Master’s thesis - master Innovation Sciences

Cloud computing technology in manufacturing firms

Identifying adoption factors, challenges, and corresponding solutions

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Summary

Nowadays, digital technologies are transforming societal and business environments. One of these technologies, cloud computing technology, has gained much popularity and attention in recent years, and is about to radically reshape the manufacturing industry. This research aimed to increase knowledge on the process around cloud computing adoption, implementation, and usage in Dutch manufacturing firms. More specifically, adoption factors, challenges, and corresponding solutions were identified.

For this purpose, an inductive and qualitative research approach was pursued. Twenty semi-structured interviews were conducted with employees from nineteen different manufacturing firms and one firm that helps to solve issues related to information technology within the manufacturing sector. Interview data were complemented by secondary data from documents and articles. The Unified Theory of Acceptance and Use of Technology was used as a theoretical lens and extended by adding adoption factors, challenges and solutions, making the adapted model particularly suitable for the process around cloud computing technology adoption, implementation and usage.

According to the interviewees, the most important adoption factors relate to relief; usability; location independence; data accessibility, exchangeability, safety and security; productivity; monetary benefits; flexibility; integration; extra services and opportunities; market pull; technology push; internal push from the IT department; and the coronavirus. The frequently mentioned challenges are resistance from the workforce; lack of knowledge and people with the right skills; data accessibility, safety and security; dependence on cloud suppliers; monetary detriments; integration; performance; governance; internet connection; and challenges abroad. Finally, some solutions were mentioned, such as a hybrid cloud; agreements on accessibility, ownership, geo-redundancy and geographical place of data; involve employees and provide them with training, workshops and tests; replace employees where necessary; create a network by visiting conferences; cooperate with third parties such as consultants and startups; bidirectional feedback with relevant parties; let the IT department guide the technology related processes; create a future vision with strategy (e.g. exit or second mover strategy); create a redundant internet connection; and stay close to the basics.

These results function as a guideline which might help managers that are currently trying to implement cloud computing technology, or considering to do so in the future. Such a guideline increases preparedness and therefore helps managers to avoid or better deal with major (unexpected) issues. Subsequently, this decreases effort and costs associated with the implementation of such a complex technology in firms.

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The past eight months, I have been working on this research with a lot of enthusiasm and pleasure. However, this would not have been possible without some people, whom I would like to thank here. To begin with, I would like to express my sincere gratefulness to my supervisor, Annika Lorenz, for all the time and effort she spent to provide me with valuable feedback and ideas, and for her continuous support during the process. Next, I would like to thank all the participants of the research for the conversations we had during the interviews. I retrieved a lot of relevant and interesting information and opinions which enabled me to conduct this research. Finally, I would like to thank my peer reviewers for their feedback and suggestions to improve the research.

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1. Introduction

1.1. Background

‘’Digitalization is booming’’, ‘’Digitalization: one of the megatrends that is affecting us all’’ and ‘’How digital technology can change our world’’ are examples of headings an observant reader will find frequently in today’s newspapers and on firms’ websites (Huawei, 2018; Urban Hub, 2018; Orange, 2017). Implementation and usage of digital technologies is a major trend that is currently changing both society and business (Parviainen et al., 2017). It shifts the ways we communicate and changes the ways we fulfill our roles in work and daily life. Possibilities are infinite; in daily life, mobile devices, apps, tools and automation allow customers to get fast customized products and services on-demand, while in business life machines and products are able to communicate without human interaction (TIIR, 2018). The most influential digital technologies include the Internet of Things, big data, robotics, virtual reality, artificial intelligence, cloud computing and 3D printing (Frank et al., 2019).

These digital technologies provide multiple benefits. The main economic benefits are transparency and interconnection of processes, along with increased levels of efficiency, flexibility, quality, and customization (Müller et al., 2018). Moreover, it increases the accessibility and attainability of worldwide knowledge and information (Khan et al., 2015). It may also result in higher employment rates, mainly in the information technology (IT) sector, but also in sectors such as healthcare, trade and industry (Khan et al., 2015; Forbes, 2018A). Yet, the most important societal benefit is general life quality improvement, which is not only achieved through high quality and highly customized consumer products, but also by increases in safety through high-tech innovations in healthcare, transport and crime prevention (Lewis & Lewis, 2011; Menvielle et al., 2017). Furthermore, digital technologies contribute towards worldwide sustainability in the form of e-health services, robotics, tools to map environmental damage, or emission reduction solutions, for instance (Seele & Lock, 2017).

Digitalization also changes the ways firms do business. It is penetrating, as it can transform any sector on a global level (Wyman, 2014). For example, companies need to adopt digital technologies in the organization or in the operation environment (Parviainen et al., 2017). It can help to create new forms of knowledge and expertise that provide important reciprocal insights necessary for complex innovations (Dougherty & Dunne, 2012). In sum, digitalization is inescapable for firms striving to keep up with the pace of a fast-changing world and willing to create or sustain a competitive advantage.

The way goods, materials and substances are transformed into new products is quickly being revolutionized by digital technologies (The Record, 2019). On the one hand, customers are demanding more, newer, better, high quality products nowadays. On the other hand, products are manufactured from increasingly scarce resources, as sustainable and affordable as possible. As the performance of (digital) technologies improves, manufacturing firms have to deal with new challenges today, including increased complexity, pace, demand, and amounts of data (Industryweek, 2017). Several digital technologies, such as artificial intelligence, big data and robotics are applied to deal therewith (Bahrin et al., 2016). Yet, cloud computing technology (CCT) is one of the digital technologies that is gaining much popularity in manufacturing firms. This is because it enables dynamic, scalable and virtualized resources via the web (Xu, 2012), making the technology essential for firm survival in manufacturing (TDTP, 2019; Cloudtech, 2019). Data and functionality will progressively be deployed to the cloud, causing more data-driven services for production systems and increased rates of data-

sharing across firms (Bahrin et al., 2016). Diverse manufacturing firms have already successfully realized the potential of CCT. For example, General Electric chose to adopt Amazon Web Services (AWS) as provider, hosting over two thousand cloud-based apps and services (Matthews, 2019). According to General Electric's chief technology officer: *''Adopting a cloud-first strategy with AWS is helping our IT teams get out of the business of building and running data centers and refocus our resources on innovation as we undergo one of the largest and most important transformations in GE's history''* (CBR, 2017). It is expected that by 2023, almost 50% of all organization-level software will be based on CCT services among manufacturers (Industryweek, 2017).

1.2. Research gap and objective

Although CCT is facing a marvelous future in manufacturing firms, current knowledge on adoption factors in this sector is still quite limited (Al-Hujran et al., 2018). General motivations have indeed been identified for the technology, but usually not in the context of the manufacturing sector (Alkhater et al., 2018; Widyastuti & Irwansyah, 2018). Particularly, the internal organizational factors - firm's specific characteristics such as complexity of processes and supply chain processes - remain narrowly identified (Kyriakou & Loukis, 2019). This is mainly because a large share of the studies on CCT is focused on the development of the technology itself, rather than on the adoption factors (Gangwar et al., 2015). Moreover, CCT adoption, implementation and usage is by far not without challenges (Fitzgerald et al., 2014). The most important challenges relate to security, performance, costs, complexity, customization facilities and evaluation (Feuerlicht et al., 2011; Maresova et al., 2017). Although numerous studies have investigated security problems and some related solutions (e.g. Jain, 2012; Rao & Selvamani, 2015), most studies neither dive deep into the other challenges, nor come up with corresponding solutions. Thus, despite many manufacturing firms seem excited to apply CCT technology, there is little agreement on the motivations, challenges and corresponding solutions of the technology in the sector. Hence, the purpose of this research is to contribute to this research gap, which has led to the following research question and sub-questions:

RQ: *''What does the adoption, implementation and usage of cloud computing technology look like in manufacturing firms?''*
SQ1: What are the motivations to adopt cloud computing technology in manufacturing firms?
SQ2: What challenges are associated with the adoption, implementation and usage of cloud computing technology in manufacturing firms?
SQ3: How do manufacturing firms deal with challenges related to cloud computing technology?

For this purpose, an inductive and qualitative research design was pursued. Semi-structured interviews with manufacturing firms were the main source of information. Through different rounds of coding in NVivo and Excel, the most important concepts contributing to the research aim became apparent. In turn, the Unified Theory of Acceptance and Usage of Technology (UTAUT) was used as a theoretical lens to identify the underlying motivations that make firms decide to adopt CCT. Next, the framework was extended, based on the interviews, as adoption factors, challenges and corresponding solutions were added to the model. Sections three and four will elaborate on this.

1.3. Relevance

Answering the research question offers both empirical and societal contributions. This research adds towards research on CCT adoption factors, challenges and corresponding solutions related to firms that operate in the manufacturing industry. Another empirical, or methodological contribution, relates to the fact that most of the studies that identify IT adoption factors apply quantitative research techniques, in which they create and analyze surveys (Salim, 2012; Attuquayefio & Addo, 2014). This research, however, has applied qualitative research methods through semi-structured interviews.

In turn, the results of the study function as guideline which might help managers that are currently trying to implement CCT, or will consider to do so in the future. Such a guideline increases preparedness and therefore helps managers to avoid or better deal with major issues. Subsequently, this decreases efforts and costs associated with the implementation of such a complex technology. This might therefore contribute to a higher organizational productivity in the use of IT. This is required, because currently it seems that productivity increases relatively slowly compared to the large investments that are done in IT, a phenomenon known as 'the productivity paradox' (Brynjolfsson, 1993; Van Ark, 2016). All in all, chances of firm survival will increase as a sustained competitive advantage is achieved more easily. In the end, a higher productivity will benefit society due to higher innovation rates in the manufacturing industry, which brings the previously mentioned benefits, such as increased life quality, increased safety, and customized and high quality customer products.

Another large societal benefit of the research relates to the accessibility and storability of data. Research on CCT helps firms to efficiently organize and structure larger amounts of data than before. This means that information accessibility increases, thereby decreasing costs of data access (e.g. transactional costs). Additionally, data are stored very securely, and will only be accessible to the people that have the rights to do so. This does not only concern firms, but also private data of individuals, because firms often store data for and of their clients. Thus, increased options and increased levels of safety for data storage and accessibility are societal contributions of the research too.

Finally, this research offers two theoretical contributions. Although the UTAUT model is appropriate to identify adoption reasons, it lacks applicability for identifying implementation and usage challenges as well as corresponding solutions. Therefore, the first theoretical contribution is the extension of the framework in such a way, that it is not only applicable for the technology adoption stage, but also for what happens after that moment. In other words, the contribution is the identification and inclusion of the challenges as well as corresponding solutions that usually arise when adopting, implementing or using the technology. Secondly, most of the scientific contributions that apply the UTAUT model identify IT adoption factors of individuals (Tönissen, 2016). This research, however, has aimed to identify these factors at the firm level. The application of the model to business context thus is a theoretical contribution as identifying factors at the firm level is hardly ever being done.

1.4. Thesis outline

The remainder of this research is structured as follows. The next section provides a literature review and background information on digitalization and CCT, in particular. Section three will illustrate the current form of the theoretical framework that will be applied and eventually extended: UTAUT. The fourth section describes the methodological approach used for the empirical part of the research. Section five presents an overview of the results, based

on the semi-structured interviews. Section six, in turn, presents the extended UTAUT model, discusses the theoretical and practical contributions, calls on the limitations of the study and provides directions for future research. Finally, the research question and sub-questions are answered and conclusions are drawn in the seventh section.

2. Literature review

2.1. Digital technologies in manufacturing firms

The need of firms, organizations and educational institutions to use and apply computer-based information technologies has grown into its own set of adoption research. This is often referred to as research on digitization and digitalization. Although these concepts are regularly used interchangeably, their meanings differ significantly and require clarification. Digitization involves the conversion of physical signals towards digital information, ultimately into binary digits (Tilson et al., 2010). Digitalization, in turn, encompasses the broader application of digitization technologies in extensive individual, organizational, and societal contexts, for example to improve business processes (Legner et al., 2017). Digital technologies in manufacturing change the ways products are designed, fabricated, used, operated, and serviced post-sale, but it also changes the operations, processes and energy footprint of factories (Ezell, 2018). Ezell et al. (2018) name the following motivations to adopt digital technologies in manufacturing firms: efficiency, acceleration of time-to-market for new products, optimization of inventory and processes, reduction of waste, improvement of working conditions and alignment of supply and demand.

The implementation of a digitalized business model is not without problems (Fitzgerald et al., 2014). Despite many employees recognizing the importance and potential of digitalization, a large share is struggling to find ways to get this potential out of it (Parviainen et al., 2017). Other problems relate to the strong bias towards ideas from the ‘outside’, considering employee resistance to use or implement external ideas and technologies because they were ‘not invented here’ (Piezunka & Dahlander, 2015). Employees also commonly express their fear to be replaced completely by digital technologies, inducing job losses (Forbes, 2018A). Indeed, many routine actions are already being executed by computers and machines, and this will only increase in the future, simply because machines can do routine work more efficiently. Yet, more technicians would be required to deal with this increased number of machines, which would in turn lead to more IT-related jobs (Leimeister et al., 2015). To make a long story short, the loss of jobs would be largely compensated for by the creation of new jobs.

2.2. Adoption and usage of cloud computing technology in manufacturing firms

Even though numerous studies have looked into factors affecting IT adoption in firms, CCT adoption is a less developed research area (Sharma et al., 2016). Still, there are some studies that have tried to identify reasons for adoption of CCT in manufacturing firms. According to Misra and Mondal (2011), criticality of work done, data sensitivity, utilization pattern of resources and size of IT resources are determining factors. Low et al. (2011) found that specifically the support from the top management team, firm size, competitors, trading partners and relative advantage contribute significantly towards this decision. Based on an

analysis with the technology-organization-environment (TOE) framework (Tornatzky et al., 1990), which can be used to determine technological, organizational, and environmental factors for technology adoption in firms, Oliveira et al. (2014) largely agreed with Low et al. (2011), and added complexity and technological readiness. In fact, there are a few studies that have investigated CCT adoption factors using the TOE-model (e.g. Borgman et al., 2013; Gangwar et al., 2015; Gutierrez et al., 2015). However, the aforementioned studies are relatively outdated, especially in terms of the latest technological changes and trends, and therefore more recent research is required.

Besides adoption factors, a few studies have also investigated what the challenges are of CCT adoption and usage. Problems related to security, performance, costs, complexity and customization facilities kept returning (Feuerlicht et al., 2011). Díaz et al. (2016) found that security and privacy are key concerns in the deployment of CCT. In 2010, IDC carried out a study on CCT problems. According to their survey, 87% of the respondents mentioned security as an issue, followed by service availability and performance, both counting for 83% (IDC, 2010). Clearly, mainly the security issues are a popular research topic, and sometimes even solutions are being suggested (e.g. Rao & Selvamani, 2015; Jain, 2012). Again, these studies are outdated, and other challenges have not received the same amount of attention, let alone solutions to overcome these challenges.

2.3. Background

Cloud computing is defined as *''a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction"* (Mell & Grance, 2011, p.2). In other words, it offers computing power and data storage for the user, while the user itself does not have to manage it. The most important characteristics of CCT are: on-demand service, network access, shared resources, scalability/elasticity and measured service (pay-by-use) (Ren et al., 2017).

Hosted platforms usually are outdated as these servers cannot keep up with the increased pace, demands and amounts of information today (Industryweek, 2017). Cloud-based solutions, in turn, can deal with today's increased amounts of data, complexity, and connectivity as it provides the required time, access to data, and scalability of online services (Industryweek, 2017). Cloud-based services fit in a business environment with growing and fluctuating demands. The word 'cloud' refers to using the internet for managing, storing and processing data. So, in its most basic form, it is defined as an internet-based type of computing, that allows on-demand network access to shared computer resources. An important aspect is that one pays for the real use of computing resources and facilities (Hoover & Martin, 2008). The end-user does not need to be the owner of the hardware and/or software, neither has the information about who exactly is the owner, and the end-user therefore is not responsible for the service itself.

CCT consists of three main delivery models: infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS), and software-as-a-service (SaaS). They are classified based on the end-user needs, where a SaaS model takes over most of the end-user, and an IaaS model the least. When a firm wants to implement CCT, it needs to choose one of these three models. IaaS offers hardware, such as server, storage and network, as well as the associated software (operating systems, virtualization technology, file system) as a service (Bhardwaj et al., 2010). However, the user is still able to manage the operating system, database, applications and

data. PaaS represents the CCT level that grants online entry to the resources necessary to build applications using the internet, without the necessity to install software (Velte et al., 2010). In other words, next to the hardware, the operating system and databases are managed by the cloud. In turn, SaaS provides the hosting of an application to web delivered services to its customers, who can access the service online via the web (Wu et al., 2011). This means that the entire application is being managed by the supplier, including infrastructure, development, operating system, updates, etc. The user thus has no influence on it. Figure 1 shows the architecture of a cloud computing environment along with examples.

