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The effects of leadership, emotional intelligence, and computer playfulness on employees' intention to use industry 4.0 technologies

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Abstract

This research explores the effects of leadership style, emotional intelligence, and employee perceptions of new technologies on the acceptance of Industry 4.0 technologies within multinational production organisations. Through a literature review and an online survey distributed among managers and employees from three distinct organisations, the study addresses the central question: "What are the effects of leadership style, emotional intelligence, and employee perception of new technologies on their acceptance of Industry 4.0 technologies?"

The study builds on the Unified Theory of Acceptance and Use of Technology (UTAUT) model, exploring the effects of instrumental leadership, emotional intelligence, and computer playfulness. Results reveal significant relationships between instrumental leadership and perceived usefulness, subjective norm, and perceived management support. Leader emotional intelligence demonstrates connections with subjective norm and perceived management support, and above all computer playfulness relates positively with perceived ease of use and perceived usefulness. Employee emotional intelligence, however, does not present any significant relationships within the proposed model.

Theoretically, the study explores the fit of instrumental leadership, emotional intelligence, and computer playfulness within the UTAUT model, providing insights into their impact on technology acceptance. We propose three new antecedents for the UTAUT model as well as question the importance of mere perceived management support. Practical implications include the contribution of instrumental leadership to successful technology roadmap implementation, importance of emotional intelligence training, and the value of hiring individuals with a passion for technology and computer playfulness.

These findings offer organisations valuable insights for implementing Industry 4.0 technologies successfully and contribute to the ongoing discourse on leadership, emotional intelligence, and technology acceptance.

Keywords: Computer playfulness, Emotional intelligence, Instrumental leadership, UTAUT

Table of Contents

1 Introduction

In the past five years a selective group of organisations have increased their efforts to implement Industry 4.0 into their operations (Gregolinska et al., 2022). However they state, a large majority of them are stuck and fail to reach the full potential of their investments into this relatively new industrial revolution. In 2011, the term "Industry 4.0" came up for the first time, when Kagermann et al. (2011) mentioned the main ideas of Industry 4.0 at the Hannover fair and illustrated how these ideas could be implemented in organisations to create a bridge between the virtual and physical world (Kagermann et al., 2011; Hupfer et al., 2018). These main ideas include the integration of the virtual and physical world, in which a seamless integration connects digital information to physical processes, as well as Internet of Things that connects a wide range of products and services to exchange data, and even autonomous decision making. The latter referring to monitoring and decision-making processes to enable companies to be controlled in near real-time.

Throughout the various industrial revolutions, employee behaviour became increasingly more considered, and is still researched to this day by scholars like Schneider and Sting (2020) who found cognitive frames to successfully implement industry 4.0 technologies. But perhaps, the most well-known example from which employee behaviour was derived are theories X and Y by McGregor (1960) or the Hawthorne studies from the nineteen-thirties which showed that the effect employees modified their behaviour based on the awareness of being observed (McCarney et al., 2007). Both theories arguably underline the increasing interest in employees' views on their work. For this research the interest in employees is no less as it aims to further understand the employees' acceptance of industry 4.0 technologies. This understanding of acceptance is critical for the implementation success (Piderit, 2000; Ford & Ford, 2009) of new technologies in organisations. However, the employees' acceptance of Industry 4.0 technologies is not the only factor influencing the successful implementation.

Changes, such as implementing new technologies, create new systems which always requires leadership (Kotter, 1996). The leadership style in which leaders delegate tasks and decisions rights among employees empowers the employees in their implementation efforts (Sloof & von Siemens, 2021). According to Schepers et al. (2005) the traditional leadership styles of transactional and transformational leadership have a positive effect on the acceptance of new technologies. Thereby, positively influencing the success rate of the implementation. These leaders can further influence the implementation the performance and productivity of the employees by understanding their own and their employees' emotions, especially in moments of change (Chrusciel, 2006). In other words, it would require the leaders to be emotionally intelligent, and thus have a high degree in which they are able to perceive, express, and appraise emotions (Mayer & Salovey, 1997). Arguably, these

factors such as leadership and emotional intelligence have an influence on the acceptance and performance of new technologies, being Industry 4.0. Hence, the main research question is: *What are the effects of leadership style, emotional intelligence, and employee perception of new technologies on their acceptance of industry 4.0 technologies?*

The aim of this study is to investigate whether and how the existing UTAUT model by Venkatesh et al. (2003) can be enriched with a new set of variables such as leadership, emotional intelligence, and computer playfulness. The study builds on previous research (e.g., Van Dun and Kumar, 2023) where leadership and emotional intelligence played a significant role in defining the acceptance and adoption industry 4.0. In addition, the research will explore the relationship between computer playfulness and acceptance of smart industries. The findings of this study can provide valuable insights for organisations looking to optimize their resources, whether by emphasizing the development of emotional intelligence or considering a shift in leadership style, to achieve maximum acceptance of smart industries.

This thesis will begin with a review of theory on the relevant literature. This theory will cover the topics of Industry 4.0, acceptance of technology, leadership styles, emotional intelligence, and perception of Industry 4.0. Next the method is presented, in which is explained why a specific method is chosen, the sampling, data collection, and analytical procedures are explained. After the method the results are presented which will be followed by the discussion which will also present avenues for further research.

2 Theory and hypothesis development

For this research the main literature is drawn from several topics. The research sets to find out what the relation is between emotional intelligence, leadership styles, perception of industry 4.0, and acceptance of industry 4.0. Therefore, the theories that form the base of the research are related to these topics and described in this chapter.

2.1 Industry 4.0

The industrial revolutions as we use it as term today refer to periods in history when there were advancements in the way goods were produced and manufactured in such a way that it increased its GDP per capita (Lucas, 2004; Fitzsmmons, 1994). The first industrial revolution around the end of 1700s was characterized by the use of water and steam power in industrial processes. This resulted in the creation of factories and machines that could perform tasks that were once done by hand, thus increasing productivity and efficiency.

The second industrial revolution at the end of the 1800s marked the transition from mechanical to mass production, which was made possible by the use of electricity and assembly lines. An example of such an assembly line is the model Ford T line (Drath & Horch, 2014). This made it possible to produce goods at a large scale and rate, leading to the rise of large-scale manufacturing companies reaching the consumer market with their products.

At the end of the 1900s the third industrial revolution was well underway with integration of programmable logic controllers into the manufacturing process (Drath & Horch, 2014). This automation allowed for greater precision and control over manufacturing processes, leading to increased efficiency, reduced costs, and improved product quality.

The fourth industrial revolution, also known as Industry 4.0, builds upon the accomplishments of the previous industrial revolutions and is characterized by the integration of digital and physical world (Sarfraz et al. 2021). This industrial development led to the creation of production facilities that can autonomously control production processes (or from a distance) and optimize efficiency. Industry 4.0 is also marked by the emergence of new technologies such as the Internet of Things (IoT), artificial intelligence (AI), and big data, which connect the physical and digital world even further according to Sarfraz et al. (2021).

Industry 4.0 can be defined as a collective term for technologies relating new technologies, in many studies it is referred to as Smart manufacturing, industrial internet, or integrated industry (Hofmann & Rüsch, 2007). Based on a literature review by Liao et al. (2017) the main research areas of industry 4.0 are in the manufacturing sectors.

2.2 Unified theory of acceptance and use of technology

Industry 4.0 is related to technologies that have an impact on the day-to-day activities of people. Thereby the people working with these technologies are ought to accept them, in other words it is "the degree to which a person believes that using technology would be free from effort and enhance their job performance" (Davis, 1989, p.320). A well-known theory in this regard is the unified theory of acceptance and use of technology (UTAUT). It was developed by Venkatesh et al. (2003) by further developing on the existing Technology Acceptance Model (TAM) by Davis (1989). The first, Technology Acceptance Model incorporated the perceived ease of use and perceived usefulness as precedent to the intention to use a technology. The perceived ease of use is defined as the degree of ease associated with the use of a technology, whereas, perceived usefulness is described as the degree to which someone believes that using a technology will benefit them. The model was soon updated to TAM 2 by Venkatesh and Davis (2000) by adding more social factors into the model such as subjective norm, image, and voluntariness, as well as adding result-oriented factors such as job relevance, output quality, and results demonstrability. Years later, Venkatesh and Bala (2008) added antecedents to perceived ease of use which were, computer self-efficacy, perception of external control, computer anxiety, computer playfulness, perceived enjoyment, and objective usability. This addition created the TAM 3 model thereby reaching the last stage of the model its evolution (Figure 1).

