Reluctance in Industry 4.0 use within SMEs: empirical findings

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ABSTRACT

Industry 4.0 is expected to revolutionize the manufacturing industry. Opportunities and challenges are widely identified by academics and organisations. However, studies on factors that potentially influence the reluctance of Industry 4.0 use were, to our knowledge, lacking. A research model consisting of six relevant Industry 4.0-related factors that potentially could influence the reluctance of Industry 4.0 use is hypothesised. In order to test the model, multiple regression analysis is applied on a sample of 30 Dutch Small and Medium sized Enterprises (SMEs) from 19 sectors. The empirical findings show that Risk of Change and Difficulties to Adjust the Production Process are positive drivers of the reluctance of Industry 4.0 use. Data Risks and Risk of Job Losses showed a significant negative relationship to the reluctance of Industry 4.0 use, and the hypotheses Lack of Time and Costs were rejected due to insufficient empirical evidence. Moreover, it is shown that SMEs have a completely different perspective concerning Industry 4.0, when compared to each other.

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Industry 4.0, Industrial Internet of Things, SME, empirical research

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1. INTRODUCTION

The business environment is changing rapidly in the beginning of the 21st century with influences of the Internet, Big Data, Cloud Computing and Smart Products (Schmidt et al., 2015). The rate of business innovation creates a lot of new opportunities and challenges for organizations facing the upcoming state-of-the-art industrial revolution, known as Industry 4.0. Existing value creating business models are expected to change, due to this novel industrial revolution (Müller, Kiel, & Voigt, 2018; Stock & Seliger, 2016). This illustrates the far-reaching impacts for today's dynamic business environment.

Technological advancements of the past resulted in a series of consecutive industrial revolutions. The first industrial revolution, where the steam engine notably increased the production capacity, as well as the production speed (Estevadeordal, Frantz, & Taylor, 2003), resulted in a significant contribution to the growth of the economy (Atack, Bateman, & Weiss, 1980; Nuvolari, 2006). The fast pace of technological advancements, culminated into the second industrial revolution, which opened doors for companies to enable themselves to start mass production, with the invention of the assembly line, and the support of electrical power (David, 1990; Devine, 1983; Rosenberg, 1976). Furthermore, in this period starting in the late 18th century till the beginning of World War I (Mokyr, 1998), a culmination of technological advancements in the telegraph (Bargh & McKenna, 2004; Jensen, 1993) and railway network (Jensen, 1993; O'rourke & Williamson, 2002) ended up in a wave of globalization. This created opportunities for people to cross borders, and facilitated the ease for organizations to out-source its production to low-cost areas (Porter, 2000). Globalization was seen as the drastic accelerator of economic growth (Sachs, 2000).

Ensuing the wave of globalization, the third, and most recent industrial revolution loomed. For the first time in history, automation of the production process became a reality (Georgakopoulos, Hornick, & Sheth, 1995; Kagermann, Helbig, Hellinger, & Wahlster, 2013), due to the implementation of information technology (IT) and robotics (Ribeiro & Barata, 2011). This digital revolution stressed to what extent information technology would play a role in our contemporary society (Porter & Heppelmann, 2014; Porter & Millar, 1985), and shaped favourable business opportunities for organisations to improve their efficiency (Melville, Kraemer, & Gurbaxani, 2004) and effectiveness (Bharadwaj, 2000). Information technology changed the way businesses work (Davenport & Short, 1990), and gave more power to consumers, since they got instant access to enormous amounts of data (Labrecque, vor dem Esche, Mathwick, Novak, & Hofacker, 2013). All these amounts of aggregated data are nowadays known as the buzzword "Big Data". Due to the emerging nature of Big Data, various definitions exist in the academic literature (Wamba, Akter, Edwards, Chopin, & Gnanzou, 2015). Russom (2011) for example, defines Big Data using the 3Vs, volume, velocity and variety. 'Volume' grasps the enormous amounts of data and storage capacity that is necessary, 'velocity' entails the speed of new data generation and 'variety' aims to cover the large diversity of formats and sources (Russom, 2011). Since managers can have access to these vast amounts of data within the company, they are able to measure exceedingly more about their company, and this knowledge helps them to make better informed decisions that can fuel business performance considerably (McAfee, Brynjolfsson, Davenport, Patil, & Barton, 2012).

Next to Big Data, the Internet of Things (IoT) in association with Industry 4.0 is rising in popularity too. The concept of the Internet of Things is based on the interconnectedness of various sensors, actuators, tags and devices through the Internet (Al-Fuqaha, Guizani, Mohammadi, Aledhari, & Ayyash, 2015; Atzori, Iera, & Morabito, 2010). All these objects or *things* around us will be able to interact and cooperate with each other to achieve common goals (Gubbi, Buyya, Marusic, & Palaniswami, 2013). The influence of the Internet contributed for a large extent towards the wave of globalization in the third industrial revolution, and created opportunities for people together with businesses to get connected at a fast pace, and unforeseen scale. The same is expected to happen with most of the objects around us that will create a smart interconnected environment (Gubbi et al., 2013).

The industrial revolutions of the past encouraged the shift from craftsmanship to mass production (Kanji, 1990), in contrast, in the last decades it seems to shift back to the old paradigm where production was more specifically tailored towards the individual (Ribeiro & Barata, 2011). This demand for more personalisation and flexibility in the production process creates challenges for existing production facilities (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014). Nonetheless, this is the territory where the next industrial revolution, Industry 4.0, develops in. Industry 4.0 promises to provide manufacturers with rewarding business models, as well as greater efficiency, quality, customization and flexibility, but also better conditions at the workplace (Müller, Kiel, et al., 2018). However, Industry 4.0 also comes with a great deal of challenges (Kagermann et al., 2013) in the form of technological, economic, scientific, political and social challenges. For instance, the difficulties in the development of a network environment or the development of smart devices (Zhou, Liu, & Zhou, 2015). These upcoming challenges play an important role for industrial manufacturers. Especially, since they reveal reluctance and slow adaption towards this new paradigm of Industry 4.0 in manufacturing (Müller, Kiel, et al., 2018).

Although, a lot of concepts and ideas already exist in the field of Industry 4.0, it still seems that only the larger companies have the power, and assets to really handle it well. That is one of the reasons that clustering of smaller companies rose in popularity, since "the successful transformation towards the fourth industrial revolution requires conditions intrinsic to clusters – mutual trust, compatibility and close cooperation, or shared norms" (Götz & Jankowska, 2017, p. 1640). Moreover, Porter (1998) stresses the importance of clustering and states: "A cluster allows each member to benefit as if it had greater scale or as if it had joined with others without sacrificing its flexibility" (Porter, p. 81). Still, for individual Small and Medium sized Enterprises (SMEs) willing to implement Industry 4.0, it could be seen as a hassle, because of a lack of formal methods and standards that are openly accessible (Radziwon, Bilberg, Bogers, & Madsen, 2014). SMEs are expected to approach the large consultancy firms, who are in the possession of these well-defined Industry 4.0 methods, but these firms are moneywise not an option for most SMEs in the market.

Furthermore, present-day literature in the field of Industry 4.0 focusses for a great extent on large firms (Arnold, Kiel, & Voigt, 2016; Radziwon et al., 2014), but hardly on SMEs (Müller, Buliga, & Voigt, 2018; Schmidt et al., 2015). For SMEs willing to be part of the implementation of Industry 4.0, factors like R&D (Monostori, 2014), planning and time could play a role in order to implement Industry 4.0 into the business, and this is not always easily accessible for smaller scale companies. This emphasises the need for an investigation of the factors that could potentially make existing SMEs reluctant towards the use of Industry 4.0 within their organisation.