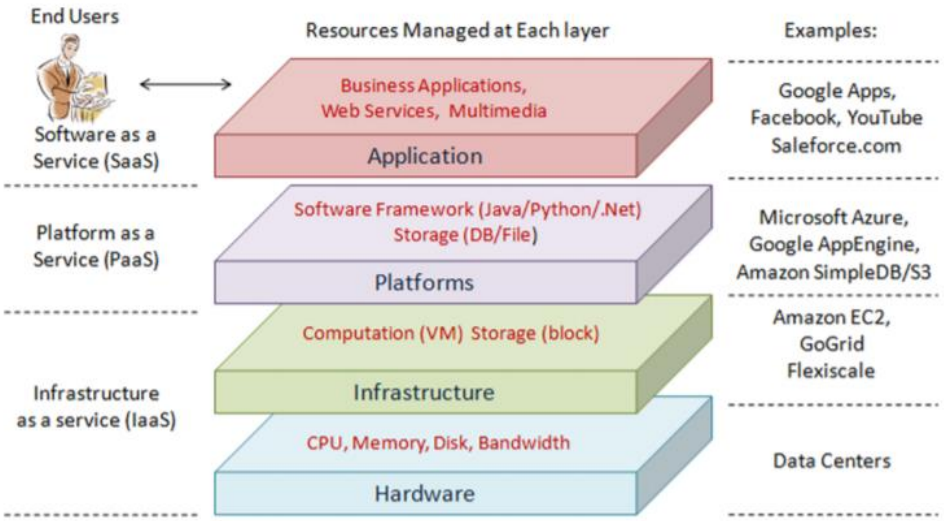

Figure 1: Cloud computing architecture (Zhang et al., 2010).

Next to service models, several deployment models can be distinguished. According to Mell and Grance (2011), there are four main models: private, community, public, and hybrid clouds. In the case of a private cloud, the cloud service is exclusively meant for one particular organization including several consumers. It can be managed either internally or by a third party and hosted both internally as well as externally. When the cloud is based on a community, only the designated organizations have access. This is often used by organizations with shared goals. In turn, a public cloud is accessible for everyone with interest. That is an advantage for sure, but sharing of big resources can also be a huge disadvantage for organizations with specific security requirements. Both community and public clouds may be managed and hosted by one or more organizations, or by one or more third parties, or a combination between them. Finally, a hybrid cloud model, which is the most common service model, is a combination of at least two of the three aforementioned cloud infrastructures, that remain separate but are connected in a way that benefits are accomplished.

3. Theoretical framework

3.1. Choice of theoretical framework

As mentioned in the introduction, the UTAUT framework is usable to identify motivational factors for IT adoption. However, even though the name suggests the framework is applicable for technology acceptance *and use*, I argue that it falls short in the usage part. This is because it is a technology adoption model, meaning that it can help to identify factors that lead to, or not lead to, technology adoption. Yet, no attention is being paid to what happens

after a technology has been adopted. For example, when using a specific technology, problems are almost always unavoidable. However, the framework in its current form needs to be extended to answer the second and third sub-questions of this research, namely what the challenges are and how to overcome them after CCT has been adopted by a manufacturing company. As mentioned before, the extension of the model was based on the information that was gathered during the interviews and desk research. This section provides a brief overview of the important elements, concepts, and definitions of the framework.

3.2. The Unified Theory of Acceptance and Use of Technology

New software systems and IT´s must be accepted and used by employees in organizations to improve productivity (Dabroek, 2016). There is a large quantity of models which can help to understand why a particular IT was adopted or not, each with its own determining factors. In 2003, Venkatesh et al. published a paper in which they compared eight models[1] on IT adoption. The more salient characteristics of those eight models were combined and resulted in an overarching model, or theory. It was named the 'Unified Theory of Acceptance and Use of Technology'. While the eight models together could only explain 53% of the variance of the intention to adopt and use IT, the UTAUT model achieved a variance as high as 70% (Venkatesh et al., 2003). This was an important step towards an overarching tool for managers to evaluate and construct strategies regarding the acceptance and use of new (information) technologies (de Sena Abrahão et al., 2016). In its most basic form, the UTAUT model attempts to explain factors that influence the intention as well as the actual decision to adopt an IT. Thereby, the model helps to assess the chance that a new IT will be applied successfully and it assists to understand the most important incentives that could lead to acceptance. The model has been applied and tested broadly since its introduction (Chao, 2019). Obviously, CCT is an IT and therefore this framework is of great value for this research.

The model consists of four main components, called key constructs. These include performance expectancy, effort expectancy, social influence, and facilitating conditions. An IT is more likely to be accepted and used when performance expectancy, effort expectancy, social influence and facilitating conditions increase. While facilitating conditions have a direct effect on use behavior, the other three key constructs have a direct influence on behavioral intention, and therefore an indirect influence on use behavior. While behavioral intention entails what a user is planning, or intending, to do, use behavior is what the actor actually decides. Table 1 provides definitions and examples of the aforementioned components.

Table 1: Components of the original UTAUT model and its definitions (Venkatesh et al., 2003).

Components	**Definition**	**Examples of what is being measured**
Performance expectancy	*''The degree to which an individual believes that using the system will help him or her to attain gains in job performance''* (Venkatesh et al., 2003, p.447).	- Improvement through use of the system - Enhancement of productivity - Positive impacts on performance - Usefulness for company/employees

[1] Theory of reasoned action, technology acceptance model, motivational model, theory of planned behavior, a combined theory of planned behavior/technology acceptance model, model of personal computer use, diffusion of innovations theory, and social cognitive theory.

Effort expectancy	*''The degree of ease associated with the use of the system''* (Venkatesh et al., 2003, p.450).	- Ease of use - Importance of use - Stress free interaction
Social influence	*''The degree to which an individual perceives that important others believe he or she should use the new system''* (Venkatesh et al., 2003, p.451).	- Usefulness for coworkers - Use by coworkers - Encouragement by managers
Facilitating conditions	*''The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system''* (Venkatesh et al., 2003, p.453).	- Availability of the system - Knowledge to operate the system - Good placement within the corporate culture

Furthermore, the model consists of four moderators that determine the impact of the four key constructs on behavioral intention and use behavior: gender, age, experience and voluntary use (Venkatesh et al., 2003). It is hypothesized that the influence of performance expectancy will be moderated by gender and age, so that the effect will be stronger for men and younger people. The influence of effort expectancy on behavioral intention is thought to be moderated by gender, age, and experience, in such a way that the effect will be stronger for women, older people, with little experience. Next, the effect of social influence on behavioral intention is hypothesized to be moderated by all moderators, so that the effect will be stronger for women, older people, in mandatory settings with little experience. Finally, the effect of facilitating conditions on use behavior is moderated by age and experience, so that older people with more experience will have the largest effect. Figure 2 gives a schematic overview of the model.

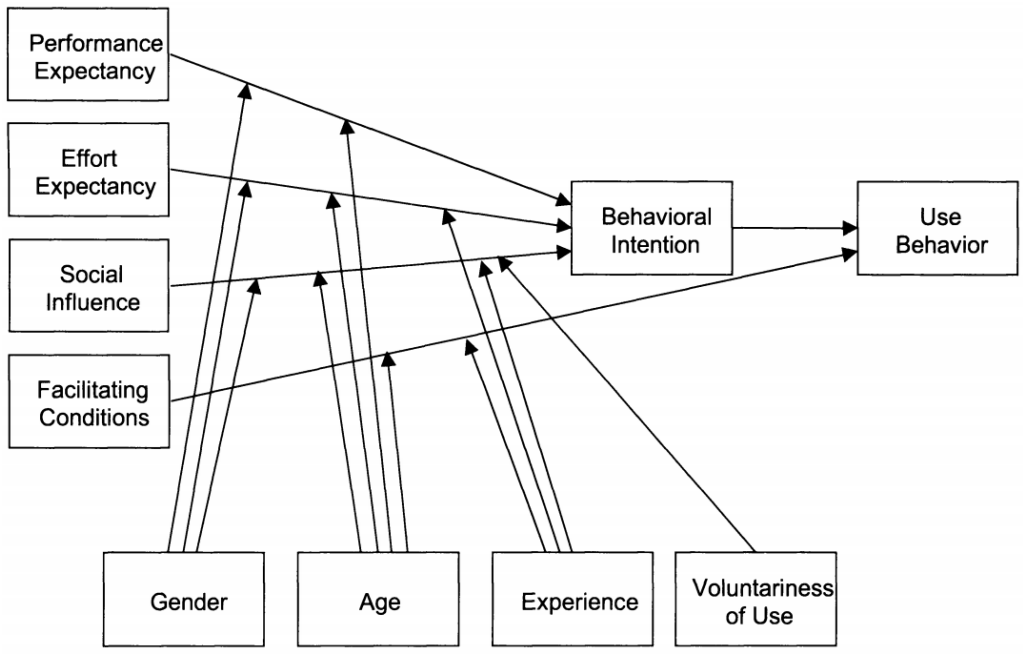

Figure 2: The Unified Theory of Acceptance and Use of Technology in its basic form (Venkatesh et al., 2003).

4. Methodology

4.1. Research design

The objective of this research was to gather in-depth information on CCT adoption factors, challenges and solutions. Thus, the interest lied in describing a particular situation, thereby answering the 'what' and 'why' questions related to CCT. For this aim, qualitative semi-structured interviews with Dutch manufacturing companies functioned as the main source of data. The sample included multiple firms with one key respondent each, that could tell valuable information to help answer the research question. Therefore, this research required a descriptive, qualitative, multiple holistic case study approach (Yin, 2011). Where needed, documents and articles including relevant information about CCT complemented the data that was extracted from the interviews.

To retrieve the right information from the respondents, I divided the interview questions into three different segments, each representing one sub-question: 'reasons for cloud computing adoption', challenges of cloud computing adoption and usage', and 'solutions to the challenges'. The questions on adoption factors were based on the four key constructs from the UTAUT model, as well as on the concepts identified in documents and articles during desk research. The questions related to challenges and solutions were mainly based on desk-research too, but the formulation and openness of the questions allowed the interviewees to come up with challenges and solutions themselves that were not identified prior to the interviews. The interviews included some questions with regards to the moderators (gender, age, experience, voluntariness of use) too. However, as the main aim was not to exactly measure or identify the effects of these moderators, they received limited attention.

Observations and interviews led to findings from which broad industry specific conclusions were drawn. Because the aim was to create or extend theory as an outcome of semi-structured interviews, this research required an inductive approach (Bryman, 2016). Inductive reasoning makes broad generalizations from specific observations, in this case from the interviews. In optimal form, cases are selected that differ on one particular variable, such as size (e.g. small vs. large), industry segment (e.g. food manufacturing vs. clothing manufacturing), or phase of technology implementation (e.g. recently adopted vs. adopted years ago). This differentiation can indeed largely be found in the sample.

4.2. Data collection

To gather data and information on the research topic, different sources were used. Although desk research was not enough to provide an answer to the main and sub-questions of the research, it functioned as a starting point for the investigation. Desk research helped to create an initial starting list of codes and consisted of academic articles as well as (recent) news articles. Google Scholar and Scopus represent the main sources used for academic papers. Several keywords[2] and combinations thereof were used to find interesting articles for the research.

Next, I gathered information via semi-structured interviews with employees and managers of manufacturing firms, which helped to extend the initial list of codes. Basically, the semi-structured interviews functioned as the main source of data for this research.

[2] Examples of keywords are: ''digitalization'', ''cloud computing'', ''adoption'', ''manufacturing'', ''reasons'', ''motivations'', ''problems'', ''challenges'', ''solutions''.

Originally, the interviews would take place in-person at the interviewees' work sites. However, due to the corona crisis, only the first two interviews were conducted at the employees' workplace. All the other interviews were conducted in a remote way, such as Teams or Skype, with both audio and video connection to reflect real life conversations as much as possible. When this was impossible or unwanted, the interview was carried out on the phone.

The interviews were semi-structured because this offers several benefits in comparison to other types of interviews (Bryman & Cassell, 2006). The largest advantage is the possibility to formulate questions in an open-ended way, enabling further discussion when an interviewee mentions something interesting or relevant that requires clarification. During the interviews, I used a pre-formulated interview guide, yet, deviation from the guide was desirable to retrieve more information about particular topics that seemed especially meaningful to the interviewees. Due to the semi-structuredness, a fixed question order lacked and the questions asked varied a little between the interviews. Appendix A provides an overview of the interview guide I used to conduct the interviews.

4.3. Sampling strategy

In qualitative research, purposive sampling is often seen as the most suitable sampling strategy, in which the research question(s) lie(s) at the center of the sampling selection (Bryman, 2016). Moreover, samples in qualitative research are likely to be chosen with the goal that the specific study units have the most relevant and plentiful information about the topic of study (Yin, 2011). So, based on the research (sub-)questions, manufacturing firms were selected and contacted. More specifically, the sample consisted mainly of manufacturing firms that have adopted and started to use CCT recently, or are considering to do so. The sample included a couple of manufacturing firms that specifically chose not to adopt CCT too. As mentioned in section 4.1., the sample also included manufacturing firms that differ with respect to size or industry segment, to create a little variation in the sample for broader generalization. All manufacturing firms of the sample are located and operating in the Netherlands, for convenience and better accessibility of data. To gather information from different perspectives, one interview was also conducted with a company that provides solutions to manufacturing firms that experience IT related issues.

Each year, several lists are published on the internet that include manufacturing companies in The Netherlands. The firms that are in the lists are often ranked (top 10/20/100) based on how successful they are in a particular year, in terms of relative revenue increase for instance. The lists consist of firms of all different kinds of manufacturing industry segments, such as: transport, logistics, infrastructure, construction, metals, machinery, chemicals, aerospace, automotive, hightech, medtech, consumer products, maritime, offshore, paper, plastics, packaging, and printing. Almost all firms in these ranking lists were approached to retrieve their thoughts and choices with regards to CCT, to make sure whether a particular firm fit in the sample described in the previous paragraph. The names of the lists that were used to create the sample are deliberately not provided to guarantee the privacy and anonymity of the firms that participated in the research. After reading critical information about a particular firm on its website, I scanned the employee page on LinkedIn to find suitable respondents, preferably those with a background in IT, innovation, and/or technology, who were then approached via InMail, regular email or telephone. In addition, I applied snowball sampling, because this is an easier way to get in touch with potential interviewees when investigating a group that has an important characteristic in common (sector/industry in this case) (Biernacki & Waldorf, 1981).

In total, I carried out 20 interviews with 21 respondents between 11-03-2020 and 14-05-2020. The interviews were all conducted in Dutch. The duration of the interviews varied between 27 and 81 minutes, with an average of about 43 minutes per interview. This resulted in a total of 865 minutes, or almost 14.5 hours of information. Data collection ended as soon as the last few interviews did not bring new insights, meaning that data-saturation was reached at that point. Appendix B provides an overview of the interview(ee)s. It must be noted that, due to privacy reasons, the names of the employees are explicitly not mentioned. Appendix C, in turn, provides a description of each of the firms that participated in the research. Again, due to privacy and anonymity agreements with the respondents, the names of the organizations are not mentioned. Moreover, the organizations in appendix C are published in a random order, and can therefore not be linked to an interviewee's number (e.g. firm A does not correspond to IV1).

4.4. Data analysis

All interviews were recorded and transcribed, after permission had explicitly been asked for. This way of working made it possible to fully focus on the interviews without being distracted by continuous note taking. The transcripts were then put into NVivo, which is a purposively-built tool to assist qualitative and mixed-methods research. It helps to store, organize, categorize, visualize and analyze data. Data analysis in NVivo consisted of a couple of coding steps. Coding is defined as *"to arrange things in a systematic order, to make something part of a system or classification, to categorize"* (Saldaña, 2015, p.9).

Before the interviews were conducted, investigation of literature strands around CCT in manufacturing firms helped to create an initial list of codes. Appendix D provides the initial starting list of codes and indicators based on the literature and UTAUT model. The category 'solutions' was not in the table, because interview questions on predetermined solutions would influence the respondents too much and therefore lead to bias in the results. Rather, the interviewees had to come up with the solutions themselves. Of course, there was also enough room for the respondents to mention adoption factors and challenges that were not identified in the literature. After the interviews were conducted, the first step of the data analysis was the application of open coding, a process in which words, phrases, sentences or even entire paragraphs are assigned codes (called nodes in NVivo). These codes represented the underlying issue or phenomenon an interviewee was talking about or relating to. This resulted in a large open list of codes, partly including predefined codes based on literature, but mainly consisting of new codes that were assigned in NVivo.

To create a better overview of data and codes, I did further coding in Excel. Since this research had three sub-aims, three different Excel sheets were created: one with codes regarding adoption factors, one with codes regarding problems or difficulties, and the final one with solutions interviewees came up with. All first order codes in NVivo were individually checked, after which the codes and corresponding quotes were either translated to English and put in one of these sheets, or excluded from the research if there was no significant value with regards to one of the three research aims.

After all relevant first order codes were transferred from NVivo to Excel, the second phase of coding, axial coding, was done in Excel. This entailed the clustering and summarizing of initial and open codes into categories, usually based on one or more common characteristic(s). This round was followed up by another round of classification to divide the large number of categories into broader categories and subcategories. The third round of coding, selective coding, was not carried out because the (sub)categories that had emerged

during axial coding could be used to answer the research sub-questions, and so the main research question. Each subsection in section 5. represents one of the identified categories.