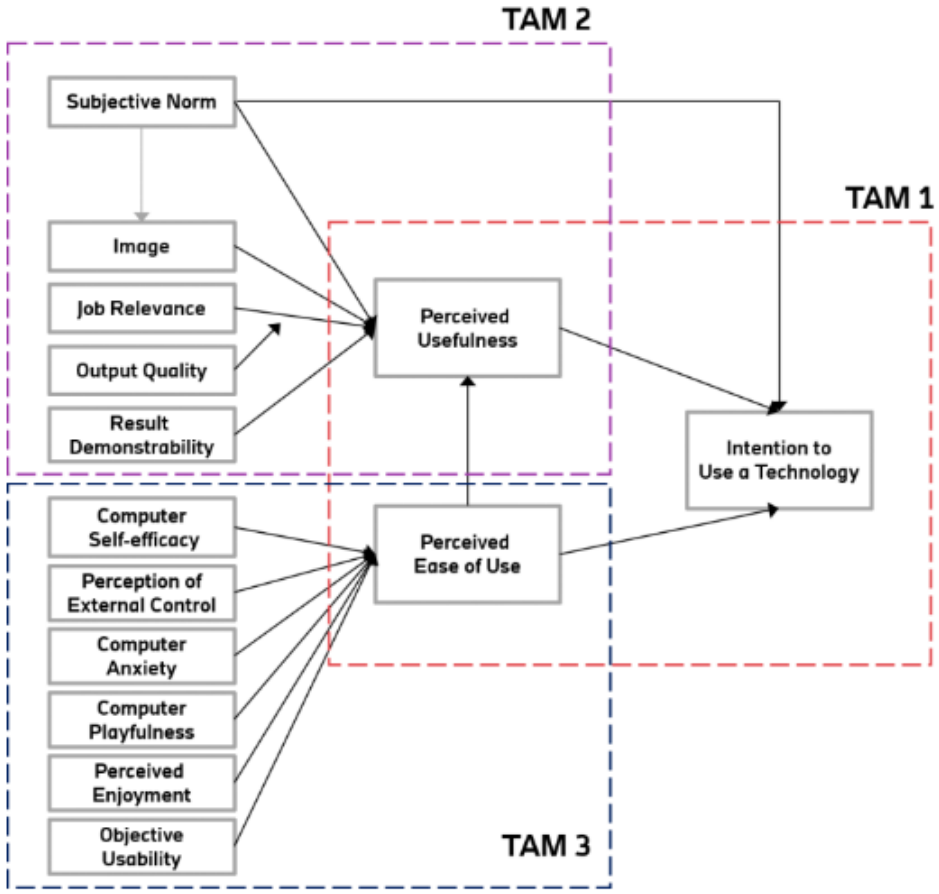

Figure 1 Evolution of the Technology Acceptance Model (Innovation Acceptance Lab, 2020)

At the time of creations of the UTAUT model neither TAM 1 nor TAM 2 incorporated soft factors such as social influence and facilitating conditions. By the addition of those factors the UTAUT was created (Venkatesh et al., 2003). After the creation of UTAUT it took more years to include some of those soft factors into the newly developed TAM 3.

The UTAUT model is created by unifying eight dominant theories and models into one Unified Theory of Acceptance and Use of Technology which will also be the preferred method for this research. For multiple reasons the UTAUT model can be preferred over the other technology acceptance models. To start with, the UTAUT model is a combination of eight different theories and models but remains quite simple to use (Venkatesh et al., 2003; Venkatesh and Bala, 2008). The simplicity of its use makes it applicable in many different fields and countries, however often paired with the use of TAM or another model (Williams et al., 2015). The wide use of this model proves the effectiveness of the UTAUT model as a starting point for further research. Moreover, the model was able to account for 70 percent of variance in usage intention in the study the UTAUT model originates from which was a substantial improvement over the original eight models (Venkatesh et al., 2003). However, this high variance is only achieved when the key relationships are moderated with gender, age, experience, and voluntariness (Van Raaij & Schepers, 2008). Another disadvantage is that the UTAUT model is too simplified to accurately predict the intentions and behaviour (Bagozzi, 2007). Moreover, both Van Raaij and Schepers (2008) and Bagozzi (2007) mention that arguable important independent variables have been left out and the others are general. It is exactly this general operationalization of the existing models that makes UTAUT a good model to assist with the measurement of the intention to adopting new technologies (Williams et al., 2015), giving way for this study to expand upon the existing UTAUT model.

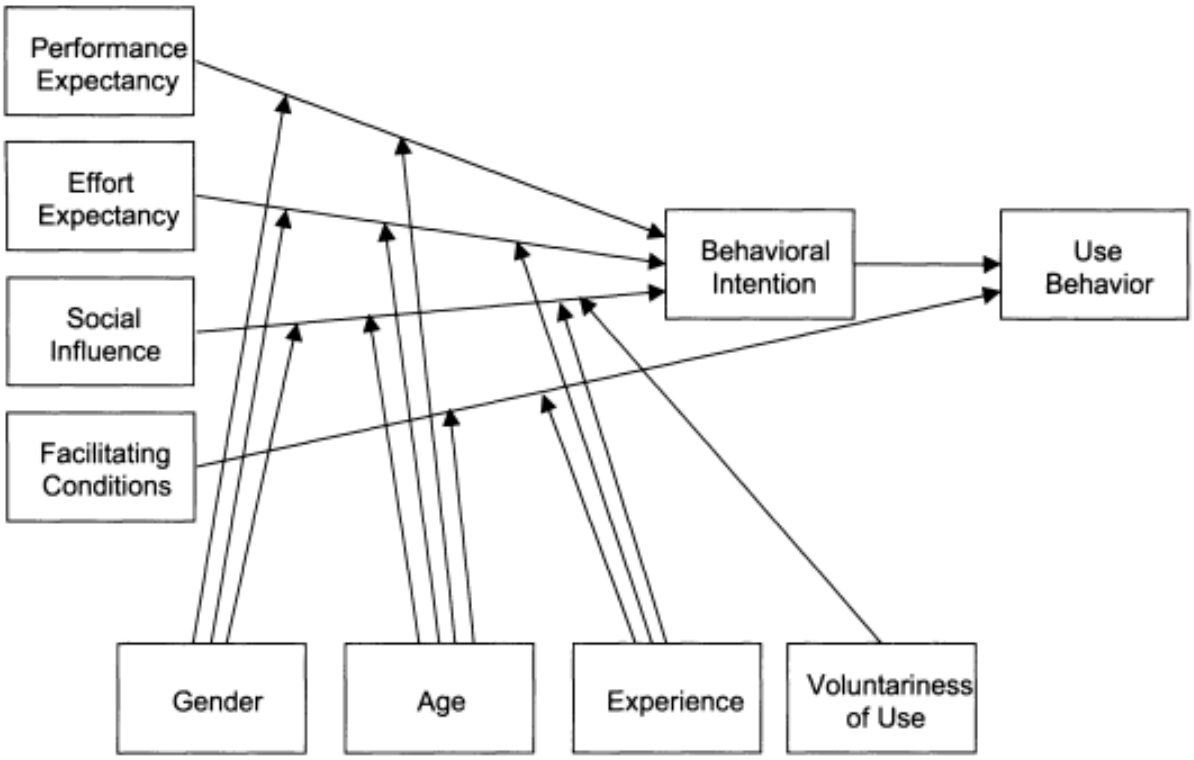

Figure 2 Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003, p. 447)

The UTAUT model is used for this research as it incorporates the social influence and facilitating conditions. Which make a continuation of the exploratory research by Van Dun and Kumar (2023) possible. They stated avenues for studying the differences in technology acceptance that are achieved by different leadership styles. Moreover, it is stated that a leader's emotional intelligence might detect upon the general consensus among staff members (Neufeld et al. ,2007; Van Dun and Kumar 2023). Furthermore, van Dun and Kumar (2023) found evidence that charismatic leadership precedented all four sub-dimensions of the UTAUT. On the contrary, Manko (2023) found that transformational leadership was an antecedent for all sub dimensions of UTAUT as well. Both finding by Manko (2023) and van Dun and Kumar (2023) indicate that the leadership style influences possible technology acceptance. Making both avenues of leader emotional intelligence and leadership style worthwhile to research further. However, there could not be any leader without employees. Therefore, for this research we incorporate the softer sides of the TAM 3 model by Venkatesh and Bala (2008) specifically the variables relating to computer playfulness and computer anxiety, as both are employee oriented and could help elaborate on the role of individual cognitive perception of industry 4.0 technologies (Van Dun & Kumar, 2023).

2.3 Role of instrumental leadership style in employee intention to use Industry 4.0 technologies

Schneider (2018) emphasized the importance of leaders developing strategic transformation paths, which involve defining a clear roadmap for the transformation towards industry 4.0 technology usage. Roadmaps are commonly used to articulate a clear, common, and shared vision while simultaneously carrying out a radical innovation (Phaal et al., 2004). A generic roadmap as proposed by Phaal et al. (2003) consists out of several layers. The first being external influences, followed by deliverables, technology, skills, and resources. Such a roadmap closely resembles the variables as proposed by Antokanis and House (2014) for their fuller full-range of leadership. They defined instrumental leadership as the application of leader expert knowledge on monitoring of the environment and of performance, and the implementation of strategic and tactical solutions (Antokanis & House, 2014). For example, the external influences in a roadmap closely relate to environmental monitoring, whereas the path-goal facilitation can relate to the recourses that are made available within the roadmap and the strategy formulation and implementation might be seen as the actual roadmap. Lastly, the monitoring of the roadmap closely resembles the outcome monitoring. Because of the similarities in nature of the roadmap and instrumental leadership we have decided to choose this type of leadership style rather than the commonly known styles as proposed by Avolio and Bass (2001).

In Venkatesh and Bala (2008) they proposed to further include managerial decision making into the model. For example, managers can, through design characteristics, user participation, training, and peer support increase perceived ease of use and perceived usefulness. In Venkatesh et al. (2003) the subjective norm or social influence is introduced as the degree to which people perceive that important others believe he or she should use the system. This may include the leaders. Therefore, we believe that the leadership style has a relationship with the subjective norm as is underlined by Chrusciel (2006) who found that environmental monitoring, monitoring and support, and path goal facilitation led to a strengthened team. Moreover, leaders can decide on the allocation of resources for said interventions thereby supporting employees in their preparedness for the use of the new technologies (Venkatesh and Bala, 2008). The allocation of the resources for the interventions can underline the importance of new technologies for the management. This avenue for further research was too proposed by Williams et al. (2015) who stated that perceived management support can out itself in ways of training and support as well as organisational policies and procedures all of which a leader can influence. Therefore, we formulated the following hypothesis:

H1: The positive relationship between instrumental leadership style and employees' intention to use I4.0 technologies is mediated by employees' (a) perceived ease of use; (b) perceived usefulness; (c) subjective norm; and (d) perceived management support.