Based on arguments raised earlier, and the understudied field of SMEs in the literature of Industry 4.0 this paper aims to answer the following research question:

RQ: *What factors influence the reluctance of Industry 4.0 use within SMEs in the Netherlands?*

The current available academic literature in the field of Industry 4.0 is to a large extent focussed on the potential use of Industry 4.0, and how business models need to adapt to the upswing of Industry 4.0 (Porter & Heppelmann, 2014; Schmidt et al., 2015). In addition, academics tend to emphasize the positive aspects of Industry 4.0 implementation (Schmidt et al., 2015; Stock & Seliger, 2016), therefore this paper aims to identify the other side of Industry 4.0, and that it could possibly find reluctance within the business environment. Furthermore, the paper intents to add to the empirical research findings regarding Industry 4.0, since these are very scarce today. One of the empirical studies performed by Schmidt et al. (2015) identified five factors, production time improvement, level of automation, mass customization, the amount of idle data and technology use that are positively influencing the 'potential use of Industry 4.0'. The results were based on 133 experts in the field of Industry 4.0 in Germany. The paper at hand aims to contribute to the existing academic work of Schmidt et al. in a way that this paper focusses on the factors that are expected to make SMEs reluctant towards the use of Industry 4.0.

As a matter of fact, a lot of the existing research in the field of Industry 4.0 has its roots in Germany, and given that Germany is one of the countries at the forefront of the Industry 4.0 transition, this particular research wants to add to the empirical results of another country, namely the Netherlands. One of the reasons for this is that Germany is in the top tier of export markets (Aspeslagh & Dekker, 1998), as well as one of the best trading partners of the Netherlands. This way, a more holistic view can be created by understanding how SMEs deal with the adaption of Industry 4.0 in general, as well as this research would contribute to a better overview of the current state of Industry 4.0 in the Netherlands.

The paper is organized as follows. Section 2 consists of a theoretical background on the emerging nature of Industry 4.0, together with a detailed explanation on the challenges that formed the basis for six hypotheses, and the research model. Section 3 describes the methodology, followed by the empirical results in Section 4. In Section 5 the discussion of the results, theoretical and managerial implications, limitations, and suggestions for future research will be presented. Finally, in Section 6 the conclusion of this research paper will be presented.

2. RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

2.1 Industry 4.0 and its emerging nature

It is expected that Industry 4.0 will revolutionize the manufacturing industry. The term Industry 4.0 "represents a smart manufacturing networking concept where machines and products interact with each other without human control" (Ivanov, Dolgui, Sokolov, Werner, & Ivanova, 2016, p. 386). To elaborate on this definition, Kolberg, Knobloch, and Zühlke (2017, p. 2845) define Industry 4.0 as "the vision of smart components and machines which are integrated into a common digital network based on the well-proven internet standards". There are multiple definitions to find in the literature of Industry 4.0, since there is no common agreement on a definition. However, what most of the definitions have in common is the shared idea of an integrated digital network without human intervention. An overview of the definitions in recent scientific literature can be found in Table 1.

Kagermann et al. (2013, p. 8) explain that in the future, "businesses will establish global networks that incorporate their machinery, warehousing systems and production facilities in the shape of Cyber-Physical Systems (CPS). These Cyber-Physical Systems consist of storage systems, smart machines and production facilities that can autonomously exchange information, trigger actions and control each other independently." This promotes foundational improvements in industrial processes, not only in engineering and manufacturing, but also in material usage and life cycle management (Kagermann et al., 2013).

Given the novelty of the Industry 4.0 concept, and the lack of public open standards on how to implement Industry 4.0, the implementation is not straightforwardly accomplished (Radziwon et al., 2014). Nonetheless, Müller, Buliga, et al. (2018) found out that the complexity of integrating Industry 4.0 technologies into existing organizational hierarchies and structures, as well as into production and logistics systems is more challenging for large companies than in SMEs, since SMEs have higher flexibility and the ability to respond quicker to changing market conditions. This stresses the importance in differences between large firms and SMEs. In agreement with the exploratory nature of this paper, we have examined the scarcely available scientific literature of Industry 4.0 to identify challenges in the implementation of Industry 4.0 that could potentially make SMEs reluctant towards the use of Industry 4.0. In the following section, a detailed explanation on the

Table 1. Research definitions on Industry 4.0.

Author (year, page)	Definition
Ivanov et al. (2016, 386)	"Industry 4.0 represents a smart manufacturing networking concept where machines and products interact with each other without human control."
Kagerman et al. (2013, 14)	"In essence, Industrie 4.0 will involve the technical integration of CPS into manufacturing and logistics and the use of the Internet of Things and Services in industrial processes. This will have implications for value creation, business models, downstream services and work organisation."
Kolberg et al. (2017, 2845)	"Industry 4.0 is the vision of smart components and machines which are integrated into a common digital network based on the well-proven internet standards."
Lasi et al. (2014, 240)	"The term Industry 4.0 collectively refers to a wide range of current concepts, whose clear classification concerning a discipline as well as their precise distinction is not possible in individual cases. [...] The concepts are: smart factory [...], cyber-physical systems [...], self-organization [...], new systems in distribution and procurement [...], new systems in the development of products and services [...], adaptation to human needs and corporate social responsibility [...]."
Schmidt et al. (2015, 17)	"In this paper Industry 4.0 shall be defined as the embedding of smart products into digital and physical processes. Digital and physical processes interact with each other and cross geographical and organizational borders."
Oesterreich & Teutelberg (2016, 122)	"The term Industry 4.0 comprises a variety of technologies to enable the development of a digital and automated manufacturing environment as well as the digitisation of the value chain."

development of six hypotheses will follow. These form the foundation of the research model.

2.2 Hypotheses development

Businesses are influenced by factors that eventually determine the success of the organisation (Lückmann & Feldmann, 2017), and together with the upswing of Industry 4.0 a lot of promises have been made as well. Promises like improvements and advances in efficiency, flexibility and resource productivity (Kagermann et al., 2013) are just a few of the many factors to take into account for managers that want to implement Industry 4.0. Nonetheless, the implementation of Industry 4.0 within the industry is not done effortlessly. To illustrate, Schumacher, Erol, and Sihn (2016) created a maturity model for Industry 4.0 to access the readiness and maturity of manufacturing enterprises using nine dimensions, but it could be probable that these nine dimensions insufficiently cover the broadness of the Industry 4.0 concept, not to speak about the time that is involved in merging into an Industry 4.0 environment. Dimensions such as the environment and sustainability, but also a dimension of change could contribute to get a more holistic maturity model.

SMEs are more flexible when it comes to change compared to large firms (Müller, Buliga, et al., 2018), but smaller firms on average have less human resources, and less specialist staff (Kagermann et al., 2013) what makes it harder to tackle tasks. This could also imply that employees in SMEs have more differently oriented tasks outside the original scope of expertise, but these need to be completed in similar time, what means that time is an important factor within the SME segment of the economy.

A potential implementation of Industry 4.0 comes with numerous impacts on existing organisations; employee training (Kagermann et al., 2013), production process adaption (Lasi et al., 2014), new business models (Müller, Buliga, et al., 2018) and R&D (Monostori, 2014) to name a few, but all these adaptations require time. These are just some of the important aspects that need to be taken into account for an Industry 4.0 implementation, but there are numerous additional factors that come into play. Organisations need to realise that a transformation to Industry 4.0 impacts roughly the entire organisation.