Figure 3 provides an overview of the coding process. As explained, selective coding was not executed, so the final step from themes/concepts towards assertions/theory was not part of the analysis. Appendix E provides an example of how open codes were created, how these codes were assigned to quotes, and how all these codes were divided into the different (sub)categories. The example that can be found in appendix E was used to create section 5.1.5.

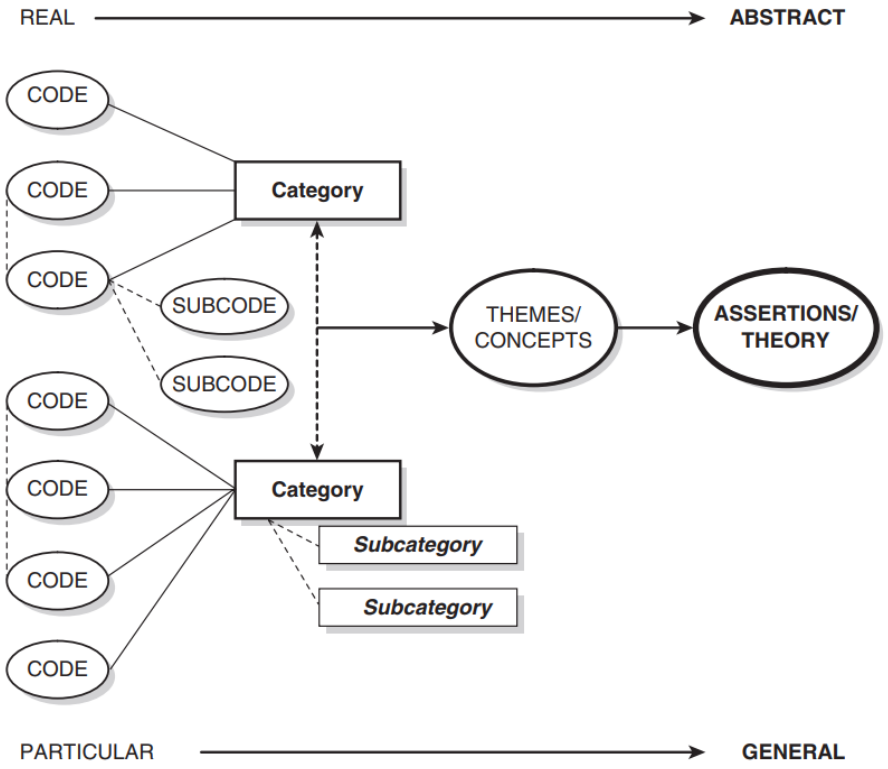

Figure 3: The process of coding (Saldaña, 2015).

4.5. Research quality indicators

This research aims for the highest quality possible. Replication and reliability are assured because detailed methodological descriptions were given about both data collection and data analysis. All the interviews were transcribed, meaning that another researcher could use these interviews to investigate the same topic. Moreover, the coding process is explained in detail, and an example is provided in appendix E that shows the different steps of coding. More specifically, it shows the quotes and their codes, how the codes were (sub)categorized, and how this resulted in section 5.1.5. Due to the fact that the described approach was consistently pursued during the entire research, there is research transparency which benefits the quality of the research.

External validity, or generalizability, is not of core concern for this research. Yet, interviews were conducted with different kinds of manufacturing firms, so there is variation in the sample (e.g. in terms of size, adoption choice and manufactured products). Although the findings are not necessarily true for all Dutch manufacturing firms, the results include the most common adoption factors, challenges, and corresponding solutions, that were mentioned by multiple interviewees, enabling broader generalization. Data triangulation with external sources also contributed to external validity of the research. Finally, internal validity is

maximized as the interview questions were formulated in an open way and as a strict methodological approach was pursued to uncover relationships (e.g. how problems are caused and how they can be solved).

5. Results

5.1. Adoption factors

5.1.1. Relief

One of the most frequently mentioned advantages of CCT turned out to be the relief it offers within manufacturing firms. The interviewees often mentioned that the technology removes the worry that one could have for keeping an eye on the functionality, hardware or software of systems. IV2 said: *''Why would I want to be responsible for a backup or checking if it functions properly? I don't care about that, I don't want to worry about that, which is why I prefer to host it in a data center.''* In this way, the manufacturing firm - mainly the IT department - is being unburdened and doesn't have to worry about or be responsible for likewise tasks. In other words, the cloud supplier takes over the responsibility of tasks related to running servers, thereby basically making himself the problem owner. This situation where the cloud supplier is actually the problem owner of the entire system and takes care of everything, was seen as the main advantage by some of the interviewees (e.g. IV13). Many occurring problems are now often fixed by the cloud supplier, without the need of the user to even mention the problem, because both discovering as well as fixing any problems related to CCT fall under the responsibilities of the supplier. IV14 neatly summed up the tasks from which they are now being unburdened: *''Not only do they (cloud suppliers) provide hosting for infrastructure, applications and data, but they also provide monitoring, management, updates, and solutions to problems that occur.''*

In turn, this relief leads to a shift of work for the IT department in most manufacturing companies, simply because they have more time to take care of other organizational issues. Basically, the IT department is now able to focus on the things that are more critical for the firm, so they can deliver more value, as explained by IV10: *''I don't think maintaining the infrastructure contributes to our business. I think it's a shame that we spent our time and energy on it, while it can now be largely outsourced. You just want your own people to add much more value to the business.''*

5.1.2. Usability

Another main advantage is that, in general, a company doesn't need a lot of knowledge about CCT to start adopting and using it. As explained by IV1, a user doesn't have to know anything about it, one can simply log in and do its things without having to think about it. This means that the technology is very user-friendly, making the threshold to apply the technology rather low for all organizations. This usability was confirmed by IV19: *"We are also moving towards a completely cloud-oriented solution, which is much easier to use nowadays because it is in the cloud. And that is actually always the case, when something is available in the cloud, it is just very easy to use.''* IV8 explained that everyone can easily create an account and decide who has access to it. This increases manageability and clarity within manufacturing firms.

5.1.3. Location independence

One more benefit is that people can perform their job from basically all locations. It doesn't really matter anymore whether work is carried out are at home, at the office, in public transport, or somewhere else, as long as there is reliable access to an internet connection, a person is able to properly do its work. In other words, as explained by IV12, CCT highly increases availability, which in turn makes functionality more easily available in multiple locations. Being able to enter the work environment anywhere increases the ease to cooperate and communicate with colleges, as exemplified by IV1: *''You have the same files everywhere, you can work simultaneously, you don't have to be in the same building, these are only benefits.''* In turn, this location independence often leads to a higher productivity, as well as to an increase in available time. In 2016, the average Dutch employee spent about 50 minutes to get from home to work, and 50 minutes to get back home later that day (CBS, 2018). As CCT makes it easier to work from home, this time can be utilized much more efficiently, either for a person's private or work-related tasks. As IV15 put it: *''Everyone is very happy because everyone is very efficient and effective, you have a travel time of 30 seconds to your work just by turning on your laptop.''* Some CCT tools that are used very often by employees when they work from their homes were mentioned multiple times. Microsoft Teams is believed to be the most important communication tool, while SharePoint is believed to be the most important tool for data and information sharing.

5.1.4. Data and information

5.1.4.1. Data accessibility and exchangeability

CCT offers multiple advantages related to data and information. To begin with, and linking to the previous benefit of location independence, data accessibility is extremely high. IV15 thought that it is important to be able to store all organizational data in one central place which is easily accessible: *''You need one central environment where your data comes together. So, I need one source of the truth, or at least I need one central place to get information.''* Some of the interviewees even mentioned that the accessibility of data and information is the most important benefit for them to adopt CCT. For instance, IV3 said: ''*As far as I'm concerned, the exchangeability and accessibility of information is the largest profit factor you have with cloud applications.''* Both the accessibility and exchangeability of data make CCT particularly suitable for cooperation and communication. In fact, CCT encourages a shift towards a collaborative situation, where information is simply available and where decisions can be made quicker than in the past (Dogo et al., 2019). This exchangeability can be used not only for sharing data within one's own company, but also to share data with the outside world, such as external parties or customers. In fact, the technology is helpful to spread data across multiple regions. IV11 mentioned that this mainly is a benefit for companies that are located all over the world, which is regularly the case with large manufacturing companies (Tate et al., 2014).

In turn, the cloud can also be helpful in situations where data analysis can be a rich source of information. As IV9 mentioned: *''So with that data on how machines produce, how efficiently their processes run, that's just a very rich source of information for customers, but just as good for us.''* It could be interesting to look at, for example, how one customer performs compared to another customer, or even compared to the market average. That information could even be put into (or sold as) a monthly, weekly, or daily report, whereby the customer has insights in how his machine is running. Concluding, increasing numbers of data and

information are deployed to the cloud, expanding data accessibility and exchangeability for and between firms, and enabling more services based on data analysis, as mentioned by Bahrin et al. (2016) in section 1.1.

5.1.4.2. Data safety and security

There is a widespread feeling that safety and security of organizational data and information is a problem related to CCT, especially in large manufacturing firms (Chen & Zhao, 2012). This has mainly been caused by bad news about hacks and cyber-attacks on the cloud, which will be elaborated on in section 5.2.4. Yet, many of the interviewees opined that data is never safer when an organization keeps all the data on-premise compared to a cloud-hosted solution. As IV10 put it: *''Microsoft will make every effort to ensure that our data is safe there, and they have much more capacity to ensure that our data is safe than the four IT guys we got in our own organization.''* A cloud supplier, such as Microsoft or Amazon, is better able to secure data due to the incredible amounts of money they spend on data safety and security, but also because of their long experience, which has resulted in huge amounts of knowledge and expertise (Ramachandran & Chang, 2016). One example of a system that Microsoft uses is 'Microsoft Enterprise Mobility + Security', which they themselves define as an intelligent platform for mobility management and security, thereby helping to secure and protect the organizational data and enabling employees to work in new and flexible ways (Microsoft, 2020). It includes several technological solutions, however, it is often difficult for users to understand how these technologies work to warrant security of data and information (Pekkarinen, 2018). Additionally, cloud suppliers often provide extra protection tools for free, bringing data protection to an even higher level (Sanchez-Gomez et al., 2016). As sketched by IV8: *''You even get all kinds of things for free, such as protection and stuff, which you normally should have arranged yourself.''* This also relates back to the aforementioned usability and relief, because the supplier makes sure that data is protected well, without the intervention or interference of the user.

5.1.5. Productivity

CCT can bring organizational productivity to the next level (Apostu et al., 2013). The first reason for this has already been mentioned, namely that it makes communication and collaboration a lot easier. Cloud-based solutions are often aimed at more convenient collaboration with people, regardless of location (IV4). IV5 confirmed this: *''Communication, collaboration, yes, that just takes off the moment you start applying cloud computing technology in your organization.''* Many communication tools have already been fully transferred to the cloud, such as the telephone exchange in IV19's organization, which is now the primary communication method there.

Secondly, the efficiency in general increases because people can be more productive at home (Bloom, 2014; section 5.1.3.), but also because data and information can be processed and analyzed in a more efficient way. This was nicely sketched by IV6: *''The real advantage of cloud computing is that it must improve the efficiency of the processes. And in order to improve efficiency, we think we have to say that we can process and analyze in a better way because all the data is easily available.''* This again touches upon data accessibility and exchangeability, mentioned in section 5.1.4.1., which makes data analysis easier and more efficient, and thereby enhances productivity (Langmead & Nellore, 2018).

Thirdly, the technology contributes a lot to the continuity of organizations, also called business continuity. Business continuity refers to actions, planning and preparations that are

undertaken to make sure that an organization has the capacity to keep running its critical operations at all times (MHA, 2017). In manufacturing firms, the IT department plays an important role in providing business continuity (Schuh et al., 2017). IV14 even told that their old on-premise servers could not keep up with the pace and demands of their organization anymore: *''We are increasingly working 24/7, factories are open 6/7 days a week and run 16-20 hours a day, and I just couldn't keep everything running with my on-premise architecture… I asked myself, what is the maximum achievable business continuity level I can achieve with my on-premise architecture? That level did not really meet the needs of the organization.''* Concluding, IV14 had no choice but to adopt CCT to achieve the demanded level of business continuity.

Finally, the technology contributes to a higher level of business intelligence, which comprises all tools (e.g. technologies or applications) that help to collect, integrate, analyze, and present organizational data and information, with the aim to support decision making (Negash & Gray, 2008). Several interviewees mentioned that the integration of Internet of Things, big data, and other smart tools/devices/systems within organizations require integration of CCT. IV6 had an explanation for this: *''On the one hand, the intelligence goes to the cloud, on the other hand, we see that products, engines, and sensors are getting smarter, which means they can be linked to the cloud. Our estimate is that a large part of the business intelligence, and with it the value of your solutions, will shift to the cloud.''* Concluding, CCT facilitates collaboration and communication, and increases efficiency, business continuity and business intelligence, and therefore has a stimulating effect on organizational productivity in general.

5.1.6. Monetary benefits

Although cloud prices have significantly dropped in recent years (Byrne et al., 2018), it is often referred to as being expensive (this will become clear from section 5.2.). Still, there are multiple monetary benefits that go hand in hand with the technology. One main advantage is that CCT is relatively easy to apply, without spending a lot of money or without having to do large investments (Bliedy et al., 2018). This is in contrast to the previous situation in which an organization wields an on-premise solution, because then large investments have to be made, such as purchasing the necessary datacenters and servers. According to IV18, the aforementioned is exactly the reason why the technology is so easily accessible for everyone: *''You can just start with fewer resources than you needed in the past, and then you can also try things out, it is more accessible. And when you conclude that it does not fit, you just pull the plug and you stop it, without having invested a lot.''* This accessibility and the low threshold to try it out is especially good news for relatively small businesses, such as startups, due to the fact that they often lack the financial resources to create, develop or buy the basic technology themselves (Gkikas, 2014). IV6 mentioned that the organization he works for really needs cloud suppliers such as Microsoft or Amazon, even though it is quite a large organization. So, it may not only be an advantage or necessity for small and medium sized organizations, but also for large ones.

Relating to the low investment costs, another advantage is the pay-per-use scenario that CCT handles. This means that a firm only pays for what it actually uses. IV8 and IV11 explained that in the past, organizations always had to buy quite some overcapacity for only one or a couple of peak moments they expected to experience in the future. When using a cloud-based solution, a firm only pays for extra capacity when it is actually being used during those peak moments. In turn, when the extra capacity is not necessary anymore, it vanishes

immediately, and so do its costs. This, in turn, causes the costs to be much more predictable ad hoc, as IV16B explains: *''You can very clearly predict what your expenses will be. My Office 365 licenses cost this, I used it this much, so I spend this per month on my Office 365. I have this many servers, I spend this per month on Azure. So you can manage your costs much more predictably.''* What can also increase cost predictability, is the ability to set a limit in advance on the amount of money an organization wants to spend on cloud services per time unit (Rittinghouse & Ransome, 2016). Although most interviewees agreed that the technology offers more cost predictability, IV11 said: ''*One of the disadvantages that you want to look at, to estimate the costs in advance, is something incredibly difficult to do.''* So, not all interviewees agreed with the claim that CCT offers more cost predictability.

Some final monetary benefits are flexibility in cost structure and low storage costs. According to IV8, this flexibility is an important adoption factor: *''The moment we decide, well, this customer is canceling so we don't need all their servers anymore, then we just stop buying them, and then, yes, we just don't get that bill anymore.''* Section 5.1.7. will elaborate on flexibility as an adoption factor. Finally, IV9 said that *''Storage is terribly cheap in the cloud, you can barely make it that cheap yourself.''* To conclude, there are multiple advantages of CCT related to costs, such as cost predictability, high accessibility due to low investment costs, the pay-per-use scenario, flexibility in cost structure and cheap storage of data and information.

5.1.7. Flexibility

Starting to make use of CCT, as well as quitting its application can be managed fast and in a flexible way. According to some interviewees, an organization can start with its adoption almost anytime, which accelerates the time to market (Ezell et al., 2018). Additionally, this flexibility also leaves enough room to try out the technology and experiment with it, without spending a lot of time, money and effort. For instance, the technology offers the possibility to create a trial account, so (potential) users can examine all kinds of cloud computing and cloud hosting services. According to IV14, the ability to play around is important, because progress can actually only be made when there is room to experiment and make mistakes. The technology also allows to switch fast between different applications, which is useful in situations where a new and, in the eyes of the user, more suitable application becomes available. If the application suits, one can easily scale down the contract(s) related to the older application. If the new application does not suit the user, he or she can easily make use of the previous application again almost immediately.

