisite. This also applies on the contact with the suppliers. Corporaal et al. (2015) mentioned that tech workers have increasingly contact with suppliers. The results of the research also indicate that this way of working is different than before and has to do with the variance of knowledge needed in regards to Smart Industry Technologies. The findings showcased that this contact is mainly about technical parts of the supplied product. The results also indicate that tech

workers have increasingly interaction with other authorities from outside the organization to gain technical knowledge. Smart Industry (2016) already mentioned that they think that the changing working environment demands new skills and knowledge. In this study we found that the required knowledge is not always present in the company. Companies solve this by interacting with other authorities that can provide the missing knowledge.

There are two streams about the effects of this increasing contact beyond the boundaries of the organization. In regards to Zapf et al. (2001), interaction outside the organization is pretty often related to burnout complaints. Zapf et al. (2001) state that interaction outside the boundaries of the organization could involve emotions. Cordes and Dougherty (1993, p. 644) state that burnout is caused by "direct, intense, frequent, or lengthy interpersonal contacts". The second stream takes it from a different point of view. Regarding to Grant (2007) interaction outside the organization will positively affect the affective commitment, persistence, motivation and helping behaviour. Warr (2007) weight up these two streams and concluded that there is a certain level which works positive on the well-being of the employee and an overwhelming level works negative on the well-being. Since the way interaction outside the organisation is designed different than before it could be beneficial to look at these two outcomes of the interaction and design jobs with a balanced level of contact outside the boundaries of the organization. Corporaal et al. (2015) found that this also asks for different skills than before. These skills are related to advising, negotiation and communication.

Task interdependence

The results of this study on task interdependence indicate that the complexity of the Smart Industry technologies and the fragmentation of specific knowledge ask for different types of collaboration and brings additional dependencies in work based on knowledge. When you look at the definition of task interdependence it becomes clear this has to do with the connection an employee's job has with other jobs (Kiggundu, 1981, 1983; Thompson, 1967; Wageman, 2001). In this study we found that the connections with other jobs are increasing. Corporaal et al. (2015) already mentioned that multidisciplinary teams are becoming more common. This is in line with the findings of this study. Within every company a certain extent of multidisciplinary is found, also teamwork is very common and this is something that is originated due to the complexity of technologies.

Regarding to Smart Industry (2016) knowledge plays an important role within the Smart Industry context. This study indicates that the knowledge about technologies becomes divided among the tech workers. This makes that tech workers depend on each other when they have to perform a task on the border of another's expertise.

Barley and Kunda (2001) state that when jobs require more participation in multidisciplinary teams it becomes more important to have interpersonal and decision making skills. This was also mentioned in the interviews. In addition to this, interviewees mentioned that it is useful to have some knowledge of the other discipline to understand topics on the border of different disciplines.

Feedback from others

The results of this study on feedback from others indicate that combination of the Smart Industry technologies, smart manufacturing, digitalization and a network-centric approach, brings new opportunities to gather and provide feedback information by the use of data. This statement can be discussed when it comes to which characteristic of the job design model is

related. The results of this study indicate that this type of feedback produced by Smart Industry aspects contains both aspects from feedback from the job itself and feedback from others. When you look at the definition of feedback from the job this is about the feedback that comes directly from the job and is related to the individual performance (Hackman & Lawler, 1971; Hackman & Oldham, 1980)". Some parts of this are applicable since data generated by a produced product can be used as feedback. When it comes to feedback from others two Humphrey et al. (2007) state that this is different from feedback from the job since it is not something that is generated right out of the job and it contains interpersonal aspects. The supervisors indicate that the data they use for feedback is generated by the manufacturing process which is connected to other machines by a network centric approach. The big data is analysed and used as input for the feedback. This feedback from the data is also used as input for interpersonal feedback.

When it comes to feedback from the supervisor a shift is found from feedback on specific technical aspects towards feedback on the team process and performance. Morgeson, DeRue and Karam (2010) also mention that managing a team is different than managing for example a department. They mention that monitoring the team, encourage the team's self-management and challenge the team are for example important aspects which are needed. Supervisors mention that their leadership also asks more for these aspects. For a supervisor it gets harder to provide feedback on the performance in relation to the actual technical product since there is a gap in the knowledge. Supervisors mention that they cannot keep up the knowledge since the development pace is too fast.

When it comes to the effects of feedback from others Klunger & DeNisi (1996) state that feedback is more likely to cause a positive effect when it is more focussed on the job. All these new Smart Industry technologies make it possible to provide more specific feedback on the performance of the task. This feedback can be both digital or input for interpersonal feedback. These new and specific sources can be beneficial to increase the effectiveness of feedback.

Social support

The results of the study on social support indicate that fragmentation of knowledge and the need for specialistic insights in regards to a single product asks for more support from colleagues and other external stakeholders than ever before, affecting the supervisor's role. Knowledge is fragmented and people depend on each other's' knowledge. Corporaal et al. (2018) also stated that tech workers are specialist more often. To be effective, interviewees describe that knowledge sharing and supporting each is necessary to produce the product and features that are needed within the specific needs of a customer. The merge of different far-reaching technologies and the demand for customization is the root for this need for support.