Therefore, as time is precious for companies in general, we want to identify the company's willingness to invest their time in Industry 4.0, and formulated the following hypothesis:

Hypothesis 1 (H1): ***A lack of time will positively influence the reluctance of Industry 4.0 use.***

As transforming to Industry 4.0 requires numerous adaptions from the previous third industrial revolution, costs are expected to be a crucial factor. Especially for SMEs, since the investments need to be affordable in order to be able to transform to Industry 4.0 (Radziwon et al., 2014), but the novelty of Industry 4.0 makes it costly for SMEs to implement (Müller, Buliga, et al., 2018).

For example, one of the findings of the study of Müller, Buliga, et al. (2018) was that they interviewed a SME representative that wanted to invest in a real-time information collection system among all its 180 machines, and this totalled to a sum of 360.000 euro, what amounts to 2.000 euro per machine. Moreover, to perform data analysis, further expenditures were required. Hence, costs of adopting CPS can rise rapidly, and needless to say is that the implementation of Industry 4.0 in SMEs is undoubtedly expensive (Brettel, Friederichsen, Keller, & Rosenberg, 2014; Müller, Buliga, et al., 2018). High investment costs regarding Industry 4.0 are a major obstacle for companies in Germany and the Middle East, as is confirmed by Bitkom Research (n.d.), and PwC (n.d.).

Moreover, SMEs circumvent to invest capital in technologies with uncertain results (Hirsch-Kreinsen, 2016). Given the lack of formal methods to implement Industry 4.0 (Radziwon et al., 2014), uncertainty increases substantially, and this makes SMEs doubt whether to implement Industry 4.0, or that they should face the risk of missing out (Schmidt et al., 2015).

What also plays an important role is the technology acceptance model (Venkatesh & Bala, 2008), since Industry 4.0 goes hand in hand with a high degree of technology adoption and use. Companies need to be ready for this high impact change. In practice there are various examples to find of IT implementation failures leading to enormous financial losses (Venkatesh & Bala, 2008). Therefore, we want to identify if costs contribute positively to the reluctance of Industry 4.0 use, and if a SME is willing to invest money in Industry 4.0, therefore the following hypothesis is proposed:

Hypothesis 2 (H2): ***Costs will positively influence the reluctance of Industry 4.0 use.***

Industry 4.0 implementation creates a smart factory with an integrated network of smart products and machines that can communicate with each other via the Internet (Kolberg et al., 2017; Müller, Buliga, et al., 2018). Moreover, Industry 4.0 creates an Industrial Internet of Things (IIoT) (Wan et al., 2016) in combination with Cyber-Physical Systems (Lee, Bagheri, & Kao, 2015), which means that the Internet will play a crucial role in Industry 4.0.

On the one hand managers get substantially more information about the production process through the interconnectivity of the Internet, but on the other hand this comes with new challenges in the form of privacy and associated threats with regard to consumers (Jazdi, 2014), data safety and security (Jazdi, 2014; Kagermann et al., 2013). Müller, Buliga, et al. (2018) found out that one fourth of the SMEs in their sample have concerns regarding data security e.g. stolen exclusive information or external deactivation of fabrication systems. This stresses the importance of cyber-security (Lu, Li, Qu, & Hui, 2014; Monostori, 2014). The protection of data and digital systems needs to be on a high level to protect systems from hackers (Zhou et al., 2015), and increase confidentiality and integrity (Drath & Horch, 2014; Kagermann et al., 2013).

Existing research found that demands of data protection regulations, and data security are both seen as a major obstacle for companies regarding Industry 4.0 use (Bitkom Research, n.d.). This is not a rare occurrence, given the high amount of concerns within companies. Since these upcoming data risks, like the enormous increase in data collection, possibilities of machines being hacked, and data storage vulnerabilities will get more and more important during the popularity rise of Industry 4.0. Therefore, the following hypothesis is formulated:

Hypothesis 3 (H3): ***Higher data risks will positively influence the reluctance of Industry 4.0 use.***

The anticipated industrial revolution is predicted to penetrate into company's physical machines, IT systems and strategies, but also into the existing job market. Industry 4.0 is expected to have a major impact on the roles employees have within manufacturing companies (Bonekamp & Sure, 2015; Kagermann et al., 2013). Therefore, the implementation of Industry 4.0 in SMEs should not go without contemplating worker needs (Stock & Seliger, 2016). Employees within firms still need to understand and possess the qualities to approach the new Industry 4.0 concept, since they need to acquire additional competencies to deal with in a new smart manufacturing environment (Erol, Jäger, Hold, Ott, & Sihn, 2016).

Industry 4.0 is expected to take over a lot of the routine tasks of workers, and workers have no other choice then to accept that in the future their existing tasks no longer exist (Erol et al., 2016). This means that workers need to adapt to this new manufacturing paradigm and interaction with CPS (Kagermann et al., 2013). It can be foreseen that workers will resist to these new technologies, since their skills are no longer needed (Frey & Osborne, 2017). Moreover, the increasing demand for higher-skilled labour (Rüßmann et al., 2015) can have far-reaching consequences for the labour market in general. However, there are also opportunities for workers in an Industry 4.0 environment in the form of augmented reality systems, these systems can guide users to perform tasks they are unfamiliar with directly in the users field on the work floor (Paelke, 2014; Rüßmann et al., 2015). This could be a solution for the gap in required skills of workers on the work floor. Also, the worker's flexibility as a mobile problem solver will be of great importance within Industry 4.0 (Gorecky, Schmitt, Loskyll, & Zühlke, 2014), since flexibility will get more and more important within jobs of the future (Bauer, Hämmerle, Schlund, & Vocke, 2015) as repeating tasks will be regulated by Industry 4.0 techniques.

Another aspect of employment and Industry 4.0 is the acceptance of new technology by personnel (Dombrowski & Wagner, 2014). The transformation towards a new manufacturing paradigm can cause anxiety by users of these new techniques, and this can have a significant negative influence on the decision of workers to use a new technology (Bozionelos, 2004; Heinssen Jr, Glass, & Knight, 1987). This is not surprising considering the results of a study by Frey and Osborne (2017), they found out that machinists have a 65% probability of being substituted through computerisation. The same study also concluded that 47% of all US employment is in a high-risk category, just to sketch the looming danger of Industry 4.0. One interesting point was raised by Hirsch-Kreinsen (2016), they found that SMEs generally have a lower level of automation than large companies. This explains why SMEs rely more heavily on their manufacturing employees. Accordingly, it is inevitable to assess the relationship between risk of job losses and the reluctance of Industry 4.0 use. This explains why risk of job losses is added to research model, the hypotheses covering this aspect is formulated as follows:

Hypothesis 4 (H4): ***Higher risk of job losses will positively influence the reluctance of Industry 4.0 use.***

The transformation to Industry 4.0 is expected to come with a lot of changes, reaching from the development of a new production process to educating workers on the work floor, but what is inevitably most important is the general aspect of change. Industry 4.0 will create opportunities for the development of new business models together with a new way of doing business (Kagermann et al., 2013), this highlights the innovative character of Industry 4.0 (Müller, Buliga, et al., 2018). However, Industry 4.0 is such a broad concept with enormous impact and changes on an existing organisation, that is also comes with a lot of risks. For example, employees will get an entire new role within a smart factory, since work content, work processes, and the working environment will change completely (Kagermann et al., 2013).

Moreover, the production process needs to be redeveloped to make it work in an efficient smart factory (Hirsch-Kreinsen, 2014; Lasi et al., 2014), and companies need to be ready for the implementation of these technological advancements. Not only the production process of SMEs needs to be changed, but also other factors require adjustments, for example, the work places, product spectrum and human-machine-interfaces to name a few aspects (Müller, Buliga, et al., 2018). The implementation of Industry 4.0 is a big step forward in the manufacturing environment and therefore companies need to take risk in actually transforming to Industry 4.0, while their existing business model could still be working. This raises questions for companies, since why would an organisation embrace such a large risk of transforming to a smart factory, not knowing exactly if this will provide substantial benefits, and returns.