Moreover, flexibility is offered in terms of scalability, which was also identified as a main benefit of CCT by Xu (2012) in section 1.1. This entails that CCT is more adaptable to the changing needs or demands of users or clients. More specifically, one can move much quicker compared to on-premise solutions. IV11 said: *''It is often the case now (on-premise), when new employees come in, a computer has to be purchased and we have to set it up. It will take quite some time before we have access to it. This is easily arranged with the cloud.''* With on-premise solutions, processes start to slow down when server demand is spacious above average, to be able to deal with the increased amount of data and/or users. IV18 compared this situation with a traffic jam on a busy highway. An advantage of CCT is that it easily adapts to changes in demand. Thus, when additional capacity is required, this capacity is delivered immediately as a result of the enormous flexibility and scalability. This happens automatically, without the interference of a user who has to ask it, as this has often been agreed upon in some form of a contract in advance. As explained in section 5.1.6. already,

when the additional capacity is not necessary anymore, it vanishes and so do the associated costs. This flexibility is especially useful for manufacturers that have fluctuating consumer demands, for example due to seasonal influences. IV12, who works at a manufacturing company that sells all kinds of bicycles, explained that there is a large difference between consumer demand in the winter and summer. The scalability is also useful for companies that deal with fluctuating numbers of employees, which has been proven very recently by the rise of the coronavirus. For example, IV15 explained that during the beginning of the corona crisis, many Polish and Hungarian employees that were working for a Dutch manufacturer at the time, left The Netherlands to return to their home countries. A couple of weeks later, they all returned to The Netherlands. In this situation, CCT was used efficiently to scale down when the employees left, and to scale up again when they returned. In this way, the server and storage capacities of the organization were well able to stay in line with the demands, resulting in a lower price tag, which was also mentioned as a benefit by Ezel et al. (2018) in section 2.1.

5.1.8. Integration

Today, the technological environment is standardized, as cloud suppliers use only a few things that are specific to them (Leelavathy et al., 2015). According to IV10: *''It's one platform where you have all those applications, that work together, and then you let your internal processes connect with your customer externally, which creates a very integrated image, and that's exactly where you want to go.''* Several interviewees mentioned that there are also many companies or other external parties that can easily integrate with the cloud. For example, when choosing a cloud hosting party, such as AWS, then there are also many other third parties that can easily integrate with AWS, because it is highly standardized. Moreover, it is often emphasized (e.g. by IV7) that CCT is necessary to integrate with other digital technologies, such as Internet of Things and big data, where own data is enriched with data from multiple other sources.

5.1.9. Extra services and opportunities

Extra services related to CCT are usually not a primary reason to adopt it, but once a user gets insights in what these extra services might bring, this might change. IV8 said: *''A second important reason, and that is also evolving day by day, is what additional services such a cloud hosting provider offers… You have all kinds of extra services they offer, such as artificial intelligence, and data-based prediction.''* This goes hand in hand with the opportunities companies want to embrace by adopting CCT. These days, (cloud computing) technology is close to and easily accessible for many people, and there are many opportunities for organizations to become smarter, more productive, more efficient and more effective (Tao et al., 2018). This is because there is a widespread feeling, as explained by IV14, that all kinds of tools are evolving at a high pace, making much progress, that companies want or need to take advantage of those developments. IV19 said that he was seeing close links with industry 4.0, and explained that his company is quietly and carefully discovering to see what the opportunities can bring them.

5.1.10. Other adoption factors

5.1.10.1. Market pull

Finally, some people and external factors were mentioned during the interviews that (have) increase(d) the adoption rate. To begin with, one frequently mentioned factor is that

CCT is ‘unstoppable’. Multiple interviewees said that it is just a matter of time until all manufacturing firms - either fully or partly - adopt the technology. The need is recognized more and more, and many are convinced CCT is an absolute requirement for business continuity, as explained in section 5.1.5. This general feeling causes organizations to become unwilling to be left behind, or be categorized as non-innovative. IV17 explained that his organization felt that they could not be left behind, and therefore started exploiting CCT opportunities. Moreover, IV18 said: *‘’If you don't come along you will soon be a lonely cowboy.’’* Being a lonely cowboy negatively affects organizational image, as explained by IV1: ‘’*The moment you say that you have everything in-house, a lot of people start laughing because you are so old fashioned. You don’t want that, it damages your image.’’* Firms often strategically promote, foster and pursue a reputation that they spend much effort to become technological and innovative frontrunners (Höflinger et al., 2018), and they can use CCT to promote this reputation. Organizations also tend to look and even mimic what their competitors and partners do, which was considered as an adoption factor by Low et al. (2011) (section 2.2.). If another firm already makes use of CCT, this will stimulate the adoption process, as it will quickly lead to trust in the technology (Obal, 2017). So, there is a strong market feeling that the switch should be made from on-premise towards cloud-based solutions, either because of the technological need or to benefit an expected image. This largely matches with Low et al. (2011), who argued that competitors, trading partners and relative advantage influence the decision to adopt.

5.1.10.2. Technology push from cloud suppliers

External parties that often seem to play a large role in the adoption process are cloud suppliers, such as Microsoft. As one of the largest and most well-known cloud suppliers, it has a very powerful position. There are multiple interviewees that mentioned that they have a ‘Microsoft unless’ strategy. IV14 said: *‘’In our case, we do as much as possible with Microsoft. Whether we are looking at an ERP system, another infrastructure, or at certain software platforms, the first thing we ask, is: is it possible with Microsoft? Does Microsoft have things in its portfolio for that? If not, we will look elsewhere.’’* One could wonder why so many interviewees are enthusiastic about Microsoft, but that is explainable. Apart from the fact that they have great services for acceptable prices, Microsoft wields a very pushy strategy, it is constantly pushing cloud solutions towards companies. IV20 even goes a step further, calling the Microsoft model a ‘heroin model’, because it is very addictive and one can hardly escape from it once making use of Microsoft since the younger ages: *‘’Microsoft has one model, it does not have a license model, but it has a heroin model. They start at schools, everyone gets Office 365 for education, it's all free, so everyone in school knows the Microsoft products, with the result that everyone who graduates knows all those tools from Microsoft. So when you finish school, you want Microsoft products at your company, because if you want something different, you will need to get trained. Moreover, Microsoft doesn't call you a customer, but a user. To me, a user is someone who uses a needle, which is why we say it is a heroin model. So that's why we say, you can't escape a party like Microsoft.’’* Yet, it seems a very effective strategy because so many firms adopt cloud services from Microsoft. In fact, by the end of 2019, Microsoft Azure had the second largest market share in cloud services (15%), after Amazon Web Services (33%) (Canalys, 2020). Other large cloud suppliers are Salesforce, IBM, Google, SAP, and Oracle. In terms of revenue over 2019, Microsoft is even frontrunner with a revenue of 44.7 billion US dollars, with Amazon as a runner-up with a revenue of 34.8 billion US dollars (Cloud Wars, 2020). Other parties with a significant revenue over 2019 on

cloud services are Oracle, IBM, and Salesforce, with respectively 26.7, 21.2, and 13.3 billion US dollars (Forbes, 2019; ZDNet, 2020; CNBC, 2019).

5.1.10.3. IT department

Sometimes, the IT department of the manufacturing firm is (partly) responsible for CCT adoption. In the recent past, the IT department was often not seen as an essential department within organizations. Currently, their importance is being recognized more, which has led to increases in organizational expenditures on IT related occasions, such as human capital and required tools (Shea et al., 2019). This is proven by the fact that an increasing number of firms include one or more IT managers in their board, where they take the role of Chief Information Officer (CIO), or Chief Technology Officer (CTO), for example. In this way, technology is more often pushed internally by the IT department, rather than by the board of the organization. One reason why IT employees are pushing CCT, is because their role shifts at the moment CCT is applied, as IV16B believes: *''You are actually going to change the role of the IT employee, who will function much more as a director, guiding and directing the partner or supplier to certain quality requirements, and it will become less involved with hardware.''* This enables the IT department to focus more on actual value creation in the business, rather than making sure that the processes keep running.

5.1.10.4. Coronavirus

Finally, it is worth mentioning what the effect of the coronavirus has been on CCT adoption. IV14 pointed out: *''The corona crisis has really turned everything upside down… Then we suddenly found completely new ways of working. Things that would never have gone so fast otherwise."* It was experienced as a large shock for some organizations to start using CCT at the moment corona came in, but after a couple of weeks, the proof was delivered that it is very useful to enable employees to work at home, and that it has even become a necessity these days. As IV5 said: *''Especially now that corona is also happening, when I look at how many people you can actually keep working without them being on location, yes, I think we have all provided proof that it is very much offers possibilities, and it is also a huge risk if it is no longer possible.''* Clearly, the coronavirus has accelerated, and in some cases has even been a major cause of CCT adoption in manufacturing firms.

5.2. Challenges

5.2.1. Resistance

The adoption of any new technology leads to organizational changes, and changes usually lead to new ways of working and thus to different requirements from employees. Therefore, organizational changes often result in resistance from employees. This resistance usually starts at the moment it becomes clear that a new technology - CCT in this case - will be adopted in the future. So, resistance occurs both during the adoption process, as well as during the implementation process (Serban & Lorga, 2016). IV5 explained that it does not really matter whether the change is 'good' or 'bad' in the eyes of the employees, there is almost always a wave of resistance because people want to maintain their habits or status quo. As a result of organizational change or technology adoption, old ways of working may no longer fit. In turn, employees need to adapt to the new situation by finding new ways to carry out their roles, which means extra effort from the workers' side. Additionally, IV15 explained that

changes bring uncertainty and unfamiliarity, which in turn, often lead to fear and anxiety (DiFonzo & Bordia, 1998).

Another reason why many manufacturing firms have experienced resistance from the workforce, is because the manufacturing industry historically is a slow moving and conservative sector. Therefore, this sector is more averse to change or innovation and holds traditional values longer, compared to other sectors (Forbes, 2020A). IV7 said that manufacturing employees are mostly not enthusiastic about changing things that already work out, and rather want to stay away from it and leave it as it is now. Especially IT related changes are hard to implement in sectors with a high degree of conservativeness (Oliveira et al., 2014). This conservativeness may be caused because the board sometimes does not explain to its employees why they want to implement a new technology or organizational change, and instead just tries to push it through the organization. IV18 has experienced this multiple times: *''It is often a management that wants something, and pushes it through, but the average person simply does not know how to deal with it.''* As explained by IV3: *''Technology is not a limiting factor, apparently it is the business we are in, in which people do not yet fully understand the need.''* If employees don't understand the motivations for particular changes, resistance is not a strange outcome, as most people can only show their support when they understand what is going on.

One final factor that came up influences the degree of resistance: the industry life cycle and the accompanying age of the workforce. According to IV18: *''Certainly in the metal industry, where I have much experience, there is quite some aging. Then you stay at the top with older people who also maintain their old routines, and then such an adoption is very challenging.''* Several interviewees mentioned that resistance more often comes from the older generation compared to the younger generation. As IV16A said: *''I have colleagues who are now around the age of 60, and who think, I'm going to quit in a few years, don't change too much it is all fine as it is now.''* It is understandable that they don't want to invest too much time and effort in learning new things. However, this hinders organizational change and progress. On the other hand, the younger generation usually is perceived as more enthusiastic about likewise technological adoptions, according to multiple interviewees (e.g. IV5, IV15, IV17). Of course, there are always people at age who are still interested in the latest trends, technologies and hence change, and resistance to change also comes from the younger generation. Yet, in general, one could conclude from the interviews that in the manufacturing sector, resistance to change and new technologies, such as CCT, increases with age.

All in all, resistance was mentioned as an occurring challenge, caused because employees want to remain their habits, change goes hand in hand with unfamiliarity and so fear, the manufacturing sector is a slow moving and conservative sector, and there is aging in the industry. However, following from the interviews, resistance does not occur because employees are afraid to be replaced entirely by machines, as mentioned in 2.1. A negative bias to ideas from the outside (Piezunka & Dahlander, 2015) neither seems to be a reason for resistance to CCT according to the interviews.

5.2.2. Lack of knowledge

Despite the high usability described in section 5.1.2., for some people, it is difficult to understand how a new technology works. This might result in problems on two sides. On the one hand, there is a lack of knowledge about CCT to let the board make the right decisions. In other words, as explained by IV1, it is hardly possible to make a completely rational decision because not all relevant information is available to make that decision. On the other hand,

several organizations face the problem of lack of knowledge of users, resulting in difficulty with adapting to a new environment. According to IV3, manufacturing firms that adopt CCT have to deal with ordinary end users who do not understand it as quickly as one would expect, due to differences in looks or interface. Lack of knowledge on the user's side might result in an undesired situation, where particular services are bought multiple times for example, as explained by IV16B: *''You see that with all those cloud services that the knowledge is still too low. So that people start buying something they already bought, on a monthly basis, because they do not know that they have already bought it.''* Again, this factor seems related to age, as especially the older generation within a company seems to lack knowledge more often on how the technology works.

5.2.3. Lack of people with the right skills

Both the way the organization is managed, as well as the way employees need to carry out their tasks changes with CCT adoption. As clearly illustrated by IV4: *'The moment you start developing or changing in the direction of a cloud-based solution, you actually need other people. At a certain point you are no longer carrying out a technical process, but you are much more involved in a part of organization and direction. And by no means all people who previously had that technical role are suitable, or able, to develop or change with it."* In other words, the new situation requires different people with different skills, because the employees' qualities no longer match with the demands of the organization. The new situation will more likely require human capital with capabilities related to organization control and management, and not everybody holds these capabilities. Thus, adopting CCT leads to a shift in work of employees, and might lead to a misfit between existing employees and new demands of working, thereby provoking a human capital reorganization (Dregger et al., 2016). This is oftentimes experienced as negative by the current employees, as some of them might lose their jobs.

5.2.4. Data and information

Although data security and safety are on a much higher level at a cloud supplier than on-premise (section 5.1.4.2.), some problems related to data and information were mentioned by the interviewees as well. This is no surprise however, since data and information security issues were identified by multiple studies as the main challenge. For example, some interviewees experienced problems while setting up firewall security settings and coming up with passwords with a lot of requirements. Consequently, users experienced difficulty with logging in after some time.

Others experienced problems related to data security and accessibility. IV8 said that it is important to keep an eye on and pay enough attention to the accessibility of cloud related services: *''I think the accessibility of everything that is cloud-related is also a disadvantage, because everyone gets access to it so easy, and it is very easy to create access for somebody else too. So in terms of security, cloud is something that really has to be taken seriously.''* IV5 even called data security *''the biggest challenge for me.''* As mentioned in section 5.1.4.2., there is always a fear that data and information, either of the organization or of the users, is not safe in the cloud. Usually, this fear is caused by bad news about hacks and cyber-attacks on the cloud, such as in 2017. In this year, 14 million customers' details were left unprotected on a cloud server of Amazon, resulting in the public availability of users' details, including names, phone numbers, email addresses, and passwords (Get2Clouds, 2017).

Multiple interviewees said that it would be very problematic if sensitive business information that is stored in the cloud, would be accessed by other parties. IV20 compared the critical business information with a Coca Cola recipe: *''If others get that, that's the same as the Coca Cola recipe, if it ends up in the wrong hands, you're done. That is something we want to prevent.''* IV20 continued that information does not necessarily need to be retrieved by other parties but employees of the cloud supplier themselves are able to get to that information too, which is a risk. IV20 used to work for a cloud supplier in the past, so he clearly knows what the possibilities are and where the dangers lie. IV1 confirmed these thoughts, and mentioned privacy is one of the tricky things, because as an organization, it is detrimental to sell the imaginary soul to a cloud supplier. However, by giving cloud suppliers access to all kinds of information, they have access to much organizational data and information. Thus, although data accessibility is an advantage of CCT, attention must be paid to data security and privacy, because data accessibility may be (too much) at the expense of data security and privacy.

Additionally, the risk of easy data sharing was a problem sometimes, for example at the organization of IV8: *''Most people want to be able to work with something as easy as possible. But as easily as possible also means that it is not safe at all.''* The ease with which data and information can be shared with others, poses a risk for the organization because sensitive business data can be shared easily as well, and if this data is shared with the wrong party, it may form a serious threat. These worries were often caused or aggravated by bad news and stories on social media. For example, several interviewees mentioned that after bad news was published about 1.2 million Microsoft accounts that were compromised in January 2020 (Forbes, 2020B), they - as well as other current and potential users - became frightened that this might happen to them sooner or later too.

5.2.5. Dependence on cloud suppliers

The current dependence on cloud suppliers is high, too high according to almost all interviewees. Basically, an organization can no longer do everything itself, and so is in the hands of the supplier and the platform that the supplier delivers. IV10 mentioned this problem: *''You would like to have more grip on the applications, because those applications are also becoming increasingly business-critical.''* The problem of overdependence is that if the external party screws it up, the consequences for the manufacturing firm cannot be overseen, and therefore it forms a large risk. So, cloud suppliers have almost complete control over the CCT user, while in an ideal world, much more would be discussed, where users have more control over themselves, thereby decreasing dependence. As a result of this dependence, cloud suppliers are more and more the ones who decide both the direction and pace of change within manufacturing companies (Jean et al., 2012; IV17). IV20 said that from the moment at which CCT is adopted, the cloud supplier suddenly is inside the organization's business operations: *''Now it is cloud, they just enforce it, so they are actually in your business operations, in your own business processes, and then Microsoft suddenly determines the world.''*

One could say that the user should end the relationship when the dependence on another party is too large, but this is extremely hard because the applications that are being used have increasingly become business critical. In this situation, the user has been (vendor) locked-in by the cloud supplier, a phenomenon which was also mentioned by IV5 and IV7. IV6 recognized the situation: *''Once you are on such a platform, it is not so easy to get rid of it.''* The (vendor) lock-in problem in cloud computing technology is defined as an unwanted

situation where the cloud user is dependent on one cloud supplier, while this user is unable to move to another comparable supplier without making substantial costs, legal constraints, or technical incompatibilities (Opara-Martins et al., 2016). In other words, due to the high transaction costs customers would have to pay to switch to alternative cloud-based solutions, the cloud provider almost permanently captures its customers. This is exactly one of the main goals of a cloud supplier: locking the user in so it can sell all its products to the current users at prices much higher than would have been possible without having locked-in the users. This situation is undesired from the user's point of view, but unfortunately hardly avoidable.

