MASTER THESIS

Quality of Work in the Smart Industry; How to measure?

A qualitative research on the appropriate aspects for a quality of work measuring instrument in a smart industry environment with the WEBA (Welzijn Bij de Arbeid) as a starting point.

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Acknowledgement

Two years ago, I graduated from the HAN University of Applied Sciences and got my degree in Finance and Control. I started at Radboud University for the Premaster Business Administration and subsequently chose the specialisation Organisational Design and Development. Now, two years later, I am handing in my Master Thesis. This thesis – ‘Quality of Work in the Smart Industry; How to measure? - is the last step before I can actually say that I have completed my Master's degree.

A master thesis is already a challenge and a master thesis in times of COVID-19 is even more challenging. Nevertheless, I look back on a successful process in which I have developed myself both personally and academically. I would like to take this opportunity to thank everyone who has helped me during this process.

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Hopefully, you will enjoy reading my master thesis.

Lotte van Rodijnen
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Abstract

The development of smart industry is quite technology driven. However, in recent years, there have also been various discussions about the consequences of technological developments for the quality of work. This research contributes to the literature on the impact of smart industry technologies on the quality of work by investigating which aspects are necessary in a measuring instrument in order to provide a representative picture of the quality of work in a smart industry environment followed by analysing the WEBA (Welzijn Bij de Arbeid), investigating if the original WEBA is still applicable for companies in a smart industry environment and, if not, show whether an adaptation or extension of this original WEBA is possible.

This research took an qualitative approach. Data has been collected in two companies in a smart industry environment by means of eight interviews, seven company related documents, one questionnaire and five transcripts of fellow researchers. Coding is used to analyse the data.

The findings of this research is the high degree of relevance of the current WEBA with little changes. And the development of an additional module with three non-structural items to measure the quality of work in a smart industry environment: (1) Training methods; (2) Productivity; (3) Ambitions and state of mind.

This research compared the WEBA with the current characteristics of quality of work in a smart industry environment. In addition, this research found no negative effects of digitalisation on quality of work in these companies. This research shows that it does not directly lead to job losses and that digitalisation does not lead to stress either, but rather has a stress-reducing effect. This is in contrast to various theories that point to negative effects of digitalisation on quality of work.

This research is part of a Dutch multi-year study 'Toward the digital factory' conducted by the HAN Lean-QRM centre. The results of this research contribute to this project because they provide insight into the consequences of digitalisation at two partner companies. At these, and the other partner companies, there is great uncertainty about how to deal with the consequences of digitalisations on the quality of work. The results of this research can be used directly in the network of the HAN Lean-QRM centre and in their practical research. When companies recognise and can identify with the companies in this research, it also provides them an idea of the expected changes in the field of quality of work as a result of digitalisation. Also further research can be built up on this research.

Keywords: Quality of Work, Measuring tool, Industry 4.0, Smart Industry, WEBA(Welzijn Bij de Arbeid)-method, Tool development

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Chapter 1. Introduction

This chapter introduces this research. It first describes the introduction of the topic (1.1). Secondly, the research objective and research question (1.2) and the theoretical and practical relevance (1.3) are described. The chapter concludes with an outline of the thesis (1.4).

1.1 Introduction of the topic

This research is part of a Dutch multi-year study 'Toward the digital factory' conducted by the HAN Lean-QRM centre. Within this project, guidelines will be drawn up for implementing and working with online real-time planning simulation to support operations in a smart industry environment. The real-time process is duplicated in a software process, process simulation. Everything that happens in real life also happens in the simulation (HAN Lean-QRM Centrum, n.d.).

Online real-time planning simulation is one of the technologies in the fourth industrial revolution. The technologies emerging from the fourth industrial revolution are scaled under the terms 'Industry 4.0' and 'Smart Industry'. These terms were created by the German and Dutch governments respectively to name the future vision for industry of both countries (Bissola & Imperatori, 2019; Lorenz, Rüßmann, Waldner, Engel, Harnisch & Justus, 2015; Smart Industry, 2015). The fourth industrial revolution is service-centred and oriented toward virtual and digital technologies. Within the fourth industrial revolution production systems are driven by flexible manufacturing and real-time data to enable customised production by horizontal and vertical integration, which enables smart factories (Li, Hou & Wu, 2017; Thoben, Wiesner & Wuest, 2017). In this research, the technologies within the fourth industrial revolution will be referred to as ‘Smart Industry’.

The development of smart industry is quite technology driven. However, in recent years, there have also been various discussions about the consequences of technological developments for the quality of work. According to Steijn (2019), there is little attention in the theory for the human factor in digitalisation. Digitalisation can have a positive and a negative impact on the quality of work. The question is whether technology causes tasks to disappear because these tasks are taken over by technology or whether technology causes more tasks to be added to the employee's work package because of this technology. When these tasks that disappear or are added contain regulation possibilities, it has an impact on the quality of work (Karasek, 1979). An example of a positive effect is employees having more room for autonomy, professionalism, and growth opportunities. However, it can also happen that employees feel they have less autonomy and freedom than before the digitalisation, in this case, digitalisation has a negative effect on the quality of work (De Sitter, 1994; Socio-Economical Council, 2016).

An instrument to measure the quality of work is the WEBA (Welzijn Bij de Arbeid). The WEBA was chosen and appropriate for this research because this measurement tool is an official instrument from the government. The WEBA was developed in 1989 by commission from the Directorate-General of Labour of the Ministry of Social Affairs and Employment of the Netherlands to be able to operationalise the obligations concerning well-being at work that were included in the Dutch legislation method. At the time, the WEBA was used to assess the quality of work for various occupations, including administrative work, packing work, operator work and cleaning work. The WEBA is a qualitative research method in which an external specialist observes employees at work and provides an indication of the quality of work on this basis (Project group WEBA, 1989).

Over the years, various versions of the original WEBA have been developed, each sector has its own specific points on which the quality of the work can be measured, and these are also weighted differently in terms of importance. Therefore, there are, among other things WEBA's for nurses (Grunveld, 1993) and teachers (Christis, 1994). The WEBA for primary and secondary education is the WEBO (Workload in Education) and this one was developed on behalf of the Ministry of Education and Science (Christis, 1994). De WEBA for Higher Professional Education (HBO) is the WEHBO, this instrument builds on the WEBO (Fruytier, Christis, Beetstra, Hengeveld, Maccow, Ronge & Thunnissen, 2011). In addition, the WEBA has been applied to Dutch home care organisations (Schouteten, 2004) and a variant, the NOVA-WEBA was developed by commission of the government as an quantitative tool in relation to the qualitative WEBA. The NOVA-WEBA looks at the quality of work in a quantitative way and a questionnaire is filled in by the employees themselves instead of by an independent researcher (Dhondt, Houtman & TNO Preventie en Gezondheid, 1996).

All these different variants of the WEBA were developed because the original WEBA was not sufficient in that sector or at that specific time. The original WEBA was developed firstly to deal with the occupational health and safety legislation (Project Group WEBA, 1989). In addition, since the WEBA was developed in 1989, technological developments have changed and the quality of work has become more important among employees and therefore also among companies (Atlassian, n.d.; Li et al, 2017; Thoben et al., 2017). A measurement tool for the quality of work is therefore also important in the times of smart industry. However, the question is whether the original WEBA, or eventually the NOVA-WEBA is sufficient as a measurement tool in a smart industry environment. The literature does not provide enough guidance on this. Research will have to show whether the original WEBA is applicable on a job in a smart industry environment. When this is not the case, research also has to show whether an adaptation or extension of this original WEBA is possible.

1.2 Research objective and research question

A combination of the new technologies in the fourth industrial revolution, referred to as smart industry (Bissola & Imperatori, 2019; Li et al., 2017; Smart Industry, 2015; Thoben et al., 2017), little attention for the human factor in digitalisation (Steijn, 2019) and the question whether the original WEBA measures the quality of work in the appropriate manner in a smart industry environment (Project group WEBA, 1989) is the reason for this research.

Based on the focus and context of this research, the objective of this research can be formulated as follows:

> *"Contribute to the literature on the impact of smart industry technologies on the quality of work*
>
> by
>
> *investigating which aspects are necessary in a measuring instrument in order to provide a representative picture of the quality of work in a smart industry environment*
>
> - followed by
>
> *analysing the WEBA: investigating if the original WEBA is still applicable for companies in a smart industry environment and, if not, show whether an adaptation or extension of this original WEBA is possible"*

To reach this objective, the following research question is answered:

> *"Which aspects are necessary in a measuring instrument in order to provide a representative picture of the quality of work in a smart industry environment?"*

1.3 Theoretical and practical relevance

The theoretical relevance of this research is to contribute to the theory of quality of work and specifically to the WEBA. The WEBA originated in the 1980s during the third industrial revolution in which the development of the computer and the application of ICT were central. We have now reached the fourth industrial revolution, the smart industry, in which the intensification of information and communication technology based on cyber-physical systems is central (Bissola & Imperatori, 2019; Li et al., 2017; Smart Industry, 2015; Socio-Economical Council, 2016; Thoben et al., 2017). There is a gap because the WEBA is developed in a time without the smart industry technologies. Nowadays there are smart industry technologies and still it is important to measure the quality of work. But the question is whether the WEBA is the right measurement tool for this measurement. With the advent of new technologies, changes may occur in primary operations, preparatory, supporting or managerial activities or information exchange at the workplace. These changes may affect the way quality of work at the workplace is measured. This research has to fill this gap by examining whether the original

WEBA is applicable in a smart industry environment and, if not, show whether an adaptation or extension of this original WEBA is possible.

The practical relevance is to describe the changes in the quality of work in a smart industry environment. This can give companies that want to digitalise and automate an idea of what can change in the quality of work conditions. In addition, a practical relevance of this research is to describe the relevance of the dimensions of a current measuring instrument for quality of work, the WEBA, and to give possibilities for changes or extensions of this measuring instrument. Implementing these changes or extensions will provide an indication for a measurement instrument for measuring the quality of work in a smart industry environment. This measurement tool can be used by researchers and/or companies to measure the quality of work in a smart industry environment. In addition, for companies that want to take steps in implementing new technologies regarding smart industry, it can give an indication of the future quality of work by measuring the quality of work of the intended function using this way of measuring. Furthermore, the findings of this research contribute to the multi-year Dutch study 'Towards the digital factory' of the HAN Lean-QRM centre, by providing information about the quality of work in a smart industry environment. This information can be used directly for advice and further research in the partner companies of the HAN Lean-QRM centre.

1.4 Outline of the thesis

The remainder of this research report consists of four chapters. Chapter 2 deals with the theoretical framework of this research. It provides an overview of the literature by describing the key concepts of this research and the connection between these key concepts. These key concepts are smart industry, quality of work and the WEBA. Chapter 3 describes the method by which this research was conducted. It provides detailed information on the chosen research method by covering the research setting, research strategy, data collection, data analysis, research quality and research ethics. Subsequently, chapter 4 describes the results of this research. With a concluding paragraph on how the quality of work can be measured in a smart industry environment. Finally, in chapter 5 the research question is answered by means of a conclusion. Subsequently theoretical and practical implications are described, there is given an reflection on the research findings and research process, the limitations are described and recommendations for further research are given.

Chapter 2. Theoretical framework

This chapter deals with the theoretical framework of this research. It provides an overview of the literature by providing insight into the key concepts of this research based on the research question: *"Which aspects are necessary in a measuring instrument in order to provide a representative picture of the quality of work in a smart industry environment?"*

These key concepts are: industry 4.0/smart industry (2.1), quality of work (2.2) and WEBA (2.4). In addition to these key concepts, the connections between these key concepts are also explained. These are: the influence of smart industry on quality of work (2.3), the quality of work in the WEBA (2.5) and the WEBA in smart industry times (2.6). Finally, a visual representation of the key concepts summarized (2.7) is presented.

2.1 Industry 4.0/Smart Industry

2.1.1 History industrial revolutions

Industry 4.0 is the term for the fourth industrial revolution. This fourth industrial revolution was preceded by three previous industrial revolutions. The first industrial revolution took place at the end of the 18th century and was focused on the invention of the steam engine. The second industrial revolution took place at the end of the 19th century and is also called the technological revolution. It focused on new technologies such as communication technologies, electricity, and the rise of the oil industry, which led to the emergence of mass production. The third industrial revolution took place from the 1970s and onwards. This is where the computer made its appearance in the workplace, which ensured the availability of information all over the world (Li et al., 2017). The fourth industrial revolution represents the introduction of the internet of things with internet of services in production, which makes it possible to connect production systems vertically and horizontally, which enables smart factories (Thoben et al., 2017). The development of the industrial revolutions is visible in the figure below, Figure 1.