Summarizing, Industry 4.0 is said to change the traditional methods of industrial manufacturing (Zhou et al., 2015), and consequently we want to incorporate the risks of change in our research model, and therefore the following hypothesis was formulated:

Hypothesis 5 (H5): ***Risk of change positively influences the reluctance of Industry 4.0.***

Industry 4.0 comes with numerous adjustments (Brettel et al., 2014), but most importantly the production process of companies is required to be adapted to work with technologies of a smart manufacturing facility. For bigger firms and SMEs this is essential, since they should be able to adapt the nature of their production processes conform Industry 4.0 standards. This can create difficulties, for instance in production processes of SMEs that are dependent on craftsmanship. For these companies it is nearly impossible to integrate Industry 4.0 techniques in the production process, since the emphasis of craftsmanship comes down at human labour, a lack of automation, and a lack of motivation towards the use of new technologies (Müller, Buliga, et al., 2018). This is in strong contrast with what Industry 4.0 offers. Therefore, the attitude, motivation and nature of the production process of similar companies could have a great influence on how companies see the adaptability of the production process.

The existing production process could possibly face problems when adapting towards an Industry 4.0 interface, since CPS come with a lot of autonomous decision-making (Kagermann et al., 2013; Lasi et al., 2014), and this needs to be feasible in production processes of companies transforming to an Industry 4.0 production platform.

Furthermore, mass-customisation and increasing flexibility are also an important matter in Industry 4.0, since production in batch size one and an emphasis on individual needs (Stock & Seliger, 2016) gets the standard. This needs to be feasible for products in the product line of organisations willing to implement Industry 4.0 within their organisation (Shafiq, Sanin, Szczerbicki, & Toro, 2015).

To identify if difficulties of adjusting the production process within SMEs will positively influence the reluctance of Industry 4.0, the following hypothesis is proposed:

Hypothesis 6 (H6): ***Difficulties to adjust the production process will positively influence the reluctance of Industry 4.0.***

These six hypotheses are combined in a research model, presented in Figure 1. The hypothesised relationships with regard to the reluctance of Industry 4.0 use are shown as well.

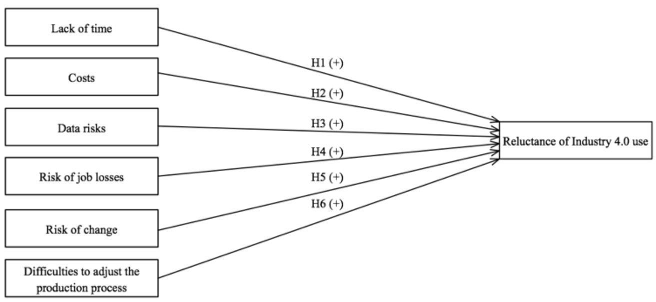

Figure 1. Hypothesised research model.

3. METHODOLOGY

3.1 Research design and empirical setting

In this empirical research paper, the results of our quantitative study are used to investigate the effects of lack of time, costs, data risks, risk of job losses, risk of change and the difficulties to adjust the production process have on the reluctance of Industry 4.0 use, within SMEs in the Netherlands. The data collected to test the six hypothesis were based on a survey, and the reluctance of Industry 4.0 use is classified based on discussions with respondents in our sample. To ensure a high quality of our research model, the constructs have been inspected and adapted by a researcher at the University of Twente and a head of R&D at a large production company in the industry related to Industry 4.0.

Moreover, to classify the 'reluctance of Industry 4.0 use' we deepened our knowledge in the Industry 4.0 concept, by formal discussions with the project manager of the Fabrication Lab in Enschede, as well as with the head of R&D at a large production company in the region.

3.2 Data collection and sample

This research focusses on factors that potentially contribute to the reluctance of Industry 4.0 use within Dutch SMEs. As a consequence, leading personnel of 43 Dutch SMEs was selected at random and contacted personally, following two criteria of the SME definition of the European Union: staff headcount below 250 and annual turnover below 50 million euro. At the end, data of 30 SMEs was collected, resulting in a response rate of around 70%. Of the 30 companies, three were micro SMEs with less than 10 employees, and an annual turnover below 2 million euro. Fifteen were small SMEs with less than 50 employees, and an annual turnover below 10 million euro. Finally, twelve companies were medium-sized SMEs with less than 250 employees, and an annual turnover below 50 million euro. The companies in the sample belong to 19 sectors. The largest sectors of the sample were metal (6), graphic (3), printing (2), furniture (2) and agriculture (2). An overview of the full sample can be seen in Table 2 in Appendix A. Only employees of SMEs in a leading function were considered for this research, the sample involved CEOs (10), COOs (10), head of sales (3), head of R&D (1), CTO (1), technical development manager (1), and experienced authorized representatives of the companies: sales engineers (2), assistant to CEO (1) and a controller to finish off the sample. Table 2 in Appendix A shows the personal and organizational characteristics of our sample ($N = 30$).

3.3 Measurement and data analysis

Based on the hypothesis development, we established measurement items for the six hypotheses that grasped the concise idea of the factors. As a next step, all measurement items were reviewed by our supervisor at the University of Twente, to ensure that the scales were understandable and the research objective was resembled accurately. Moreover, the phrasing of several items was adjusted and fine-tuned.

The six constructs were measured with single items on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). A detailed outline of these measurement items can be found in Table 3 in Appendix B. To measure the 'reluctance of Industry 4.0 use' we had to define our own classification scale, since academic investigation in Industry 4.0 is novel (Arnold et al., 2016), and no measurement scale in such form was available (Müller, Kiel, et al., 2018). The scale to define the reluctance of Industry 4.0 use, ranges from 1 (low reluctance) to 5 (high reluctance). The detailed classification scheme used in this paper is presented in Table 4 in Appendix C.

In order to evaluate the six hypotheses developed in Section 2 of this paper, multiple regression analysis was used. This multivariate statistical technique is particularly suitable when examining the relationship between a single dependent variable and multiple independent variables (Hair, Black, Babin, Anderson, & Tatham, 1998). To perform the analyses, the statistical software package IBM SPSS 23 was used to test our hypotheses. Given the relatively small sample ($N = 30$), additional analyses were performed to determine the trustworthiness of the results.

4. RESULTS

4.1 Evaluation of the hypotheses

Multiple regression analysis was used to test the six hypotheses mentioned in Section 2 of this paper in relation to the reluctance of Industry 4.0 use. The results of the regression analysis showed that 33.6% of the variation in 'reluctance of Industry 4.0 use' could be explained by our six independent variables ($R^2 = 0.336$). However, this regression model was not statistically significant, $F(6, 23) = 1.937$, $p = 0.118$), as can be seen in Table 5 in Appendix D. Moreover, the results showed an insignificant negative relationship for Lack of Time (H1) and Costs (H2) in relation with the dependent variable 'reluctance of Industry 4.0 use.' Hypothesis 1 (H1) suggested that a lack of time has a positive effect on the reluctance of Industry 4.0 use, and Hypothesis 2 (H2) proposed that costs have a positive effect on the reluctance of Industry 4.0 use. Hence, H1 and H2 are in the opposite direction, they need to be rejected, since both p-values > 0.05.