Another factor that emphasizes the dependence of users on cloud suppliers, is the fact that cloud suppliers offer their customers unfinished products or services, and that the users just (have to) accept this. Especially IV10 mentioned this problem multiple times: *''They launch the product as if it is already finished, but it just is not. It is simply a minimal viable product, it works with the minimum requirements… Sometimes you are disappointed because it does not include basic things that it should… You can see that they are working on it, but apparently we also just accept that that product is only half finished, which is something I constantly wonder, how is that possible?''*

The opposite situation happens regularly too: rather than providing the user with an unfinished product, a cloud supplier offers an overload of services and updates, far more than necessary and far more than the user can keep up with. IV20 nicely phrased this problem: *''The change rate at which Microsoft is adding new functionalities, is at such a fast pace that it is difficult for a small organization to keep up with that. As an organization you also must be able to go along with all updates that take place in such a cloud environment, and that is really difficult.''* The fact that most interviewees mention Microsoft specifically, either is due to the fact that most interviewees make use of Microsoft-based cloud solutions, or because Microsoft offers the most updates, or a combination of both. What is sure, however, is that Microsoft's rate of change is incredibly high and that users are struggling to deal with it.

Finally, the dependence on cloud suppliers turns out to be an important factor when a problem occurs. At the moment an organizational problem occurs which can be related to CCT, this needs to be fixed as soon as possible, to secure business continuity and prevent the business from stagnating, with all the associated consequences. However, cloud users are unable to do anything about the problem in most of the cases. All a user can do is inform the supplier, although the supplier is aware of the problem oftentimes already, and wait until it has been solved. IV13 summarized by saying: *''That is inherent in outsourcing, of course, making your supplier a problem owner. When something goes wrong, you are dependent on your supplier who has to solve it.''*

In conclusion, dependence on cloud suppliers is a main challenge because of interference in organizational direction and speed of change, the vendor lock-in situation, delivery of unfinished products, the overload of new services and updates, and situations when problems need to be fixed.

5.2.6. Monetary detriments

Despite the monetary benefits mentioned in section 5.1.6., costs are considered as one of the largest reasons for not adopting CCT. Firstly, large manufacturing companies often want to switch from an on-premise solution towards a cloud-based solution. Due to the fact that the organization used an on-premise solution in the past, much money was invested in servers and licenses, for example, that were necessary for the on-premise solution. Usually, on-premise solutions are still functioning well, and therefore there is a situation of sunk costs

when an organization is willing to embrace CCT. For IV19, these sunk investment costs were the reason to keep using an on-premise solution for the business: *''We already had those servers, they have been built in the past. They are there, and you only have some maintenance costs, but that is not so bad… The moment you adopt a SaaS solution, yes, you go to a monthly amount, where you should then divest the licenses.''* Logically, divesting things that have been bought is very cost inefficient, and may therefore be a reason for not adopting CCT.

Secondly, it turns out that a lot of interviewees qualify the technology as 'expensive'. Interviewees regularly make calculations to compare the costs of running business servers on-premise or in the cloud. Yet, it frequently turns out that CCT is the most expensive option. Sometimes, the difference is huge, which was the case for IV20: *''Last year, I figured out that if I have to put our server park at Azure, I would need to spend five or six times more money compared to what we now spend on our current server park.''* These relatively high costs may have several reasons. The first reason is that the cloud market is being dominated by a handful of large parties, such as Microsoft, Amazon, Google and Alibaba (Canalys, 2020). These parties keep the price high, and they can do that, because there hardly are comparable alternatives. IV19 said CCT will become more interesting if more cloud providers join the competition, so prices will drop. Another reason for the relative expensiveness is that a user really needs to pay for every single piece it uses. In the beginning, it looks like the price is fair but when taking into account all the extra services that are needed, the price increases significantly. IV1 compares it with buying LEGO: *''You pay a certain cost for each block you use. So that quality that you want to deliver, it also has an immediate impact on the cost price that you want to have. Every system you add is like LEGO, you have to buy every single block.''* This type of business model where a firm needs to pay for each additional service, is called software-as-a-service, or SaaS. What is more, is that support can be very expensive, even though it might not be necessary once in the future. Still, the risk of not buying support is too high, because whole processes within factories come to a halt when the cloud stops functioning, and when that happens, the losses are gigantic.

Thirdly, businesses often do not understand the importance of the IT department. Although budgets have increased in the past years according to some interviewees, budgets for IT investments, including CCT, are still rather low. According to IV13: *''We have relatively little time and budget for real technological innovation such as cloud computing.''* IV3 added: *''The innovations that we commit mainly focus on our end products, and significantly less on innovations on the IT side.''* In the end, these relatively low budgets in combination with the high costs of cloud computing and sunk investments in on-premise technology, sometimes block organizational adoption of CCT.

5.2.7. Integration

CCT has developed and is still developing at a rapid pace. However, this pace is so high, that cloud application developers and suppliers often cannot keep up with it. IV13 sketched the tough situation that many application developers are currently in: *''Our suppliers are also struggling with the entire cloud concept. A supplier has developed a package, has often invested in such a package for over 15 years, and then the market forces, everyone asks for cloud, and they must also participate…The application supplier is in a lot of pain because it actually steps out of its comfort zone, and needs to deal with a lot of problems, such as knowledge that they often do not have in-house.''* There is actually no one who can help the application developers, they all need to find out everything themselves. This might lead to a

disconnect between cloud computing suppliers and application developers, in turn not benefitting integration.

Today, there are also still differences between systems. According to IV7, the main disadvantage of CCT is its interfacing with other systems. Several interviewees explained why this is a problem and what causes it. The first reason is that ERP systems are often customized, so that the ERP system fits well with the previous processes, making it hard or even impossible to switch to the cloud, which is very standardized. IV12 said that in practice users always find out after the first setup that adjustments must be made to make the systems integrate well. The second reason is that manufacturing firms are often running on old or legacy systems, making it, again, hard or impossible to entirely shift to the cloud. This especially is a problem in the manufacturing sector because production machines are often ° used for several decades. As IV1 explained: *''We brought products into the world in the 1980s that still run on old systems. Those were sold 'as is' in that period, and those systems can easily run 40, 60, or 80 years. The customer simply expects that his tools will also continue to work, which means that we have a lot of legacy and applications that cannot be used in the cloud at all.''* The third and final reason is data formatting. IV2 noticed that data formatting often is a problem, which entails that one system cannot read the format of another system. In that case, exchanging digital information is impossible too. Again, this often means that adjustments need to be made to ensure that outgoing traffic can be sent, and incoming traffic can be received.

In the past, a new version of a service or system was available only occasionally, and therefore there was enough time to test that new version before it would be published. However, this situation has changed. As new versions and updates are following up one another extremely rapidly, there is often no time, or developers are just unwilling to test them ad hoc. Consequently, the release of a brand-new version may cause existing functionalities to be destroyed or to stop working properly. IV14 explained that this happened to his organization already: *''We use AFAS, which is our human resources system, also a cloud application. They had done an update and it was not even that big, but it had made our interface system totally unworkable.''* Apart from the integration problem, this example again shows the degree of dependence of CCT users on external parties, as an external party can stagnate a user, either accidentally or on purpose.

5.2.8. Performance

Performance issues are one of the main fears of managers, which can result in unwillingness to adopt CCT. One reason is that cloud suppliers are not always willing to guarantee the user a minimum form of performance, as IV13 explains: *''Some things are just very difficult to agree on, performance is of course always a thing. If a supplier is unable or unwilling to commit to a performance, stop it.''* Moreover, it is often unclear how the performance will work, especially because many cloud users use hybrid cloud forms. It is, however, not expected by IV12 that complexity is going to decrease: *''I do think that the complexity of the landscape will increase even further and further. So its management is becoming increasingly important.''* Moreover, relating back to the customization issues mentioned at the previous subsection, too much customization in the cloud could have negative effects on performance. IV5 opined that the more customizations an organization makes, the more the performance collapses. It is therefore a consideration how many customizations are made at the expense of total performance.

5.2.9. Internet connection

Another factor that could stand in the way of CCT adoption is a bad internet connection. One essential feature of CCT is that a strong internet connection is always required for sufficient accessibility, as emphasized by IV11: *'In any case, you have to have a good internet connection, because if it were to drop, you have a problem.''* So, when there is little coverage, a bad connection, or just latencies, the technology is not usable (Raza et al., 2015). IV9 added that well-developed countries also deal with problems related to unreliable internet connections: *''One of the problems has to do with the fact that some customers are in areas where the internet accessibility is very poor. Also in Germany and Australia, for example, there are large areas where internet connection coverage may not be as good as you would expect.''* One of the interviewees, IV13, has already experienced internet related problems in the past. His organization tried to implement CCT, but as a result of their location around the port area in Rotterdam, the latencies were so huge that it was unworkable, and therefore they went back to their previous on-premise solution. All in all, CCT only works when there is a reliable internet connection at all times.

5.2.10. Challenges abroad

Being a large manufacturing firm can mean that the organization has several locations which are not situated in The Netherlands, but across the globe. This may bring challenges with the adoption, implementation and usage of CCT. To begin with, and related to the previous section (5.2.9.), the quality of internet abroad often is worse than what an organization requires. IV2, who works for a firm that also has some factories in China, told that internet connection in China is not reliable enough to work with CCT: *''In any case, China is not an option, because the Chinese firewall is literally the great wall. When I'm in China I'm hardly able to get in my Citrix environment for which I don't even need a very strong connection. No, that is not an option anyway.''* Although CCT would bring many advantages for IV2's organization, it is considered no option in China because of problems there. IV6 confirmed that this is a problem: *''There are so many countries where the internet is not free and open, and that means that your cloud services are not applicable there.''* Some things are just totally blocked abroad, especially in China due to the great Chinese firewall, which is the effect of legislative actions and technologies used by China's government to regulate the internet (Clayton et al., 2006). For example, several versions and services of Google and Microsoft are oftentimes not freely accessible there (The Guardian, 2018; BBC, 2019). Going to the cloud is not considered an option then, because all services must always be accessible for everyone.

Moreover, it is often challenging to create an international working cloud environment due to differences between the legal systems of countries (Molnár-Gábor et al., 2017). Either organizations just don't want to spend time and effort on finding out what the legal system is like, or because it is clear that the legal system does not meet the demands of the organization. IV2 declared that it may very well be the case that, for example, South Africa is perfectly reliable in terms of laws and regulations for protection of data, but it is too much work to figure it out. In turn, IV1 explained that going to the cloud in Russia is never considered an option, because legislation on the protection of patents is so weak there.

5.2.11. Governance

Although problems in governance were only mentioned by two interviewees, it is worth mentioning. On the one hand, IV20 pointed at problems related to data governance: *''An*

employee joins a company and leaves after some time again. And what you want to prevent is that you give him his own account with his own passwords, and that you lose the data when he leaves. So what you are particularly concerned with is governance, data governance, and governance of credentials." This sounds logical, because an organization wants to keep all its information inside, and prevent it from 'escaping'. On the other hand, both interviewees pointed to difficulties they (had) experienced with organizational governance or management, because using CCT certainly requires a different way of governance. IV5 said: *"The challenge is becoming more and more, I certainly notice as an IT manager, how are you going to keep a decent governance about how we deal with certain things? And how do we use it? And how certainly not?"* This was proven, for instance, by the fact that everybody had to work from home due to the corona crisis, as it really demands another way of organizational governance.

5.3. Solutions

5.3.1. Data and information

5.3.1.1. Hybrid cloud

One solution that was commonly mentioned to fix the problems related to data safety and security, is to implement a mix of cloud and on-premise installation, a hybrid cloud option. Especially for the manufacturing industry, it is not always possible or wished to go fully into the cloud, as IV5 explains: *"A lot of companies can certainly go to 100%, but I think that the manufacturing industry, with the heavy packages and more of that kind of software that is sometimes a bit behind, I don't see it happening so quickly that they go all the way to 100%. I think you always keep a slightly hybrid like solution there."* Many interviewees said that they consider on a case by case basis whether a piece of data or information can be brought outside or should be kept on-premise. Currently, manufacturing firms often choose to run 'the core' on-premise. IV16A even had to promise the board of his organization to keep all the vital information on-premise at all times, so it will never be shared with the outside world. IV17 is in a likewise situation and expects this will not change soon: *"I expect that more of our applications will be in the cloud, but I think our jewels will remain on-prem. We can put all other more common data, that less sensitive data, in the cloud."* IV13 agreed with IV17 and also expects that this situation, where the most sensitive is stored on-premise, will not change in the near future. Thus, organizations look at the data sensitivity of a piece of data, and based on that classification, it is decided to either store it internally or externally. IV17 explained that in his organization, they have developed some kind of a data classification trajectory over time: *"It is also necessary that we go through that data classification process. We looked as closely as possible to classify all our data. So we started looking, okay, what kind of data do we actually have and how sensitive is that data? Now suppose that the data falls into the hands of others, perhaps competitors, to what extent could it bother us? For example, we went through a lot of data and placed a classification on it. And based on that classification, we decided to either keep it on-premise or to put it in the cloud."* This might be very time consuming, but still an important thing to do. In this way, a firm prevents competitors from ever being able to get insights in business critical details.

5.3.1.2. Strict agreements

It sounds obvious, but it should also be emphasized that it is highly important to make strict agreements with the cloud supplier, especially about organizational data and information.

Sometimes users forget this and then unwanted situations are the result. IV7 did not see safety as an issue as long as an organization is careful and able to make good agreements with its cloud supplier. IV6 added that these agreements, for example about legally regulating how data are handled, need to be supported by contracts. IV17 mentioned an example of what such an agreement could be like: *''...secure your documents, and then you ensure that they cannot technically be forwarded by email or that screenshots cannot be taken.''* This is an agreement an organization will need to make themselves with their supplier, and the supplier is the one that has to ensure that documents are delivered in such a secure way.

5.3.1.3. Geographical place of data

The location where data is being stored is an essential requirement for CCT users. Literally all interviewees who spoke about the geographical place of data absolutely wanted their data to be in the European Union (EU) at all times. IV2 said that this has to do with the European GDPR: *''If I know that my data is within Europe, then I know that there are laws I can trust, and I think that's important, and I don't want to have a discussion about that.''* This also, or especially, goes for the data of locations that are located abroad. IV17 mentioned that the organization he is working for, demanded that the data of their Chinese locations ended up in the European tenant, so it is stored on European territory, for the same reason as just explained by IV2: trustworthy legislations. Although one would expect that users would be okay with data storage in other Western territory, such as the USA, they did not want their data stored or hosted there. In the beginning, cloud suppliers did not really know what to do with these requirements, but currently cloud suppliers understand the problem or fear that mainly European companies face, and are willing to agree upon these demands. IV17 said: *''Microsoft also knows that many companies have doubts about storing data on American territory, for example. So I have to say that they have classified it, they also guarantee that if you sign a contract within the EU, that your data will also remain within the EU''*.

Furthermore, linking to the geographical place of data as well, IV10 indicated the importance of data geo-redundancy: *''If you have your ERP package here in Amsterdam, you have to make sure that if it fails, it will transfer to Dublin, for example. So you have to make sure that the most critical applications are also duplicated, geo-redundant, and then you can continue at another location.''* Geo-redundancy means that data is being replicated as well as stored in more than one datacenter or place at the same time. In case the primary site fails, for example due to a natural disaster, the data will not be affected or lost because it is stored somewhere else safely at the same time (Cosmadopoulos et al., 2010).

5.3.1.4. Data ownership and access

The final remark about protection of data is that ownership and access should be thought of well in advance. Especially the question ‘what happens with my data when I want to leave this cloud supplier’ is an important one. IV2 was very clear about what he would want in that particular situation: *''I just want the supplier to deliver the data in a certain format that I can do something with, and that the supplier destroys the data when I want that, because you aren't allowed to keep the data.''* On the other hand, accessibility should also be managed on the user side. As IV8 explained: *''By really providing access to as little people as possible but also by looking back very easily who approaches such an account, who does what in such an account, and to apply policy that most things are closed.''* In other words, only the right people should be given access to data, and there must be a clear overview of what people actually do and can do with those rights.

5.3.2. Employees

Employees do sometimes experience difficulties with CCT, for instance due to new ways of working and lack of knowledge (section 5.2.2. and 5.2.3.). However, dealing with changes is often only a matter of time, it is a learning process, a phenomenon which is called learning-by-doing in economics (Arrow, 1971). Learning new things requires just doing something, investing time in it, and then people will slowly start to understand it piece by piece (Anzai & Simon, 1979). IV9 believes in the process of learning-by-doing, and therefore opines that one should just start with CCT implementation: *''If you do not start, you don't know where you're going. So then it is often a matter of starting and doing, taking small steps, and learning new things through those small steps.''*

To speed up this learning process, there are several measures that can be taken by the organization. To start with, it is essential to continuously involve all employees. IV6 and IV16A respectively said: *''Involve people in the process, and involve people early''* and *''You have to continue to involve people in the why, in the how, and make them enthusiastic.''* When an organization tells its employees what is being done and explains why, people are much more likely to put in some extra effort and cooperate in the process. IV15 put it nicely: *''If the manager involves the right people who are also driven to make that a success, then you see that such an implementation process runs smoothly.''* So, involving people, for instance by information sharing and involvement in decision making, are associated with lower levels of organizational change cynicism, and therefore with lower levels of organizational resistance (Brown & Cregan, 2008).