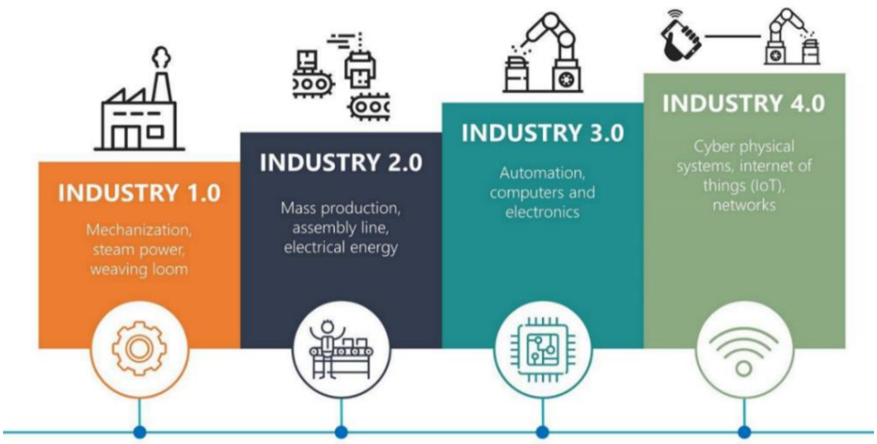

Figure 1. Development industrial revolutions (PRINTmatters, 2019)

2.1.2 Industry 4.0

Within industry 4.0 there are nine concepts. It is important to understand these concepts in order to recognise an industry 4.0 environment in this research. These nine concepts are defined by the Boston Consulting Group (Lorenz et al., 2015) and used by several authors in the field (Bartodziej, 2016; Saniuk, Grabowska, & Gajdzik, 2020). To define the nine main concepts of industry 4.0 Lorenz et al. (2015) used case studies from Germany, because they recognise Germany as the world leader in industrial revolutions. These nine main concepts of industry 4.0 are:

1. Big data and analytics: big data and analytics means exploring large and varied data sets to discover useful information for businesses such as market trends, customer preferences, hidden patterns, and unknown correlations.
2. Autonomous robots: autonomous robots stands for the wider use of robots as they become more autonomous, flexible, and cooperative.
3. Simulation: simulations mirror reality in a virtual model in order to achieve an optimal machine setting.
4. Horizontal and vertical system integration: horizontal system integration is networking between individual devices, machines, and production systems. Vertical system integration is controlling the different parts of the supply chain.
5. Industrial internet of things: the industrial internet of things brings together machines, people, and analysis through a network of many devices connected by communication technologies.
6. Cybersecurity: all the new technologies also bring risks of cyber-attacks. Cybersecurity consists of processes, controls and technologies designed to protect systems, data, and networks from cyber-attacks.
7. The cloud: in the cloud data and programmes can be stored. Cloud services provide real-time information to support devices and sensors.
8. Additive manufacturing: additive manufacturing is also known as 3D printing, which produces prototypes of individual parts.
9. Augmented reality: augmented reality supports services in production (Lorenz et al., 2015).

2.1.3 Smart industry

Where Germany is a leader in industrial revolutions, the Netherlands is still somewhat behind (Bissola & Imperatori, 2019; Lorenz et al., 2015; Smart Industry, 2015). The terms ‘Industry 4.0’ and ‘Smart Industry’ are used interchangeably in the literature. The term industry 4.0 was presented by the German government as the future vision for German industry (Lorenz et al., 2015). In the Netherlands, the term smart industry was presented by the Dutch government (Bissola & Imperatori, 2019; Smart Industry, 2015). Smart industries are defined as “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, 2015, p. 17).

Smart industry does not focus on exactly the same pillars as the Boston Consulting Group for industry 4.0, but here the focus is mainly on three categories. However, the concepts within the Dutch smart industry and the German industry 4.0 can be linked. The first category is the *next generation of manufacturing technologies* such as robots, drones, and 3D printers. This first category can already be directly linked to the autonomous robots and additive manufacturing of industry 4.0. In addition, it can also be linked to simulation and additive manufacturing, which are both support systems for manufacturing. The second category is the *network-centric approach*. This network-centric approach replaces the linear manufacturing process with intelligent and flexible network approaches. A network like this is able to connect different aspects such as machines, companies and value chains and products and parts across production plants. This category can therefore be linked to the software related concepts of industry 4.0; namely, big data and analytics, horizontal and vertical system integration, cybersecurity, and the cloud. The third category is the *digitalisation of information and communication*. Communication was already one of the most important developments of the third industrial revolution, but this also continues in the fourth industrial revolution. Through the internet and other software, digitalisation is taken to another level. The communication technologies not only provide communication between all partners in the value chain, but also the digitalisation of product quality, information about users, and parameters in the products based on sensors can provide new innovations in the production process, products, and services. This third category can therefore also be directly linked to the industrial internet of things of the industry 4.0 concepts (Bissola & Imperatori, 2019; Lorenz et al., 2015; Smart Industry, 2015). The above described connections between smart industry and industry 4.0 are shown in the table below, Table 1.

Table 1. Connection smart industry and industry 4.0

Smart industry	**Industry 4.0**
Next generation of manufacturing technologies	(2) Autonomous robots (3) Simulation (8) Additive manufacturing (9) Augmented reality
Network-centric approach	(1) Big data and analytics (4) Horizontal and vertical system integration (6) Cybersecurity (7) The cloud

Digitalisation of information and communication	(5) Industrial internet of things

In the remainder of this research, the term ‘Smart Industry’ will be used with its three categories: next generation of manufacturing technologies, network-centric approach and digitalisation of information and communication.

2.2 Quality of Work

Quality of work is, together with quality of working relations and quality of the organisation, a functional requirement, or relevant organisation variable (De Sitter, 1994). There are several definitions of quality of work. De Sitter (1994), founder of the sociotechnical design theory in the Netherlands defines quality of work as "production of meaning" (p. 81). In other words; quality of work means that the work has to be meaningful and that there are sufficient possibilities to deal with work related stress.

De Sitter (1994) bases this definition on Karasek's job demand control model. Karasek's job demand control model is one of the most well-known models for promoting health in a work environment through the evaluation of stress and stress factors. Karasek's job demand control model contrasts job demands with job decision latitude. The result is four types of jobs: passive jobs, high strain jobs, low strain jobs and active jobs. The model shows that pressure of work alone does not directly lead to high psychological strain, but the combination of pressure of work and the possibilities for regulation that the work offers does. When possibilities for regulation in the work are limited, the pressure of work cannot be tackled, which leads to stress complaints. When there are sufficient possibilities for regulation, work pressure can be dealt with in the right way, so that work can once again be experienced as challenging and motivating (Karasek, 1979).

De Sitter (1981) elaborates on this model by saying that when jobs consist of both executive and controlling tasks, the job scores well on quality of work. When this is the case, there is a balance between the control needs and the control possibilities. A positive side effect of this balance is that the stress risks in the work situation remain small.

Another definition of quality of work is the one of Van Hootegem, van Amelsvoort, van Beek and Huys: "Quality of work means that in the work, the work environment, and the organisation all conditions are fulfilled to feel good at work" (2008, p. 85). This definition is in line with the following dimensions stated by De Sitter (1994); Quality of work can be divided into external and internal requirements. External requirements are low absenteeism and employee turnover. The external requirements can be translated into internal requirements. Internal requirements are opportunities for learning and development, employee involvement, and controllable stress conditions (De Sitter, 1994).

Learning and development opportunities arise from the work itself. Employee involvement has to do with both the individual and the organisational perspective. At the organisational level, involvement can be linked to the needs and possibilities for regulation of employees within a certain job. Controllable stress conditions are determined by the work itself and the work environment (Van Hootegem et al., 2008).

In this research, the definition of Van Hootegem et al. (2008) is used. This definition, as described above, best matches the three internal requirements of quality of work according to De Sitter (1994). Therefore, these three internal requirements are also used in combination with the definition of Van Hootegem et al. (2008) in this research. Below, all three internal requirements of quality of work are explained.

2.2.1 Learning and development opportunities

According to Karasek (1979), learning opportunities are one of the indicators for meaningful work. In addition, development within a job is important in order to teach an employee new behaviour, which leads to more meaningful work (Karasek, 1979). Learning and develop opportunities in work have to do with the way employees are challenged to perform tasks in a different way and learn. A task should contain both learning and development opportunities for employees. It should also trigger employees to do their best to contribute to the viability of the organisation and it should challenge employees to experiment with different ways of doing their jobs. Learning and develop opportunities should arise from work and contribute to a fulfilled life as employees develop skills, moral virtues, and practical wisdoms. The consequences of a lack of learning and development opportunities is that employees get stuck and do not progress in their jobs (Achterbergh & Vriens, 2019; De Sitter, 1994).

2.2.2 Employee involvement

Employee involvement in the work refers to the possibilities for regulation of employees in relation to the needs for regulation (Karasek, 1979). When employees feel involved in their work, this is called involvement. There are two types of involvement, namely 'social' and 'intrinsic' job-related involvement. Social involvement is related to the social network around the work, being involved in it provides a feeling of social involvement. Intrinsic involvement is more at the task level. Employees feel intrinsically involved when they see that they are part of the process and therefore feel involved in the process. The consequences of a lack of involvement are isolation and alienation. Isolation means that employees feel alone during their work. Alienation means that employees find their work meaningless (Achterbergh & Vriens, 2019; De Sitter, 1994).

2.2.3 Controllable stress conditions

Karasek (1979) identifies stress as a possible gradation of low quality of work. Stress conditions are controllable when employees are able to deal with work-related stress. When this is not the case, there is a situation of uncontrollable stress conditions. These uncontrollable stress conditions may arise when an employee's task is dependent on many other tasks and/or employees. The employee is then not able to deal with disruptions him- or herself. This results in stress because a high level of disruptions and a lack of regulatory potential creates a feeling of being out of control, which in turn leads to uncontrollable stress conditions (Achterbergh & Vriens, 2019; De Sitter, 1994).

2.3 Influence Smart Industry on Quality of Work

The ongoing discussion about technological developments and their impact on the quality of work is a similar discussion to the one in the 1980s and 1990s. At that time, there was discussion about the effects of automatization, in that case information and communication technology on the quality of work (Steijn, 2019). A study by Steijn and De Witte (1992) at that time concluded that humans were subordinate to technology because there were no choices regarding the desired technological developments.

A key difference from the technological developments of the 1980s until 1990s compared to now is the loss of jobs and tasks. The technological developments in the last century actually created jobs (Steijn, 2019). However, the current technological developments according to Frey and Osborne (2017) will lead to a net loss of jobs. Automation will result in the loss of jobs among others in administration and production. In addition to the loss of these jobs, employees will be expected to be more flexible to deal with the digitalisation (Frey & Osborne, 2017).

The Socio Economic Council (SER) (2016) conducted a study, commissioned by the Dutch government, on technological developments and their impact on the labour market. At that time, there are two debates going on about technological developments. The first debate has to do with the speed at which technological developments are taking place and thereby the impact on employment (Socio-Economic Council, 2016). An important light on this debate is the article by Frey and Osborne (2013), they state that in the United States, due to technological changes, almost half of the jobs are at risk of being automated. However, this statement is partly qualified by other studies that come to less far-reaching results (Socio-Economic Council, 2016). The second debate has to do with intervening in technological changes. This can be done in two ways; the technological changes can be seen as opportunities. In this, the technological changes create wealth growth through productivity growth and new employment opportunities in learning and development opportunities for employees, which is one of the three dimensions of quality of work. However, the technological changes also bring uncertainties. The expectation from the literature is that new technologies may start to cause job losses and the fact that machines will take over the work of humans, which in line may affect the quality of work, because, for example, the humans' possibilities for regulation become less, which leads to lower employee involvement (Achterbergh & Vriens, 2019; De Sitter, 1994; Socio-Economic Council, 2016).

The Socio Economic Council's (2016) study focuses primarily on the impact of digitalisation on the economy and society. There is also a section focused on the impact on the quality of work. However, there the conclusion is that the exact impact of digitalisation on the quality of work is not clear in advance and that the impact may vary for the specific circumstances, such as sectors and jobs. The reason for this is that there is a risk that the quality of work will be negatively affected by digitalisation because the autonomy of the employees is reduced and the tasks they have to perform are smaller. When this is the case, the learning and develop opportunities decrease (Achterbergh & Vriens, 2019; De Sitter, 1994; Socio-Economic Council, 2016).

Frey and Osborne (2013) focused on jobs and tasks that are disappearing. There have also been studies on the changes in jobs and tasks as a result of digitalisation. Based on studies, there are different opinions on the effect of digitalisation on jobs and tasks. There are two sides: one side believes that the new technologies are likely to replace human workers. The other side consists of those who do not believe this and think that human workers will continue to be needed. Their argument is that during the previous industrial revolutions, the number of jobs continued to increase gradually. Both sides may be right, this depends on where it is viewed from. From the industry side there are fewer and fewer human workers, but from the employment side there is a shift from jobs in industry to services (Brynjolfsson & McAfee, 2015).

However, other studies show that this fourth industrial revolution is different from the previous three industrial revolutions. Previously, digitalisation never completely eliminated jobs because human workers were always able to keep up by learning new skills through training and education. However, with further digitalisation, this is increasingly becoming a challenge (Brynjolfsson & McAfee, 2011). The way of working is changing and so are the skills of human workers: "there has never been a better time to be a worker with special skills or the right education, because these people can use technology to create and capture value. However, there has never been a worse time to be a worker with only 'ordinary' skills and abilities to offer, because computers, robots, and other digital technologies are acquiring these skills and abilities at an extraordinary rate" (Brynjolfsson & McAfee, 2014, p. 9).

Most research on digitalisation and its impact on the human worker focuses on the jobs themselves and what happens to them, and on the skills that these human workers need. What is missing is research into how the quality of work is being measured in an smart industry environment and which aspects are appropriate in this measurement tool. To be able to do this research, first a tool has to be chosen as a starting point for the development of the measurement tool for the quality of work. In the next section, this will be discussed. The tool to be analysed as a starting point is the WEBA-method.

2.4 WEBA

2.4.1 History WEBA

The WEBA (Welzijn Bij de Arbeid) methodology was developed in 1989 by the WEBA project group following a study commissioned by the Directorate-General of Labour of the Ministry of Social Affairs and Employment of the Netherlands. The reason for this study was the change and operationalisation of the welfare provisions in the Dutch Working Conditions Act (Project Group WEBA, 1989).