2.4 Role of leader emotional intelligence in employee intention to use Industry 4.0 technologies

Industry 4.0 technologies are disruptive and require new ways of working which requires change for employees. According to Nordin (2011) emotional intelligence contributes to employees' attitude to organisational change. The topic of human emotions has been of interest long before it had ever been created into an actual construct (Law et al., 2004; Cherniss, 2000). Chernis (2000) found that when psychologist began to write about intelligence the focus was on cognitive functions such as memory and problem-solving. But there were researchers who were interested in non-cognitive parts. Wechsler (1940) referred to intelligence as being intellective and non-intellective in which the latter referred to personal social factors. Around the same time period, Thorndike and Stein (1937) wrote about social intelligence which would later be continued by when he introduced the multiple intelligence theory in 1983 (Gardner, 2011). Which proposed that people have an interpersonal and intrapersonal intelligence. The former relates how people interact with others and perceive others emotions whereas the latter relates to the understanding and control of their own emotions. This theory would later be confirmed and expanded upon by Salovey and Mayer (1990) and Wong and Law (2002).

Ever since emotional intelligence became a topic, it has been growing in interest among researchers (Dulewicz & Higgs, 1999). More interestingly however is the debate whether an individual can develop its emotional intelligence and to what extent it was innate (Goleman, 1996; Dulewicz & Higgs, 1998a, 1998b). According to Gardner (2011), the interpersonal and intrapersonal intelligences are not static but rather developable. Therefore, the measurement results of an emotional intelligence test should be used for the purpose of personal development, much of this development will be achieved through the means of reflection on individual behaviours (Dulewicz & Higgs, 1999). Continuing on this argument we found that Rosete and Ciarrochi (2005) researched that a leader's emotional intelligence can influence employee outcomes, such as performance. This argument was further specified to include that a leader's perception of employees' emotions influenced the employee outcome (Vidyarthi et al., 2014). Therefore, we have reason to believe that a leader's emotional intelligence can influence the intention to use industry 4.0 technologies through the several antecedents of the UTAUT model. As we believe that a leader's emotional intelligence influences a leader's capability to understand what an employee is experiencing when using a new technology. This understanding of emotions is what can help a leader guide an employee and

emphasize on how said technology may improve its work or how easy the technology may actually be to use. Moreover, a leader's emotional intelligence is related with the interpersonal intelligence (Gardner, 2011) which is how a leader interact with others. We know from Venkatesh et al. (2003) that this relates to the subjective norm an employee may experience when using a new technology. Lastly, a leader's emotional intelligence may help convey the importance of the technology to management. All of which lead us to hypothesize that:

H2: The positive relationship between leader's emotional intelligence and employees' intention to use I4.0 technologies is mediated by employees' (a) perceived ease of use; (b) perceived usefulness; (c) subjective norm; and (d) perceived management support.

Except for the relation between a leader's emotional intelligence and the precedents of the UTAUT model, Rosete and Ciarrochi (2005) found that emotional intelligence is related to a leader's effectiveness in being able to achieve organisational goals. On the contrary, Gardner and strough (2002) investigated the influence of emotional intelligence on leadership. They concluded that emotional intelligence has a predictive ability of leadership style, especially transformational leadership. However, some researchers like Palmer et al. (2001) note that the active use of emotional traits and the ability to monitor and manage is what is more important. Because of these arguments we believe that there is a relation between a leader's emotional intelligence and its instrumental leadership style as presented in the hypothesis below:

H3: There is a positive relationship between a leader's emotional intelligence and their instrumental leadership style.

2.5 Role of employee emotional intelligence in employee intention to use Industry 4.0 technologies

Due to the complexity of new technologies, it is increasingly difficult for employees to effectively adopt and utilize new technologies (Venkatesh and Bala, 2008). The magnitude of these impacts of new technologies makes employees reluctant to accept the newly introduced technology (Lapointe & Rivard, 2005). Nordin (2011) argues that it is emotional intelligence that contributes to employees' attitude to organisational change and thus acceptance of said changes or new technologies.

Moreover, van Dun and Kumar (2023) suggested to research an employee's emotional intelligence as precedent to the UTAUT model. But they were not the first to suggest that emotional intelligence has its place with the UTAUT model. Even Venkatesh and Bala (2008), the creators of the

model, suggested that the emotions, al be it related to computer attitude, have a place in the TAM 3 works. As they suggested that these computer related emotions have a place in TAM 3, we aim to explore whether emotional intelligence as a whole, influences either perceived ease of use or perceived usefulness.

Moreover, as presented in Venkatesh et al. (2003) social influence contains the notion that a individuals' behaviour is influenced by the way they believe others will perceive them as a result of using a technology. This belief can be influenced by how the person recognises and understand the emotions of others.

Additionally, Eisenberger et al. (1986) found that employees who perceived management support would respond with positive work attitude and behaviour. This is reiterated by the study of Zampetakis et al. (2009) who found that employees with high EI are more capable of taking appropriate actions that influence entrepreneurial behaviour. Entrepreneurial behaviour may be defined as "Getting things done in an entrepreneurial – innovative and unusual – way" (Mair, 2005, p. 51) which could be an innovative Industry 4.0 technology. By these definitions we believe that emotional intelligence relates with perceived management support to the intention to use industry 4.0 technologies. Giving reason to explore whether there is a relation between any of the precedents of UTAUT and employee emotional intelligence. Which lead us to the following hypothesis:

H4: The positive relationship between employee's emotional intelligence and their intention to use I4.0 technologies is mediated by their (a) perceived ease of use; (b) perceived usefulness; (c) subjective norm; and (d) perceived management support.

2.6 Role of computer playfulness in employee intention to use Industry 4.0 technologies

The variables related with computer playfulness were first introduced into TAM 3 by Venkatesh and Bala (2008). They stated that a person their individual relation with technology may be of influence on their acceptance of new technologies. Sometime after, this was also proposed by Schneider and Sting (2020) who introduced it as the playful frame from their proposed five cognitive frames, with the other frames being traditional, anthropocentric, utilitarian, and functional. Moreover, Schneider and Sting (2020) observed that the playful frame adoption is only prevalent in lower-level employees compared to higher level employees. In an updated version of the UTAUT model, UTAUT2 by Venkatesh et al. (2012), the construct of hedonic motivation was added. This construct is described as enjoyment and fun which closely resembles the computer playfulness construct. According to Tamilmani et al. (2021), this is closely related to intrinsic motivation of an individual which reflects the enjoyment and fun associated with using technology. Whereas, Blut et al. (2022) refers to

hedonic motivation in terms of technology acceptance as pleasure, enjoyment and intrinsic motivation in technology interaction. Both Tamilmani et al. (2021) and Blut et al. (2022) refer to this type of motivation as an important factor in the prediction of a person's intention to use technology. Indeed, from Venkatesh and Bala (2008) their TAM 3 model we know that computer playfulness has an influence on perceived ease of use as they found that people who enjoy working with new technologies were more likely to see added value of said technology. However, as from UTAUT2 (Venkatesh et al. 2012) we know that hedonic motivation relates to intention to use they did not state any relation between computer playfulness and perceived usefulness. This relation was indeed recommended in newer studies by Tamilmani et al. (2020) who found that the perceived usefulness in terms of performance improved as they used more features of the technology. Therefore, we formulated the following hypothesis:

H5: The positive relationship between employee's computer playfulness and their intention to use I4.0 technologies is mediated by (a) perceived ease of use; and (b) perceived usefulness.

2.7 The model

Based on the hypothesis from the previous sub chapters a research model was derived.

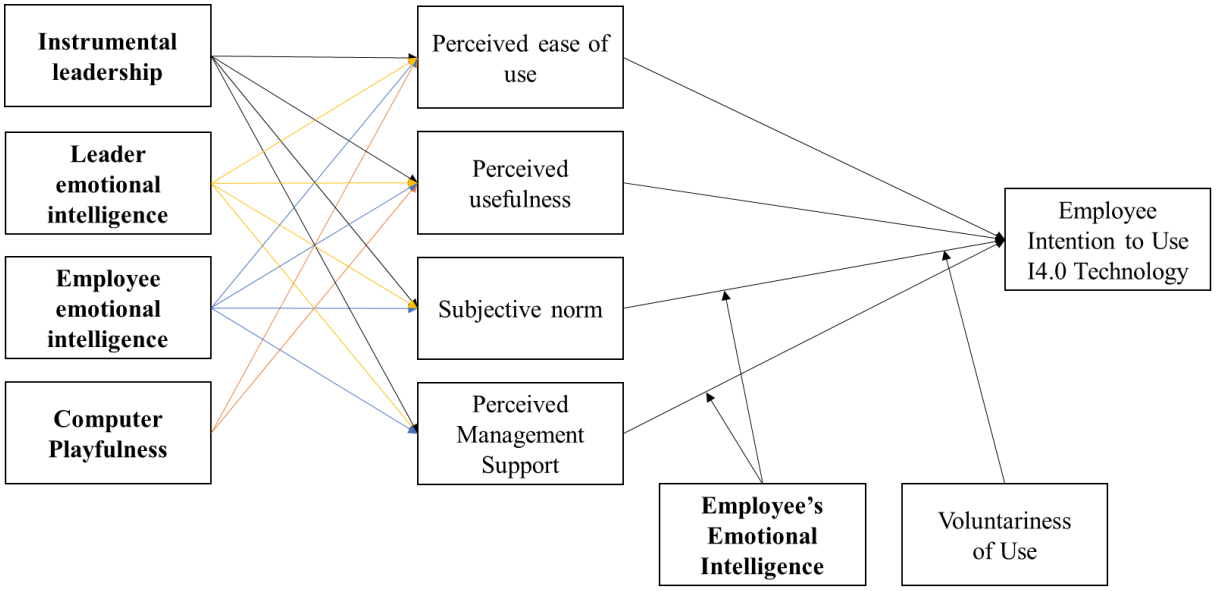

Figure 3 Hypothetical model, bold variables are an expansion of the UTAUT model.

3 Method

In this chapter the type of data collection is presented as well as the research design. The research design will help answer the previously formulated research questions. In the next section of this paragraph the research design is elaborated on which will be followed with an explanation for the sample, an overview of the concepts that are to be answered during the data collection, the data collection process, the analysis of said data, and lastly the ethics that are involved with the collection and analysis of the participants' data.