The social support form supervisors also shifts from technical support to support on the process. The interviewees indicate that the far-reaching Smart Industry technology makes it impossible to have a supervisor with all the technical knowledge. On the other hand, the collaboration shifted from a production process towards teamwork. This also asks for other ways op supervision and support (Morgeson et al., 2010). Corporaal et al. (2018) mentioned that Smart Industry context asks for a supervisor who supports within the process when necessary. This is completely in line with the statements of the interviewees.

When looking at the definition of social support used in this study, this study found another type of support, namely the support from outside the company. The definition used in this study was formulated by Grant and Parker (2009, p. 325) "Social support is the degree to

which employees receive assistance from supervisors and co-workers (Karasek, 1979; Karasek & Theorell, 1990)". This support from outside the company is a new phenomenon that has to do with the far-reaching knowledge and the changing customer specific question a company gets. Customers often have very specific needs for things an organization has no knowledge of. Tech workers will search for support from outside the company when the right support cannot be found inside the boundaries of an organization.

The extent the social support is present in a job affects the well-being of an employee and indirectly the performance (Grant & Parker, 2009). This means that in the Smart Industry environment more social support is needed, indicating that this is an important job design characteristic to pay attention to in the (re)design of jobs. The need for social support is dependent on the preferences and situation of an individual (Oldham & Hackman, 2010). So when it comes to social support we talk about a need for customization of the composition of the job of an individual.

Comparison of expected and empirical findings

In Table 16 a comparison of expected and empirical findings van be found. In this paragraph the comparison will be discussed. When it comes to task interdependence the literature expected that employees would become more independent in the time and place they work. The empirical findings partly support this, since tech workers can now log into the production process of their customer from anywhere if they feature a device and internet. But in the interviews there was nothing mentioned that this influences the task interdependence. Another expected change was that the communication among employees would be digitalized more often. The empirical findings support this expectation. The expectation was that production companies would work more in multidisciplinary teams. This was also found in the empirical findings. The tech workers now work with more disciplines and different specialists on more complex problems in teams. Beside this it came up that technology becomes more important within the production process and that the production process relies on the up time of the technology. This was found in the empirical results, but not presented in Table 3.

When it comes to digitalization it came true that data plays an important role in the feedback cycle. It is used as input for supervisors to give feedback to others, but it also appears on the shop floor directly from the machine. The feedback is becomes more detailed due to the influence of data. Beside the expected changes it is found that supervisors itself shift from a more technical feedback approach to a process orientated approach.

When it comes to social support it was expected that the digitalization would influence the social interactions people would have. In this research no empirical findings are found to support this. Also it was expected that the source of the support may change and also technology would be used as a support tool. This is partly supported by the empirical findings. Another sources that is being used for social support are external parties. Technology is also consulted when problems occur (e.g. data analytics and feedback from data).

In Table 3 several predictions where made about the interaction outside the organisation. The empirical findings support that the interaction with customers is changed and the extent of the contact increased. This is due to the specific technical needs and questions customers have. The automation of administration and additional tasks did not came up as a reason for this contact. The main reason that came up was the need for specialist in depth technical knowledge. Beside the expected changes the empirical findings indicate that the extend of the contact with suppliers increased. This has to do with specific technical questions. In line with this more support is being asked from external parties about in depth technical issues.

Table 16: Comparison of expected and empirical findings

Social characteristic	***Comparison***
• *Task interdependence*	
Expected	- Employees become more independent in the time and place they work. This may influence the task interdependence - The way employees communicate is digitalizing. This may influence the interaction in the workspace - Multidisciplinary teams are more often applied since more complex knowledge is needed. This may influence the type and sort of interaction employees have
Empirical findings	- Tech workers work in multidisciplinary teams. The complex problems now a days ask for specific knowledge and different views - More complex problems that ask for different specialists makes that employees are more dependent on each other deliver a product successfully - Collaboration changed since communication is digitalized more often (e.g. digital information screens to communicate with supervisors and colleagues) - It also came up that technology becomes more important within the production process and that the production process relies on the up time of the technology
• *Feedback from others*	
Expected	- Digitalization may influence the way people receive feedback from others - Direct feedback from the job is getting more detailed by the use of data and technologies. This may influence the frequency and subject in relation to feedback from others - Data may play a bigger role in the aspect feedback from others
Empirical findings	- The role of the supervisor in relation to feedback changed. In the past the feedback was more focused on technical aspects and today it is more focused on the process - Data plays a more important role in the feedback loop. Data from inside and outside the company is retrieved and analysed - Feedback on performance is also retrieved from for example screens in the workplace
• *Social support*	
Expected	- The expectations are that people will interact differently due to the digitalized communication, multidisciplinary teams and new interdependencies - The sources of support may differ. It may be that support will be found in technologies
Empirical findings	- Tech workers are increasingly dependent on each other's specialisms. Tech workers ask for more social support - The support a supervisor gives changed from individualistic to teamwork based - When support cannot be found inside the company the tech workers try to find the support outside the company.
• *Interaction outside the organization*	
Expected	- The way people communicate is changing. This may affect the interaction outside the organization - Customers have more and more specific needs. This may increase and change the interaction outside the organization - The automation of administration and other additional tasks could bring opportunities to spend time differently. It could provide an employee time to interact more with the customer - Knowledge is getting more complex. This may cause that the experts will advise the customers on specific parts of the technology