To be able to analyse the results, a statistically significant model is necessary, therefore a (backward and forward) sequential search method was performed. This resulted in a regression model where 32.6% of the variation in 'reluctance of Industry 4.0 use' could be explained by four independent variables ($R^2 = 0.326$). The results of this statistically significant model $F(4, 25) = 3.016$, $p = 0.037$), with significant effects of four independent variables can be found in Table 6. Preliminary analyses were performed to validate the model and guarantee that there was no violation of the assumptions of linearity, homoscedasticity and the independence of the error terms as presented in Figure 2 in Appendix E, as well as the assumption of the normality of the error term distribution, as can be seen in Figure 3 in Appendix F. Based on the multiple regression model, we found the following results:

Hypothesis 3 (H3) suggests that data risks have a positive effect on the reluctance of Industry 4.0 use. The empirical data show a statistically significant negative relationship ($\beta = -0.466$, $t = -2.627$, $p < 0.01$). Based on our model, we must reject the hypothesis because of a negative value. Higher data risks indicate a lower reluctance of Industry 4.0 use. Thus, H3 is the opposite of the prediction.

Hypothesis 4 (H4) proposes that employment risks have a positive effect on the reluctance of Industry 4.0 use. Again, the empirical findings indicate a significant, but negative effect of employment risks and the reluctance of Industry 4.0 use ($\beta = -0.388$, $t = -2.222$, $p < 0.05$). Thus, H4 is also the opposite of the prediction.

Hypothesis 5 (H5) suggests that the risk of change has a positive effect on the reluctance of Industry 4.0 use. The empirical results indicate a significant and positive relationship between the risk of change and the reluctance of Industry 4.0 use ($\beta = 0.268$, $t = 1.521$, $p = < 0,10$). According to these results, H5 is supported.

Hypothesis 6 (H6) proposes that the difficulties to adjust the production process has a positive effect on the reluctance of Industry 4.0 use. The empirical findings show a significant

Table 6. Multiple regression analysis results (4 independent variables).

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.571[a]	,326	,218	1,29645

a. Predictors: (Constant), Difficulties to adjust the production process (H6), Data Risks (H3), Risk of Job Losses (H4), Risk of Change (H5)

ANOVA [a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20,280	4	5,070	3,016	.037[b]
	Residual	42,020	25	1,681		
	Total	62,300	29			

a. Dependent Variable: Reluctance of Industry 4.0 use

b. Predictors: (Constant), Difficulties to adjust the production process (H6), Data Risks (H3), Risk of Job Losses (H4), Risk of Change (H5)

Coefficients [a]

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	4,253	,961		4,426	,000		
	Data Risks (H3)	-,664	,253	-,466	-2,627	,015	,857	1,167
	Risk of Job Losses (H4)	-1,091	,491	-,388	-2,222	,036	,887	1,127
	Risk of Change (H5)	,331	,218	,268	1,521	,141	,871	1,148
	Difficulties to adjust the production process (H6)	,417	,167	,450	2,504	,019	,837	1,195

a. Dependent Variable: Reluctance of Industry 4.0 use

positive effect for the difficulties to adjust the production process and the reluctance of Industry 4.0 use ($\beta = 0.450$, $t = 2.504$, $p < 0.01$). Hence, H6 is supported.

To present the results of the multiple regression analysis for the entire sample of 30 companies we created Figure 4.

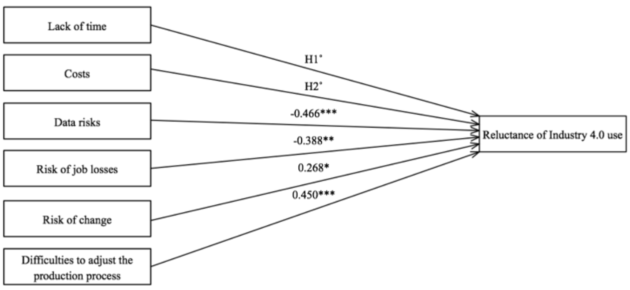

Figure 4. Results multiple regression analysis. Note: $N = 30$; ° = hypothesis rejected; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

4.2 Additional investigation of the results

Since the sample ($N = 30$) is relatively small, it has direct effect on the statistical power and appropriateness of the multiple regression analysis (Hair et al., 1998), therefore additional analyses were performed to determine the trustworthiness of the results.

To assess the degree of multicollinearity, a bivariate correlation matrix of the original nonsignificant regression model was created in Table 7 in Appendix G. Multicollinearity is the term to indicate a (nearly) linear relationship between explanatory variables in linear regression (Silvey, 1969), and could have far-reaching negative consequences on the predictive power of the regression model, as well as the estimate of the regression coefficients and their tests of statistical significance (Hair et al., 1998). The correlation matrix, as can be seen in Table 7 of Appendix G, indicated no extraordinary correlations, except a statistically significant correlation between Costs (H2) and Risk of Change (H5), namely $r = 0.462$, $p < 0.01$. This potentially problematic correlation could have made an independent variable redundant in the predictive effort of the regression model (Hair et al., 1998). However, this was no longer an issue in the significant regression model (Table 6), since the insignificant coefficient ‘Costs’ (H2) was excluded in the statistically significant regression model.

To assess the potential effect of multicollinearity even further, an analysis of the tolerance and Variance Inflation Factor (VIF) was set up, as shown in Table 6. Tolerance is a direct measure of multicollinearity, “which is defined as the amount of variability of the selected independent variable not explained by the other independent variables” as mentioned by Hair et al. (1998, p. 197). This analysis strengthened the results of the statistical significant regression model, since both, the tolerance and VIF, are not indicating any characteristics of multicollinearity. The tolerance is high, as is necessary (Hair et al., 1998), and the VIF is far below the common threshold of 10 (Chennamaneni, Echambadi, Hess, & Syam, 2016). Summarizing, one could conclude that multicollinearity was not an issue in the statistically significant regression model.

These additional analyses of the sample led to a more trustful regression model, however, the effects of the relatively small sample size ($N = 30$) are still most directly influencing the statistical power of the significance testing and the generalizability of the results.

5. DISCUSSION

5.1 Interpretation of the key findings

The aim of this research was to investigate the factors that influence the reluctance of Industry 4.0 use within SMEs located in the Netherlands. The findings showed interesting results, two hypotheses were rejected, two hypotheses showed statistical evidence in the opposite direction, and the last two hypotheses were supported by empirical evidence.

The gathered data on the SMEs showed opinions that were widely spread, especially the results on the influence of Lack of Time (H1) and Costs (H2) on the reluctance of industry 4.0 use. This could be due to the completely different perspectives of SMEs that were identified, from a CEO stating that "we have never heard of the term Industry 4.0" to a CTO explaining that "we are already using Industry 4.0 within our organisation, and try to maximise its potential". These opinions have consequences for the reluctance of Industry 4.0 use. An overview of the different perspectives of SMEs on Industry 4.0 can be found in Figure 5. This could be a potential reason why no statistical evidence was found for hypothesis 1 (H1) and hypothesis 2 (H2).

Lack of time and costs are both very company specific as became clear from the survey, since one organisation wants to make time for a possible Industry 4.0 implementation, and another one does not even see potential in it. Time is an important factor for organisations, not only for measuring efficiency increases (Kagermann et al., 2013), but also important if an organisation creates time to innovate. Therefore, the factor Lack of Time (H1) was expected to be important. However, the study at hand was unable to identify statistical evidence for the relationship between a Lack of Time (H1) and the reluctance of Industry 4.0 use. Other studies could potentially identify this particular relationship using a bigger sample size.