Next to involving employees, organizations could also try to help them in the form of workshops or training. This is something that numerous manufacturing companies are already doing, and it is bearing fruit. IV8 has experience with workshops at the organization, where someone is invited who knows more about a particular topic, and tries to bring over this knowledge to the group of employees. IV19 has also mentioned that his organization provides training: *''We held some training sessions, which everyone could attend on a voluntary basis, so that you get the early adopters, who could have a look.''* However, if all relevant employees are not forced to participate in those trainings, there is a chance that a large number will not show up, especially the people who are resistant, while it is particularly this group of people the training is meant for. Therefore, it might be more effective to give workshops or training once in a time that employees are obliged to attend.

Moreover, employees could be tested in some form, which is a variant way of training them. This could be done by testing users on how they handle their data, for instance. IV18 explained that he was regularly tested at the previous company he worked for. According to him, it was a good way to keep people on their toes: *''The company I previously worked for, there you regularly received test emails, and if you responded well, you received a compliment. So there it happened, also quite regularly, sometimes a few times a week, and sometimes it didn't for a long time, but there you were really tested with those kinds of emails.''* Of course, this is just an example, but it shows that there are many possibilities to test employees in a playful way.

What must be realized as well, is that new technologies may require different qualities of employees. When the current employees are not willing or able to get (re)trained in such a way that they acquire the required capabilities, it mostly results in an undesired situation. As IV4 sketches it: *''The moment you want to achieve the shift to the cloud in your organization, you must realize that this also places different demands on your staff, which can mean that you need to get rid of some of them.''* In other words, firing the employees that cannot or do

not want to cooperate, should be considered as a serious option. It is therefore important to be clear to employees about what is expected from them, from the moment an organization decides to apply a new technology such as CCT. At the same time, it is advised to look outside for brand new talents, because young people are often more open to tackling new challenges and are likely to develop the competences they need for this fast (Wollebæk & Selle, 2003).

5.3.3. Third parties

Nowadays, it is hardly possible to run an entire company without making use of external parties, a trend called the collaboration strategy or open innovation (Forbes, 2018B; Chesbrough, 2006). It can take many forms, such as startup-corporate or corporate-corporate collaborations. The first thing which is important to do, is to create a network to be able to retrieve useful information. For example, IV6 regularly visits conferences, where he speaks a lot to startups and other companies about technology they develop, and discusses possibilities for a partnership or cooperation in some form. Talking a lot with others provides new and useful information that would otherwise not have been accessed so easily, or at all. Next to conferences, another way of retrieving external information that was often mentioned is to be member of a group or network with similar firms, where recent and potential developments are openly being discussed. While IV5 said he is a member of a cybersecurity group, IV18 said he is a member of a lean manufacturing network. According to IV6, these networks of groups are useful *''to retrieve information, about what the need is, and how the need is developing but also how other companies deal with certain situations.''*

Additionally, one can also make use of rather different kinds of third parties. Consultancy companies were clearly mentioned most often as the third party that interviewees work with. They are mainly used to provide a clear overview of the (technological) options, to help starting up a new project, and to help protect data in some way, for which the manufacturing firm is lacking knowledge and experience. Those third parties do have knowledge and experience, and are willing to provide advice to the large manufacturing companies. IV4 explained that his company sometimes makes use of third parties to start up new projects: *''Then we will see if a specialist needs to be hired, who will then, in most projects I deal with, only briefly bring in his specialism to ensure that you start in the right way, or in certain installations of the piece of infrastructure. And once that is done, and it has become a routine job to roll things out, you will do it with your own people again.''* These third parties are often hired with the aim to adopt the lacking knowledge as soon as possible, as it has become more and more difficult to acquire all relevant information today. As IV14 said: *''In the past, we often thought we would find everything out ourselves, but now we discovered that it is simply not possible anymore. Knowledge is so difficult to acquire, there is so much that we can find out, that we are much more effective by hiring knowledge on certain subjects. And whether that is for a project to create something, or to manage it, we are going to do this more and more with third parties.''* Those manufacturing companies also seek to receive advice, as IV11 said: *''I don't know a lot about these specifics, and then it is nice if you have companies that are actually only working on it and who can advise you.''* Using consultancy companies is certainly advantageous for firms that lack the (financial) resources to find out everything themselves, particularly for relatively small firms. However, one needs to keep in mind that help from a consultant can be costly, especially those related to IT solutions (Entrepreneur Europe, 2018).

A partnership can also go one step further than seeking knowledge and advice only for the first phase of a new project: collaboration. IV16A mentioned that they are moving much

more towards a collaborative situation, where information is simply available and where decisions can be made very quickly. Such a collaboration can be between a large manufacturing company and a startup, for instance. As IV6 said: *''We actively seek cooperation with startups because a lot of startups are very technology focused. In part, we can develop applications ourselves, and in part, we can supply third-party applications to our customers in a partnership. And in that sense, we also look at it in such a way that we don't have to do everything ourselves.''* So in the case of IV6, startups help the corporate with development of applications. Startup-corporate collaborations often work properly because of their natural fit. While startups have brand new and innovative ideas, the corporate has the resources and power to get the ideas on the market (Kanbach & Stubner, 2016). Yet, startup-corporate collaboration is only one of the examples, there are many more collaboration possibilities, such as: joint ventures, strategic partners, alliances, network alliances, modular corporations, outsourcing, and virtual corporations (Philips et al., 2000).

Although many interviewees explained that Microsoft is huge and not that well approachable, it is possible to share ideas and feedback with them. For example, IV10 said that she has close contact with Microsoft. She visits the USA once a year to give feedback and receive information from them about what they are doing and what direction they are going. Keeping in touch with the cloud supplier will benefit the process of making proper agreements, for example related to data security, as mentioned in section 5.3.1.2., or agreements about support. IV13 touched upon the importance of service level agreements with the cloud supplier: *''You have to have very good service level agreements on your services, just like we already have with our suppliers. The important systems just have a 24/7 agreement, so you can just call someone 24 hours a day. And then you really get someone who can log in and watch along with you.''* Saving money on support might become fatal later. When the cloud stops working, an organization basically freezes, or at least some significant processes freeze. The costs can mount up very fast, and that is why it is so important to get proper service level agreements with cloud suppliers.

Finally, interviewees explained that they have close contact with another third party: their customers. Customers may also encounter problems with CCT as a result of the adoption by the manufacturing firm. IV6 said it is very important to keep close contact with the customers and to monitor their satisfaction: *''So that you have a team that is constantly monitoring customer satisfaction, who is constantly monitoring how it is being used, whether it is being used properly.''* This is one way to create satisfied customers, and satisfied customers usually means that they stay.

Concluding, there are multiple third parties that manufacturing companies can work with. Either way, it is important to create a network, to be able to retrieve knowledge about the market, and to accept that an organization is not able anymore to do everything itself nowadays.

5.3.4. The role of the IT department

Due to the challenges mentioned in section 5.2., the board is sometimes hesitant to adopt CCT, especially because it can be difficult for the board to have a clear overview of what the possibilities are, and how to get there. Fortunately, the IT department can be of value thereby creating the overview as well as bringing the right messages to the board. As IV14 explained: *''The success of making good use of technological possibilities, and cloud and the like, really starts at the board table. So really a technology strategy, that is becoming increasingly important, and we, as an IT department, to help the board with that."* IV19

strengthened this and said that he showed and explained the new possibilities CCT offers to his board. One way to bring the story to the board, is simply by (partly) joining the board as an IT manager. This is currently happening more and more. According to IV14: *''It becomes normal that those who previously called themselves IT managers are increasingly moving towards that board. You can see that the CIO is an increasingly important role. That that chief information officer, who is next to the CEO and the CFO, then also co-manages the company from the IT perspective.''* Related to section 5.3.3., a partner could also help with this process. IV17 told that his organization renewed the entire IT environment in 2018. In order to get to that point, this was done together with a partner, which helped to highlight the good aspects of CCT to the board. Thus, the IT department increasingly creates and provides an overview of (information about) technological opportunities, such as CCT, for the board.

Moreover, a situation where the IT department shows the technological possibilities and makes the board enthusiastic about them, is a solution to the problem related to resistance from employees. Usually the board makes decisions top-down and the employees have to live with that decision and execute it. Hence, they are resistant. So, actually, a solution to improve acceptance by employees is if decisions are made bottom-up and brought up from the workforce, which is the IT department in this case.

5.3.5. Organizational policy

Adopting innovative technologies does not make much sense without having developed a clear future vision. A company must have a clear picture where it wants to be in an x amount of years, as IV2 explains: *''I just want to know, what does this organization want? What do the managers want? And does the management agree with this? We need to know together, where we want to go.''* According to IV3, it is highly recommended to have a good overview of the process, so it is clear who can perform and who actually performs particular tasks. To develop such a future vision, the board should consider several strategies in advance. Two strategies were mentioned frequently during the interviews.

The first one is to set up an exit strategy, which means to always keep in mind what happens and what needs to be done in case a relationship or cooperation with the cloud supplier is going to be ended. IV4 agreed with this and emphasized that it is important to consider the entire process from beginning to end: *''From the customer's point of view, you should look at the entire lifecycle of certain solutions. And then it is not only about entering the cloud and making use of it, but also leaving the cloud and cleaning it up.''* Coming up with an exit strategy in advance could help to prevent a lot of trouble.

Another strategy that organizations can choose for is a second mover strategy. CCT still is an upcoming technology, and its mass adoption has started relatively recently in the manufacturing industry (Industryweek, 2017). This means that it currently is not working ideally, some beginner problems are still included. IV13 pointed at the pioneering issues that users want to prevent: *''Then you are finally live in the cloud, and then you get the first customer, and of course you get the first problems, and that means that waiting is sometimes not wrong at all…If you have a supplier who will unburden you, then in fact it would be nice if he is already out of the pioneering phase.''* On the other hand, as explained in earlier sections, CCT usage is very flexible, and if it doesn't work as hoped or expected, it is easy to get rid of the technology without having invested a lot of time and effort. Still, it might not be a bad idea to wait some time until the most common problems have been solved.

5.3.6. Internet connection

The problem of bad connection and latencies related to the internet cannot be fixed right away. IV9 thought that it is a matter of time: *''I think for those customers that is indeed just a matter of waiting. We are not a company that can deal with the internet itself, we are not going to do that. So you are dependent on local authorities, or on other companies, technology companies that see enough potential to establish a better connection.''* Fortunately, internet connection is developing fast nowadays. With the 5th generation of internet being introduced, a new super-fast network is set up, which will probably be advantageous for companies that are currently struggling with their internet connections. It therefore seems that it is only a matter of time until almost all companies at almost all locations have access to good connections in The Netherlands. Of course, there are still large international differences nowadays. Evidence of Friederici et al. (2017) shows that there is a highly uneven economic impact of internet connectivity across geographies and social strata. Especially wealthy Western countries have highly reliable internet and it keeps improving. Anyway, The Netherlands falls under the wealthy Western category, and therefore it is only a matter of time for the sample of this research - Dutch manufacturing firms - until the internet is reliable enough at any place.

Besides, IV16B mentioned the worth of redundant connections, something similar to geo-redundancy of data as discussed in section 5.3.1.3. Redundant internet connections ensure that there is some kind of backup connection available at all times. If the primary internet connection is not strong enough or totally fails, the redundant internet connection takes over, increasing continuity and performance of business processes.

5.3.7. Keep it simple

One final tip is worth mentioning: despite endless possibilities related to CCT, some interviewees emphasize to 'keep it simple'. As IV15 explains, it is important not to overdo or rush things. So, start with the basics, and then expand step by step. Keeping it simple is key according to IV5: *''I love to keep everything as close to the source as possible. I think that's the most important thing I can say, and stay away from too much customization. Keep it simple, that is really the key with cloud computing, I think.''* Concluding, do not get blown away by all the possibilities, but investigate them one by one, and decide whether it could be of value. Using external parties during this process might also be helpful, as explained previously.

6. Discussion

6.1. Empirical and theoretical implications

The current study provides new insights into adoption factors, challenges and solutions regarding CCT in manufacturing firms. To begin with, Ezell et al. (2018) named an increase in efficiency, acceleration of time-to-market, and alignment of supply and demand as important adoption factors. Moreover, Xu (2012) pointed out the dynamic ability and scalability of resources via the web, while Bahrin et al. (2016) mentioned increase in data exchangeability as an essential aspect. The interviews indeed validate these factors as described in section 5.1. Still, some other relevant factors were identified which add to previous studies. The most important comprise relief of the IT department, high usability of the technology, location independence, monetary benefits, and the role cloud suppliers play in the adoption process. With regards to challenges, there is plenty recent research on problems with data safety and

security (e.g. Fan et al., 2019; Ghambhir et al., 2018). Moreover, Piezunka and Dahlander (2015) had identified employee resistance as a challenge, but the causes they found were unsimilar to those identified during this research. In addition, performance issues and monetary detriments were identified by Feuerlicht et al. (2011). The aforementioned challenges largely overlap with the challenges mentioned during the interviews. Yet, the respondents mentioned some other relevant challenges that also need to be taken care of, such as dependence on cloud suppliers, lack of knowledge and people with the right skills, integration issues and challenges abroad. Finally, research on solutions for the challenges in CCT adoption, implementation and usage mainly lacked attention in previous studies. Only solutions on data and security issues have received considerable attention in the literature. Therefore, almost all the solutions identified contribute to the research gap. Especially solutions for employee resistance, how to overcome lack of the right skills and knowledge in the workforce, the role of the IT department, and organizational policy are rather new.

Another main aim of the study was to extend the original UTAUT framework developed by Venkatesh et al. (2003). More specifically, the interviews were used to reexamine adoption factors and to add challenges and solutions to the model. In contrast to the original model, the UTAUT model derived in this thesis consists of three different phases. Although exact causal relations cannot be proven to be statistically significant in qualitative research, the arrows between the boxes provide an indication of the relationships as they are experienced by the respondents. Furthermore, from the interviews it became clear that the moderating effects were small, irrelevant or even unknown, and therefore the moderators were excluded from the extended model. Yet, ‘age’ seemed to be a relevant factor in the process of CCT adoption, implementation and usage. Rather than being the only moderator, it was included within the factors themselves (e.g. age influences the amount of resistance from the workforce). The model is explained below and it is advised to take appendices D and F into account. Appendix D shows the initial coding list based on literature, along with indicators that have helped to categorize the adoption factors and challenges. It must be noted that the model is simplified, as the large number of adoption factors and challenges have been grouped into respectively five and six boxes. Appendix F, which basically is the new UTAUT model in table form, shows how all the single factors were categorized. Figure 4 gives an overview of the extended framework.

Phase one consists of the adoption factors, and can be recognized by the light blue boxes. The adoption factors described in section 5.1. have been divided under the four key constructs from the original model: 'performance expectancy', 'effort expectancy', 'social influence', and 'facilitating conditions'. The extended model includes one key construct - ‘monetary benefits’ - because the factors in this category represent the same underlying phenomenon and the adoption factors that are in this category could not be allocated to any of the four key constructs. This new key construct includes adoption factors that were exemplified in section 5.1.6. In the original model, ‘facilitating conditions’ does not have a direct effect on ‘behavioral intention’, but on ‘use behavior’. The interviews, however, made clear that the five key constructs all pose a direct influence on ‘behavioral intention’, so the model was adapted to this finding. In turn, ‘behavioral intention’ decides the ‘use behavior’ as is the case in the original model as well. Appendix F gives an overview of how the different adoption factors were grouped into the five key constructs.

The second phase consists of all the challenges that were mentioned in section 5.2., and can be recognized by the orange boxes. All the challenges that were mentioned during the interviews have been divided into six categories: 'resistance', 'data and information risks', ‘monetary detriments’, 'dependence on cloud supplier', 'internal problems', and 'external

problems'. Again, appendix F gives an overview of the how the identified challenges were categorized. At the first glance, it may seem as technology adoption causes all these challenges. This is not true, however, because many challenges can indeed occur before the decision to adopt or not adopt CCT is made. For instance, resistance from the workforce may occur as soon as the board of an organization makes clear that it is considering CCT adoption, and not just after the moment the board announces that a firm will adopt the technology. Yet, the adoption factors and challenges were divided into different phases so the benefits and drawbacks are easily distinguishable. To take into account that the (potential) challenges and 'use behavior' can influence each other, the arrows between 'use behavior' and each of the challenges are bidirectional.

The green blocks represent the third and final phase, and include all the solutions from section 5.3. that were mentioned to solve the challenges of phase two. Categorization of solutions would not make any sense, because these categories would then be called exactly the same as the challenges, and it would still be a question what the solutions are by looking at the model. Therefore, the solutions were not categorized, but published individually in the model. The challenge of ´monetary detriments´ is the only category for which no solutions were found. Yet, the ´monetary benefits´ from phase one represent the adoption factors related to costs and therefore backup the solutions that are missing for the category of ´monetary detriments´. The solution ´organizational policy´ was further split into three different solutions. The model is published on the next page (figure 4).