3.1 Research design

As mentioned in the introduction this research combines the concepts of Technology Acceptance with Leadership, Emotional intelligence, and Computer Playfulness. The several topics of this research can be classified in a continuum from mature to nascent prior available theory as described by Edmondson and McManus (2007). They mention that extensive theory that is available prior to the research can be classified as mature, these theories are elaborate and with precise models. Given that, as presented in the previous theory section, there is an extensive amount of literature readily available on all topics of the research and the research field is steadily developing, we focus on the intermediate to mature theory approaches (Edmondson and McManus, 2007). This approach entailed reaching out to a sample for quantitative research through the means of a survey. With the possibility to obtain data from field sites. Additionally, this meant that the research heavily relied on existing survey scales. The hypotheses testing was performed through statistical inference.

3.2 Sampling

Through purposive sampling we reached out to organisations that operate in the production industry and have implemented some industry 4.0 technology in recent years. The success rate at which the industry 4.0 technology can be different throughout the organisations, which for some was even reason to participate with this study.

The first organisation was an international organisation located in the Netherlands which is a supplier of engine parts to various manufacturers within Europe. This organisation employs well over five hundred people across two divisions in the Netherlands. Over the last three years they have invested in 3D modelling of engine parts and cloud computing to simulate tests remotely that otherwise would have required to build an actual engine for testing. The second organisation produces specialised lenses. This international organisation employs over 30 thousand people across 38 countries. The organisation was chosen to participate with as they had recently implemented both cloud computing software and automated machinery. The last organisation is a business that specialises in the automation of production facilities through the application of controllable programmer units. Worldwide, this organisation employs over 20 thousand people across 176 countries. As they implement automation within productional facilities they offer a type of cloud

computing to manage and monitor the implemented automations. This organisation has various locations through Europe and participated with locations from the Benelux and UK.

Table 1: Participating organisations

	Sector	Employees World Wide	Potential Sample	Sample (response rate)
Organisation A	Automotive	81.000	100	34 (34%)
Organisation B	Medical	30.000	50	15 (30%)
Organisation C	Process automation	20.000	100	49 (49%)

Several locations of the participating organisations were visited in order for the researcher to get more familiar with the type of organisation. Throughout the visits production processes were shown and applicable industry 4.0 technologies were recognized, deeming the organisations a good fit for the research. Moreover, it was discussed with the contact person of the organisation which people would participate in the research. The selection of the participants was carried out by the organisation while considering some of the following requirements:

1. The candidate regularly works with the newly implemented Industry 4.0 technology.
2. The candidate used to work regularly with the newly implemented Industry 4.0 technology.
3. The candidate leads personnel working with the newly implemented Industry 4.0 technology.[1]

To achieve a selection based on these criteria a non-probability sampling method of purposive sampling has been chosen. This allowed for selecting candidates based on some judgement by the researcher looking for representatives that fit the research objective (Vehovar et al., 2016 p. 333). Whereas, with probability sampling the group of candidates would be selected randomly thereby increasing the chances of involving candidates that are not actively involved with the Industry 4.0 technology. However, a negative aspect of the non-probability sampling method is the risk of researcher bias which is ought to be mitigated by asking managers to select candidates based on the previously given criteria.

As the survey was distributed among both employees and supervisors the descriptive statistics in (Table 2) show the initial distribution. With a response rate of 37.6% the rate was relatively decent. However, because not all participants completed the whole questionnaire some numbers are higher

[1] It is assumed that candidates leading personnel have experience or work with the Industry 4.0 technology.

than those related to the other descriptives. It was decided to keep their answers within the data because of the already small sample sizes. Noticeable from Table 2 is that the participants span all ages and that there are a high number of males (64%) versus females (4%). The latter can be explained by the departments that were requested to participate. As during the field visits mostly men were seen working in the departments. Further, the age distribution is not normally distributed; the test of normality shows that with a significance of .031 on the Shapiro-Wilk test is not a normal distribution. Moreover, it is notable that 31% of the people have been in their current position up to 3 years as well as that 25% of people stated that their highest completed level of education is a Bachelor from a University of Applied Sciences (UAS), while 42% of the participants has completed a master's degree at an UAS or higher.

Table 2 Descriptive statistics

Descriptive Statistics

Statistics	Item	Frequency	Percent	Cumulative Percent
Organisation a	A	15	15.3%	15.3%
	B	34	34.7%	50.0%
	C	49	50.0%	100.0%
	Total	98	100.0%	
Gender	Male	63	64.3%	64.3%
	Female	4	4.1%	68.4%
	Missing	31	31.6%	100.0%
	Total	98	100.0%	
Age b	<20	0	0.0%	0.0%
	21-30	12	12.2%	12.2%
	31-40	17	17.3%	29.6%
	41-50	14	14.3%	43.9%
	51-60	13	13.3%	57.1%
	61-70	2	2.0%	59.2%
	Missing	40	40.8%	100%
	Total	98	100.0%	
Position	Employee	37	37.8%	37.8%
	Supervisor	12	12.2%	50.0%
	Organisation C	49	50.0%	100.0%
	Total	98	100.0%	
Years in Organisation c	<1	1	1.0%	1.0%
	2-3	8	8.2%	9.2%
	4-6	10	10.2%	19.4%
	7-9	10	10.2%	29.6%
	10-12	12	12.2%	41.8%
	13-15	4	4.1%	45.9%
	16-18	3	3.1%	49.0%
	19-21	4	4.1%	53.1%
	22-24	2	2.0%	55.1%
	25-27	1	1.0%	56.1%
	28-30	2	2.0%	58.2%
	Missing	41	41.8%	100.0%
	Total	98	100.0%	
Years in current Position	1	7	7.1%	7.1%
	2-3	24	24.5%	31.6%
	4-6	9	9.2%	40.8%
	7-9	5	5.1%	45.9%
	10-12	6	6.1%	52.0%
	13-15	1	1.0%	53.1%
	16-18	2	2.0%	55.1%
	19-21	2	2.0%	57.1%
	21-24	1	1.0%	58.2%
	25-27	0	0.0%	58.2%
	28-30	1	1.0%	59.2%
	Missing	40	40.8%	100.0%
	Total	98	100.0%	
Highest completed education	Secondary school	2	2.0%	2.0%
	High-school	6	6.1%	8.2%
	Vocational degree	4	4.1%	12.2%
	Bachelor UAS	24	24.5%	36.7%
	Master UAS	3	3.1%	39.8%
	University Bachelor	5	5.1%	44.9%
	University Master	9	9.2%	54.1%
	Graduate (PhD.)	1	1.0%	55.1%
	Other	9	9.2%	64.3%
	Missing	35	35.7%	100.0%
	Total	98	100.0%	

a For organisation C a division between supervisors and employees cannot be made due to an error in distribution

b For the purpose of presenting the years were summarised into a range

c For the purpose of presenting the years were summarised into a range

3.3 Data collection

For the data collection a questionnaire has been chosen to accommodate for the large number of participants. The questionnaire has been made in two-fold one for employees and one for their managers.

3.3.1 Instrumental leadership style

To measure the concept of leadership style the scale developed by Antokanis and House (2014) was chosen. These questions describe the way the participants perceives the leader in four sub concepts of instrumental leadership: Environmental Monitoring (EM); Strategy Formulation and Implementation (SF); Path-goal Facilitation (PG); and Outcome monitoring (OM). These factors were represented with four questions each with examples such as “My supervisor recognises the strengths of our organisation” (EM), “My supervisor ensures that his/her vision is understood in specific terms” (SF), “My supervisor facilitates my goal achievement” (PG), and “My supervisor provides me with information concerning how mistakes can be avoided” (OM). Totalling the number of questions to sixteen to measure the concept of instrumental leadership. The questions were presented randomly and answered by a five-point Likert scale ranging from ‘Not at all’ (1) to ‘Frequent, if not always’ (5).

3.3.2 Emotional intelligence

To effectively measure the emotional intelligence of leaders and employees, the Wong-Law Emotional Intelligence Scale (WLEIS) was applied. In this scale Wong and Law (2002) differentiate between four factors: Other Emotional Appraisal (OEA); Regulation of Emotions (ROE); Self-Emotional Appraisal (SEO); and Use Of Emotion (UOE). These factors are represented by four questions with questions such as “I am sensitive to the feelings and emotions of others” (OEA), “I can always calm down quickly when I am very angry” (ROE), “My supervisor has a good sense of why I have certain feelings most of the time” (SEO), and “My supervisor always set goals for myself and then try my best to achieve them” (SUOE), totalling to a total of sixteen questions measuring the concept of emotional intelligence. The questions were then copied in such a way that it describes the supervisor. Each of the questions were presented at random and answered by a seven-point Likert scale ranging from ‘Totally disagree’ (1) to ‘Totally agree’ (7).

3.3.3 Computer playfulness

To measure the perception of new technology, Vankatesh and Bala (2008) introduced two constructs: Computer Enjoyment and Computer Anxiety. Both factors aim to understand the attitude and interaction with technology. Computer Enjoyment (CE) describes the joy people perceive when using new technologies. Whereas, with Computer Anxiety (CA) it describes the opposite, with discomfort when using the technology. To measure these factors, Venkatesh and Bala (2008) developed a questionnaire comprising of four and three questions each, totalling seven questions.

The questions were presented randomly and answered on a seven-point Likert scale ranging from 'Strongly Disagree' (1) to 'Strongly Agree' (7). Examples of such questions were "I find using the new technology to be enjoyable" (CE) and "New technologies make me feel uncomfortable" (CA).

3.3.4 Perceived ease of use

Perceived Ease of Use (PEOU) as used by Venkatesh et al. (2003) is a dimension used in assessing opinions on new technologies. This measures individuals perceptions of the ease with which they can use a new technology to achieve expected results. Participants respond to questions like "I find it easy to use this new technology and achieve the desired results" on a seven-point Likert scale, ranging from 'Strongly disagree' (1) to 'Strongly agree' (7).