This change meant that employers had to consider the wellbeing of work, the state of the art of labour and business administration. In addition to this legal reason, there was also a social significance in view of the technical and organisational innovations of that time (Project group WEBA, 1989). The WEBA method must be used to achieve two objectives: "(1) work situations must be assessed for the presence of welfare risks, and (2) it must be possible to give indications for the improvement of these work situations" (Project group WEBA, 1989, p. 17). Welfare risks are understood to mean: the chance of psychological overload, the chance of discomfort in and through the work, and the opportunities for learning and development (Project group WEBA, 1989).

According to the Project group WEBA (1989), improving the quality of work was important not only for social reasons, such as employee participation, employee development and job satisfaction, but also for economic reasons, such as making the best possible use of the available qualities of employees, flexibility and preventing incapacity for work and absenteeism.

The WEBA method was developed and, according to the Project group WEBA (1989), can be used in various ways. The WEBA method can serve as a starting point for the development of a working conditions policy, it can be the engine of the working conditions policy, it can be applied as various instruments; policy-, redesign-, evaluation- or control instrument (Project group WEBA, 1989).

2.4.2 Procedure WEBA

The WEBA method is a qualitative research method for analysing a workplace. An external specialist observes an employee in the performance of his job and asks a number of questions in order to assign scores to seven well-being dimensions with this information. These well-being dimensions are completeness of the job, organisational tasks, short cyclicality, degree of difficulty, autonomy, contact possibilities and information flows (Project group WEBA, 1989).

The well-being dimensions translate the well-being risks into seven well-being conditions, each with a well-being or quality question. The well-being dimensions are each briefly explained below, based on the WEBA:

1. Completeness of the job; (Is the function a complete function?): a function meets this quality requirement when the function consists of preparatory, executive, and supporting tasks. This complete job also contains sufficient learning opportunities because the employee prepares and supports the work himself/herself.

2. Organisational tasks; (Does the job contain sufficient organising tasks?): a task is organising when the employee has control over the work and can arrange matters or solve problems. These problems are then above the level of the individual job. It is important to note that the task is only rated positively if the problems are actually solved.

3. Short cyclicality; (Does the job contain enough non-short-cycle tasks?): a task is short-cycle if its cycle time is less than one and a half minute. When this is the case, the control capacity is very small, which results in stress risks.

4. Degree of difficulty; (Does the job contain a balanced distribution of easy and difficult tasks?): the level of difficulty of the job is okay when there is a balanced distribution of easy and difficult tasks. Too many easy tasks limit learning opportunities and too many difficult tasks increase the risk of psychological overload.

5. Autonomy; (Does the job contain sufficient autonomy?): a job is sufficiently autonomous when employees can independently determine the pace, method, order of work, working conditions and workplace. Employees only learn from the work when they do not work exactly as prescribed but determine this method themselves.

6. Contact possibilities; (Does the job contain sufficient contact possibilities?): Employees must be able to contact others in the work, this contributes to the learning possibilities. Making contact can be done through supporting each other, contact about the work and social contacts that are not directly about the work.

7. Information flows; (Is sufficient information provided?): the provision of information must be in order in order to make use of control possibilities. In addition, information can provide feedback on results, which promotes learning opportunities (Project group WEBA, 1989).

The WEBA method consists of three phases: (1) describe the job, (2) assess the job and (3) improve the job. The first phase comprises the first three steps (1) describing the quality characteristics, in this step the well-being dimensions mentioned above are described. The information is documented with the help of so-called WEBA forms. The next step is (2) constructing the job matrix, in which the information on the completed WEBA forms is combined on a conveniently arranged form, the job matrix. This matrix provides a total score for each well-being dimension. The last step in the first phase is (3) identifying control problems, in which the control problems are identified in order to be able to assess whether the control possibilities are sufficient. Within the second phase the first step is (4) answering the quality questions, these questions must be answered on the basis of a three-way scale: sufficient, limited, insufficient. The next step is (5) composing the well-being profile, in which the quality questions are answered in a reasoned way and a well-being profile is created. Within phase three the last step is (6) indicating the welfare measures, whereby measures are drawn up to improve the welfare profile (Project group WEBA, 1989).

During the research of the Project group WEBA (1989), the WEBA method was tested on various tasks. These tasks are: secretarial work - word processing, administrative work - data entry, manual assembly work, machine work on a line, family care, packing work, shop assistant work, operator work, process control, managerial work, cleaning work, carpentry work, kitchen work, general nursing work and bus driver work.

2.4.3 NOVA-WEBA

A shortcoming of the original WEBA method is the fact that it is purely observational and the scores of the well-being dimensions are assigned by an independent researcher. These independent researchers must be experts who can use the WEBA. However, these experts must first be trained and they only take a snapshot (Delarue & Van Hootegem, 2003; Pollet, Van Hootegem & de Witte, 1999). Therefore, a number of years after the WEBA method was developed, the NOVA-WEBA was developed as an quantitative tool in relation to the qualitative WEBA. When using the NOVA-WEBA, a questionnaire has to be completed by the employees themselves instead of the independent researcher (Dhondt et al., 1996). The intention was to better measure the quality of work. However, various researchers have questioned this. A study by Pollet et al. (1999) did not show any correlation between the results of both measuring instruments. Delarue and Van Hootegem (2003) conducted a follow-up study; this study, too, shows that a comparison of the two measuring instruments does not yield significant correlations. The results of these studies are contrary to expectations. The intention was for the NOVA-WEBA to be an extension of the WEBA, but they turn out to be two instruments that measure a totally different reality regarding the quality of work, one from a qualitative point of view by an independent researcher (WEBA) and one from a quantitative point of view by the employees themselves (NOVA-WEBA) (Delarue & Van Hootegem, 2003).

The NOVA-WEBA is quantitative and therefore for the use of the NOVA-WEBA in a smart industry environment a lot of information is needed. However, this information is not always available, as the developments of the smart industry are still in their early stages. At this moment, the NOVA-WEBA is therefore not a suitable measuring instrument for the quality of work in a smart industry environment. In the remainder of this study the NOVA-WEBA will therefore be omitted, and the focus will be on the original WEBA.

2.4.4 WEBA in other industries

After the development of the WEBA, several variants were designed for the WEBA in other industries, in addition to the NOVA-WEBA commissioned by the government. Among others there are WEBA's for nurses and teachers. The WEBA for nurses differs in that there is no criteria for the division of preparatory, executive and support tasks. The only requirement is that all three tasks must be present; the presence of these tasks promotes the regulation possibilities of a job and thus reduces stress risks (Grunveld, 1993).

The WEBA for primary and secondary education is called WEBO. WEBO stands for Workload in Education and was developed on behalf of the Ministry of Education and Science. A special WEBA, the WEBO, for education was necessary because education was given specific autonomy by the government and because the work pressure among teachers was generally high. The WEBO was developed to help the education sector make use of the space for implementing independent educational, organisational and personnel policies and to distribute and reduce the workload among teachers in a more balanced way (Christis, 1994). An instrument that builds on the WEBO is the WEHBO. WEHBO stands for Workload in Higher Professional Education (HBO). The WEHBO was developed because the tasks and problems encountered in HBO differ from those in primary and secondary education. The difference between the WEBO and WEHBO is therefore the lists of tasks, the overview of problems that can be encountered and the network of job holders in which the employees operate (Fruytier et al., 2011).

So, there are several variants of the WEBA because the original WEBA was not sufficient in these situations. This research will look specifically at the developments of the quality of work in the smart industry and how to measure this quality of work. In order to do this, the next section will first deal with the aspect of quality of work in the original WEBA and will then look at whether or not there is a reason why the original WEBA fits in with smart industry times.

2.5 Quality of Work in WEBA

After discussing the quality of work (chapter 2.3) and the WEBA (chapter 2.4), it is important for this research to look at the aspects of quality of work in the original WEBA. As described in chapter 2.3, three aspects of quality of work can be distinguished: learning and development opportunities, involvement, and controllable stress conditions (De Sitter, 1994). The WEBA in its turn has seven well-being dimensions; completeness of the job, organisational tasks, short cyclicality, degree of difficulty, autonomy, contact possibilities and information flows (Project group WEBA, 1989). In order to explain the quality of work in the WEBA, we look from the well-being dimensions at the dimensions of the quality of work. The table below, Table 2, shows on which dimension of quality of work the well-being dimensions have an influence.

Table 2. Well-being dimensions WEBA and dimensions quality of work

Well-being dimensions WEBA	**Dimensions Quality of Work**		
	Learning and development	Employee involvement	Controllable stress conditions
Completeness of the job	X	X	X
Organisational tasks	X	X	X
Short cyclicality	X	X	X
Degree of difficulty	X	X	X
Autonomy	X	X	X
Contact possibilities	X	X	X
Information flows	X	X	X

The conclusion of this table is that all well-being dimensions of the WEBA have an influence on the three dimensions of quality of work. On the one hand, this is logical because the WEBA is intended to measure the quality of work (Project Group WEBA, 1989). Nevertheless, it is important for this research to make this clear. The WEBA therefore measures according to the quality of work dimensions that are also used in this research. The question is, however, to what extent the WEBA can be applied in smart industry times. The next section focuses on this.

2.6 WEBA in Smart Industry times

The WEBA was developed to comply with occupational health and safety legislation (Project Group WEBA, 1989). In the years following the development of the WEBA in 1989, quality of work became much more important. In the 1990s, the first employees started to put their own needs and interests above those of the employer and employers had to ensure better quality of work (Atlassian, n.d.). As the New York Times reported, "Companies that fail to factor in quality-of-employee-life issues when imposing total quality management or 're-engineering' or any other of the competitiveness-enhancing, productivity-improving schemes now popular may gain little but a view of the receding backs of their best people leaving for friendlier premises." (1993, p. 21). In the 2000s, technological developments began to affect labour. Low-skilled jobs disappeared, and more social and analytical skills were expected from employees. The opportunity for learning and development was therefore increased (Achterbergh & Vriens, 2019; Atlassian, n.d.). By 2010, the workforce was more diverse than ever. Different generations were working together; baby boomers, generation X and Y and millennials. The emergence of the millennials in the work field brought about a different view of the work field with respect to the new technologies. All the different generations have different needs and interpretations of quality of work. For example, the millennials have grown up in a time where technology is every day, it is normal. At the same time, the fourth industrial revolution began, with new technologies. The millennials will be able to adapt more quickly to the new technologies. In addition, it was expected that the rise of the robot would have a positive influence on the quality of work because the robot would create more different tasks in a job and support the employees, making the employees more involved, have more learning and development opportunity and the stress would be lower because the heavy work would be replaced by a robot (Achterbergh & Vriens, 2019; Atlassian, n.d.; Iberdrola, 2020). Looking at the trend from 2020 onwards, the quality of work becomes increasingly important. Workers attach less value to where they work, but more value to how they work with their team. Collaboration and interaction can thus be seen as a new requirement for quality of work (Atlassian, n.d.).

The question is therefore whether the original WEBA with its well-being dimensions still measures the quality of work in the right way. To identify, it is important to look at the components on which the WEBA focuses, the well-being dimensions in relation to the developments in the smart industry. These could be the three categories of the smart industry as described in chapter 2.1.3 Smart industry; next generation of manufacturing technologies, network-centric approach and digitalisation of information and communication. However, the literature does not provide enough guidance. There is a gap in the literature to describe the quality of work of a job in the smart industry technologies. The WEBA can be a good instrument for this, but because the developments of smart industry are still in the early stages, research will have to show whether the original WEBA can be applied to these smart industry jobs or whether an adaptation or extension of this original WEBA is necessary to be able to measure the quality of work in a smart industry environment.

2.7 Key concepts summarized

A visualisation of the key concepts summarized is created based on the explanation and elaboration on the different concepts that form the basis for this research. This conceptual model provides the structure for this research and shows the connection between the different concepts. The main concepts are smart industry (chapter 2.1), quality of work (chapter 2.2) and the WEBA (chapter 2.4). These main aspects are each described separately in this chapter. The smart industry has an influence on the quality of work; this influence is described in chapter 2.3. The dimensions of the quality of work are reflected in the WEBA; these relationships are described in chapter 2.5. Next, a section is devoted to the question of whether the original WEBA can still be applied in the smart industry, chapter 2.6. This question cannot be answered on the basis of this theoretical framework. This research will therefore focus on answering this question and identify how to measure the quality of work in a smart industry environment. This visualisation of the key concepts is shown in the figure below, Figure 2.

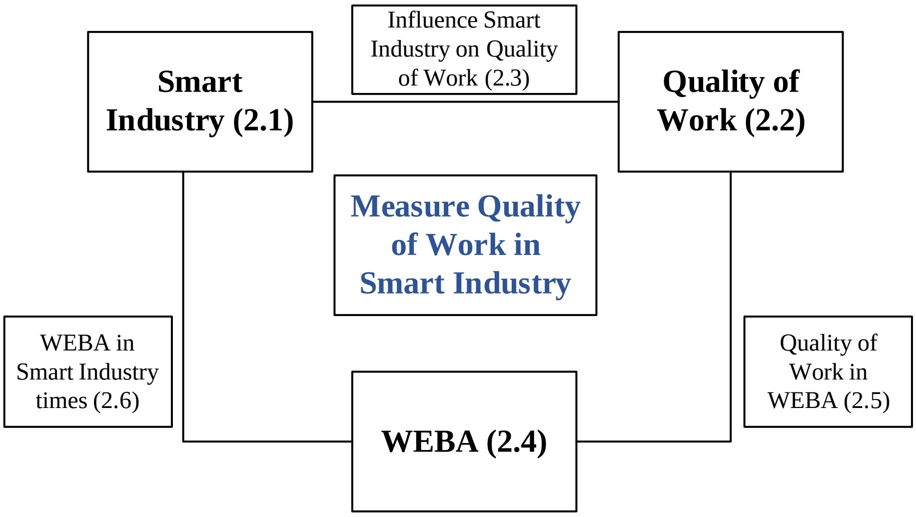

Figure 2. Key concepts summarized

Chapter 3. Methodology

This chapter describes the method by which the research was carried out to answer the research question: *“Which aspects are necessary in a measuring instrument in order to provide a representative picture of the quality of work in a smart industry environment?”*.