Moreover, the costs that are required for an Industry 4.0 transformation are important, since research showed that costs are a crucial factor for a potential Industry 4.0 implementation (Bitkom Research, n.d.; Hirsch-Kreinsen, 2016; Müller, Buliga, et al., 2018; PwC, n.d.). However, this research was unable to provide statistical evidence for the relationship between Costs (H2) and the reluctance of Industry 4.0 use. Therefore, this research could be repeated with a larger sample size to find a potential relationship between costs and the reluctance of Industry 4.0.

Upcoming challenges regarding data safety, privacy, and protection against hackers are rising concerns within the business environment (Jazdi, 2014). Consequently, cyber-security is gaining in prominence, and companies want to have their data safely stored and well protected (Lu et al., 2014; Monostori, 2014). The findings of our research indicate the opposite, data risks are not seen as a major threat within SME businesses. This study showed empirical evidence that there is a negative relationship between Data Risks (H3) and the reluctance of Industry 4.0 use, which is remarkable given the findings of previous studies (Bitkom Research, n.d.; PwC, n.d.). A potential reason for this negative relationship could be that organisations are actually anticipating this particular rise in the importance of data, and cyber-security, so that this would not have an effect on the reluctance of Industry 4.0 use. However, the negative effect of data risks and the reluctance of Industry 4.0 use could not be reasonably explained in the paper at hand, therefore further studies are recommended.

A possible implementation of Industry 4.0 also has far-reaching consequence for the existing workforce. Contemporary work of employees is expected to be, for a large extent, taken over by robots. Moreover, employees are expected to help in situations that need more flexibility, in contrast to repetitive tasks. These technological advancements lead to possible concerns within employees, for example will their job still exist in 10 years, or is there still a job for those tasks that used to be performed. Therefore, the risk of job losses is growing (Frey & Osborne, 2017). However, the results of this study indicate a negative effect between the Risk of Job Losses (H4) and the reluctance of Industry 4.0 use. This is in contrast with what one might expect. A possible reason for this could be that managers of SMEs are not concerned that Industry 4.0 will cause layoffs, but that this actually creates new jobs, so this would imply that there would be less reluctance. Or another possible reason could be from the perspective of the employee that employers want to cut costs by laying off people within their organisation, and that this has an influence on the reluctance of Industry 4.0 use. The interesting findings regarding the Risk of Job Losses (H4) opened doors for further research, since the exploratory nature of this paper could not provide a reasonable explanation for the observed effect at hand.

Change and especially change management could be some of the most important aspects when transforming to an Industry 4.0 factory. Change is a broad concept, that has an influence on many parts of the organisation, and therefore this should be managed properly. Industry 4.0 is accompanied by changes in the production process (Hirsch-Kreinsen, 2014; Lasi et al., 2014), human-machine-interfaces (Müller, Buliga, et al., 2018) and the work that employees perform (Bonekamp & Sure, 2015), to name a few. The list of changes that are required to actually

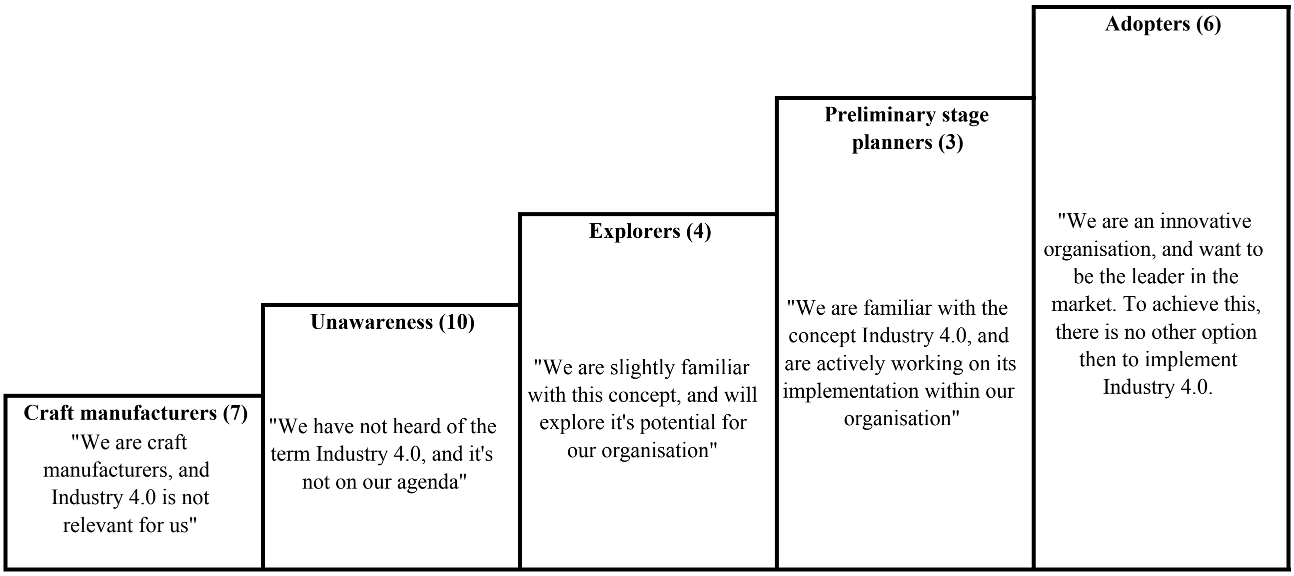

Figure 5. SME perspectives on Industry 4.0.

transform to Industry 4.0 is extensive, therefore companies need to take a big risk in deciding to implement Industry 4.0 or not. This paper shows evidence that Risk of Change (H5) has a positive effect on the reluctance of Industry 4.0 use, and therefore acknowledges the impact that risk of change has on the reluctance of Industry 4.0 use. So, SMEs need to be cautious, and take into account the cumbersome when transforming to Industry 4.0. Risk of change has a big impact on managers, and how they should think carefully about the implementation of Industry 4.0, since this is not an easy-going process.

The difficulties to adjust the production process are important for managers willing to implement Industry 4.0. A careful plan needs to be formulated to what extent a production process needs to be adjusted, and how it needs to be changed in order to transform to Industry 4.0. The findings of this study support this, since empirical evidence was found that the Difficulties to Adjusts the Production Process (H6) have a positive effect on the reluctance of Industry 4.0 use. Industry 4.0 can fulfil the growing demands for mass-customization on an ultra-personalised level (Stock & Seliger, 2016). However, managers still need to consider, if the organisation they are working for is appropriate for the transformation to Industry 4.0, since not all organisations are. Therefore, the difficulties to adjust the production process enforce a close look into the organisations own production process and to discover the possibilities of an Industry 4.0 implementation.

5.2 Implication for theory and practice

This study contributes to the literature of Industry 4.0 in several ways. First, the exploratory nature of this study discovered factors, Risk of Change and Difficulties to Adjust the Production Process that have a positive effect on the reluctance of Industry 4.0 use. Also, this paper tried to bridge to research gap that currently exists around the reluctance of Industry 4.0 use, since the majority of the research papers expose the positive viewpoint of Industry 4.0 (Schmidt et al., 2015; Stock & Seliger, 2016). The paper also discovered interesting negative effects of Data Risks and Risk of Job Losses on the reluctance of Industry 4.0, however the paper at hand was unable to explain these results reasonably, therefore further research is recommended.

Second, this paper contributes to the scarcely available empirical findings in the field of Industry 4.0, and consequently this study adds to the existing empirical findings of factors in the literature in the field of Industry 4.0 (Müller, Kiel, et al., 2018; Schmidt et al., 2015).

Third, this paper adds empirical results to the understudied field of Industry 4.0 within SMEs, research is mainly focused on large firms (Arnold et al., 2016; Radziwon et al., 2014). This will help academics to get a better overview of Industry 4.0 within SMEs.