Empirical findings	- The extent tech workers have contact with the suppliers increased due to Smart Industry. This is due to the specific technical knowledge tech workers have and others do not have - The extent tech workers advice customers increase due to Smart Industry. This is due to the specific technical knowledge tech workers have and others do not have - Tech workers mention that the extent they retrieve knowledge from external parties increased. When tech workers have to deal with specific problems in which there is no expert within the company they retrieve it externally

5.1 Limitations

This study has several limitations due to the choices that were made. One of the limitations is about the choice to only measure the social characteristics of job design. As discussed in the theory scholars found that the social characteristics are not the only components of a well-designed job. Scholars also proofed the importance of motivational characteristics and work context characteristics. Because this study only researched the social characteristics obviously no methods are applied to gather information about such motivational or work context characteristics. But this study indicates that the line between social characteristics and other characteristics is thin, since the characteristics are coherent. This study for example found changes on the characteristic feedback from others. Humphrey et al. (2007) point out that there is also a characteristic related to feedback from the work. One could debate if the results in this study on the characteristic feedback from others could be categorized under the characteristic feedback from work. Feedback from others is replaced by feedback from data generated from machines in some cases. One could also explain this as feedback from work.

Another limitation of this study is that the cases in this study do not represent all the companies who work with Smart Industry. This study only researched companies which operate in the technical sector. Smart Industry technologies are also applicable in for example healthcare, transport, construction or perhaps education. An example of Smart Industry in transport can be a full automated shipyard who is able to switch between different containers and which gathers data. The limitation of the choice to only research the technical is that when the research would be conducted in other branches the results may be different. So it is not reliable to apply the answers to the research question on other branches than this study contains.

5.2 Practical implications

The Smart Industry brings a lot of changes and opportunities for adopting new and smarter technologies for the companies. For companies who adapted Smart Industry technologies it is important to keep in mind that this changes the social characteristics of job design. The changes found need to be taken into account when it comes to job redesign. The first practical implication proposed is related to skills. The change in the social characteristics asks for new skills. It is important to bear this in mind when designing jobs. The interaction characteristics ask for more interpersonal interaction. A couple of interviewees mentioned that interpersonal skills do not belong to the standard toolbox of a tech worker. An advice would be to train those employees who have contact inside and outside the company step by step on the job. Another implication related to skills and especially relates to those people who have contact with the customers is about the training of advisory, project-based and negotiation skills. These skills were mentioned by people who have daily contact with the customer, but were not developed

before entering this role. In this case also a step by step on the job approach is advised to develop these company specific skills. In addition to this data plays an important role in feedback. An implication would be to support those employees who use their analytical skills if needed. When tech workers do not feature this skill it is recommend to train this step by step on the job by slowly expose them to work with this skill. The above is very important since skills are an important factor in work-success (Boselie, 2010).

The second implication is about the role of the supervisor. The work process changed dramatically. The employees from almost all companies work in teams and have seen a change in the feedback and support of the supervisor. It is important that companies are aware of this facilitating role of the supervisor. Supervising a team asks for other knowledge and skills than supervising a production process (Morgeson et al., 2010). The way of supervision affects the performance of an individual. Another problem is that supervisors become alienated from the actual technical process. The consequence can ben that they get cannot come along with the technical people when it comes to daily communication. Supervisors should also be involved in the technical process to keep up minimal knowledge on the technical products. This helps to be able to keep up a minimal level of technical communication.

The third implication is about the design of job and the personal preferences of an individual. A proper job design should enhance the meaningfulness, responsibility and knowledge of results of an individual. This physical state should lead to a certain behaviour, attitude, role outcome and well-being (Humphrey et al., 2007). The word certain is mentioned on purpose since job design is a phenomenon that assumes that the preferences in job design of an individual are pretty much depend on individual preferences (Oldham & Hackman, 2010). The fit between job design and the individual preferences in turn determine the psychological state and the outcomes. Organizations should be aware of the fact that a good job design is based on individual preferences. An implication would be to give the people within the teams the chance to craft their own job. It is necessary to evaluate this job crafting process with the individual to make sure a perfect fit will be established and the positive outcomes mentioned by Humphrey et al. (2007) will be stimulated as much as possible to contribute on the performance.

5.3 Suggestions for future research

This study focused on the social job design characteristics of Humphrey et al. (2007) and the effects of Smart Industry. The disadvantages of this choice were also discussed in the limitations. Contemporary research on job design focuses mainly on health and well-being (Parker, Morgeson & Johns, 2017). The suggestion will be to focus more on the changing work environment and its effects on job design. Earlier the motivational factors have been researched in relation to Smart Industry by Bosch (2016). This study and the study of Bosch (2016) are characterized by its explorative character and found changes in the characteristics involved in the research. Future research could involve the work context characteristics of the job design model of Humphrey et al. (2007). When this is done in a similar approach the results could be combined and an overreaching study can be composed. To indicate relations between Smart Industry and the change in (social) job design characteristics it can be of added value to design a quantitative measurement instrument. This measurement instrument could be based on the work design questionnaire of Morgeson and Humphrey (2006) to measure the whole job characteristics model. To measure the impact of Smart Industry the pillars

described in Smart Industry (2016) and the impact caused by Smart Industry should be translated in a quantitative scale. In this way the extent Smart Industry affects the company can be compared to the job design characteristics in a way that relations can be indicated.