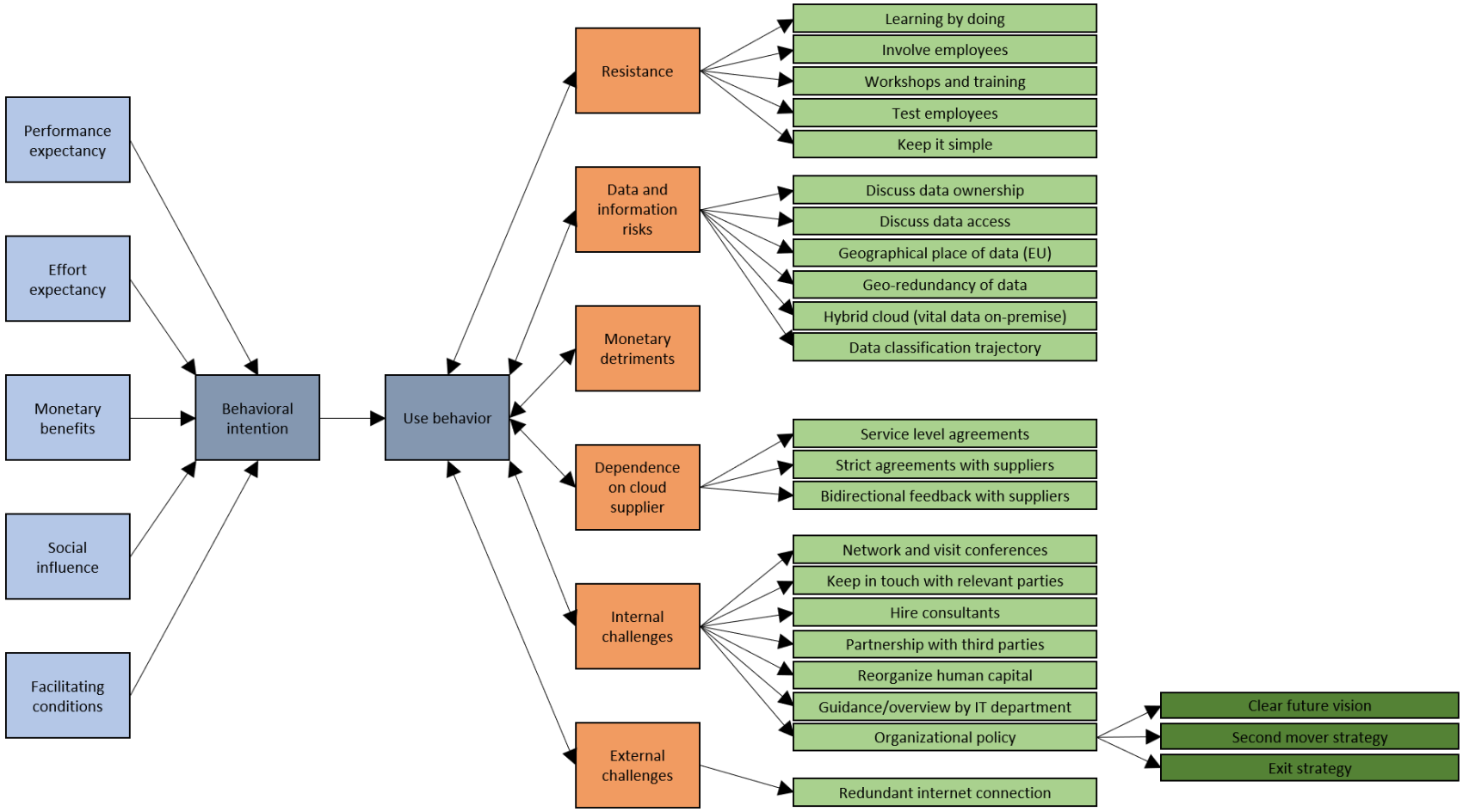

Figure 4: Extended UTAUT framework including adoption factors, challenges and solutions for cloud computing technology adoption, implementation and usage in Dutch manufacturing firms.

6.2. Managerial implications

To give some managerial implications, the most important solutions from section 5.3. should be taken into account, because these solutions will help the management to facilitate and stimulate the process of CCT adoption, implementation, and usage. It is highly advised to make proper appointments with cloud suppliers and other relevant actors from both inside and outside the organization. Agreements with suppliers should take into consideration safety, security, geo-redundancy and place of data (European Union), as well as cloud service, and performance. Agreements within the organization can include how data and information are protected and handled. A hybrid cloud-based solution is an option for those who are hesitant to store critical business information externally.

To reduce resistance from the workforce, the management can take action to make its employees enthusiastic about CCT. The best way to achieve this is to involve them in the entire process from beginning to end, and to provide information, training, workshops and tests. In this way, the employees can get used to the new situation, which will increase acceptance, and so speed up the learning process. At the same time, the management can screen who is unable or unwilling to go with the organizational flow, and replace them by bright new talent.

Next, some managerial implications relate to the use of third parties. It is highly advised to build a proper network with likewise organizations, by visiting conferences regularly and become member of different groups. Another way to retrieve information is to hire consultants or set up partnerships, either temporarily or permanently. Moreover, it is important to keep close contact with all external parties (cloud supplier, clients, competitors) to share feedback about CCT related matters. In contrast to making use of external actors, the board should also realize what the importance is of its own IT department. This department can be of particular value in guiding the process by emphasizing the possibilities of IT related technologies, such as CCT, but also in reducing employee resistance because it represents a bottom-up direction of technology acceptance.

Finally, managers always need to keep in mind to stay as close to the basics as possible, and to develop and pursue a clear organizational policy. This could include a clear future vision so the organization can work towards a desired state. It is also advised to always keep in mind what would happen if the technology does not work as expected or hoped, and how to end a relationship with the cloud supplier.

6.3. Limitations of the research

Due to its exploratory nature based on semi-structured interviews, this research has some limitations which are taken into account in this section. First of all, twenty interviews were conducted with relevant Dutch manufacturing actors. However, all except the first and second took place in a remote way via Skype, Teams, or the phone, due to the situation around the coronavirus. Ideally, all interviews would be carried out in real life at the work sites of the interviewees. Real life conversations often make it easier to express and understand body language and decrease the risk of misunderstandings (Chron, 2019). In other words, remote conversations are less personal than face-to-face conversations. Furthermore, since eighteen out of twenty interviews were done remotely, it was not possible in these cases to get a guided tour through the firm, which would both have been pleasant and educational for extra organizational background information.

Secondly, qualitative research is always somewhat subject to the researcher(s). This research was done by a single researcher, and therefore it might well be possible that other researchers or even groups of researchers come to a little different conclusions. Yet, their broader findings would most likely still be very similar to those of this thesis. Moreover, a clear and detailed description of data collection and data analysis has highly increased transparency, which, in turn, increased replication and reliability significantly. For instance, the research includes clear descriptions on how the respondents were found and approached, and the interview guide that was used is published in the appendix. In addition, the thesis includes a clear description of the coding process and the appendix even provides an example of how coding was executed and how this led to the results section of one of the adoption factors. In other words, in-depth descriptions of how data were collected and analyzed brought levels of replication and reliability to a maximum. In addition, interviews were triangulated with external research documents to decrease bias and to increase research quality, making the results not just fully dependent on the interviews and personal interpretation.

A final limitation has to do with the fact that the sample of the research was partly based on data accessibility rather than on particular case selection. As long as an organization could be qualified as a manufacturing firm and was willing to participate in the research, it was included in the sample and an interview was scheduled. However, within the manufacturing industry, there are still many different branches and directions, such as chemicals, consumer products, construction, and hightech, to mention a few. Ideally, a particular branch within the manufacturing sector would be the sample, to increase generalizability and data specificity. It might well be possible that a machinery manufacturer deals somewhat differently with CCT compared to a cosmetics manufacturer, for example. Yet, for data accessibility reasons, the sample included many kinds of manufacturing firms. Otherwise there would probably have been trouble during the process of data collection, resulting in a too small sample. Still, although the results are not generalizable for the aforementioned reason, the results of this research do give broader insights into the process of CCT adoption, implementation and usage in manufacturing firms.

6.4. Future research

Multiple avenues for future research are given in this section. Many different adoption factors, challenges and corresponding solutions were identified during the research. In fact, so many factors were identified, that there was no time nor space to treat each of these factors very much in-depth. Additionally, this research adopted a qualitative methodology, and did not aim to quantify and statistically prove significant relationships between different factors. Rather, the results and extended UTAUT model provide an indication of relationships between factors and is therefore a first step towards understanding the relationships. Taking into account the above, two directions for future research are to zoom in on each of the factors individually, as well as to investigate the broader situation using quantitative methods. This will lead to more in-depth knowledge about the factors, and it may especially uncover how these factors relate to each other and to other factors that were not taken into account in this research.

Furthermore, this research had to be completed in a timeframe of 32 weeks. Therefore, it was impossible to perform a longitudinal study, which is a research design involving repeated observations or measurements over short or long periods of time (Menard, 2002). A longitudinal research design is valuable especially in situations where a process is investigated. Obviously, the adoption, implementation and usage of CCT, where adoption

factors, challenges and solutions are taken into consideration, is a process that takes multiple years in most cases. Therefore, future research should conduct longitudinal studies to investigate how the different factors change over time. Technological progress is currently very high, so the adoption factors, challenges, and solution may also change much over time. Future research should also investigate how the factors are related to where a firm is in the process. For instance, the adoption stage of CCT might include different challenges in comparison to the usage stage, and thus require different kinds of solutions too.

Finally, coming back to the limitation mentioned in the previous subsection, researchers should dive more into differences between branches within the manufacturing industry. In other words, each of the manufacturing industry segments requires an in-depth study to get more specific and generalizable results about CCT. Relating to this point, the sample of this research only includes Dutch manufacturing firms for data accessibility. Although the European Union or Europe is often considered to be one region, there are still large international differences between European countries, but also between European countries and other countries across the globe. Therefore, future research should try to identify differences between countries in how manufacturing firms deal with the adoption, implementation, and usage of CCT, and especially try to uncover what the causes of these differences are.

7. Conclusions

Nowadays, digitalization is a strong movement that is revolutionizing both society as well as business environments (Parviainen et al., 2017). Cloud computing technology is a digital technology which has received much attention in recent years, and is adopted by a significant number of manufacturing firms already. Despite its growing popularity, research on adoption factors is still quite limited, for example because too many studies have only focused on the development of the technology itself. Some studies have identified and investigated challenges related to data security. Yet, little studies have been able to identify other problems related to adoption, implementation and usage of the technology. Finally, studies so far did not come up with solutions for the identified challenges. Hence, the aim of the research was to identify adoption factors, challenges and corresponding solutions related to CCT in Dutch manufacturing firms. This resulted in the following research question: *''What does the adoption, implementation and usage of cloud computing technology look like in manufacturing firms?''*

For this aim, a descriptive, qualitative, multiple holistic case study approach was chosen. Semi-structured interviews were carried out with employees of Dutch manufacturing firms. Respondents included IT managers, innovation managers, and project managers, amongst others. The semi-structured interviews functioned as the main source of data, and were complemented by document analysis where needed. In total, twenty interviews were conducted. The interviews consisted of three types of questions: 1) questions about benefits or adoption factors of CCT; 2) questions to identify the main problems and challenges related to adoption, implementation, and usage of CCT; 3) questions that aimed to identify what actions are taken most often to solve or enlighten these challenges. The UTAUT model, developed by Venkatesh et al. (2003) to understand IT adoption, was used as a theoretical lens for this research. As argued before, the model is appropriate to help identify technological adoption factors, but falls short for what happens after a technology is adopted. Therefore,

this framework was extended and now not only includes adoption factors, but also important challenges and corresponding solutions around CCT in manufacturing firms.

To provide an answer to the main research question, three sub-questions were set up. The first sub-question was: *''What are the motivations to adopt cloud computing technology in manufacturing firms?''* Adoption of CCT relieves the IT department of manufacturing firms because the cloud supplier makes himself problem owner, thereby unburdening IT departments so they can deliver more value to their organizations. Next, a high usability makes it possible for the majority of people to easily work with the technology without the need of much technological knowledge, and enables employees to work from almost any place with access to a reliable internet connection. Relating to location independence, data accessibility and exchangeability are large benefits too, as data is simply available from almost any place, smoothing data sharing and analysis, and improving communication and collaboration methods. Compared to on-premise solutions, cloud-based solutions bring safety and security of data to the next level. Also, organizational productivity gets a boost for several reasons: people can work from all locations, communication and collaboration is easier, data can be analyzed and processed more efficiently, business continuity is increased, and business intelligence is improved. Although the technology is not cheap, there are some monetary benefits too: the pay-per-use scenario makes sure that a user only pays for what is actually used, adoption of the technology does not require an organization to make large investments, there is flexibility in cost structure, cost predictability is high and storage costs are low. Flexibility is another adoption factor, because it accelerates time to market, allows experimenting with the technology, and it enables scalability, so that demand and supply are always right in balance. Another benefit is the technology's high standardization, so it can integrate conveniently with many other applications and programs. The technology also allows to discover additional services and to dismantle opportunities. Finally, some other factors which accelerated CCT adoption were brought to light, such as market pull caused by competitors, technology push from cloud suppliers, internal push from the organizational IT department, and the corona crisis.

The second sub-question that demanded an answer was: *''What challenges are associated with the adoption, implementation and usage of cloud computing technology in manufacturing firms?''* To begin with, some organizations experience(d) resistance from the workforce during adoption and implementation of CCT. Organizational change often results in resistance as employees need to apply new ways of working, causing uncertainty and anxiety because people want to remain their habits. The slow moving and conservative character of the manufacturing sector even increases resistance to change. In general, the respondents experience that resistance increases with age. Other challenges related to a lack of knowledge and a lack of employees with the right skills, even though the usability of the technology is considered high. There are some challenges related to data and information too. High accessibility of data and information as well as the ease with which data can be shared can also become a danger if the data is too easily accessible or if data is (accidentally) shared with the wrong people. It could be disastrous when business sensitive data and information become publicly available as a result of this, or due to hacks or cybercrimes, which are dangers as well. Setting up firewall settings and coming up with passwords for users were also qualified as common issues. Furthermore, CCT makes users very dependent on their cloud supplier(s) and products. This makes the supplier very powerful because it is actually inside the business processes, thus able to persist influence on the users' direction and speed of change. When the technological progress of cloud services is slow, users actually need to wait for the progress to occur, because they are unable to do it themselves. Under other

conditions, when progress of the cloud tools is too fast, users are forced to move along or they will lose grip on their own situation. This dependence is illustrated by two prevalent situations. On the one hand, cloud suppliers often deliver unfinished products, representing too slow progress. On the other hand, suppliers regularly offer many services and updates in short periods, making a user unable to keep up with the pace. Moreover, due to the fact that the cloud supplier becomes a user's problem owner, a user is hardly able to fix problems related to the cloud itself. This dependence is difficult to decrease, because users are (vendor) locked-in by the cloud supplier. There are also monetary deficits related to the technology. It is often qualified as expensive due to market domination by a few large players and because users need to pay for every single service. In addition, large investments were usually done in the past for the on-premise solutions, which makes the switch towards a cloud-based solution very cost inefficient due to the sunk costs argument. Another challenge is that IT budgets are, although they have increased, still rather low. There are also some integration issues, such as a misfit between cloud suppliers and application developers, because application developers can neither keep up with the rate of technological change. Besides, updates are often not tested before they are released, causing more integration problems nowadays. On-premise solutions are also often highly customized, so that a switch towards a cloud-based solution needs a lot of adaptations until it can integrate. In other words, customization is often at the expense of performance. Cloud suppliers are often even unwilling or unable to guarantee a particular level of performance to the user. Some final common problems are: an internet connection that is unreliable or too weak, differences between legal systems of countries, and governance issues as the way of managing an organization changes.