3.3.5 Perceived usefulness

Perceived Usefulness (PU) is another construct used by Venkatesh et al. (2003). It focuses on individuals' perceptions of how using a new technology can improve their performance. Participants express their opinions through questions such as "I have noticed that using this new technology improves my performance" on a seven-point Likert scale.

3.3.6 Subjective norm

Subjective Norm (SN) plays a role in understanding the acceptance of new technologies (Venkatesh et al., 2003). This measures the social influence people experience for the use of a new technology. Questions such as "People who are important to me think that I should use this new technology" are answered on a seven-point Likert scale.

3.3.7 Voluntariness of use

Voluntariness of Use (Vol) as proposed in the UTAUT model by Venkatesh et al. (2003) explores whether individuals feel compelled to use a new technology. Participants respond to statements like "My supervisor does not require me to use this new technology" on a seven-point Likert scale, expressing their level of agreement or disagreement.

3.3.8 Perceived management support

The Perceived Management Support (PMS) construct is used to operationalize the facilitating conditions within the UTAUT model. It aims to capture the degree to which employees perceive that their managers support them in their work. The questions in this dimension measure employees' perception of their managers' willingness to provide resources, assistance, and encouragement. To measure the concept of Perceived Management Support (PMS), Holt et al. (2007) developed a scale of four measures. However, for the relevance of this research only the perceived management support scale was used. This scale consists of a set of six questions of which two were "Every senior manager has stressed the importance of new technology" and "Management has sent a clear signal that this organisation is going to change". These questions were presented randomly and answered on a seven-point Likert scale, ranging from 'Strongly disagree' (1) to 'Strongly agree' (7).

3.3.9 Employee intention to use I4.0 technologies

Behavioural Intention (BI) as used in the UTAUT model of Venkatesh et al. (2003) is the final measure that was introduced. In the context of new technology adoption. It assesses participants' intentions to use a new technology assuming they have access to it. Questions like "I intend to use this new technology assuming I have access to it" prompt individuals to express their intentions on a seven-point Likert scale, ranging from 'Strongly disagree' (1) to 'Strongly agree' (7).

3.3.10 Reliability analysis

Table 2 shows the reliability analysis per variable; each of the variables consist of several items. Table 1 too shows the results of the reliability analysis for the overarching constructs. In the initial reliability analysis, all of the relevant individual variables of each construct were assessed, presenting some variables with a Cronbach's Alpha below the required threshold of 0.7 for acceptable reliability. Especially, the Self-Emotional Appraisal and Use of Emotion had a Cronbach's Alpha of 0.541 and 0.627, respectively. Further analysis of these items showed that neither recoding nor deletion would increase the Cronbach's alphas. However, since the overall Emotional Intelligence construct had a high Cronbach's Alpha of more than 0.821 (see, Table 2) and is successfully used throughout different studies (Zampetakis et al. 2009) these items were retained as is. Interestingly, the same items were included in the construct of Leaders' Emotional Intelligence, which *did* meet the required threshold for both items.

Additionally, the Voluntariness variable showed a Cronbach's Alpha only 0.467, which was too low to be considered acceptable. Despite attempts to increase the Cronbach's Alpha through recoding and deletion of items, the results were still below the acceptable threshold. As a result, we disregarded this construct in the further analyses.

Finally, all of the previously mentioned variables are part of larger constructs, these constructs were too tested for reliability. Which resulted in excellent Cronbach's Alphas as presented in Table 3. The excellent values for the Cronbach's Alpha meant that all constructs could be used in further analysis.

Table 3 Reliability per sub construct

Reliability Analysis per Variable

Constructs	N Items	Cronbach's Alpha	Mean	Std Dev.
Instrumental leadership	**16**	**0.958**	**3.531**	**0.801**
Environmental Monitoring	4	0.818	3.825	0.693
Strategy formulation and implementation	4	0.891	3.486	0.902
Path–goal facilitation	4	0.911	3.405	0.941
Outcome monitoring	4	0.918	3.408	0.999
Leader's emotional intelligence	**16**	**0.937**	**5.043**	**0.823**
Others emotional appraisal	4	0.896	4.736	1.129
Regulation of emotions	4	0.882	5.197	1.004
Self emotional appraisal	4	0.885	4.799	0.856
Use of emotion	4	0.831	5.431	0.973
Employee emotional intelligence	**16**	**0.821**	**5.570**	**0.565**
Others emotional appraisal	4	0.819	5.330	0.952
Regulation of emotions	4	0.831	5.548	0.924
Self emotional appraisal	4	0.541	5.690	0.654
Use of emotion	4	0.627	5.711	0.689
Computer Playfulness	**7**	**0.895**	**5.878**	**0.827**
Computer Anxiety	4	0.844	3.139	0.663
Computer Enjoyment	3	0.838	5.814	0.944
Perceived Ease of Use	**4**	**0.879**	**4.770**	**1.211**
Perceived Usefulness	**4**	**0.878**	**4.684**	**1.047**
Subjective Norm	**4**	**0.725**	**4.257**	**1.034**
Perceived management support	**6**	**0.815**	**4.230**	**1.136**
Voluntariness of use	**3**	**0.476**	**4.421**	**1.047**
Employee intention to use I4.0 technologies	**3**	**0.822**	**5.333**	**1.028**

3.4 Data analysis

The Statistical Package for the Social Sciences (SPSS) was used to analyse the data collected in this research. Through SPSS a reliability and correlation analysis were performed. After which, the mediations and moderations were tested. A commonly used method for testing for mediation is the approach introduced by Baron and Kenny (1986). This method is based on several regression analyses which all have to be significant in order to be able to assume mediation. Moreover, it requires a normal distribution of the data. Another method is the Process Macro of Hayes (2012) which is an extension of the SPSS software package. The Process Macro allows to enter variables into a predefined model which will then run a mediation test. A great advantage of the Process Macro is that it applies Bootstrapping which does not assume any underlying distribution of the data. It is exactly that reason why we preferred Process Macro over Baron and Kenny (1986) as the data, even

after logarithmic transformation and deletion of several outliers was not normally distributed. Moreover, the Process Macro also allows for entering moderated mediations which made it another reason why this method was preferred.

3.5 Ethics

With the collection of data ethics were included, prior to the invitation of organisations to participate in the study the research proposal was submitted to the Ethics Committee of the University of Twente. The Ethics committee granted permission to conduct the research, number 220541, after which the first organisations were approached with a two-pager (Appendix I) to spark their interest to participate in the study. The interested organisation gave their permission to distribute the survey amongst the employees they selected to participate. All the selected potentially participating employees were made aware through a cover letter of the questionnaire, what the intent of the study is. They were made aware that participation is entirely voluntarily, anonymous, and that consent can be withdrawn at any moment before submission of the questionnaire. The cover letter also informs the participant that their data is stored according to ISO and NEN regulations on encrypted data drives.

The research is subject to regulations of the EU General Data Protection Regulation (GDPR), the Code of Conduct for the use of personal data in Scientific Research by VSNU (the Association of Universities in the Netherlands), and the obligation to report a security incident (data breach or otherwise) at the University of Twente.

4 Results

This chapter presents the analysis of the survey data in a stepwise manner where all of the single possible interactions are analysed first before testing the hypotheses.

4.1 Correlation Analysis

In Table 4, the correlation matrix is presented that reveals findings with regard to the correlations between the constructs. Notably, a significant positive correlation could be observed among several variables. In particular the strong correlation of .693 between instrumental leadership and leader emotional intelligence.

A significant positive correlation of .590 was observed between the mediators perceived ease of use and perceived usefulness. Moreover, subjective norm had a significant positive correlation with perceived ease of use (.499), perceived usefulness (.499) and perceived management support (.382). In addition to the significant positive correlations with the other mediators, subjective norm also showed a significant positive correlation with instrumental leadership (.498).

Furthermore, perceived management support showed a significant positive relation with instrumental leadership (.560). Lastly, intention to use presented a significant positive relation with computer playfulness (.511) and with three out of the four mediators. Namely, perceived ease of use (.635), perceived usefulness (.684), and subjective norm (.430).

There were also a few insignificant correlations that require a mention. The lack of correlations with perceived management support indicated that this variable most likely will not show any meaningful mediations in the following analyses. Another notable variable that lacked correlation was employee emotional intelligence which did not show any correlation with any other variable.

Table 4 Correlation matrix overarching constructs

Correlation Matrix

	N items	M	SD	1	2	3	4	5	6	7	8	9
1. Instrumental leadership	16	3.531	0.801	(0.958)								
2. Leaders emotional intelligence	16	5.043	0.823	.693***	(0.937)							
3. Employee emotional intelligence	16	5.570	0.565	.145	.209*	(0.821)						
4. Computer Playfulness	7	5.878	0.827	-.041	-.047	.138	(0.895)					
5. Perceived Ease of Use	4	4.769	1.211	.281*	.12	.054	.262	(0.879)				
6. Perceived Usefulness	4	4.684	1.047	.359**	.162	.151	.296*	.590***	(0.878)			
7. Subjective Norm	4	4.256	1.034	.058	.087	.313	.498***	.499***	.429***	(0.725)		
8. Perceived Management Support	6	4.230	1.136	-.287*	.097	.359**	.560***	.171	-.020	.382**	(0.806)	
9. Intention to Use	3	5.333	1.028	.511***	.135	.263	.269	.635***	.684***	.430***	-.101	(0.822)

*p <.10 **p < .05. ***p< .01

n respondents, 98

4.2 Hypotheses testing

The following section will discuss each of the individual hypotheses with their corresponding visual figure below it. Table 5, at the end of this section, summarises all of the relations from the figures. In addition, Table 6 offers a synopsis of the supported and not supported hypotheses.