In regards to the choice to only research companies in the technical sector the suggestion for future research will be to also involve companies from other branches. The disadvantages of the choice to only involve companies who operate in the technical sector is also discussed in the limitations. As discussed in the theory this can be digitalization, smart manufacturing and a network-centric approach. To provide a clear view on this suggestion the branch healthcare is taken as an example. The digitalization within health care could be linked to digitized information transfers and the analytics of big data related to medical information. Smart manufacturing can be linked to sensor technology to measure medical values or 3D printing to print an artificial hip. A network-centric approach can be linked to the connection that may be made between a pacemaker and an alarm centre. This healthcare example is an indication that Smart Industry is not only applicable in the technical sector. So the suggestion is to involve companies who work with Smart Industry technologies from different branches. A researcher could think of involving companies who work with Smart Industry technologies in for example healthcare, transport, construction or education.

5.4 Conclusion

The aim of this study was to answer the research question: 'What is the influence of the Smart Industry context on the social characteristics of job design?'. Hereafter you can find the conclusion on this question with thereafter an explanation.

Main-conclusion: The complexity of the Smart Industry context changes roles and functions of the employees and supervisors, asks for more and different interaction between (multidisciplinary) contacts from both inside and outside the boundaries of the organisation and these changes are affected by the influence of manufacturing technologies, digitalization and network-centric technologies.

The Smart Industry context asks for more social interaction with people from inside and outside the organization. The outcomes of this study indicate a positive effect of Smart Industry on the social characteristics. The outcomes for example show that more interaction is needed, more interaction in turn is related to a positive psychological state. The social interaction is also getting more diverse. Employees have more contact with other disciplines, the customers and the suppliers. Especially companies who are connected to the systems of their customer show an increase in contact with the customer. Companies should bear in mind that too much social interaction could lead to an unhealthy level of commitment and that this could lead to negative outcomes. There can be concluded that the Smart Industry effects an increase in interaction inside and outside the organization and that this can be positive if this meets the personal preferences. When looking at feedback from others there can be concluded that data plays an important role within its the feedback cycle. This gives supervisors and employees the opportunity to give detailed feedback on the performance. There can be concluded that in Smart Industry times the precision of feedback increased this works positive on the work outcomes since detailed feedback on the job works positive. When it comes to social support there can be concluded that more and different social support is needed within Smart Industry times. People are dependent on the knowledge of others and an individual needs support from

others to be successful. Within a company in which the manufacturing technologies are further developed there is a dependency found related to the manufacturing technology. Tech workers who work with these smart manufacturing technologies mention to be dependent on these technologies. There can be concluded that the level of smart technology influences the dependencies to an unknown extent. The role of the supervisor is also different since the way of support changes from a process orientated role towards a rather supportive role. This brings several challenges, for example the connection between the tech workers and their supervisor. There can be concluded that the influence of Smart Industry on social support brings changes in the need for support among tech workers and changes the role of the supervisor.

Interviewees sometimes had different views on Smart Industry and suggested simple techniques as causes of certain changes. Luckily this could be clarified with follow up questions. However, this indicates that Smart Industry is a relatively new concept that is still developing. With the current pace, Smart Industry is developing, meaning that the effects on job design will also be different over time. To keep the knowledge of job design in relation to Smart Industry frequent research on job design is needed.

This explorative research managed to discover some interesting results of Smart Industry on the social characteristics. Although its explorative character this study can be very useful in future research since the results were often ambiguous. For example, working in teams, the use of data, looking for more support and the use of data in feedback are things that came up in almost every case. The added value of this study to the existing literature is a first elaboration of the social characteristics in Smart Industry times. As far as known this combination of concepts is not researched before. The information of this study can be of high value when it comes to job redesign. Organizations can prevent parts of the negative work outcomes when jobs are designed properly. Finally, the results of this study indicate that humans in Smart Industry times use their human skills more (e.g. interaction and analytical skills) in which humans excel and perform tasks that technologies currently cannot perform.

Appendix 1: Interview (Dutch) - Protocol for employees

Naam interviewee: **Datum:**
Plaats: **Functie:**
Tijd begin: **Tijd einde:**
Bijzonderheden:

Introductie

Doel: Kennismaken met interviewee, introduceren rechten en het doel van het interview.

In het interview:

- Introductie interviewer
- Opzet onderzoek
- Benoemen rechten van interviewee
- Informed Concent
- Introductie interviewee (Functie, werkervaring (binnen de organisatie) en werkzaamheden)
  [Werkzaamheden belangrijk voor doorvragen]

Topic 1: Interdependence (afhankelijkheid van anderen)

Doel: Het uitdiepen van dit specifieke sociale onderdeel uit het baan-karakteristieken model. Het inzicht krijgen in de ervaring van dit specifieke onderdeel op dit moment en reflecteren op de veranderingen ten opzichte van het verleden (en de invloed van technologie). Een standaard doorvraag bij elke vraag is: 'op welke manier gebeurt dit?' en/of 'hoe ziet dit er uit?'