It starts with information about the research setting (3.1), then explains the research strategy that is used (3.2), followed by the data collection methods (3.3) and the way the data has been analysed (3.4). The chapter concludes with the research quality (3.5) and research ethics (3.6).

3.1 Research setting

This research took place mainly at home because of the measures surrounding COVID-19. In the beginning, literature research took place, which could be done from home using online resources. For the analysis phase of the research, two companies were contacted, and data was collected within these companies. Seven out of eight interviews with employees of these companies were conducted via Microsoft Teams. One interview was conducted on location. The analysis of these data took also place from home. The companies have been chosen with the help of the researchers of the HAN Lean-QRM centre. Companies that are relatively advanced in the implementation of a smart industry environment were chosen. The reason for this is that the aim is to look at the quality of the work of the function that will be created by smart industry and what the consequences will be. The companies can also be linked to the smart industry categories, described in paragraph 2.1.3 Smart industry. In the remainder of this document, these companies will be referred to as company A and company B. In the following paragraphs, 3.1.1 Company A and 3.1.2 Company B, more information is given about those companies and their link to the smart industry categories.

3.1.1 Company A

Company A is a company that has always been digitalised in the framed area of work they perform and the products they make. The company has standardised its own processes very strongly. The company was founded with a digitalised view. Even now in the smart industry times, it is at the forefront of technological developments. It uses the Internet of Things, which can be linked to the category of digitalisation of information and communication. All Enterprise Resource Planning (ERP) systems are linked together to receive the most accurate data at the right time. All information is in the cloud. In addition, the operators work with programs that tell them exactly what to do. All this can be linked to the network-centric approach. Finally, company A makes use of many new technologies, which is the third category, next generation of manufacturing technologies. In production, the supply of certain materials is done by Automatic Guided Vehicles (AGV) and the programming of the machines is also automated. All these connections with the categories of smart industry make this company suitable for this research.

3.1.2 Company B

Company B is a company that has been focusing on digitalisation for a number of years. The company has established a separate data innovation group that allows the company to model and develop its own software through its own IT architecture. The goal of digitalisation has always been to help production staff with data on the floor and to work more efficiently together as a result, as also indicated by Production Manager 2 in the following quote:

"First it was loners, loners become islands and we want to make those islands even bigger so that those islands can also start to be connected to each other" – (B3, Production Manager 2, 899-900).

The company uses an efficiency monitor that can be linked to the category digitalisation of information and communication. All software packages can communicate with each other, and a smart assistant is used to make information available to production staff. This information supports decision-making, shows how the production department has performed and makes control data available to the production staff, all of which can be linked to the category of network-centric approach. To achieve all this, the company also uses the next generation of manufacturing technologies, the third category of smart industry. The company uses 3D printing, collaborative robotics, sensor technology and digital boards in production, among other things. Therefore, company B also has connections with the categories of smart industry, which makes company B a suitable company for this research.

3.2 Research strategy

Bell and Bryman (2018) divide research methods in qualitative and quantitative research. This research is a qualitative research. A qualitative research strategy usually emphasizes words over quantification in collecting and analysing data. The qualitative research strategy is used to gather in-dept insights by understanding concepts, thoughts and experiences on topics that are not well understood (Bell & Bryman, 2018; Bleijenbergh, 2015; Myers, 2013; Symon & Cassell, 2012). This research is about finding out if the original WEBA is still applicable for a company in a smart industry environment and, if not, show whether an adaptation or extension of this original WEBA is necessary to be able to measure the quality of work in a smart industry environment. It is important to get insight into the context within actions take place and where decisions are made. According to Myers (2013) this is one of the key benefits of qualitative research. This research aims at investigating what is the best way to analyse the quality of work in a smart industry environment. Hereby the WEBA is tested and eventually expanded.

The starting point of this research is the current WEBA. The objective is then to identify whether the original WEBA is still applicable for companies in a smart industry environment and, if not, show whether an adaptation or extension of this original WEBA is necessary to be able to measure the quality of work in a smart industry environment. There is a gap in the theory for this phenomenon, because the original WEBA is developed in 1989 and there have been technological changes. Therefore, theory-testing and eventually expanding are the main purposes. To reach these goals, data is going to be collected about this topic, this data is being analysed in order to conclude whether the original WEBA is still applicable and if not, to indicate what adjustments, extensions or additions can be made to the original WEBA to make it applicable for companies in smart industry environments. The current literature does not provide any information on this and the WEBA is quite old and therefore not applied in a smart industry environment yet. This research will address this by investigating this. In this way the WEBA is tested and eventually built on.

3.3 Data collection

In collecting data, triangulation is very important. When applying triangulation, multiple ways of collecting data are used in the research and these sources are then compared with each other. With triangulation the researcher gets a better picture of what is happening, because he or she looks at the same topic from different sides (Myers, 2013). The data collection methods of this research are explained one by one below.

During the literature study in the theoretical framework, research has been done to identify whether the original WEBA could be applied in a smart industry environment. However, there was not enough information to make a conclusion at that time. There was a gap in the literature regarding this question. The literature showed that there are three categories within the smart industry, three dimensions of quality of work and seven well-being dimensions in the WEBA. However, the literature does not provide enough information on the relationship between these factors. Interviews, document analysis, a questionnaire and transcript analysis were conducted in order to map the relationship between these key concepts and to see whether the categories of smart industry together with the dimensions of quality of work were reflected in the WEBA's well-being dimensions.

3.3.1 Interviews

One of the most common and important ways of collecting data in a qualitative research is through interviews. Interviews give the opportunity to collect a large amount of data from people in different situations (Myers, 2013). The purpose of these interviews was to identify what managers and employees of a company in a smart industry environment consider important in terms of quality of work. The categories of smart industry recurred because the company in which the interviews took place is located in a smart industry environment, as described in paragraph 3.1 Research setting. The perspective of the interviews are the three dimensions of quality of work. The respondents will be asked how they see this being assessed in their work. The indicators that these respondents brought up were compared to the well-being dimensions of the WEBA.

The interviewing method used is semi-structured. This way of interviewing can ensure that all aspects of the research that are important are addressed. In addition, there is also room to go into the respondent's answers (Myers, 2013; Symon & Cassell, 2012). “Semi-structured interviews involve the use of some pre-formulated questions, but there is no strict adherence to them. New questions might emerge during the conversations, and such improvisation is encouraged. However, there is some consistence across interviews, given that the interviewer usually starts with a similar set of questions each time” (Myers, 2013, p. 122). These answers of the respondent can give new insights for the research. In total eight interviews were conducted and the duration of the interviews was 1.15 hour on average. An overview of all the interviews conducted is displayed in the table below, Table 3. The topic list used for the interviews can be found in Appendix A (not included).

Table 3. Interviews conducted

Code	Function respondent	Date interview	Duration interview
A1	Chief Operation Officer	26-04-2021	1.45 hour
A2	HR Business Partner	29-04-2021	30 minutes
A3	Team Leader	30-04-2021	1 hour
A4	Quality Manager	03-05-2021	1.45 hour
A5	HR Business Partner	06-05-2021	45 minutes
B1	Innovation Manager	14-04-2021	1 hour
B2	Production Manager 1	28-04-2021	1.30 hour
B3	Production Manager 2	29-04-2021	1.15 hour

3.3.2 Documents

Other data for the research was collected by analysing documents from the organisations. Documents play an important role in the organisational field because they contain rich data and can provide details of the organisation (Symon & Cassell, 2012). The documents were used to add value to the interviews and fieldwork and helped answer the research question (Myers, 2013). Only documents from organisations in which also the interviews were conducted were used, this was important to ensure consistency of data triangulation (Symon & Cassell, 2012). Through the document analysis, the research investigated what is considered important in terms of quality of work. The document analysis was used to paint a picture of the aspects of quality of work that are considers important, the aspects by which the employees in the company determine the quality of work. All of this in a company in a smart industry environment. These aspects were then, like the data collected in the interviews, compared with the WEBA's well-being dimensions. An overview of all the documents used is displayed in the table below, Table 4.

Table 4. Documents used

Code	Document name
DA	Website
DB1	Website
DB2	Internationale code of conduct
DB3	Whitepaper: Reliability
DB4	Whitepaper: CoBots to automate high tech production
DB5	Whitepaper: Design for CoBotics
DB6	Whitepaper: Testability

3.3.3 Questionnaire

Unfortunately, due to COVID-19 measures, it was not possible to conduct interviews with production employees physically at the production location of both companies. Because the opinion of these employees was considered important, data was obtained from them in a different way. Namely by means of a questionnaire. The questions that should have been asked during the interviews were condensed and asked of the production employees using a questionnaire. The questionnaire was similar to a survey, but smaller and with open questions, making it similar to a small qualitative survey. A qualitative survey has not been used much as a data collection method. However, one of the advantages of a qualitative survey is that the respondents do not choose from one of the sets of response options but answer in their own words. Therefore, qualitative surveys can provide information on subjective aspects including experiences, opinions, narratives, and discourses of the participants (Braun & Clarke, 2013). The survey was an addition to the data collected from the interviews and document analysis. The survey consisted of open-ended questions. The aim of the survey was to obtain an initial picture of the aspects production employees in a company in the smart industry consider important in terms of the quality of work. The questionnaire was answered by 9 people, all operators from company A. The questionnaire used can be found in Appendix B (not included).

3.3.4 Transcripts fellow researchers

To complete the data collection, transcripts of fellow researchers, secondary interviews, were also used. This research is an independent project, but somewhat related to the research of Elle van der Hulst and Silke Heerink, both Master students Organisational Design and Development. These fellow researchers have conducted interviews at both company A and company B. From these transcripts, more company-specific information can be extracted and information about all digitalisations within the companies on which the interviews of this research had less focus. This data complements the data from the interviews of this research and increases the reliability and the level of detail in the results. It is also very important for triangulation, these transcripts contribute to that. An overview of all the transcripts used is displayed in the table below, Table 5.

Table 5. Transcripts used

Code	Researcher	Function respondent
A6s	Silke Heerink	Head of Purchasing
A7s	Elle van der Hulst	Head of Purchasing
B4s	Elle van der Hulst	Innovation Manager
B5s	Elle van der Hulst	Researcher
B6s	Silke Heerink	Operations Manager

3.3.5 Data collection guide

The basis for the data collection were the three categories within the smart industry, three dimensions of quality of work and seven well-being dimensions in the WEBA. These key concepts were at the beginning of the data collection and these were also the aspects that were confirmed and/or extended in this research. The key concepts are listed in the table below, Table 6. This table was used as the basis for the interviews and questionnaire.

Table 6. Data collection guide

Smart Industry	Quality of Work	WEBA
- Next generation of manufacturing technologies; - Network-centric approach; - Digitalisation of information and communication.	- Learning and development opportunities; - Employee involvement; - Controllable stress conditions.	- Completeness of the job; - Organisational tasks; - Short cyclicality; - Degree of difficulty; - Autonomy; - Contact possibilities; - Information flows.

3.4 Data analysis

The data to be analysed in this research were, firstly, the interviews. The interviews were conducted, and transcription took place immediately after each interview. The interviews were recorded during the interviewing process, of course with the respondent's permission, in order to be able to listen to them again and transcribe them. Transcribing is important for making the information explicit and clear (Symon & Cassell, 2012). For one of the eight interviews, recording (and transcribing) was not possible due to extreme background noise. Therefore, an interview report was made for this interview.

Next, the data is reduced by means of data reduction, whereby the relevant information is separated from the details and less important information. Data reduction is necessary because a semi-structured way of interviewing is used, which produces a lot of data (Symon & Cassell, 2012). Data reduction took place by means of coding. The codes used were first order themes, second order themes and overarching dimension. The first order themes were the open codes that were extracted directly from the data. These were then combined to form the second order themes. Next, these were combined again to form overarching dimensions, which form the basis for the results. The coding process was the same for the interviews, the documents, the questionnaire, and the transcripts, and will be explained in more detail below.

The second method of data collection in this research was document analysis. The documents were coded in the same way as the interviews; by means of first order themes, second order themes and overarching dimensions. Next, the questionnaire answers were also analysed. In the questionnaire, only open questions were asked. The answers to these questions were combined per question and then coded by means of first order themes, second order themes and overarching dimensions. Finally, the transcripts of the fellow researchers were coded the same way as the transcripts of the interviews from this research.

The coding process, as described above, took place after the interviews had been transcribed, the documents collected, the questionnaire responses merged, and the transcripts received. For the coding is this research, the tool Atlas.ti has been used. Coding is one of the most commonly used approaches to analyse qualitative data (Myers, 2013). It helps to reduce the amount of data and to get an overview of the collected data. This means, that once coding has started, the analysis has also started (Miles & Huberman, 1994). In this research, first order or open quotes from the interviews, documents, questionnaire, and transcripts are referred to as first order themes, by means of the code in vivo function in Atlas.ti. By extension, these first order themes were merged at corresponding points and designated as second order themes. Finally, this step was repeated for the second order themes from which the overarching dimensions emerged. A part of the codebook is included in Appendix C (not included), to illustrate the coding process.