Hypotheses 1.a suggested that Instrumental leadership is linked to the intention to use, mediated by perceived ease of use. Mediation analysis showed no significant indirect effect (ß = 0.185, CI [-0.649, 0.486]) of Instrumental leadership on intention to use through perceived usefulness. Consequently, hypothesis 1.b was not supported.

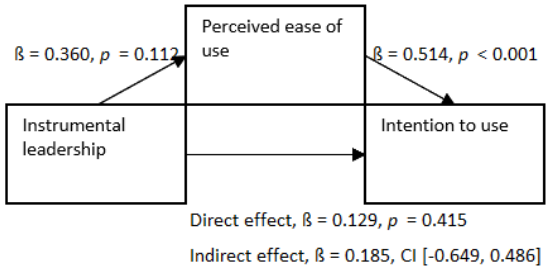

Figure 4 IL, PEOU, ITU

Hypotheses 1.b stated that instrumental leadership is associated with the intention to use, mediated by perceived usefulness. The results of the mediation analysis were significant with an indirect effect (ß = 0.228, CI [0.014, 0.448]) of Instrumental leadership on intention to use through perceived ease of use. Therefore, hypothesis 1.a was supported.

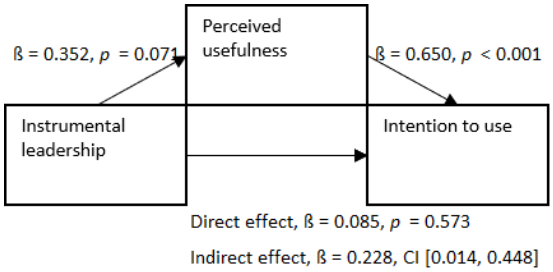

Figure 5 IL, PU, ITU

Hypotheses 1.c stated that Instrumental leadership is associated with the intention to use, mediated by the subjective norm. The mediation analysis indicated that there was a significant indirect effect (ß = 0.229, CI [0.004, 0.595]) of Instrumental leadership on intention to use through subjective norm. Therefore, hypothesis 1.c was supported.

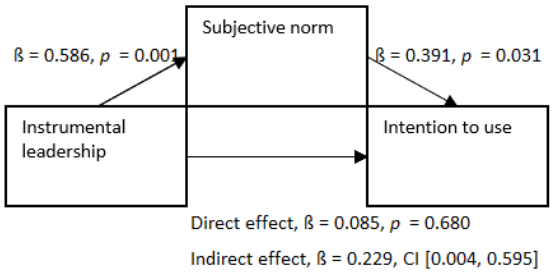

Figure 6 IL, SN, ITU

Hypotheses 1.d proposed that Instrumental leadership is tied to the intention to use, mediated by perceived management support. The result of the analysis regarding the indirect effect showed that there was no significant (ß = -0.249, CI [-0.637, 0.040]) effect of Instrumental leadership on intention to use through perceived management support. Hypothesis 1.d was thus not supported.

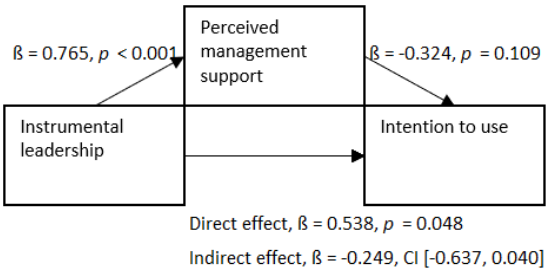

Figure 7 IL, PMS, ITU

Hypotheses 2.a stated that leader emotional intelligence relates to the intention to use, mediated by perceived ease of use. The mediation analysis indicated that there was no significant indirect effect (ß = 0.038, CI [-0.215, 0.297]) of leader emotional intelligence on intention to use through perceived ease of use. Therefore, hypothesis 2.b was not supported.

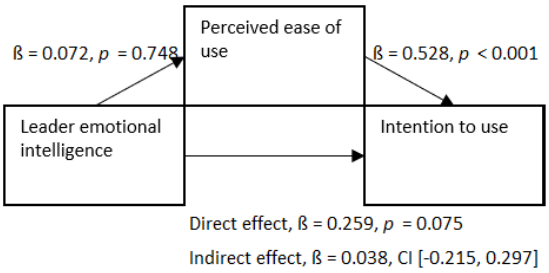

Figure 8 LEI, PEOU, ITU

Hypotheses 2.b stated that leader emotional intelligence relates to the intention to use, mediated by perceived usefulness. The mediation analysis indicated that there was no significant indirect effect (ß = 0.113, CI [-0.124, 0.337]) of leader emotional intelligence on intention to use through perceived usefulness. Therefore, hypothesis 2.b was not supported.

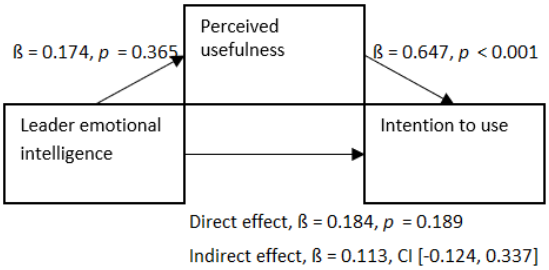

Figure 9 LEI, PU, ITU

Hypotheses 2.c posed that Leader emotional intelligence is linked to the intention to use, mediated by the subjective norm. The mediation analysis indicated that there was a significant indirect effect (ß = 0.229, CI [0.006, 0.404]) of leader emotional intelligence on intention to use through perceived usefulness. Thus, hypothesis 2.c was supported.

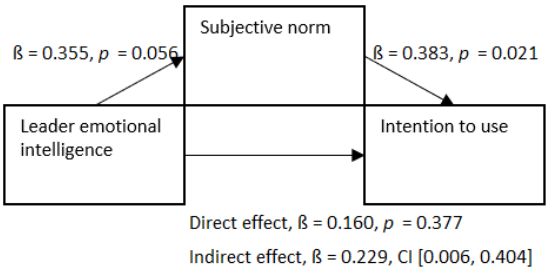

Figure 10 LEI, SN, ITU

Hypotheses 2.d suggested that Leader emotional intelligence is connected to the intention to use, mediated by perceived management support. From the mediation analysis we found that there was no significant indirect effect (ß = -0.131, CI [-0.313, 0.153]) . Therefore, hypothesis 2.d was not supported.

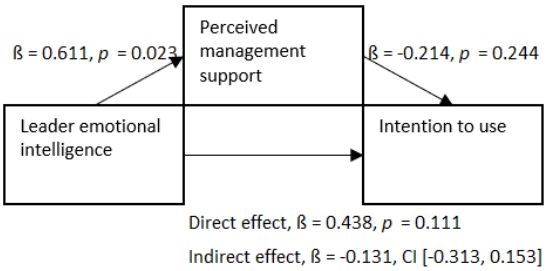

Figure 11 LEI, PMS, ITU

Hypothesis 3 suggested that emotional intelligence relates to leadership style. Following up on the mediation analyses of instrumental leadership, we found that emotional intelligence and instrumental leadership style had a significant positive relationship of (ß = 0.680, $p < 0.001$). Therefore, hypothesis 3 was supported.

Hypotheses 4.a suggested that employee emotional intelligence is connected to the intention to use, mediated by the perceived ease of use. After the mediation analysis it was clear that there was no significant indirect effect (ß = 0.157, CI [-0.300, 0.700]). Consequently, hypothesis 4.a was not supported.

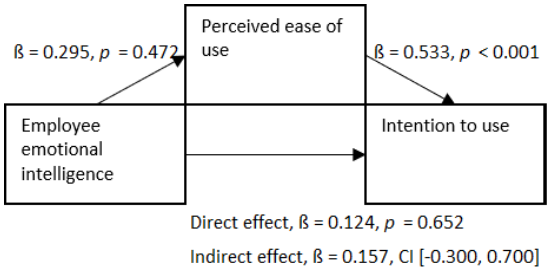

Figure 12 EEI, PEOU, ITU

Hypotheses 4.b stated that employee emotional intelligence is related to the intention to use, with perceived usefulness as the mediator. The mediation analysis indicated that there was no significant indirect effect (ß = 0.229, CI [-0.309, 0.794]) of leader emotional intelligence on intention to use through perceived usefulness. Therefore, hypothesis 4.b was not supported.

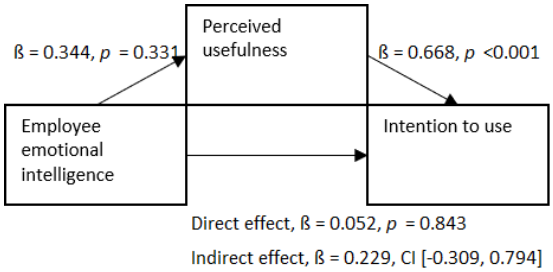

Figure 13 EEI, PU, ITU

Hypotheses 4.c stated that employee emotional intelligence relates with intention to use, mediated by the subjective norm. From the mediation it showed that there was no significant indirect (ß = 0.076, CI [-0.171, 0.430]) of leader emotional intelligence on intention to use through subjective norm. Thus, hypothesis 4.c was not supported.

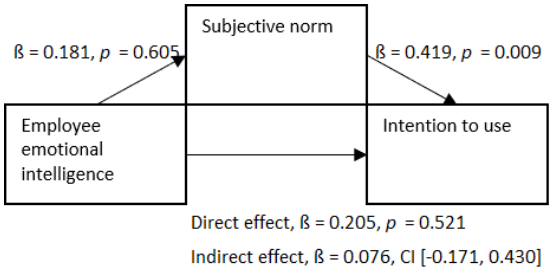

Figure 14 EEI, SN, ITU

Hypotheses 4.d proposed that employee emotional intelligence is associated with the intention to use, mediated by perceived management support. The mediation analysis indicated that there was no significant indirect effect (ß = -0.022, CI [-0.316, 0.193]) of leader emotional intelligence on intention to use through perceived management support. Therefore, hypothesis 4.d was not supported.