Vragen:

- Hoe is de afhankelijkheid van anderen in jouw werk veranderd in de afgelopen 5 jaar?
  [Baan-karakteristiek waar nodig toelichten]
    - Hoe heeft technologie een rol gespeeld in deze verandering?
        - [Bij het noemen van SMI technologie doorvragen op de verschillende technologie]
            - [Verduidelijking in het verschil tussen het verleden en nu van het karakteristiek en de invloed van SMI technologie]
        - [Bij het niet noemen van technologie]
            - [Zoeken naar de achtergrond en eventueel coderen wanneer wel SMI gerelateerd]

Topic 2: Feedback from others (feedback/terugkoppeling van anderen)

Doel: Het uitdiepen van dit specifieke sociale onderdeel uit het baan-karakteristieken model. Het inzicht krijgen in de ervaring van dit specifieke onderdeel op dit moment en reflecteren op de veranderingen ten opzichte van het verleden (en de invloed van technologie). Een standaard doorvraag bij elke vraag is: 'op welke manier gebeurt dit?' en/of 'hoe ziet dit er uit?'

Vragen:

- Hoe de feedback/ terugkoppeling die je krijgt van anderen in jouw werk veranderd de afgelopen 5 jaar? [Baan-karakteristiek waar nodig toelichten]
    - Hoe heeft technologie een rol gespeeld in deze verandering?
        - [Bij het noemen van SMI technologie doorvragen op de verschillende technologie]
            - [Verduidelijking in het verschil tussen het verleden en nu van het karakteristiek en de invloed van SMI technologie]
        - [Bij het niet noemen van technologie]
            - [Zoeken naar de achtergrond en eventueel coderen wanneer wel SMI gerelateerd]

Topic 3: Social support (Ondersteuning van anderen)

Doel: Het uitdiepen van dit specifieke sociale onderdeel uit het baan-karakteristieken model. Het inzicht krijgen in de ervaring van dit specifieke onderdeel op dit moment en reflecteren op de veranderingen ten opzichte van het verleden (en de invloed van technologie). Een standaard doorvraag bij elke vraag is: 'op welke manier gebeurt dit?' en/of 'hoe ziet dit er uit?'

Vragen:

- Hoe is de ondersteuning van anderen in jouw werk veranderd de afgelopen 5 jaar? [Baan-karakteristiek waar nodig toelichten]
    - Hoe heeft technologie een rol gespeeld in deze verandering?
        - [Bij het noemen van SMI technologie doorvragen op de verschillende technologie]
            - [Verduidelijking in het verschil tussen het verleden en nu van het karakteristiek en de invloed van SMI technologie]
        - [Bij het niet noemen van technologie]
            - [Zoeken naar de achtergrond en eventueel coderen wanneer wel SMI gerelateerd]

Topic 4: Interaction outside the organization (contact buiten de organisatie)

Doel: Het uitdiepen van dit specifieke sociale onderdeel uit het baan-karakteristieken model. Het inzicht krijgen in de ervaring van dit specifieke onderdeel op dit moment en reflecteren op de veranderingen ten opzichte van het verleden (en de invloed van technologie). Een standaard doorvraag bij elke vraag is: 'op welke manier gebeurt dit?' en/of 'hoe ziet dit er uit?'

Vragen:

- Hoe is het contact met mensen buiten de organisatie binnen jouw werk veranderd de afgelopen 5 jaar? [Baan-karakteristiek waar nodig toelichten]
    - Hoe heeft technologie een rol gespeeld in deze verandering?
        - [Bij het noemen van SMI technologie doorvragen op de verschillende technologie]
            - [Verduidelijking in het verschil tussen het verleden en nu van het karakteristiek en de invloed van SMI technologie]
        - [Bij het niet noemen van technologie]
            - [Zoeken naar de achtergrond en eventueel coderen wanneer wel SMI gerelateerd]

Afsluiting

- Bedanken
- Eventuele vervolgafspraken wanneer nodig

Appendix 2: Interview (Dutch) - Protocol for supervisor

Naam interviewee: **Datum:**
Plaats: **Functie:**
Tijd begin: **Tijd einde:**
Bijzonderheden:

Introductie

Doel: Kennismaken met interviewee, introduceren rechten en het doel van het interview.

In het interview:

- Introductie interviewer
- Introductie interviewee (Functie, werkervaring (binnen de organisatie) en werkzaamheden)
- Opzet onderzoek
- Benoemen rechten van interviewee
- Informed Concent

Topic 1: Interdependence (afhankelijkheid van anderen)

Doel: Het uitdiepen van dit specifieke sociale onderdeel uit het baan-karakteristieken model. Het inzicht krijgen in de ervaring van dit specifieke onderdeel op dit moment en reflecteren op de veranderingen ten opzichte van het verleden (en de invloed van technologie). Een standaard doorvraag bij elke vraag is: 'op welke manier gebeurt dit?' en/of 'hoe ziet dit er uit?'