The managerial implications of this paper would be that managers of SMEs can learn for best-practices from each other in what kind of factors to consider before implementing Industry 4.0 in a company. Especially, this paper showed that Risk of Change and Difficulties to Adjust the Production Process should be well investigated before implementing Industry 4.0 within an organisation. This will help practitioners to better prepare themselves for the new Industry 4.0 revolution. This way, our research contributes to a more efficient transition toward the use of Industry 4.0 techniques within organisations.

Furthermore, in the discussions with SMEs it became clear that SMEs have a highly different attitude regarding the reluctance of Industry 4.0 use within their organisation. The opinions were widely spread, but still a large group of the SMEs was not familiar with the Industry 4.0 concept. Therefore, we want to advice managers of SMEs to explore the possibilities of Industry 4.0 for their organisation, since the implementation of Industry 4.0 is able to equip SMEs with far-reaching benefits and opportunities (Müller, Kiel, et al., 2018). However, organisations need to consider the factors identified in this research paper.

Finally, based on the findings it needs to be stressed that the transformation to an Industry 4.0 environment requires close monitoring and proper change management as well as top management involvement is necessary to promote change management processes and activities to embody a clear vision and strategy to get this innovative and entrepreneurial philosophy into the attitude of the employees. Managers need to be ambitious, and convince employees of the potential benefits Industry 4.0 will bring to the organisation, and actively address the concerns employees might have. This will contribute to a smoother transition from organisations old practices, to a novel Industry 4.0 way of doing business.

5.3 Limitations and suggestions for further research

As with most of the empirical studies, this paper suffers from several limitations that are worth considering for further research activities. The most obvious limitation in this research is the small sample size due to a lack of time. The number of SMEs participated in this research was rather limited for a quantitative study, and therefore this influenced the generalizability of these research findings. Hence, further research activities could repeat this study with a bigger sample size to validate the results of this paper, and may identify relationships between both of the variables, Lack of Time and the reluctance of Industry 4.0 use, and Costs in relation to the reluctance of Industry 4.0 use.

Second, due to a lack of time the operationalisation of this research design was based on single survey items. To improve the quality of the results, further research activities should create a broader operationalisation of the different variables tested in this research design, to more adequately measure the constructs of this study.

Third, further research undertakings should take into consideration other variables that could potentially influence the reluctance of Industry 4.0 use, for example conservativeness of top management, economic state, employee adaptability, and so on.

Fourth, the coding in the classification scheme for the reluctance of Industry 4.0 based on a single coder, this could be a threat to reliability and validity, therefore future research should use multiple coders to lower these possible threats of reliability and validity.

Fifth, this paper found interesting results regarding the relation between both, Data Risks (H3), Risk of Job Losses (H4) on the reluctance of Industry 4.0. Further research should explore these relationships, since the paper at hand was unable to explain these relationships reasonably within the context of this research paper. Moreover, to get a possible better understanding on these constructs, surveys should be addressed to ICT managers (H3) and employees itself (H4) to obtain the most reliable information.

Sixth, this paper was focussed on SMEs in the Netherlands, and could therefore limit the generalisability of our findings, since most certainly different international Industry 4.0 approaches and cultural backgrounds as well as differences in political support exist. Thus, future studies could carry out an international study to identify country-specific insights to get a broader view on Industry 4.0.

Lastly, to obtain more detailed knowledge on the reluctance of Industry 4.0 another research design could be chosen, for example a qualitative design. That would provide rich knowledge, and more insights into the aspects SMEs nowadays face with regard to the reluctance of Industry 4.0 use.

6. CONCLUSION

It is expected that Industry 4.0 will revolutionise the manufacturing industry. Numerous opportunities and challenges have been identified by academics and organisations. However, given the emerging nature of Industry 4.0 it is still not entirely implemented in an organisation, not even by the leaders in this field. Large companies and SMEs are in different phases of Industry 4.0 adoption, from partial implementation to not even knowing what the Industry 4.0 concept entails. This stresses the novelty of the Industry 4.0 concept.

Industry 4.0 will most probably increase in popularity over the coming years, but also the challenges need to be overcome. The purpose of this study was to identify the factors that would have an influence on the reluctance of Industry 4.0 use. The multiple regression analysis on the data of this empirical study of 30 SMEs identified interesting results. Data Risks (H3) and Risk of Job Loss (H4) turned out to have a negative relationship with the reluctance of Industry 4.0 use. Possible reasons for this could be that organisations are actually anticipating this rise in the importance of data and cyber-security as well as that SMEs are not concerned that Industry 4.0 will cause layoffs, but that this actually creates new jobs, respectively. Further research is necessary to provide clear explanations for these findings. Moreover, the positive influence of Risk of Change (H5), and the Difficulties to Adjust the Production Process (H6) on the reluctance of Industry 4.0 were supported by this research. Lack of time (H1) and Costs (H2) were rejected due to a lack of statistical evidence.

The empirical findings add to the scarce literature available on this particular topic of Industry 4.0, as well as it helps managers to make better informed decisions regarding a possible Industry 4.0 implementation. Given the exploratory nature of this study and its interesting findings, it is recommended to research this particular field of the reluctance of Industry 4.0 use even further. This could be done in the form of qualitative research, since this would contribute to the broadening and deepening of knowledge on the reluctance of Industry 4.0 use.

7. ACKNOWLEDGEMENTS

First of all, I want to thank my two supervisors I. A. R. Torn, MSc. and Dr. F. Schuberth for all their invested time, effort and feedback when writing this thesis. They really motivated me to get the most out of this paper, as well as they have made me even more enthusiastic about the topic Industry 4.0. Second, I want to thank all the 30 companies for their time and participation in this research project. Lastly, I want to thank Dr. J.M. Jauregui Becker for his useful feedback during the process of writing this thesis.

8. APPENDICES

8.1 Appendix A

Table 2. Description of the company and personal characteristics (*N* = 30).

No.	Industry	Yearly (2017) revenue in €	No. of employees	Emloyee function
1	Product Development	8.000.000	45	Technical Development Manager
2	Medical	50.000.000	130	Head of R&D
3	Graphic	1.000.000	20	COO
4	Rubber and plastics	1.500.000	14	CEO
5	Metal	5.000.000	13	Sales engineer
6	Metal	8.000.000	35	CTO
7	Building products	40.000.000	175	COO
8	Natural stones	1.000.000	6	Head of sales
9	Concrete	15.000.000	60	COO
10	Graphic	1.000.000	7	CEO
11	Precision engineering	13.000.000	70	COO
12	Cold technology	35.000.000	190	COO
13	Metal	1.000.000	10	CEO
14	Furniture	900.000	10	CEO
15	Furniture	6.000.000	52	COO
16	Agriculture	10.000.000	40	Assistant to CEO
17	High Tech (microsystem technology)	7.500.000	48	COO
18	Argriculture	50.000.000	150	COO
19	Construction	10.000.000	16	CEO
20	Metal	10.000.000	60	Controller
21	Industrial	5.400.000	50	COO
22	Logistics and offshore	20.000.000	78	CEO
23	Metal	12.000.000	65	Sales engineer
24	Automotive	8.000.000	35	CEO
25	Dairy	30.000.000	140	COO
26	Printing	2.000.000	11	Head of sales
27	Printing	800.000	5	CEO
28	Metal	3.000.000	30	CEO
29	Graphic	2.500.000	24	Head of sales
30	Food	38.000.000	17	CEO

8.2 Appendix B

Table 3. Measurement items of constructs.