3.5 Research quality

To ensure the quality of this research, the quality criteria developed by Guba and Lincoln (1989 as cited by Symon & Cassell, 2012, p. 207) were assessed. These quality criteria are as follows: credibility, dependability, transferability, and confirmability. There are different views on quality criteria in qualitative research by different authors. In this research, the quality criteria of Symon and Cassell (2012) were chosen because they have jointly written several papers and books in the field of qualitative organisational management research and they are still active in the field of qualitative research methods.

3.5.1 Credibility

The credibility of a research can be compared to its internal validity. It is important that there is a fit between the reality of the respondent and the reconstruction of the researcher. In this research, credibility was ensured by means of member checking (Symon & Cassell, 2012). Firstly, this was done by asking confirmatory questions by repeating part of the respondent's answer and asking for confirmation whether that is what the respondent meant by answering. Secondly, at the end of each interview the respondent was asked whether he or she felt that he or she had been able to say everything he or she wanted to say or whether there were still things that needed to be discussed, there was room for this at the end of the interview. Thirdly, the findings of the research were sent to all respondents who felt interested.

3.5.2 Dependability

With dependability, the methodological changes and choices of the researcher are described to show how the research was carried out (Symon & Cassell, 2012). To ensure the dependability of this research, a research diary was kept throughout the research. In this diary alle results, actions, and choices were documented. The research diary can be found in Appendix D (not included). Also, the method chapter was described in detail, but there was left room for changes during the research. Finally, attention was paid to reflection and evaluation of the research. This provides future researchers the chance to arrive at the same results when repeating this research.

3.5.3 Transferability

The transferability of the research has to do with the degree to which the findings and conclusions of the research are applicable to other companies and/or parts of the population (Symon & Cassell, 2012). In this research, transferability is ensured by describing as much information as possible about the case being studied, in this case the categories of smart industry, the dimensions of quality of work, the well-being dimensions of the WEBA and the companies/places where the interviews were conducted. This allows readers of this research to conclude for themselves whether the research is transferable to his or her specific context. With this research, analytical refinement was provided (Symon & Cassell, 2012). Context was given with this research and it let others free to decide if it is transferable to their context.

3.5.4 Confirmability

With confirmability, the origin of the data is guaranteed. It is important to show where the data used in the research came from to show readers of the research how you concluded the research (Symon &

Cassell, 2012). In this research, the origin of the data is visible through the created codebook. This codebook shows the data that was used and also how the data was analysed. A part of the codebook is visible in Appendix C (not included).

3.6 Research ethics

The most important aspect of research ethics is treating others as you want to be treated yourself (Maylor & Blackmon, 2005), most of the other ethical principles are built on this most important aspect of research ethics (Myers, 2013). In this research, the Netherlands Code of Conduct for Research Integrity (2018) was applied. This code of conduct contains standards for integrity and professionalism that must be maintained by academic researchers. The first ethical concern is the treatment of participants (Netherlands Code of Conduct for Research Integrity, 2018). This ethical concern was met by informing the participants about the research in advance. They were told what the purpose of the research was, and, in the case of interviews, the interview questions were sent in advance. Secondly, the second ethical concern; informed consent was met (Netherlands Code of Conduct for Research Integrity, 2018). Together with contact persons from the organisations, it was decided which employees could be interviewed. These employees were selected on the basis of their experience with working in a smart industry environment. Third, participants were informed on the research findings (Netherlands Code of Conduct for Research Integrity, 2018). During the interviews, it was checked whether the information had been correctly understood by asking confirmatory questions. After the interviews it was agreed, if desired, to send the research results after completion of the research. In addition, all recordings of the interviews will be deleted after graduation. The fourth and last ethical concern is confidentiality and anonymity (Netherlands Code of Conduct for Research Integrity, 2018). This ethical concern was met because this research was only in the hands of the researcher and the supervisors. Furthermore, the respondents were made anonymous by using only function names.

Chapter 4. Results

This chapter provides insight into the results of this research to be able to answer the research question: *“Which aspects are necessary in a measuring instrument in order to provide a representative picture of the quality of work in a smart industry environment?”*.

First, a link is made between the companies in this research and the categories of the smart industry and their current measurement of quality of work (4.1). Then, for all three dimensions of quality of work: learning and development opportunities (4.2), employee involvement (4.3) and controllable stress conditions (4.4), the changes (in relation to the situation before the digitalisation) and characteristics in the smart industry are described. Next, the relevance of the current well-being dimension of the WEBA in the smart industry is described (4.5). Finally, it describes how the quality of work can be measured in a smart industry environment (4.6).

All the results in this chapter are based on data from the interviews conducted, the documents analysed, the questionnaire conducted and the transcripts of fellow researchers analysed. Whenever a quotation is used, it is indicated by means of the code of the data, the function of the respondent and, when applicable, the line numbers in the transcript.

4.1 Current measurement Quality of Work

At present, no measurement is done in both companies regarding the quality of work. The only thing that is actually measured in production is everything related to the production activities, such as the delivery reliability. Furthermore, it is indicated that the quality of work is measured mainly by gut feeling and by the team leaders and production managers looking at the employees in production themselves.

Despite the fact that nothing is measured with regard to the quality of work, there is a need for it. Companies want to get rid of old-fashioned ways of performance- and assessment interviews. As indicated in the following quote:

"We do want to get away from classical functioning and assessment" – (A2, HR Business Partner, 385).

There is a need for a shift in focus from performance and assessment to more coaching. The focus should be on how the employee is doing and whether he or she fits into the company and the position he or she holds.

4.2 Learning and development opportunities in Smart Industry

4.2.1 Changes in learning and development opportunities in Smart Industry

In both company A and B it is indicated that the complexity of the products is increasing. As a result, employees in both companies need more knowledge about programming and less knowledge about setting up the machine, because this is automated. The knowledge they need is much more specialised. The data collection at company B shows that in that company the problem solving abilities of the production employees should be higher. In addition, the employees here have more different competences in comparison with the past. The following quote from a production manager with around 30 years of experience also demonstrates this:

"Compared to 20 years ago, you see a learning curve. In the past, everyone could only do one or two operations. Nowadays, there is no one who can only do one operation" – (B3, Production Manager 2, 418-420).

Company B also pays a lot of attention to sustainable availability among its employees, which forces them to think about the future of their jobs. Because in this company digitalisation has increased over the years, this is a difference with company A, which was founded with a very digitalised view.

Both company A and B use their own software and self-developed smart industry tools. As a result, employees are also trained and educated within the companies themselves. The respondents from company A also indicated that there were no trained staff at the company who could start work immediately.

It can be concluded that the biggest change in learning and development opportunities in relation to the smart industry is that *different competences* are needed and therefore have to be trained. The knowledge characteristics are increasing and therefore the training courses are focused on data and the ability to read this data. These *trainings* are organised by the companies themselves. Experience and skills in the company itself become more important than the education someone has received. The next change is that *more diverse competences* are demanded from employees. All this has been accelerated by digitalisation and automation. Digitalisation has also brought other challenges for production workers. They also have to start thinking about *sustainable availability*. The work of low-skilled workers will be increasingly automated. The likelihood that their work will be taken out of their hands increases over time. So these workers face the challenge of continuing to learn and develop in order to keep up.

4.2.2 Characteristics learning and development opportunities in Smart Industry

Learning and development opportunities in a smart industry environment can be recognised by different characteristics. Company A and B both have their own company school, a so-called Academy. The lessons, training sessions and workshops given in these academies are focused on the company, whereby the latest developments are followed. The goal of these academies is to enable the employees in the production to do their work properly. Various courses are available, but a basic course is important for everyone in production. Professional knowledge is crucial and therefore the lessons, trainings and workshops from the academies are aimed at training the skills that are needed in the company. This concerns skills related to the machines, for example how these machines should be set up and used. The following quote indicates this:

"We have learned our people to deal with the level of digitalisation we have" – (A1, Chief Operation Officer, 120-121).

In addition to learning from the academies, learning is also done in company B by working alongside an experienced employee from the production line. In addition, 'all-round operators' have been appointed to train production staff in company A. These 'all-round operators' are production employees who have knowledge of all machines and are able to solve disruptions.

In both companies it is considered important that a sufficient number of employees are multi-employable. In company B the three times three method is used for this. A product or an operation must be made or carried out by at least three people and each employee must be able to make at least three products or carry out operations. The need for multi-employable employees in production can be based on a capacity requirement of both companies. In this case, production employees need to be trained in order to be able to make more products or perform operations to meet the demand. In both companies the needs of the employees themselves also play a role. When someone has a proactive attitude and wants variety in their work, there is the possibility for further learning and development.

Concluding from the above findings, the following characteristics of learning and development opportunities can be identified. The most important characteristics for recognising learning and development opportunities in a smart industry environment are, firstly, the company's **training methods**. These can be recognised by the training and courses that are given within the companies. A second way to identify learning and development opportunities in a company in a smart industry environment is the **employability** of employees in production. When employees can be deployed on multiple products or operations, they have already learned all this and developed themselves accordingly. A visible consequence of this is that teams and employees in production feel like they can manage themselves, take on tasks and responsibilities themselves and also teach each other things. This also provides the employees a good feeling, as the following quotation shows:

"My learning and development opportunities are sufficient when I feel that I control the work rather than the other way around" – (Questionnaire, Operator 6).

A third way to recognise learning and development opportunities has to do with an important note on the employability. The need for learning and development depends on the employee. There is a spread in this respect within the companies. Not all employees in production are looking for learning and development. It is important to look at the **ambitions** of the employees themselves. Employees must be open to learning and development in order to assess whether the learning and development opportunities are in order.

In the figure below, Figure 3, an overview of the paragraph above is given. Learning and development opportunities can be characterized in a smart industry environment by the training methods, employability and ambitions of the employees.

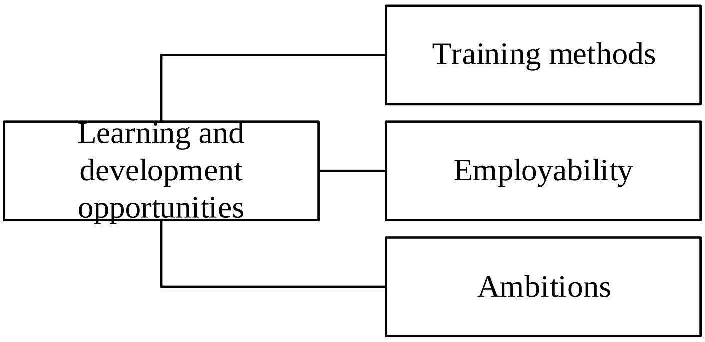

Figure 3. Characteristics learning and development opportunities

4.3 Employee Involvement in Smart Industry

4.3.1 Changes in employee involvement in Smart Industry

In terms of employee involvement, in company B the control capacity is still present to some extent, but has mainly been reduced. In company A, it is indicated that were previously the employees also did the preparatory work, such as programming, they are now only allowed to switch the machine on and off and check it. Digitalisation thus leaves much less room for individual input. Because of the high level of automation, company A also does not want people to make too many changes to the machines, as this could become normal, to the detriment of digitalisation, as errors are not corrected in the digitalisation, but are circumvented by employees.

In company B, the production managers notice that there is less interest in the products that are delivered, because the employees can see everything digitally and only receive the information that is necessary for their functioning. In company A, several employees note that the involvement with the company seems to decrease, because the company grows and becomes a lot bigger.

It can be concluded that there are a number of changes with regard to employee involvement in the smart industry. Involvement *decreases due to disruptions*. Employees are no longer empowered to solve disruptions on their own. In terms of *social involvement, not many changes* can be seen. Although the workplaces have changed somewhat, there is still enough social interaction possible between the workers in production. Intrinsic involvement has changed, however, and in a negative sense. Involvement has been *reduced by products and the company*. Involvement in the company seems to decrease, because often companies that go digital grow and become a lot bigger, there are more and more employees, which causes less involvement.

4.3.2 Characteristics employee involvement in Smart Industry

Employee involvement in the smart industry can be recognized by different characteristics. In company B the data offers employee decision support. This enables the employees to search for solutions and correct their own mistakes. In addition, there is first line support, which are contact points for employees who cannot solve their own problems. In company A the errors are registered so that they can be solved structurally and no human intervention is required in the future. An example of operational control was given by a respondent from company B. An employee had thought of a new working method and tested it, and the results could be seen by means of the data:

"So the next afternoon she said: are these numbers correct? I don't know, I had a good feeling, but that good? I checked with her, yes those numbers are really correct. Well, I say. Introduce that way of working in your team, because you have gained so much on that" – (B3, Production Manager 2, 961-963).

In both companies employees like to know what they are building and see their responsibility in it. Personal contact with the customer of the product increases the involvement with the product. An respondent from company A mentioned that employees who feel responsible for their product and company are hardly ever absent through illness, walk with a smile on their face and do the job well and maybe even a little faster than planned.

Employee involvement in company B also has to do with the use of collaborative robotics, or CoBots. A CoBot is a robot that works together with humans and is therefore an assistant to the employee. The employee operates the CoBot by bringing it to the desired position by hand. The employee is thus leading and remains an important component. The CoBot takes care of the more complex, higher diversity sub activities. In many cases, this provides the employee with more variation in the work because the CoBot does the repetitive part.

In both companies the need for involvement in the company is big. Employees need information from the company about, for example, the present and future of the company. There are various ways of providing employees with this information. The respondents mentioned quarterly meetings and newsletters as examples. This is from management's point of view the information that is issued. The question is whether this is also the information the employees want to receive.