Vragen:

- Hoe is de afhankelijkheid van anderen op de afdeling waaraan jij leiding geeft veranderd in de afgelopen 5 jaar? [Baan-karakteristiek waar nodig toelichten]
    - Hoe heeft technologie een rol gespeeld in deze verandering?
        - [Bij het noemen van SMI technologie doorvragen op de verschillende technologie]
            - [Verduidelijking in het verschil tussen het verleden en nu van het karakteristiek en de invloed van SMI technologie]
        - [Bij het niet noemen van technologie]
            - [Zoeken naar de achtergrond en eventueel coderen wanneer wel SMI gerelateerd]

Topic 2: Feedback from others (feedback/terugkoppeling van anderen)

Doel: Het uitdiepen van dit specifieke sociale onderdeel uit het baan-karakteristieken model. Het inzicht krijgen in de ervaring van dit specifieke onderdeel op dit moment en reflecteren op de veranderingen ten opzichte van het verleden (en de invloed van technologie). Een standaard doorvraag bij elke vraag is: 'op welke manier gebeurt dit?' en/of 'hoe ziet dit er uit?'

Vragen:

- Hoe de feedback/ terugkoppeling die jij geeft en krijgt aan/van anderen op de afdeling waaraan jij leiding geeft veranderd de afgelopen 5 jaar? [Baan-karakteristiek waar nodig toelichten]
    - Hoe heeft technologie een rol gespeeld in deze verandering?
        - [Bij het noemen van SMI technologie doorvragen op de verschillende technologie]
            - [Verduidelijking in het verschil tussen het verleden en nu van het karakteristiek en de invloed van SMI technologie]
        - [Bij het niet noemen van technologie]
            - [Zoeken naar de achtergrond en eventueel coderen wanneer wel SMI gerelateerd]

Topic 3: Social support (Ondersteuning van anderen)

Doel: Het uitdiepen van dit specifieke sociale onderdeel uit het baan-karakteristieken model. Het inzicht krijgen in de ervaring van dit specifieke onderdeel op dit moment en reflecteren op de veranderingen ten opzichte van het verleden (en de invloed van technologie). Een standaard doorvraag bij elke vraag is: 'op welke manier gebeurt dit?' en/of 'hoe ziet dit er uit?'

Vragen:

- Hoe is de ondersteuning van anderen op de afdeling waaraan jij leiding geeft veranderd de afgelopen 5 jaar? [Baan-karakteristiek waar nodig toelichten]
    - Hoe heeft technologie een rol gespeeld in deze verandering?
        - [Bij het noemen van SMI technologie doorvragen op de verschillende technologie]
            - [Verduidelijking in het verschil tussen het verleden en nu van het karakteristiek en de invloed van SMI technologie]
        - [Bij het niet noemen van technologie]
            - [Zoeken naar de achtergrond en eventueel coderen wanneer wel SMI gerelateerd]

Topic 4: Interaction outside the organization (contact buiten de organisatie)

Doel: Het uitdiepen van dit specifieke sociale onderdeel uit het baan-karakteristieken model. Het inzicht krijgen in de ervaring van dit specifieke onderdeel op dit moment en reflecteren op de veranderingen ten opzichte van het verleden (en de invloed van technologie). Een standaard doorvraag bij elke vraag is: 'op welke manier gebeurt dit?' en/of 'hoe ziet dit er uit?'

Vragen:

- Hoe is het contact met mensen buiten de organisatie op de afdeling waaraan jij leiding geeft veranderd de afgelopen 5 jaar? [Baan-karakteristiek waar nodig toelichten]
    - Hoe heeft technologie een rol gespeeld in deze verandering?
        - [Bij het noemen van SMI technologie doorvragen op de verschillende technologie]
            - [Verduidelijking in het verschil tussen het verleden en nu van het karakteristiek en de invloed van SMI technologie]
        - [Bij het niet noemen van technologie]
            - [Zoeken naar de achtergrond en eventueel coderen wanneer wel SMI gerelateerd]

Afsluiting

- Bedanken
- Eventuele vervolgafspraken wanneer nodig

Literature

Allen, R. C. (2009). *The British industrial revolution in global perspective (Vol. 1)*. Cambridge, VK: Cambridge University Press.

Arthur, W. B. (2009). *The nature of technology: What it is and how it evolves*. Simon and Schuster.

Bakker, A. B., & Demerouti, E. (2007). The job demands-resources model: State of the art. *Journal of managerial psychology, 22*(3), 309-328.

Barley, S. R., & Kunda, G. (2001). Bringing work back in. *Organization science*, *12*(1), 76-95.

Bauernhansl, T., Ten Hompel, M., & Vogel-Heuser, B. (Eds.). (2014). *Industrie 4.0 inproduktion, automatisierung und logistik: anwendung, technologien und migration* (pp. 1648). Wiesbaden: Springer Vieweg.

Bleijenbergh, I. L. (2015). Kwalitatief onderzoek in organisaties. Den Haag: Boom Lemma.

Bosch, D. (2016) J*ob characteristics in smart industries and the challenges for job design* ` (Master thesis). Retrieved from: http://essay.utwente.nl/71526/1/Bosch_MA_BMS.pdf

Boselie, P. (2010). High performance work practices in the health care sector: a Dutch case study. *International journal of manpower*, 31(1), 42-58.

Bryman, A., & Bell, E. (2015). *Business research methods*. Oxford: Oxford University Press.