The final sub-question to answer the research question was: *''How do manufacturing firms deal with challenges related to cloud computing technology?''* To fix the problems with regards to data security and safety, several solutions were mentioned. A hybrid cloud, which is a mix between on-premise and cloud-based solutions, allows an organization to keep the business sensitive information on-premise, which gives the organization a feeling of safety. A data classification trajectory may be of value here to decide what data can be stored in the cloud, and what data need to stay on-premise. Moreover, it is important to make proper agreements about data access and ownership with employees and the cloud supplier, preferably prior to CCT adoption. An interesting finding was that almost all interviewees explicitly demanded their data to be stored within EU borders, because this highly increases the feeling of data safety. Geo-redundancy of data was also mentioned to increase data safety and security, meaning that there is a backup of all the data that is stored. Solutions for the problems related to (resistance from) employees were mentioned too. To begin with, dealing with new situations is often a matter of time and learning-by-doing. However, several measures can be taken to speed up this process. For instance, it is highly important to involve all employees and inform them about what happens and why these things happen. Workshops and training may also help the employees to more easily deal with the new ways of working, and organizations should also consider the option of testing employees on a regular basis and providing them feedback on their actions. Yet, some employees will not be able to get along with the changes, and that could mean that the organization should fire those and look outside for new talents. Respondents also mentioned that using third parties helped with solving many problems. Especially visiting conferences and networking helps to retrieve more information than would otherwise be possible. Organizations can also use consultants because they have more in-depth knowledge and expertise and are specified in particular areas. Moreover, startups can be of value, because they are often more technology focused and therefore have more knowledge on technologies too. Organizations should also try to keep in touch with their

cloud suppliers, clients and other relevant parties, and share bidirectional feedback and make (service level) agreements with them to decrease dependence. Next, the IT department can play a significant role in guiding the process of CCT adoption, implementation and usage, by providing an overview of the technological options to the board. This also reduced resistance from the workforce because it now is more a bottom-up than a top-down implementation. Respondents also mentioned organizational policy as a solution to decrease the number of challenges. More specifically, an organization should develop a clear future vision, and take into account different strategies, such as an exit strategy and/or a second mover strategy. To fix problems related to a bad internet connection, waiting for better internet connection seemed the best option because developments related to the internet are going terribly fast. Additionally, it is important to have a redundant internet connection which means there is an internet backup, thereby increasing business continuity. A final tip to restrain challenges for CCT in general is to keep everything as simple as possible, and to stay close to the basics.

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9. Appendices

Appendix A - Interview guide

Introduction of the interview

Introduction

- Hello, my name is Rik Adelaar, I'm 22 years old and I'm a master student at Utrecht University.
- I'm following the master program "Innovation Sciences". This program particularly addresses how firms transform new ideas into marketable innovations and how to manage and promote innovation processes within companies as well as in society at large.
- Thank you very much that you have reserved time to participate in this interview, and so in my research, which is very valuable for my master thesis on cloud computing technology in manufacturing firms.

Aim of the research and research question

- Cloud computing technology is increasingly being adopted, especially in manufacturing firms, and I'm interested in the application potential of this technology.
- Through this interview you participate in a study that investigates cloud computing technology in the manufacturing industry. As you are working for a manufacturer, and as this firm is using cloud computing technology, considering to do so, or specifically not willing to do so, you are the ideal interview partner/expert on this topic.
- Basically, the goal is to identify cloud computing adoption factors, common problems and corresponding solutions. I will be happy to provide you with the main results, in an anonymous way.

Interview process

- In a moment we will start the interview with a few preliminary questions about you and the firm you work for. After this, we will dive deeper into the questions on cloud computing in relation to the organization.
- The interview is semi-structured, which means that the questions are open-ended. Please answer freely and if there is anything that pops up in your mind of which you think it is relevant or interesting, feel free to share it.
- The interview is approximately going to take about 30-40 minutes.

Confidentiality, privacy, anonymity

- The analysis of data is done confidentially and anonymously and will only be published in an anonymous form.
- In order to guarantee the best scientific results, the interview will be recorded, transcribed, and saved temporarily. The recording will only be for my own use so that I can transcribe the interview and later analyze it in peace and concentration. With your participation you agree with these conditions.
- Do you have any questions before we start?

Interview questions about the person and firm

1. Interviewee

1.1. Could you please introduce yourself?

1.2. For how long have you been working here?

1.3. What role do you fulfill in this firm?

1.4. Have you fulfilled other roles in this firm?

1.5. Have you had a comparable job in another firm in the past? Or have you had a job that is considered to be relevant for this research?

2. Firm

2.1. Can you tell something about the firm? For example:

- History
- What's the core product?
- Number of employees
- Number of locations (if applicable)
- Does the firm invest in (digital) technologies? If yes, how much?
- Does the firm invest in R&D? If yes, how much did the firm invest in R&D last year as a percentage of revenue?

2.2. Can you describe the status of digitalization of your firm?

2.3. What technologies have been implemented so far, and when did this begin? (e.g. internet of things, artificial intelligence, robotics, big data, virtual reality, cloud computing technology, 3d printing, blockchain, etc.)

2.4. Have you currently adopted/implemented cloud computing technology? If yes, since when? If not, why not?

Interview questions regarding the 3 topics

3. Motivations

3.1 Do firms in your sector in general apply cloud computing technology?

3.2. How and when did you hear about the technology for the first time?

3.3. What is/were the main purpose(s) to (not) apply it?

3.4. How do digital technologies and cloud computing in particular align with the overall strategy and goals of the firm?

3.5. Could you describe a few use cases for the application of the technology in the firm?

3.6 Have any external forces played a role in the adoption process, or was it mainly internally pushed?

3.7. If you look at the present, what are the main benefits of using the technology for the firm?

3.8. To what extent is your firm dependent on the technology?

3.9. Does the technology fulfill all the motivations it was implemented for? If not, can you elaborate on why this is the case?

4. Challenges

4.1. Have you encountered any challenges before and during the implementation of the technology? If so, can you describe a specific situation?

4.2. Have you experienced any challenges after you had implemented cloud computing technology? If so, can you describe a specific situation?

If interviewee does not mention any problems at 4.1 and 4.2, push them into the direction →

4.3. Are there any problems or difficulties you are currently experiencing or that you experienced in the past? For example related to (based on the literature):

- Complexity
- Resistance from workforce
- Costs
- Effort
- Data security
- Customization
- Evaluation

4.4. To what extent did you need to reorganize your company (to implement cloud computing technology or to deal with the challenges)?

4.5. How did you do this?

4.6. How did the employees experience the restructuring (if one can speak of a restructuring)?

5. Solutions

5.1. How have the problems you encountered been solved? (ask this question specifically directed to each challenge mentioned before)

5.2. How did you get to these solutions?

5.3. Did you cooperate with others (external support) to solve the problem(s) (e.g. consultants or technology providers)?

5.4. How much time did it take to solve these problems?

5.5. How much money did it cost to solve these problems?

5.6. Were there any minor problems? If yes, how do/did you deal with minor occurring problems?

5.7. Have you done anything to help your employees to deal with (the implementation of) cloud computing technology? (e.g. workshops)

5.8. Can you describe a few best practices (lessons learned) from your cloud technology experience regarding the implementation, the usage and the solutions of any problems?

Wrapping up

- This is the end of our interview. Would you like to add anything that has not been discussed yet, of which you think it might be relevant for the research?
- In case you are interested in the results of the investigation by the time it has been completed, it will be sent to you. This will be in July.
- I want to thank you very much for your time and participation in this study. That is greatly appreciated.
- I am also happy to send the transcript, do you want to receive it?
- Could you refer me to anybody else that would be interested in talking to us about this topic?
- If you have any questions, please contact me via r.l.adelaar@students.uu.nl or 0612352728.

Appendix B - Overview interview(ee)s

Interviewee(s)	Function(s) respondent(s)	Date	Duration	Form
IV1	Manager infrastructure	11-03-2020	49:52	In person
IV2	Project manager	12-03-2020	50:01	In person
IV3	Global IT and business application manager	16-03-2020	34:41	Phone
IV4	ICT manager	18-03-2020	49:50	Skype
IV5	ICT manager	19-03-2020	34:53	Phone
IV6	Chief innovation officer	23-03-2020	51:17	Phone
IV7	Group IT director	25-03-2020	45:46	Skype
IV8	Digital manager	27-03-2020	33:04	Skype
IV9	Senior product manager	30-03-2020	35:32	Teams
IV10	Digital manager	31-03-2020	42:13	Teams
IV11	Manager ICT	01-04-2020	26:31	Phone
IV12	IT director	03-04-2020	34:58	Phone
IV13	Team ICT leader	06-04-2020	52:01	Teams
IV14	ICT manager	06-04-2020	80:31	Teams
IV15	Account manager	08-04-2020	46:11	Teams
IV16A + IV16B	IT manager + Interim ICT manager	09-04-2020	47:05	Teams
IV17	Team leader user support and system management	21-04-2020	37:07	Teams
IV18	Vice president operations	28-04-2020	34:55	Phone
IV19	Project manager ICT	01-05-2020	34:13	Teams
IV20	IT Infrastructure and operations manager	14-05-2020	44:36	Teams

Appendix C - Overview firms

Please note that the firms are published and described in random order, so they cannot be related to a particular interviewee from appendix B (e.g. firm A does not correspond to IV1).

Firm	Description
A	Helps both businesses as well as municipalities to reduce water and carbon footprints and to reclaim valuable resources.
B	A supplier for standard fittings for chain and steel wire rope. It includes premium quality lifting, lashing and mooring fittings.
C	A full service agency where creativity and technology come together. They create, develop and implement smart and effective video, photography and digital communication tools.
D	Special vehicle manufacturer for terminal, off-road and tractors, swap bodies and shunters. The company builds trucks and terminal tractors for the transport of earthmoving and construction, trailers in ports, industry, logistics and distribution centers.
E	Manufactures parts for cranes, such as crane blocks, cable blocks and hooks. They are tailor-made for lifting weights up to several thousands of tons. The produced components are used in different sectors, such as offshore, maritime and port industry.
F	A link between technology and functionality. Within SMEs they help customers to ensure the continuity of their organization with innovative integrated solutions. This is not a manufacturing firm, but rather helps manufacturing firms with IT-related solutions.
G	Focusses on developing and providing optimal technical and technological variations for different kinds of bread, such as mixed bread, toast, baguette, brioche or country-style breads.
H	Became an independent producer of corrugated cardboard packaging. They deliver from stock, but are also available for customization, stock management, printing and erecting machines.
I	Designs and manufactures transport and sorting systems for the packaging of biscuits, cookies and crackers.
J	Produces aluminum, steel and plastic facades and facade elements, thereby paying much attention to responsibility, sustainability and innovation.
K	Producer of high-quality candles. In addition to this great diversity in types, they also offer a wide variety of sizes and shapes and have a very wide color palette and fragrance range.
L	Manufacturing, repairing and trading in physical, electrical, medical and other similar instruments and devices.
M	Manufacturer of board cardboard, for example for puzzles, game boards, picture books and luxury packaging.

N	Develops and manufactures innovative machines and production lines for the steel construction and sheet metal processing industry. This often includes complicated constructions or building in a difficult place.
O	Produces stretch films and food packaging films, providing customers with the highest possible load security and the best possible pallet stability for transporting products, thereby improving logistics process performance.
P	A bicycle manufacturer that has also produced cars, mopeds and motorcycles in the past.
Q	Originally only produced heavy equipment for the oil and gas industry, it now also produces cranes, drilling rigs, pipelay systems, ship designs and sometimes amusement park rides.
R	Supplier of technical solutions for the agricultural sector. The company produces electromechanical drives, automation solutions and energy-saving systems for greenhouse horticulture, among other things.
S	Provides reusable, sustainable and circular packaging products for transport, often in the form of pallets, to carry loads.
T	Wood fibers or impregnated paper are pressed together under high pressure and high temperatures. This firm produces sustainable plates for office desks, covering other architectural feats with their plates.

Appendix D - Initial coding list based on literature and UTAUT model

Categories	**Subcategories**	**Indicators**
Motivations	Performance expectancy	- Improvement through the use of the system - Enhancement of productivity - Positive impacts on performance - Usefulness for company and employees
	Effort expectancy	- Ease of use - Stress free interaction - Importance of use
	Social influence	- Usefulness for coworkers - Use by coworkers - Encouragement by managers
	Facilitating conditions	- Availability of the system - Knowledge to operate the system - Good placement within the corporate culture
Challenges	Security	- Data accessibility for employees - Data accessibility for the outside
	Performance	- Fulfills motivations it was implemented for - Lowers workforce
	Costs	- Money spent - Effort spent
	Complexity	- Difficulty of application - Difficulty of use - Time that needs to be invested to understand the technology
	Customization facilities	- Amount of options available - Feasibility of wishes
	Evaluation	- Perceptibility of results - Extent to which costs and benefits can be compared

Appendix E - Coding in Excel: an example

This example shows how codes were assigned to particular quotes, and how these codes were grouped in categories and subcategories. More specifically, the example below shows how different quotes were coded, subcategorized as ‘efficiency’, ‘continuity’, ‘collaboration’, and ‘communication’, and finally categorized as ‘productivity’. This was used to write section 5.1.5.

1	Interviewee	Exemplary coded statement	Open code	Subcategory	Category
2	6	'The real advantage of cloud computing is that it must improve the efficiency of the processes. And in order to improve efficiency, we think we have to say that we can process, analyze, in a better way, all the data that is available, so that we can make the process more efficient."	Improves efficiency of the process	Efficiency	Productivity
3	15	'You can organize your day better, you do something in the morning, and then you do the laundry, and then you do something in the evening, you become much more flexible, and then your output is higher."	Your output becomes higher due to flexibility		
4	2	'I sometimes think it is good that people start working at home, because then they may be able to do their work more concentrated."	More concentrated at home		
5	15	'Getting the real-time information and a reduction in the chance of error from it is also a very important one. So the second reason is to unlock information that makes you work better and more efficiently, yes."	Reduction of errors		
6	16	'You can make people work at home, the feedback we saw is that people said, 'I'm actually super productive at home, I can actually do a lot of things undisturbed, that's nice,' instead of lockin them up in the office with thirty collegues."	Productive at home		
7	14	'Further development takes place at the supplier, data storage at the suppliers, they simply guarantee continuity of access to the platform, yes, and we can get to work, so to speak."	Guaranteed continuity	Continuity	
8	14	'I fought almost one full year for that, to make clear to the organization that we simply could not guarantee the continuity of the organization in that current configuration."	Cloud gives continuity		
9	12	'In particular also the continuity of your availability. That has to do with the peak loads, the ups and downs, the extent to which you can control them."	Continuity of availability		
10	14	'And we mainly focused on the business case, if I keep doing everything in our business on the third floor, what is the maximum achievable business continuity level I can achieve? That level did not really meet the needs of the organization, but the level of the cloud did."	More continuity with cloud		
11	14	'They guarantee continuity with a twin data center. If my one data center goes down, I will move on to a second data center."	Continuity with twin datacenter		
12	14	'We are increasingly working 24/7, factories that are open 6/7 days a week, that run 16-20 hours a day, and I just couldn't live up to that with my on-prem architecture."	24/7 continuity		
13	14	'There are so many great tools in that Office cloud, with which you can get your employees so much more productive, with which you can modernize your collaborations."	Modernize collaborations	Collaboration	
14	5	'Cloud fits in beautifully with all those collaboration tools."	Collaboration tools		
15	4	'And that has to do with the fact that those cloud solutions are often aimed at more convenient collaboration with people, regardless of location."	Convenient collaboration with people		
16	5	'Communication, collaboration, yes, that just takes off the moment you do that with the cloud."	Communication and collaboration		
17	19	'The telephone exchange was at an end, we did not opt for an on-premise new telephone exchange, but a hosted solution, cloud, which now is our primary communication method."	Communication method	Communication	
18	10	'If you really want to get value from all those wonderful applications, you have to make sure that end-to-end also communications with each other are realized, so that you also get an integrated picture, and also implement the automation of your work as much as possible, because then you're going to get value from the entire cloud platform."	End-to-end communication		

Appendix F - UTAUT model cloud computing technology in table form

Categories	**Subcategories**	**Indicators**
Motivations	Performance expectancy	Relief (of IT department)
		Productivity through business intelligence
		Productivity through continuity
		Productivity through communication and collaboration
		Extra services and opportunities
	Effort expectancy	Ease of use (usability)
		Location independence
		Data accessibility and exchangeability
		Data safety and security
		Data analyzability
		Scalability
	Monetary benefits	High accessibility due to low investment costs
		Flexibility in costs structure
		Pay-per-use scenario
		Storage costs low
		Costs predictability
	Social influence	Market pull
		Technology push
		Internal push from IT department
	Facilitating conditions	Room to experiment
		Short time to market
		Standardized technology, easily integratable
		Coronavirus

Challenges	Resistance	Resistance through fear for changes
		Resistance through uncertainty
		Resistance through conservativeness
		Resistance through aging
	Data and information risks	Data sharing too easy
		Data too easily accessible (safety/security)
		Fear for hacks and cyberattacks
		Setting up firewall and passwords
	Monetary detriments	Little budget for IT department
		Expensive
		Sunk investment costs on-premise
	Dependence on cloud supplier	Unfinished products
		Offering too many updates and services
		New versions not tested in advance
		Unable to fix problems yourself
		In hands of cloud supplier, they decide direction and speed of change
		Vendor lock-in
		Disconnect between cloud computing suppliers and application developers
		Differences between systems (due to customization)
	Internal challenges	Lack of knowledge
		Lack of people with the right skills
		Performance issues
		Governance changes
	External challenges	Weak internet connection (abroad)
		Differences between countries

Solutions	Resistance	Learning by doing
		Keep it simple
		Involve employees
		Workshops and training
		Test employees
	Data and information risks	Discuss data ownership
		Discuss data access
		Geographical place of data (EU)
		Hybrid cloud (vital things on-premise)
		Geo-redundancy of data
		Data classification trajectory
	Costs	-
	Dependence on cloud supplier	Service level agreements
		Strict agreements with suppliers
		Bidirectional feedback with suppliers
	Internal problems	Network and visit conferences
		Keep in touch with relevant parties
		Hire consultants
		Partnership with third parties
		Reorganize human capital
		Guidance/overview by IT department
		Organizational policy: - Clear future vision - Second mover strategy - Exit strategy
	External problems	Redundant internet connection