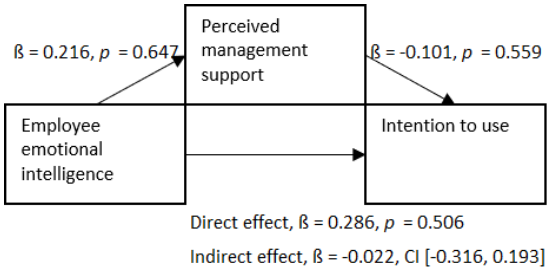

Figure 15 EEI, PMS, ITU

Hypotheses 5.a stated that Computer playfulness relates to intention to use, mediated by perceived ease of use. The performed mediation analysis showed that there was an indirect significant (ß = 0.178, CI [0.003, 0.517]) of computer playfulness on intention to use through perceived ease of use. Consequently, hypothesis 5.a was supported.

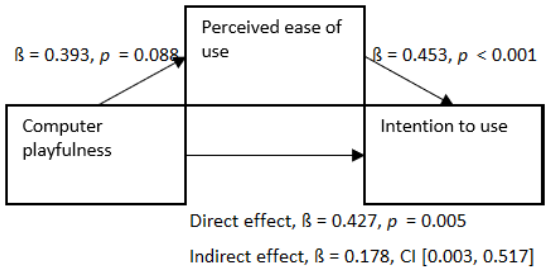

Figure 16 CP, PEOU, ITU

Hypotheses 5.b posed that computer playfulness relates to intention to use, mediated by perceived usefulness. Indeed, the mediation analysis showed that there was a significant indirect relationship (ß = 0.245, CI [0.047, 0.528]) of computer playfulness on intention to use through perceived usefulness. Therefore, hypothesis 5.b was supported.

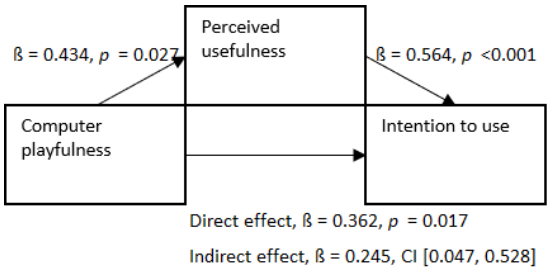

Figure 17 CP, PU, ITU

Table 5 Mediation effects

Independent	Dependent	A path	B path	Direct effect	Indirect effect
Instrumental leadership	**Intention to Use**				
Perceived ease of use		0.360	0.514**	0.129	0.185
Perceived usefulness		0.352	0.650**	0.085	0.228*
Subjective norm		0.586**	0.391*	0.085	0.229*
Perceived management support		0.765**	-0.324	0.538*	-0.249
Leader emotional intelligence	**Intention to Use**				
Perceived ease of use		0.072	0.528**	0.259	0.038
Perceived usefulness		0.174	0.647**	0.184	0.113
Subjective norm		0.355	0.383*	0.160	0.229*
Perceived management support		0.611*	-0.214	0.438	-0.131
Employee emotional intelligence	**Intention to Use**				
Perceived ease of use		0.295	0.533	0.124	0.157
Perceived usefulness		0.344	0.668	0.052	0.229
Subjective norm		0.181	0.419	0.205	0.076
Perceived management support		0.216	-0.101	0.286	-0.022
Computer playfulness	**Intention to Use**				
Perceived ease of use		0.393	0.453**	0.427**	0.178*
Perceived usefulness		0.434*	0.564**	0.362*	0.245*

*p < .05. **p< .01

Table 6 Hypotheses results

Number	Hypothesis	Status
1.a	The positive relationship between instrumental leadership style and employees' intention to use I4.0 technologies is mediated by employees' *perceived ease of use.*	Not supported
1.b	The positive relationship between instrumental leadership style and employees' intention to use I4.0 technologies is mediated by employees' *perceived usefulness*.	Supported
1.c	The positive relationship between instrumental leadership style and employees' intention to use I4.0 technologies is mediated by employees' *subjective norm*.	Supported
1.d	The positive relationship between instrumental leadership style and employees' intention to use I4.0 technologies is mediated by employees' *perceived management support*.	Not supported
2.a	The positive relationship between leader's emotional intelligence and employees' intention to use I4.0 technologies is mediated by employees' *perceived management support*.	Not supported
2.b	The positive relationship between leader's emotional intelligence and employees' intention to use I4.0 technologies is mediated by employees' *perceived usefulness*.	Not supported
2.c	The positive relationship between leader's emotional intelligence and employees' intention to use I4.0 technologies is mediated by employees' *subjective norm*.	Supported
2.d	The positive relationship between leader's emotional intelligence and employees' intention to use I4.0 technologies is mediated by employees' *perceived management support*.	Not supported
3	There is a positive relationship between a leader's emotional intelligence and their instrumental leadership style.	Supported
4.a	The positive relationship between employee's emotional intelligence and their intention to use I4.0 technologies is mediated by their (a) *perceived ease of use*.	Not supported
4.b	The positive relationship between employee's emotional intelligence and their intention to use I4.0 technologies is mediated by *perceived usefulness*.	Not supported
4.c	The positive relationship between employee's emotional intelligence and their intention to use I4.0 technologies is mediated by their *subjective norm*.	Not supported
4.d	The positive relationship between employee's emotional intelligence and their intention to use I4.0 technologies is mediated by their *perceived management support*.	Not supported
5.a	The positive relationship between employee's computer playfulness and their intention to use I4.0 technologies is mediated by *perceived ease of use*.	Supported
5.b	The positive relationship between employee's computer playfulness and their intention to use I4.0 technologies is mediated by *perceived usefulness*.	Supported

Discussion

Building on a literature review an online survey was distributed amongst managers and employees working in three different multinational production organisations that all worked with Industry 4.0 technologies. The research aimed to answer the question: *What are the effects of leadership style, emotional intelligence, and employee perception of new technologies on their acceptance of industry 4.0 technologies?* The research further explores how factors as instrumental leadership, emotional intelligence, and computer playfulness fit within the UTAUT model as proposed by Schneider and Sting (2020), Van Dun and Kumar (2023), and Venkatesh and Bala (2008). From the tested hypothesis we found that instrumental leadership relates to employee intention to use I4.0 technology mediated by both perceived usefulness and subjective norm.. As for the leader emotional intelligence we found that it relates to employee intention to use I4.0 technologies mediated by just subjective norm. Lastly, computer playfulness showed a positive relationship with employee intention to use I 4.0 technologies, mediated by both perceived ease of use and perceived usefulness.

Employee emotional intelligence however did not present any significant relationship within the proposed model though. Interestingly enough we also did not find mediations for perceived management support, the construct that operationalised facilitating conditions in UTAUT. This may indicate that there is no mediating relationship with perceived management support and intention to use in the UTAUT model. Such a change of the model has also been proposed by both Blut et al. (2022) and Tamilmani et al. (2021) as they both stated that the facilitating conditions are conditional. Moreover, the perception of management support may not even be enough, whereas it should rather be actual support. Tamilmani et al. (2021) even argued that the facilitating conditions do not directly relate to intention to use at all but rather to a new mediating mechanism. Therefore, in the following theoretical implications we argue that for all of the independent variables tested there were no mediating effects of perceived management support as it does not fit within the UTAUT model at the place we tested it. Figure 4 below visualises the identified mediating relationships that were found in an updated conceptual model, after which we will further discus the theoretical implications.

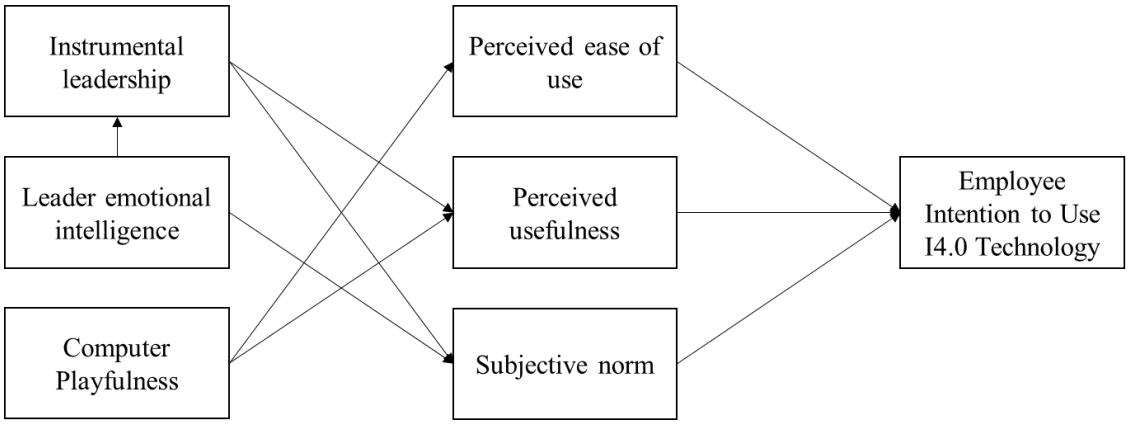

Figure 18 Updated conceptual model

Firstly, we elaborate on the added antecedent of instrumental leadership style (Antokanis and House, 2014) to the original UTAUT model. We believe that instrumental leadership possesses all the qualities that are required within effective roadmaps, which according to Schneider (2018) is crucial for implementing new technologies. From the literature, we had reason to believe that instrumental leadership too would influence the antecedents of the UTAUT model. According to Venkatesh and Bala (2008) leadership would influence perceived ease of use, perceived usefulness, and perceived management support. In which the perceived management support relation was also voiced earlier by Williams et al. (2015). Moreover, Chrusciel (2006) found that the emotional factors of leadership styles would contribute to the subjective norm of using new technologies. However, from these theoretical expectations we found that instrumental leadership style did not present a mediating relation with perceived ease of use nor with perceived management support but did with perceived usefulness and subjective norm. We believe the reason it did not present a relation with perceived ease of use could be because through instrumental leadership a leader focusses a goal (Antokanis & House, 2014). Perceived ease of use is related to an experience with a technology (Venkatesh, 2000), said experience with the technology may very well be why instrumental leadership does not influence it as it focusses on a certain goal. However, strangely enough other leadership style such as transformational did pose a relation with perceived ease of use (Neufeld et al., 2007; Van Dun & Kumar, 2023). When comparing leadership styles, we see that the charismatic approach of transformational leadership influences the relation (Van Dun & Kumar, 2023; Manko, 2023). This charismatic approach is not prevalent in instrumental leadership though. Moreover, we found that instrumental leadership did present a relationship with intention to use technologies which we did expect following the literature of Schneider (2018) as it focuses on the completion of goals (Antokanis & House, 2014). The implementation of industry 4.0 technologies can be considered such a goal, which is an explanation for the relationship.