Brynjolfsson, & McAfee, A. (2014). *The Second Machine Age.* New York: W.N. Norton & Company.

Campion, M. A., Papper, E. M., & Medsker, G. J. (1996). Relations between work team characteristics and effectiveness: A replication and extension. *Personnel psychology, 49*(2), 429-452.

Challenger, R., Leach, D. J., Stride, C. B., & Clegg, C. W. (2012). A new model of job design: Initial evidence and implications for future research. *Human Factors and Ergonomics in Manufacturing & Service Industries, 22*(3), 197-212.

Cordes, C. L., & Dougherty, T. W. (1993). A review and an integration of research on job burnout. *Academy of management review*, *18*(4), 621-656.

Corporaal, S., Alons, M., & Vos, M. (2015). *Werken in de nieuwe industriële realiteit Een verkennend onderzoek naar de verwachtingen van werkgevers over jonge technici.* Enschede: TechYourFuture.

Corporaal, S., Vos, M., van Riemsdijk, M., de Vries, S. (2018). *Werken in de nieuwe industriële revolutie*. Enschede: TechYourFuture.

Crouch, M., & McKenzie, H. (2006). The logic of small samples in interview-based qualitative research. *Social science information*, 45(4), 483-499.

Davenport, T. H., & Kirby, J. (2015). Beyond automation. *Harvard Business Review, 93*(6), 59-65.

De Jong, S. B., Van der Vegt, G. S., & Molleman, E. (2007). The relationships among asymmetry in task dependence, perceived helping behavior, and trust. *Journal of applied psychology, 92*(6), 1625.

Dooley, D.D. (2001). *Social Research Methods* (4th ed.). New Jersey: Prentice Hall

Duffy, M. K., Ganster, D. C., & Pagon, M. (2002). Social undermining in the workplace. *Academy of management Journal*, *45*(2), 331-351.

Duffy, M. K., Shaw, J. D., & Stark, E. M. (2000). Performance and satisfaction in conflicted interdependent groups: When and how does self-esteem make a difference?. *Academy of Management Journal, 43*(4), 772-782.

Edwards, R., & Holland, J. (2013). *What is qualitative interviewing?.* Edinburgh: A&C Black.

Frey, C. B., & Osborne, M. A. (2013). *The future of employment. How susceptible are jobs to computerisation.* Oxford, USA: Oxford University.

Frey, C. B., & Osborne, M.A. (2015). *Technology at work: The future of innovation and employment*. Oxford, USA: Oxford University.

Gordon, R. J. (2016). *The rise and fall of American growth: The US standard of living since the civil war*. Princeton, USA: Princeton University Press.

Grant, A. M. (2007). Relational job design and the motivation to make a prosocial difference. *Academy of Management Review, 32*(2), 393-417.

Grant, A. M., & Parker, S. K. (2009). 7 redesigning work design theories: the rise of relational and proactive perspectives. *Academy of Management annals, 3*(1), 317-375.

Habraken, M. M. P., & Bondarouk, T. (2017, November). Smarter than before: A representation of Smart Industry and its implications for HRM in the Netherlands. In *10th Biennial International Conference of the Dutch HRM Network: Sustainable HRM*.

Hackman, J. R., & Lawler, E. E. (1971). Employee reactions to job characteristics. *Journal of applied psychology, 55*(3), 259.

Hackman, J. R., & Oldham, G. R. (1975). Development of the job diagnostic survey. *Journal of Applied psychology*, *60*(2), 159.

Hackman, J. R., & Oldham, G. R. (1976). Motivation through the design of work: Test of a theory. *Organizational behavior and human performance, 16*(2), 250-279.

Hackman, J. R., & Oldham, G. R. (1980). *Work redesign*. Camebridge, VK: Harvard University.

Humphrey, S. E., Nahrgang, J. D., & Morgeson, F. P. (2007). Integrating motivational, social, and contextual work design features: a meta-analytic summary and theoretical extension of the work design literature. *Journal of applied psychology, 92(5), 1332.*

Ilgen, D. R. (1999). Teams embedded in organizations: Some implications. *American Psychologist*, *54*(2), 129.

Johns, T., & Gratton, L. (2013). The third wave of virtual work. *Harvard Business Review, 91*(1), 66-73.

Kagermann, H. (2017). *Chancen von Industrie 4.0 nutzen. In Handbuch Industrie 4.0*. Berlin, Germany: Springer Berlin Heidelberg.

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.

Karasek Jr, R. A. (1979). Job demands, job decision latitude, and mental strain: Implications for job redesign. *Administrative science quarterly,* 285-308.

Karasek, R. A., & Theorell, T. (1990). *Health work. Basic Book*. New York: Basic Book.

Kiggundu, M. N. (1981). Task interdependence and the theory of job design. *Academy of management Review*, *6*(3), 499-508.

Kiggundu, M. N. (1983). Task interdependence and job design: Test of a theory. *Organizationalbehavior and human performance*, *31*(2), 145-172.

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological bulletin, 119*(2), 254.

MacDuffie, J. P. (2007). 12 HRM and Distributed Work: Managing People Across Distances. *The Academy of Management Annals, 1*(1), 549-615.