Concluding from the above findings, the following characteristics of employee involvement can be identified. The first characteristic of involvement, which can be recognised in a smart industry environment with regard to control possibilities and control needs, is the **organisational structure** and the associated **independence** of employees in production. Social involvement can be recognised by the characteristics of **personal contact** and a sense of responsibility. The personal contact is visible in the extent to which employees can think along with the work and can contribute ideas on, for example, how the work can be done more conveniently or more efficiently. The intrinsic involvement can be recognised by the **authorisations** of the employees. Companies in a smart industry environment often work with CoBots, were the employee's powers are still big, which increases the intrinsic involvement. The level of involvement in the company shows whether the **information provided** by the company is sufficient.

Finally, it is important to reiterate that everything depends on the individual. The need for involvement can be totally different for each generation, stage of life and level of education. These groups may value very different things. An example was given during one of the interviews about the production staff in company A:

"They really like having that cup of coffee, having the freedom to take their break. Being able to do their work well, not have to work hard. And to be able to make the occasional bad joke with each other" – (A2, HR Business Partner, 234-237).

In the figure below, Figure 4, an overview of the paragraph above is given. Involvement can be characterized in a smart industry environment by the organisational structure – independence, personal contact, authorisations and information provided.

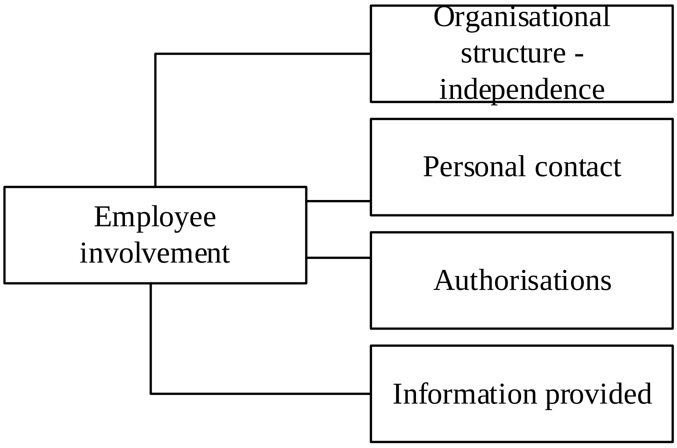

Figure 4. Characteristics employee involvement in smart industry

4.4 Controllable stress conditions in Smart Industry

4.4.1 Changes in controllable stress conditions in Smart Industry

With regard to controllable stress conditions both companies mention that there is less stress on information and uncertainty compared to the situation before the digitalisation. Everything is stored in a database and is easy to find. The data provides support in making decisions, which can reduce stress. In both companies all the necessary information is registered. There is no need to search for products or materials. In company B it is registered where the material or products are and in company A, products and materials are retrieved by the AGV.

What is interesting about this finding is that it was indicated by all respondents. There is *less stress* in a smart industry environment among the employees. The employees in production also indicated it. Two employees from the production department of company A states the following in quotes:

"Digitalisation has made work easier, more efficient and lighter" – (Questionnaire, Operator 1).

“In general, digitalisation has made everything easier and faster. Everything has also become clearer, as everything is stored in databases and is easy to find” – (Questionnaire, Operator 8).

In addition, production employees from company A have also literally said that they do not experience stress at work, as can be seen in the following quotations:

“I do not experience stress” – (Questionnaire, Operator 3).

“I do not experience stress at work” – (Questionnaire, Operator 4).

4.4.2 Characteristics controllable stress conditions in Smart Industry

In both companies it is mentioned that the state of mind of an employee is important. The following quotation shows how the state of mind of an employee in production can be recognised at first glance:

"Do they look good, do they have a smile on their face or do they have bags under their eyes" – (A2, HR Business Partner, 294-295).

In both companies, the state of mind of an employee in production can therefore be deduced from the employee's attitude. The working atmosphere is also important. In a relaxed working atmosphere, there are fewer irritations, which generally results in less stress for the employees. Offering a listening ear and remembering things said by others can also influence an employee's state of mind. In addition, employees can also indicate or report when stressful situations arise themselves.

In company A there is also mentioned another important aspect. The work that the employee has to carry out should be within his physical and mental capabilities and interests. Time pressure is an important indicator. The work must be completed within a certain time, when an employee structurally takes too long, this may be because the standard is not reasonable or because the employee experiences so much stress that he or she cannot complete the work within a certain time. In addition to a reasonable norm, the work must also be manageable for the employee. In addition, the employee should have a view and overview of the work coming up. Another possible indicator of productivity is the number of mistakes made. The making of many mistakes by a certain employee can indicate stress. However, employees indicate that this mainly comes from themselves, which is also shown in the following quote:

"If we really make a mistake, we call it a 'recovery'. This is handled very leniently and you learn from those mistakes. It doesn't happen often, you just put a bit of stress on yourself because you don't want to make mistakes" – (Questionnaire - Operator 7).

Concluding from the above findings, the following characteristics of controllable stress conditions can be identified. There are two important characteristics for recognising controllable stress conditions in a smart industry environment. The first characteristic is the **state of mind** of an employee. This state of mind can be deducted from the employee's attitude and the working atmosphere. The second possible characteristic for recognising controllable stress conditions is the **productivity** of an employee in production. If an employee does not perform up to standard, this may be due to a stressful situation.

In the figure below, Figure 5, an overview of the paragraph above is given. Controllable stress conditions can be characterized in a smart industry environment by the state of mind and productivity of the employees.

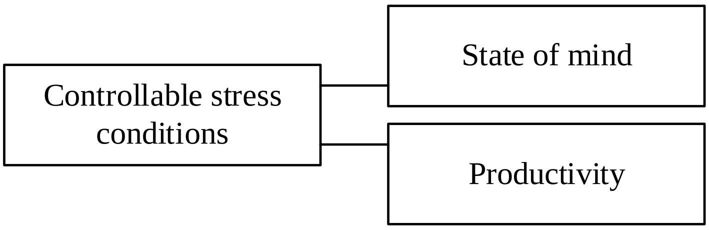

Figure 5. Characteristics controllable stress conditions smart industry

4.5 Relevance well-being dimensions WEBA in Smart Industry

After outlining the changes and characteristics of the dimensions of quality of work in the smart industry, this section discusses the WEBA dimensions one by one. It will be examined whether these dimensions are considered still relevant in a smart industry environment. Firstly, the examination is based on the interviews. Secondly, the examination is linked to the theory.

1. Completeness of the job

The first dimension, completeness of the job, is considered relevant. Variety is needed within a job. However, all of this is person-related. Consider what someone is looking for in a job, their level of education, stage of life, generation and the type of person. This dimension can also be linked to Karasek's job demand control model, employees must have sufficient possibilities for regulation (Karasek, 1979). De Sitter (1981) confirms this by saying that a job should consist of both executive and controlling tasks. This dimension measures the completeness of the job.

2. Organisational tasks

This second dimension seems less important on the basis of this research, but not irrelevant. Based on this research, it can be concluded that the freedom to solve problems above the level of the individual job is difficult in a digitalised environment. Anything above the level of the individual job is immediately related to digitalisation and is of a different job level. Employees cannot be given all the freedom they need by automating. Organisational tasks are curtailed by digitalisation and automation. However, this depends on the choices that an organisation makes. Certain choices made by organisations can lead to more or less freedom for employees. For example, the use of certain machines. This dimension also ties in with the job demand control model of Karasek (1979), in which the ability to solve problems on one's own is also considered important.

3. Short cyclicality

This third dimension is a relevant one. Several studies indicate that smart industry does not directly lead to no more short cyclicality. This is also shown in the essay by Pot (2018): "Automation and digitalisation do not automatically mean the end of short-cycle work" (Pot, 2018, p. 194). The introduction of cells or semi-autonomous teams can, however, lead to a decrease in short-cycle work (Vermeerbergen, Pless, van Hootegem & Benders, 2018). Further research will have to show whether there is also a relationship between smart industry technologies and a possible decrease in short cyclicality. This research shows that this relationship can be company-dependent. In both companies there has been a decline in short cyclical work over the years. These tasks have been taken over by robots because monotonous tasks are very suitable for robots. For these companies, this dimension of the WEBA will be less relevant because the work no longer exists. Nevertheless, this dimension is relevant and can be evaluated for each company.

4. Degree of difficulty

The fourth dimension is relevant, but it is person-dependent. There must be variety, but how much variety depends on the job and education level. The degree of difficulty can be compromised when easy tasks are automated, so that only difficult work remains. The degree of difficulty is also related to the job demand control model of Karasek (1979), solving problems can provide a good balance in the degree of difficulty.

5. Autonomy

The fifth dimension is considered relevant. Employees must have a certain degree of control over their work; this need for control over work is very present. However, this can again be person-dependent and have to do with, for example, education level and generations. However, the more digitalisation takes place, the more difficult it becomes to give employees a say in their work. Nevertheless, this has two sides; “At the right side of the organizing continuum, the digitalization organizes a work environment that supports highly qualified humans. They have broad leeway and a high degree of autonomy to design and create innovative forms of digitalization for tomorrow. At the left side of the organizing continuum, Industry 4.0 structures a work environment with narrow leeway, a low degree of autonomy and a top-down structure of control authority predetermined by digital applications” (Wilkesmann & Wilkesmann, 2018, p. 238).

6. Contact possibilities

The sixth dimension always remains relevant. Again, it is personal, but in general, social isolation does not make people happy. If an employee is not happy, he or she is not capable to do the job. More specifically, it can be examined how a workplace is organised and whether there is rotation with direct colleagues (when a small number of employees work on a product or machine). This dimension can be linked to Karasek's job demand control model by indicating this dimension as a yardstick for controllable stress conditions (Karasek, 1979).

7. Information flows

The seventh dimension has also continued to be relevant. However, this dimension has become much more complex in the smart industry. Digitalisation has made a lot more information available for the company. On the one hand, this information is visible to the employees and the employees can appreciate this and are therefore more motivated and involved. On the other hand, a characteristic of digitalisation is that the systems have to do the work, hence too much information can also create noise. The information flows are also one of the new technologies in the smart industry (Bissola & Imperatori; Smart Industry, 2015).

The table below, Table 7, summarises which WEBA dimensions are still relevant in the smart industry and which side notes apply.

Table 7. Relevance WEBA dimension in smart industry and side notes

WEBA dimension	Relevant in smart industry?	Side note
Completeness of the job	Yes	Person-related
Organisational tasks	To a certain extent	Organisational choice
Short cyclicality	Company-related	Determine for company
Degree of difficulty	Yes	Person-dependent
Autonomy	Yes	Person-dependent
Contact possibilities	Yes	Personal
Information flows	Yes	More complex

The figure below, Figure 6, provides an visual overview of the WEBA dimensions and their relevance in a smart industry environment. The green dimensions are still relevant and the orange dimensions are also relevant, but are less important on the basis of this research, which leads to a side note per dimension.

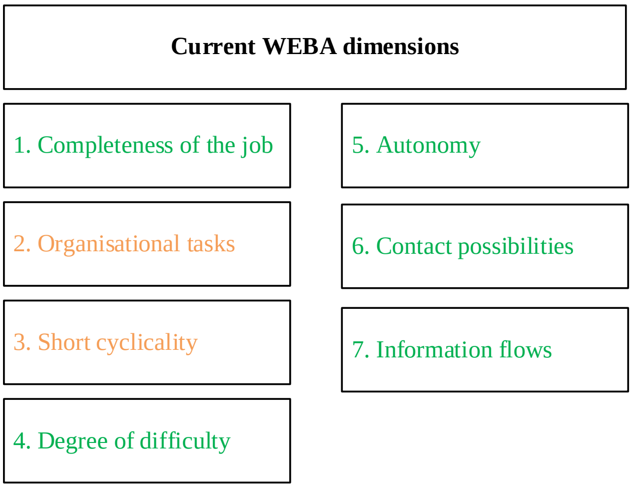

Figure 6. Relevance current WEBA dimensions

4.6 Measuring Quality of Work in Smart Industry

As described in the previous section, all the current WEBA dimensions are still relevant in a smart industry environment. There are, however, side notes to these dimensions. Two dimensions are just relevant to a certain extent or are company related. The next step is to link the characteristics in the smart industry described in sections 4.2 Learning and development opportunities in Smart Industry, 4.3 Employee Involvement in Smart Industry and 4.4 Controllable stress conditions in Smart Industry to the relevant WEBA dimensions.

The number of training methods given by a company is not measured by the WEBA and can therefore not be linked. The employability can be linked to the dimension organisational tasks when this dimension is expanded with regard to employability. The ambitions of employees correspond to the side note on many of the current WEBA dimensions. The current WEBA does not measure ambitions or the person-related aspect. The organisational structure - independence can be linked to both the organisational tasks and autonomy. Both focus on how dependent employees are. The same applies to authorisations, which can also be linked to both organisational tasks and autonomy. Personal contact is an addition to the contact possibilities dimension. Information provided can be linked to information flows. Both focus on the information. State of mind is again not to be linked because this has to do with the person-related aspect. Finally, productivity is another important characteristic in the smart industry; it is not included in the current WEBA and is therefore not linked. In the table below, Table 8, these connections are shown.

Table 8. Link characteristics smart industry and WEBA dimensions

Dimensions quality of work	Characteristics in smart industry	Link WEBA dimension
Learning and development opportunities	Training methods	-
	Employability	Organisational tasks
	Ambitions	-
Employee involvement	Organisational structure – independence	Organisational tasks Autonomy
	Personal contact	Contact possibilities
	Authorisations	Organisational tasks Autonomy
	Information provided	Information flows
Controllable stress conditions	State of mind	-
	Productivity	-

The figure below, Figure 7, provides an visual overview of the dimensions of quality of work, their characteristics in the smart industry and the link with the current WEBA dimensions.