Construct	Description (translated)
Lack of time (H1)	Within my organization, the implementation of Industry 4.0 is lagging behind due to a lack of time.
Costs (H2)	Within my organization, the implementation of Industry 4.0 is lagging behind due to the costs involved in the implementation of Industry 4.0.
Data risks (H3)	Within my organization, the implementation of Industry 4.0 is lagging behind due to data risks.
Lack of job losses (H4)	Within my organization, the implementation of Industry 4.0 is lagging behind because it is at the
Risk of change (H5)	Within my organization, the implementation of Industry 4.0 is lagging behind due to the risk of
Difficulties to adjuct the production process (H6)	Industry 4.0 is lagging behind because the production process is difficult to adjust.

8.3 Appendix C

Table 4. Classification scheme 'reluctance of Industry 4.0 use.'

Reluctance of Industry 4.0 use				
5 (high reluctance)	4	3	2	1 (low reluctance)
This organisation is based on craftsmanship and due to the production process they cannot switch towards an Industry 4.0 interface, or Industry 4.0 is not relevant to the organisation in its current form.	This organisation has not heard of the concept Industry 4.0, and there are no plans to adopt Industry 4.0 in the near future. It is unclear how the organisation would benefit from this.	This organisation is slightly familiar with the Industry 4.0 concept and it is on their agenda to explore the concept further, and how this could benefit the company. The organisation did not adopt Industry 4.0 yet, and no conrete plans to adopt Industry 4.0 in the near futre.	This organisation is familiar with the Industry 4.0 concept and is actively working on the implementation and how this should be shaped around the production process. This organisation getting closer to a real adoption of Industry 4.0 in the near future.	This organisation is innovative, familiar with Industry 4.0, and wants to be the leader in the market and that is why there is no other option than adopting Industry 4.0. Therefore, the active implementation of Industry 4.0 is in the primary stage or is already present in small parts of the company.

8.4 Appendix D

Table 5. Multiple regression analysis results (6 independent variables).

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.579[a]	,336	,162	1,34147

a. Predictors: (Constant), Difficulties to adjust the production process (H6), Costs (H2), Lack of Time (H1), Data Risks (H3), Risk of Job Losses (H4), Risk of Change (H5)

ANOVA [a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20,911	6	3,485	1,937	.118[b]
	Residual	41,389	23	1,800		
	Total	62,300	29			

a. Dependent Variable: Reluctance of Industry 4.0 use
b. Predictors: (Constant), Difficulties to adjust the production process (H6), Costs (H2), Lack of Time (H1), Data Risks (H3), Risk of Job Losses (H4), Risk of Change (H5)

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	4,330	1,093		3,962	,001
	Lack of Time (H1)	-,026	,198	-,023	-,131	,897
	Costs (H2)	-,114	,205	-,116	-,557	,583
	Data Risks (H3)	-,625	,270	-,439	-2,320	,030
	Risk of Job Losses (H4)	-1,002	,529	-,356	-1,893	,071
	Risk of Change (H5)	,395	,251	,319	1,574	,129
	Difficulties to adjust the production process (H6)	,424	,176	,457	2,415	,024

a. Dependent Variable: Reluctance of Industry 4.0 use

8.5 Appendix E

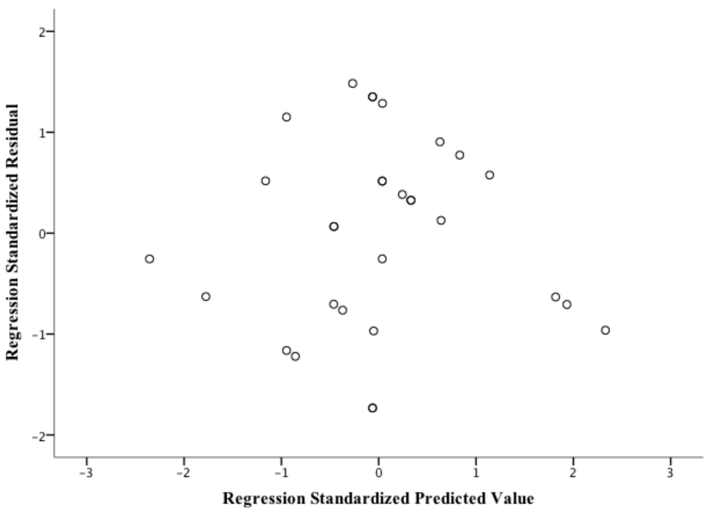

Figure 2. Plot of residuals against predictor variable (Y_i).

8.6 Appendix F

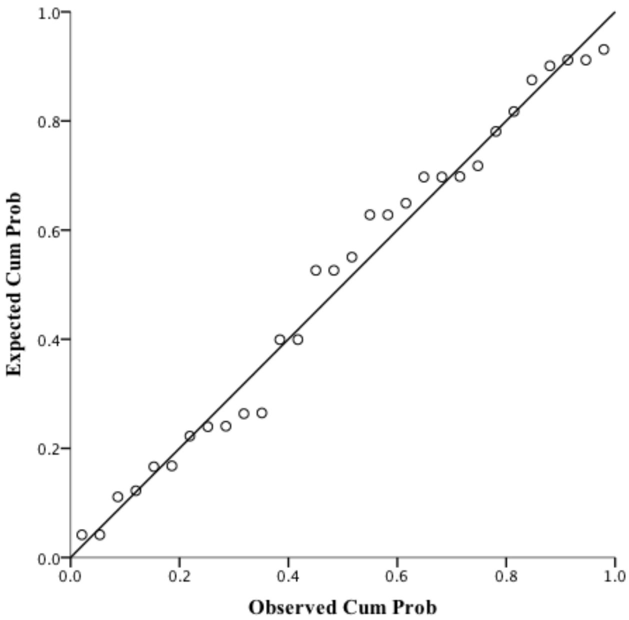

Figure 3. Normal P-P plot of regression standardized residual.

8.7 Appendix G

Table 7. Correlation matrix.

Correlations

		Reluctance of Industry 4.0 use	Lack of Time (H1)	Costs (H2)	Data Risks (H3)	Risk of Job Losses (H4)	Risk of Change (H5)	Difficulties to adjust the production process (H6)
Reluctance of Industry 4.0 use	Pearson Correlation	1	-,109	-,140	-,272	-,199	,062	,234
	Sig. (1-tailed)		,283	,230	,073	,146	,373	,107
	N	30	30	30	30	30	30	30
Lack of Time (H1)	Pearson Correlation	-,109	1	,160	,026	,085	,112	-,135
	Sig. (1-tailed)	,283		,199	,446	,327	,277	,239
	N	30	30	30	30	30	30	30
Costs (H2)	Pearson Correlation	-,140	,160	1	,285	,230	.462**	,086
	Sig. (1-tailed)	,230	,199		,063	,110	,005	,325
	N	30	30	30	30	30	30	30
Data Risks (H3)	Pearson Correlation	-,272	,026	,285	1	-,180	,218	,146
	Sig. (1-tailed)	,073	,446	,063		,170	,124	,220
	N	30	30	30	30	30	30	30
Risk of Job Losses (H4)	Pearson Correlation	-,199	,085	,230	-,180	1	,011	,226
	Sig. (1-tailed)	,146	,327	,110	,170		,477	,114
	N	30	30	30	30	30	30	30
Risk of Change (H5)	Pearson Correlation	,062	,112	.462**	,218	,011	1	-,223
	Sig. (1-tailed)	,373	,277	,005	,124	,477		,118
	N	30	30	30	30	30	30	30
Difficulties to adjust the production process (H6)	Pearson Correlation	,234	-,135	,086	,146	,226	-,223	1
	Sig. (1-tailed)	,107	,239	,325	,220	,114	,118	
	N	30	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (1-tailed).

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