McAfee, A., & Brynjolfsson, E. (2016). Human work in the robotic future: Policy for the age of automation. *Foreign Affairs*, *95*, 139.

Mokyr, J. (1990). *Twenty five centuries of technological change: an historical survey*. Abingdon: Taylor & Francis.

Mokyr, J., Vickers, C., & Ziebarth, N. L. (2015). The history of technological anxiety and the future of economic growth: Is this time different?. *The Journal of Economic Perspectives, 29*(3), 31-50.

Morgeson, F. P., & Campion, M. A. (2003). Work design. *Handbook of psychology: Industrial and organizational psychology*, *12*(2), 423-452.

Morgeson, F. P., DeRue, D. S., & Karam, E. P. (2010). Leadership in teams: A functional approach to understanding leadership structures and processes. *Journal of management*, *36*(1), 5-39.

Oldham, G. R., & Hackman, J. R. (2010). Not what it was and not what it will be: The future of job design research. *Journal of organizational behavior, 31*(2-3), 463-479.

Morgeson, F. P., & Humphrey, S. E. (2006). The Work Design Questionnaire (WDQ): developing and validating a comprehensive measure for assessing job design and the nature of work. *Journal of applied psychology, 91*(6), 1321.

Parker, S. K. (2014). Beyond motivation: Job and work design for development, health, ambidexterity, and more. *Annual review of psychology, 65*, 661-691.

Parker, S. K., Wall, T. D., & Cordery, J. L. (2001). Future work design research and practice: Towards an elaborated model of work design. *Journal of occupational and organizational psychology, 74*(4), 413-440.

Porter, L. W., & Lawler, E. E. (1968). *Managerial attitudes and performance.* Homewood: Irwin

Rhoades, L., & Eisenberger, R. (2002). Perceived organizational support: a review of the literature. *Journal of applied psychology*, *87*(4), 698.

Rush, Harold F. M. (1971). *Job Design for Motivation.* New York: The Conference Board.

Saunders, M., Lewis, P., & Thornhill, A. (2012). *Research methods for business students*. London: Pearson education.

Schwab, K. (2017). *The fourth industrial revolution*. London: Penguin UK.

Shaw, J. D., Duffy, M. K., & Stark, E. M. (2000). Interdependence and preference for group work: Main and congruence effects on the satisfaction and performance of group members. *Journal of Management*, *26*(2), 259-279.

Shields, P. M., & Rangarajan, N. (2013). *A playbook for research methods: Integrating conceptual frameworks and project management*. Oklahoma: New Forums Press.

Sims, H. P., Szilagyi, A. D., & Keller, R. T. (1976). The measurement of job characteristics. *Academy of Management journal, 19*(2), 195-212.

Smart Industry (2014). *Smart Industry actieagenda*. Retrieved from: https://www.smartindustry.nl/category/publicaties/documenten/

Smart Industry (2015) *Smart Industry: Dutch industry fit for the future*. Retrieved from: http://smartindustry.nl/wp-content/uploads/2017/08/opmaak-smart-industry.pdf

Smart Industry (2016) *Smart Industry Standaardisatie agenda.* Zoetermeer: Smart Industry. Retrieved from: https://www.smartindustry.nl/category/publicaties/documenten/

Smart Industry (2018) *Smart Industry roadmap.* Retrieved from: https://www.smartindustry.nl/category/publicaties/documenten/

Spreitzer, G., Sutcliffe, K., Dutton, J., Sonenshein, S., & Grant, A. M. (2005). A socially embedded model of thriving at work. *Organization science, 16*(5), 537-549.

Stewart, G. L., & Barrick, M. R. (2000). Team structure and performance: Assessing the mediating role of intrateam process and the moderating role of task type. *Academy of management Journal, 43*(2), 135-148.

Stone, E. F., & Gueutal, H. G. (1985). An empirical derivation of the dimensions along which characteristics of jobs are perceived. *Academy of Management Journal, 28*(2), 376-396.

Turner, A. N., & Lawrence, P. R. (1965). *Industrial jobs and the worker: An investigation of response to task attributes*. Harvard: Harvard University.

Van der Vegt, G. S., & Janssen, O. (2003). Joint impact of interdependence and group diversity on innovation. *Journal of management, 29*(5), 729-751.

Wageman, R. (2001). How leaders foster self-managing team effectiveness: Design choice versus hands-on coaching. *Organization Science*, *12*(5), 559-577.

Wang, S., Wan, J., Zhang, D., Li, D., & Zhang, C. (2016). Towards smart factory for industry 4.0: a self-organized multi-agent system with big data based feedback and coordination. *Computer Networks*, *101*, 158-168.

Warr, P. (2007). Searching for happiness at work. *Psychologist-Leicester*, *20*(12), 726.

Zhang, L. F., You, L. M., Liu, K., Zheng, J., Fang, J. B., Lu, M. M. & Wu, X. (2014). The association of Chinese hospital work environment with nurse burnout, job satisfaction, and intention to leave. *Nursing outlook*, 62(2), 128-137.

Zapf, D., Seifert, C., Schmutte, B., Mertini, H., & Holz, M. (2001). Emotion work and job stressors and their effects on burnout. *Psychology & Health, 16*(5), 527-545.