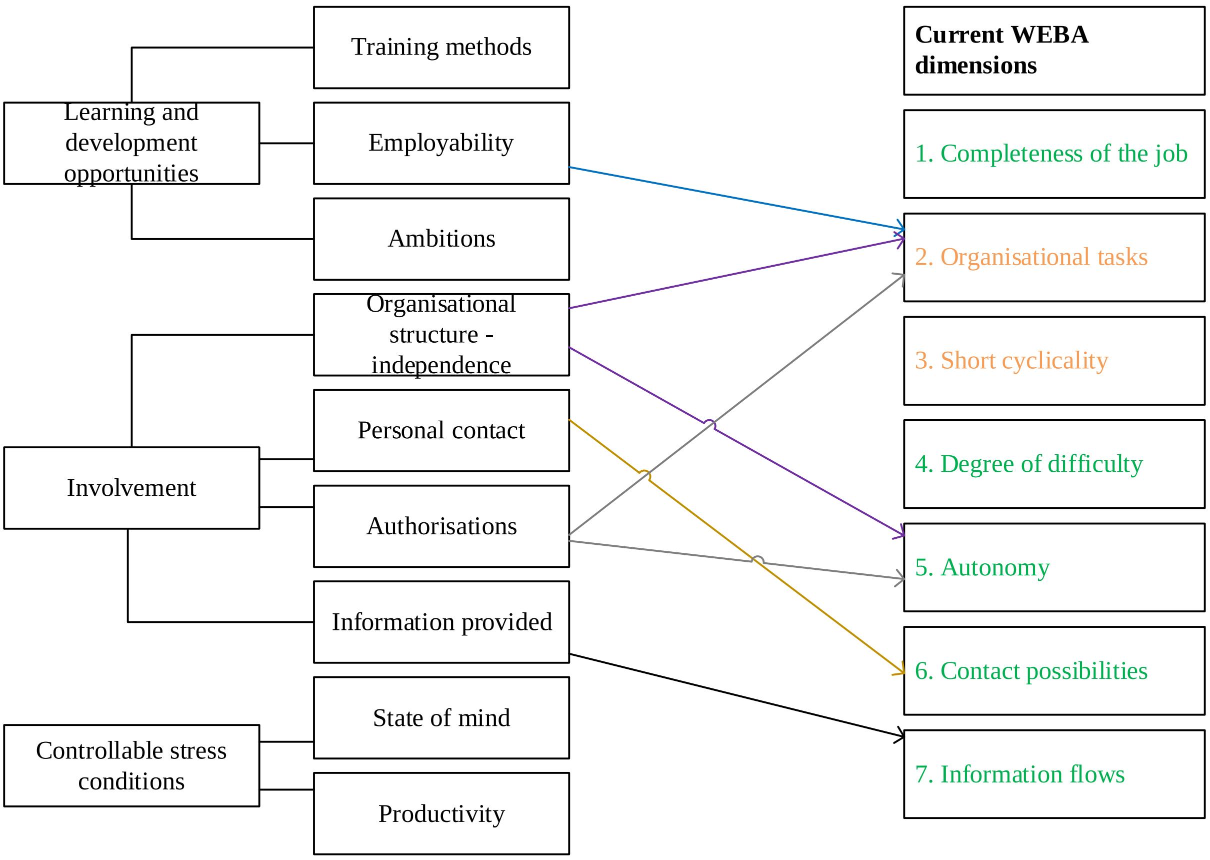

Figure 7. Link characteristics smart industry and WEBA dimensions

The next step is to provide an overview of the current WEBA with the additions and site notes that need to be taken into account in a smart industry environment, based on this research.

Dimension 1. Completeness of the job

This dimension is sufficient when a job consists of preparatory, executive and supportive tasks.

Dimension 2. Organisational tasks

This dimension measures whether an employee has control over the work and can solve problems. An addition to this dimension based on this research is to look at the employability of employees. When employees are employable in many aspects, they are trained for this and are more involved in the process, which improves their quality of work. In addition, the organisational structure and the independence of the employees can be looked at to solve these problems. The organisational structure can also show what the hierarchy in the organisation is, in other words, to what extent there is the possibility of solving problems by themselves. Finally, the authorisations of the employees can also be added to this dimension. The collaborative robotics that many smart industry companies are working with have an influence on the authorisations of the employees.

Dimension 3. Short cyclicality

This dimension measures the extent of short cycle work in a production environment. The relevance of this dimension depends on the company. When companies no longer have short cyclical work, this dimension is just fulfilled quickly.

Dimension 4. Degree of difficulty

This dimension looks at a balance between easy and difficult tasks within a job.

Dimension 5. Autonomy

This dimension looks at the independence of the employee. To what extent the employee can determine the pace, method, order of work, working conditions and workplace. An addition to this dimension based on this research is the same as for the second dimension. The organisational structure and the related independence of the employees and the authorisations of the employees can also complement autonomy.

Dimension 6. Contact possibilities

This dimension represents sufficient contact for the employees. This can be contact for support, contact about the work or social contact. An addition to this dimension based on this research is the inclusion of personal contact with customers and managers.

Dimension 7. Information flows

According to this dimension, employees must have sufficient information to solve problems and learn from them. An addition to this dimension based on this research is the information provided. This addition is almost the same as the original dimension, only this one also looks at the information about the company itself, in order to keep the employees more involved with the company.

In addition to the relevance of the current WEBA dimensions, this research has shown that other factors are important in measuring the quality of work in a smart industry environment. For these factors, an additional module can be developed with non-structural items. Companies in a smart industry environment can use the WEBA in combination with the additional module as a measurement tool for the quality of work. This module consists of the following three non-structural items.

Item 1. Training methods

By zooming in on the training possibilities within a company, a picture can be sketched of the learning and development opportunities within that company. Digitalisation means that developments are very fast and employees have to keep learning. Companies often offer these training courses themselves because the technologies can be company-specific. The possibility of these training courses has an influence on the quality of work.

Item 2. Productivity

Productivity is already measured in many companies, but is not always used to look at the quality of work. Yet this can be very useful. Productivity can say something about the stress conditions of an employee. If someone always takes too long to do his work or makes too many mistakes, this could be because that person does not feel good about himself. It is therefore also important to take this into account when measuring the quality of work, because this is an important aspect. Important here is that it does not have to have a direct cause towards low quality of work. This will then need to be investigated further.

Item 3. Ambitions and state of mind

The greatest shortcoming of the present WEBA is the personal aspect. Not every employee has the same needs, so the quality of work can be interpreted differently for everyone. One aspect that can be looked at is the ambitions of employees to learn and develop. There will be employees who have great ambitions and want to learn and develop a lot and on the other hand, there will also be employees who do not have these ambitions but still feel comfortable in their jobs. Also in terms of employee involvement, the need for this differs between different groups of employees. The personal aspect also includes the state of mind of an employee. The state of mind can say a lot about the stress conditions of an employee. It is therefore also important to look at this.

Chapter 5. Conclusion and discussion

This chapter answers the research question through the conclusion (5.1). Next, theoretical (5.2) and practical implications (5.3) based on this research are given. Subsequently, the limitations are described (5.4), the findings and the research process are reflected upon (5.5) and recommendations for further research are given (5.6).

5.1 Conclusion

The purpose of this research was to contribute to the literature on the impact of smart industry technologies on the quality of work by investigating which aspects are necessary in a measuring instrument in order to provide a representative picture of the quality of work in a smart industry environment followed by analysing the WEBA, investigating if the original WEBA is still applicable for companies in a smart industry environment and, if not, show whether an ada adaptation or extension of this original WEBA is possible. The following research question was defined to reach this goal: *"Which aspects are necessary in a measuring instrument in order to provide a representative picture of the quality of work in a smart industry environment?"*.

To answer this research question, data was collected and analysed at two companies in a smart industry environment. It turned out that there is currently no active measurement of the quality of work. However, there is a need to move away from classical assessment and performance. All the other changes in the quality of work related to digitalisation and thus the smart industry are shown in the figure below, Figure 8.

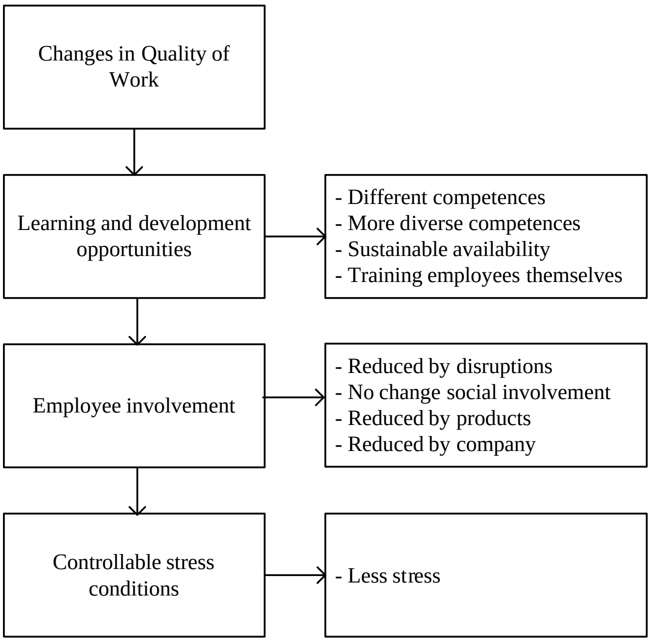

Figure 8. Changes in quality of work

Changes in learning and development opportunities are the requirement for different competences. Employees must have more knowledge of programming, for example. In addition, more diverse competences are needed; nobody can do just one operation anymore. Another change is the focus on sustainable availability. Employees have to think about this if the possibility exists that their work will also be digitalised. Finally, in the context of learning and development opportunities, it has become more important for companies themselves to train employees to work with the degree of digitalisation within that company. As far as employee involvement is concerned, there is a decline in involvement with regard to control capacity in the case of disruptions. Ideally, in a smart industry company, there is no employee who solves disruptions; this must be solved structurally. There is no change in social involvement. Intrinsic involvement has declined; there is less involvement with the product because employees only see part of the information. Finally, involvement in the company has also decreased indirectly. Digitalisation provides opportunities for a company to grow, which in turn reduces employees' involvement in the company. As far as controllable stress conditions are concerned, a decrease can be seen in the stress experienced by employees. All the necessary information is available, which causes less stress.

To determine which aspects are required in a measuring instrument for the quality of work in a smart industry environment, it was first determined how the various dimensions of quality of work in a smart industry environment can be characterised. Learning and development opportunities can be measured by means of the training methods of the companies. Ways in which employees within the company are trained in order to be able to work in the company. The next characteristic is the employability of the employees. The more employable employees are in various aspects, the more opportunities there are for learning and development. An important point to take into account is the personal preferences and ambitions of the employees. The characteristics of employee involvement in a smart industry are firstly the organisational structure and independence of the employees. This shows what the possibilities are of the employees in the case of disruptions. Social involvement can be recognised by the personal contact between employees and customers and employees and managers. Intrinsic involvement can be recognised by the authorisations of the employees. Involvement in the company can be recognised by the information provided. Controllable stress conditions can be recognised by the state of mind of the employees. In addition, the productivity of a co-worker can also be identified. Possible conclusions can be drawn from this when, for example, certain mistakes are made repeatedly.

An analysis of the relevance of the current WEBA dimensions shows that all of the seven dimensions are still relevant and, with some adjustments/additions and site notes, can be used in the smart industry. An additional module with three non-structural items can be used as an addition to the WEBA to measure the quality of work in a smart industry environment. In conclusion, there are seven WEBA dimensions and three non-structural items, which together are a measurement tool for the quality of work in the smart industry. These dimensions and items are visible in the figure below, Figure 9.

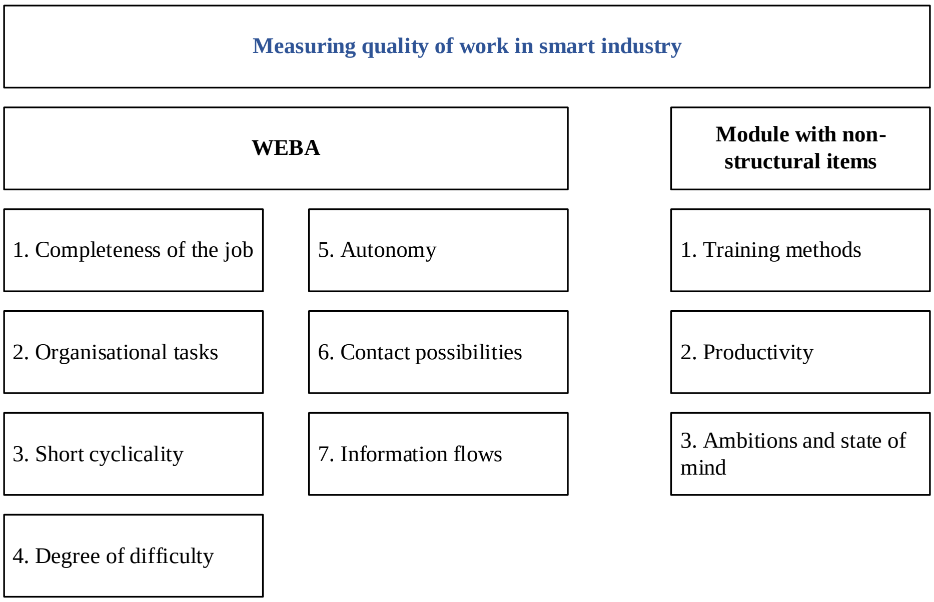

Figure 9. Measuring quality of work in smart industry

The figure below, Figure 10, provides an overview of the results. With the first part of the results; the characteristics of the aspects of quality of work to be able to measure these in a smart industry environment and the conclusion: the WEBA dimensions and the module with non-structural items for measuring the quality of work in the smart industry.

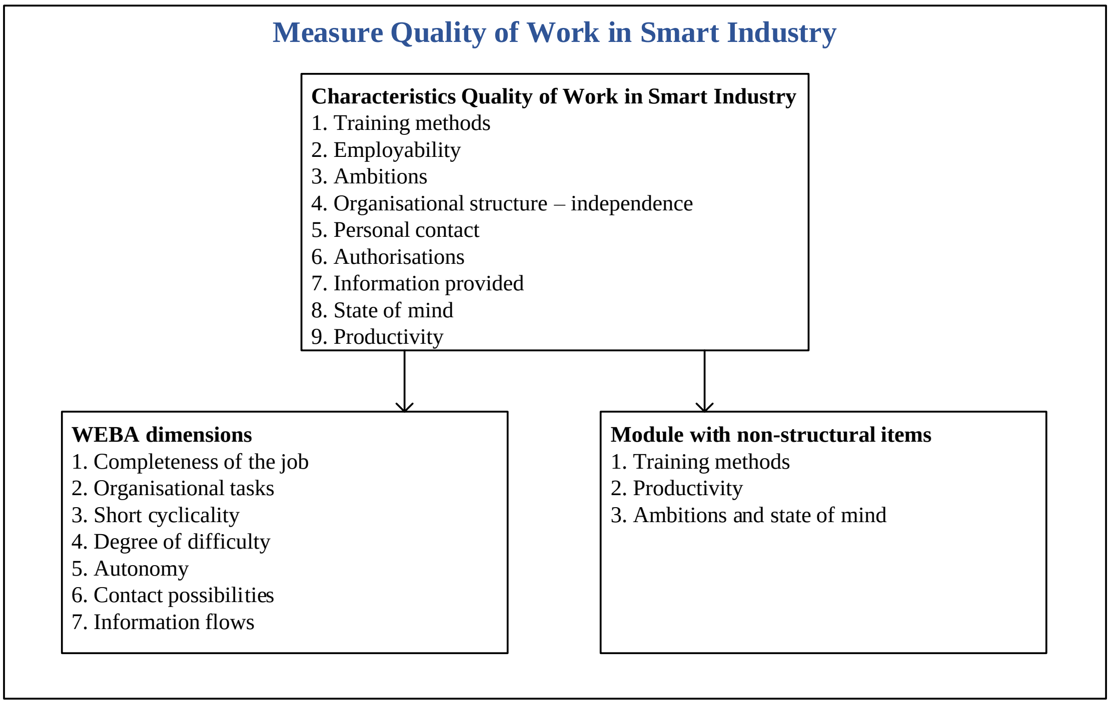

Figure 10. Visual representation of the conclusion

5.2 Theoretical implications

As a result of this research, a number of theoretical implications can be described. Firstly, this research compared the WEBA with the current characteristics of quality of work in a smart industry environment. The WEBA is a measuring instrument that is thirty years old and this research has examined whether the WEBA is still relevant and if so, which dimensions of the WEBA are still relevant. The results not only provide a picture of what is different in quality of work in a smart industry environment, but also of what is different between now and thirty years ago, when the WEBA was developed. Consider, for example, the needs of employees. In the current WEBA, the needs and personal characteristics of the employees being studied are not included. In this research this is formulated as an extra dimension that can be added to the current WEBA under the heading 'Ambitions and state of mind'. For all current WEBA dimensions, the quality of this dimension is person-dependent. By developing a module with non-structural items which can be used in addition to the original WEBA, there is a complete measurement instrument for the quality of work in a smart industry environment.

A second theoretical implication relates to the study by Frey & Osborne (2017). In the theoretical framework, it is described that the current technological developments will cause job losses and that employees are therefore expected to be more flexible in dealing with digitalisation. This research shows that job loss is not a high point on the agenda in these companies. The fact remains that work is changing and that sustainable availability needs to be considered, as also described in this research. Whether a direct consequence of this is the loss of jobs cannot be inferred directly. The increase in expected flexibility of employees can certainly be seen. Employees are expected to be able to perform multiple operations and/or make products. This is certainly different than before. This ties in with the research of Brynjolfsson and McAfee (2015), which discusses two possible effects of digitalisation on quality of work. On the one hand, the new technologies would replace human workers and on the other hand, it would actually create jobs. This research did not look directly at job loss or retention, but sustainable availability emerges, as described above.

There is a quote that emerges from the theoretical framework that is applicable; "there has never been a better time to be a worker with special skills or the right education, because these people can use technology to create and capture value. However, there has never been a worse time to be a worker with only 'ordinary' skills and abilities, because computers, robots and other digital technologies are acquiring these skills and abilities at an extraordinary rate" (Brynjolfsson & McAfee, 2014, p. 9). Indeed, the findings of this research also show that different and more diverse competences are needed among employees.

A third theoretical implication has to do with the various studies in the theoretical framework describing and concluding that digitalisation has a negative impact on the quality of work. The autonomy of employees would be reduced, tasks would become narrower and machines would take over work from employees (Brynjolfsson & McAfee, 2011; Brynjolfsson & McAfee, 2015; Frey & Osborne, 2013; Socio-Economic Council, 2016). In addition, there are some general statements in society such as that digitalisation would cause a lot of stress. If we look at digitalisations in the context of this research, i.e. digitalisations in production environments, an interesting finding is that digitalisation causes less stress. When the technologies are applied in the right way in an organisation, this can indeed have a stress-reducing effect. At the companies in this research a lot of information is available for the employees. As a result, the employees have all the necessary information at hand and there is less stress. Employees have to search less for materials, products or information, which has a stress reducing effect. This finding is based on several interviews and the questionnaire in this research. It has been mentioned by managers, team leaders and operators alike. Part of the information that is made available in these companies may also be available in other companies, but is not made available to the employees by these companies. This is a starting point for further research and will be elaborated on in the section further research.

5.3 Practical implications

In addition to the theoretical implications, this research has also resulted in a number of practical implications. Firstly, as described in the introduction, this research is part of a Dutch multi-year study 'Toward the digital factory' conducted by the HAN Lean-QRM centre. In this project, guidelines are drawn up for implementing and working with real-time planning simulation to operate in a smart industry environment. The results of this research contribute to this project because they provide insight into the consequences of digitalisation at two partner companies. In particular, the consequences for the quality of work, a somewhat underexposed aspect in the project. Based on the results of this research, follow-up research will be set up in the area of organisational development and the introduction of smart technology. All findings will be taken into account as a step in the follow-up process. The results have been discussed with the researchers of the HAN Lean-QRM centre and they are well placed to work with them. The results of this research can be used directly in their network and their practical research. This research fulfils the need to directly include and prioritize employee related aspects when introducing simulation or other smart tools.

Secondly, the results of this research are relevant for companies that participate in the study of the HAN Lean-QRM centre. These companies can measure up to the two companies in this research. This research provides an idea of the expected changes in the field of quality of work as a result of digitalisation. This can reduce the great uncertainty among companies about how to deal with the effects of digitalisations on the quality of work.

In addition to the partner companies participating in the study of the HAN Lean-QRM centre, other companies can also make use of the results of this research. A description has been given of both companies in this research of how these companies fit into a smart industry environment. When companies recognise and can identify with the companies in this research, it also provides them an idea of the expected changes in the field of quality of work as a result of digitalisation.

Thirdly, besides providing insight into the expected changes in the field of quality of work as a result of digitalisation, this study also provides insight into a possible adaptation or extension of a current measuring instrument for quality of work, the WEBA. This research has shown that there is a need within companies for a different way of assessing employees. Companies no longer want to do this in the traditional way, for instance by means of performance and assessment interviews. This research provides an impetus using a more detailed way of measuring the quality of work in a smart industry environment, by using the current WEBA and a new module with non-structural items.

5.4 Limitations

A first limitation with regard to this research has to do with the case selection. For this research, data was collected from two companies. However, both companies had limited time, which meant that only a limited amount of data was obtained. It was enough data for this research, but in order to conduct further, deeper and more detailed research, more data should be obtained from more companies.

A second limitation that has had a rather large impact on obtaining research results and data is the situation around COVID-19. Because of the measures taken, it was not possible to visit the production employees. This was the original plan, in the hope that this would be possible when the data had to be collected. However, this was not the case. Unfortunately, not a lot of data was collected from the production employees, because they could not be reached through on-site interviews. As an alternative, a questionnaire was prepared and filled in by the production employees. Unfortunately, this did not result in that much data.

The third limitation builds on the previous limitation on the situation of COVID-19. By these measures, the interviews were conducted online. This had advantages, for example it took less time because there was no travel time. However, it also had limitations, because during an online interview the non-verbal communication such as visual emotions, body posture or gestures are missed (Bleijenbergh, 2015). A lot can be gained from this non-verbal communication, especially in the area of quality of work, because this is often not directly expressed.

The fourth and final limitation concerns the language. All interviews were conducted in Dutch because all respondents were Dutch speakers. When analysing the data and writing down the research results, quotations from these interviews were used. These quotes were translated from Dutch into English to fit the report. However, a number of times the quotes in Dutch seemed very nice and in English the essence did not come across completely.

5.5 Reflection

The reflection on this research can be viewed from two sides. On the one hand, the reflection on the findings of this research and on the other hand, the reflection on the research process. To start with the reflection on the findings of this research, there are three points that can be reflected on. First, the finding about missing a person-related aspect in the WEBA. This is an important finding, because the WEBA lacks this aspect. However, the question is whether this is due to digitalisation. This is not the most obvious. Missing the focus on the person themselves is something the WEBA lacks in any case. Whether this is in a smart industry environment or not. Nevertheless, this finding has been included, because it is a major shortcoming of the WEBA and because it can be added to and thus can certainly be of added value in a smart industry environment. In addition, whether or not related to the developments of the smart industry, the need to include person-related aspects in a measurement instrument for the quality of work will have increased over the years. This may also be due to other factors, such as their level of education, stage of life, generation and the type of person. These are aspects that require further research and will therefore be described further in that paragraph.

Secondly, the WEBA dimension short cyclicality was found to be less important in this research. This is the outcome of this research based on the two companies in this research. In these companies short cyclical work does not occur anymore in production. These companies have been characterised as smart industry companies, which makes the assumption that short-cycle work will disappear in the smart industry. However, in other companies there are also voices saying that digitalisation does not directly lead to the disappearance of short-cycle work. An essay by Pot (2018) shows that there are good examples of short-cycle work disappearing as a result of digitalisation, but that in general few organisations work on this directly. All in all, short-cycle work is the work that is easiest to digitise and this is where smart industry companies will be furthest along. Digitalisation removes aspects, in this case short-cycle work, in places where you don't want it because it has a negative impact on the quality of work.

Thirdly, there are other measuring instruments for quality of work besides the WEBA that have not been included. The WEBA was chosen for this research. Because of the need to delineate the research and in relation to the limited time period, only this WEBA has been examined. In order to get a good picture of how the quality of work can best be measured in a smart industry environment, it is also relevant for further research to look at other measuring instruments. This is explained in more detail in the paragraph below.

Finally, the research process can be reflected upon. The biggest issue that arose during the research was the collection of data. Because of the COVID-19 measures, the data was collected in a different way than was ideally intended. It would have been best if there had been more discussion with the employees on the floor / in the production environment. These employees are the ones who are most affected by the changes concerning digitalisation, so they are also the ones who can best describe these effects. In this case, only a questionnaire was given to a number of operators. A disadvantage of this was that the employees had not always understood the question correctly, which was only noticed during the analysis. The questions were reasonably open, because you don't want to steer too much towards a desired answer in the question. In a conversation or interview, the questions could have been explained in more detail, which would have provided more concrete data from the operators.

5.6 Recommendations for further research

Based on the findings of this research, a number of recommendations for further research have been found. Firstly, it is recommended to further investigate the influence of education level, life phase, generation and type of person on the need for more personalised aspects in the WEBA. It can be examined how this can be measured exactly and which aspects are important to give a good picture of what someone's needs are. In this research, this is all scaled down under 'ambitions and state of mind'; in further research, it can be examined whether this can be formulated more specifically. Making it more specific must be done in a way that does not lead to qualifications, because still, depending on a generation, it is possible that there is a difference in ambitions of people within the same generation.

Secondly, in addition to the companies used in this research as a yardstick for a smart industry company, it is also important to look at other companies that are also involved in smart industry. The companies in this research are both fairly far advanced in the field of smart industry. The employees in these companies are used to or have become accustomed to the smart industry technologies. Their view of these developments, and therefore their quality of work, may therefore be different to that of a company that suddenly makes the switch to smart industry. This is related to the companies' workforce. A young, dynamic workforce will generally find the smart industry technologies interesting. Companies may also gear their selection policy and workforce to this.

Thirdly, it is recommended that further research be carried out into the influence of digitalisation on stress. This research has shown that the information made available by these two companies reduces stress. This can be a starting point for further research. The general idea about digitalisation is that it causes more stress, this research has proven the opposite, whether this is actually the case at other companies will have to be proven by further research.

Fourthly, a recommendation for further research is to work out the module with non-structural items more specifically and actually test this way of measuring. This research has given a start for how the quality of work can be measured in a smart industry environment. Follow-up research should give a picture of the applicability of this way of measuring.

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