Secondly, contrary to what we proposed based on Venkatesh et al. (2003), Van Dun and Kumar (2023), and Ciarrochi (2005), we did not find a relationship between either leader emotional intelligence and perceived ease of use or perceived usefulness. On the other hand, however, we did find a relation between leader emotional intelligence and subjective norm, as was expected based on Venkatesh et al. (2003). It is noteworthy though that this relation according to Hartwick and Barki (1994) is solely observed in mandatory settings. Hence the need for further research regarding the voluntariness as proposed by Venkatesh and Bala (2008) in their TAM3 model. The relation between a leader's emotional intelligence and subjective norm has to do with the fact that subjective norm relates to a person's perception that people who are important to them, such as their leader, think a technology should be used (Venkatesh et al. 2003). Additionally, we did not find a relation between leader emotional intelligence and perceived management support. This relation was expected by the fact that emotional intelligent leaders are more actively listening when talking with their subordinates (Pence & Vickery, 2012; Froiland & Davison, 2019) and could thereby possibly better identify their needs for support. Which leads us to believe there may be an overlap between perceived management support and leader emotional intelligence.

Thirdly, in line with the literature of Rosete and Ciarrochi (2005) and Gardner and Strough (2002), we indeed found that there was a relation between a leader's emotional intelligence and instrumental leadership style. As reported by Gardner and Strough (2002) emotionally intelligent people are more committed and successful in the workplace. Specifically, they tested this assumption between emotional intelligence and transformational leadership. This study extended those insights by shedding light that a potential reason for the relation could be that emotional intelligence is applicable in the characteristics of instrumental leadership by Antokanis and House (2014), since they highlight the proactive and strategic nature of the leadership style and emphasises on the role of guiding the organisation towards success.

Fourthly, we discuss the last proposed explorative antecedent for the UTAUT model, employee emotional intelligence. Even though proposed by van Dun and Kumar (2023) as a possible further avenue for research, we did *not* find any relation between employee emotional intelligence and the original antecedents of the UTAUT model. One of reasons that no relation was found could be due to self-reporting bias in which people may have wanted to be perceived as "more emotional intelligent" as from the quantitative analysis we see that emotional intelligence has a relatively high mean score. Another reason could be that the emotional intelligence is not an antecedent for the UTAUT model but rather a moderator for the existing relations. However, these findings are off with the findings to Hornbaek and Hertzum (2017) who found that both perceived ease of use and perceived usefulness relate to a user experience which is influenced by the users' emotions.

Moreover, in an updated version of UTAUT, UTAUT2 (Venkatesh et al. 2012), hedonic motivation was introduced which also relates to the emotional experiences of a user when using a technology.

Lastly, we shine light on a previously proposed antecedent by Venkatesh and Bala (2008), computer playfulness. From their research we had reason to believe that computer playfulness, represented by computer playfulness and computer anxiety did have a relation with two of the four UTAUT antecedents. Namely, perceived ease of use and perceived usefulness. Moreover, this avenue of playful experience with technology was also proposed by Schneider and Sting (2020) who voiced that managers should try to make employees aware of exciting elements of new technologies. We found that computer playfulness had indeed a positive relation with both perceived ease of use and perceived usefulness. The computer playfulness scale explains a person's tendency to interact spontaneously, intensively, and openly with computers (Serenko & Turel, 2007; Venkatesh, 2000). This open interaction we see from our data is an antecedent for the perceived ease of use and perceived usefulness of new technologies. The reason computer playfulness relates to perceived ease of use and perceived usefulness is because there is an intrinsic motivation to use the technology as well as a certain degree of enjoyment (Venkatesh, 2000; Hwang, 2005; Tamilmani et al., 2021). Moreover, computer playfulness is a strong indicator of intention to use new technologies (Sledgianoski, 2009; Bult et al., 2022) which makes the research into computer playfulness even more relevant.

In conclusion, the implications of this research teach us about the relationships between instrumental leadership, emotional intelligence, computer playfulness and employees' acceptance of industry 4.0 technologies. We found that instrumental leadership influences the employee intention to use industry 4.0 technologies mediated by both perceived usefulness and subjective norm. Additionally, a leader's emotional intelligence is related to its instrumental leadership style as well as it is related to employee intention to use 4.0 technologies mediated by subjective norm. Furthermore, we can emphasise the importance of computer playfulness on the employee intention to use industry 4.0 technologies, mediated by both perceived ease of use and perceived usefulness. Lastly, our research shows that employee emotional intelligence did not have any significance within the model. Overall, we can adjust and expand the existing UTAUT model with these theoretical implications as presented in figure 18.

Practical implications

These findings may also help organisations with a couple of implications to successfully implement an industry 4.0 technology into their organisation. First of all, we found that instrumental leadership has similarities with roadmaps which in turn according to Schneider (2018) is crucial for implementing industry 4.0 technologies. From our findings we can conclude that for organisations instrumental leadership can attribute to the successful implementation of roadmaps leading to industry 4.0 adoption. Thereby, organisations can invest in roadmap initiatives that could further develop peoples' understanding of technology implementation. Moreover, organisations may start introducing leadership classes and projects in which specifically instrumental leadership skills are developed.

Another initiative an organisation can participate in is the training of emotional intelligence. Studies by Slaski and Cartwright (2003) showed an increase in emotional intelligence and decrease in stress related factors after a series of lectures, group discussions, and role playing. This would not only be beneficial to stress decreasing but also relates with subjective norm. Meaning that a more emotional intelligent leader has a positive effect on the idea that employees think they should use new technologies. Which would in turn positively relate to the employees' intention to use industry 4.0 technologies.

Moreover, organisations should focus on hiring people that are passionate about technology and enjoy using technologies. As from this research we have evidence that computer playfulness both relates to perceived ease of use and perceived usefulness as well as intention to use. This practice may reduce the amount of training required for this employee. Additionally, this computer playful individual may be among the people that other individuals want to search recognition from when they are using industry 4.0 technologies (Thompson et al. 1991) i.e. this person may be considered an 'important' other that influences the degree that an employee perceives it should use the technology.

Limitations and Future Research

This study is one of the first studies that incorporated instrumental leadership as an antecedent for the UTAUT. It has been proposed before by Holst (2021) who found that a combination of both transformational and instrumental leadership would work best for implementing industry 4.0 technologies. But since it is one of the first studies to incorporate leadership into the UTAUT model we should have taken a more nascent approach as mentioned by Edmonson and Mcmanus (2007). This would have led to the incorporation of qualitative research on top of the qualitative research allowing for a better representation of the leadership aspect of this study.

Moreover, many of the regression presented in chapter 3 showed insignificant or marginal significant relationships. An explanation for these low significance results may the number of people participating in the study. With only close to a hundred participants the participation rate of approximately 37,6% was decent but the number of participants not high enough to thoroughly analyse. To further elaborate on the participants some of whom received the wrong set of questions and were therefore unable to answer all questions. When presented with the additional questions we were unable to link them with the previous answers due to anonymity. Therefore, we propose that with a follow up study greater attention is given to the distribution of the survey. Moreover, additional thought should be given to the option of sending out only one version of the survey to just the employees rather one for employees and leaders. However, to achieve representative useful data from leaders we would suggest opting for a mixed method research with both interviews and surveys.

The number of leaders that participated in the study was too low to pull meaningful statistics from. Therefore, within the study we used the employees' perception of a leader's emotional intelligence to form the construct of leader emotional intelligence. Obviously, the perception and the actual self-assessed emotional intelligence may differ from one another. This self-reported bias can be overcome by using objective measures and avoiding the use of leading questions. As for the topic of industry 4.0 through our literature review, we found that industry 4.0 is quite novel and underexplored. However, researchers like Sarfraz et al. (2021) mention an upcoming of the fifth industrial revolution already, only 10 years after the fourth had started. They expect interdependence of man and machine using cognitive computing and human intelligence are applied to achieve mass customisation and personalisation for humans Sarfraz et al. (2021). Other researchers have added that this mass customisation and personalisation should be resource-efficient (Maddikunta et al., 2022) and be compliant with sustainable development challenges (Masoomi et al., 2023). To achieve such a goal in organisations we believe that instrumental leadership can play a large role. As it focuses on a clear path while monitoring the environment which in this case quite literally is the environment where we live.

Future research to continue on this research may involve a replication of this study, omitting employee emotional intelligence as antecedent and increasing the number of participants in the study. Through Structural Equation Modelling the model could be tested at once which could present new insights which could be more in line with the literature found for our research. Moreover, in future research we propose that employee emotional intelligence is researched with all of the sub constructs as well as constructs within the model to see if it holds a place or not. As through this study we did not find any relations with emotional intelligence. However, that does not mean this study is the final answer. Perhaps with larger samples and through interviews rather than surveys there may be an observable relation within the model as we proposed.

Furthermore, the mediator of perceived management support did not show any mediation within the model. Even the b-paths of the mediation analysis showed that there was a negative relations which is also in line with the correlation analysis. Perhaps the perceived management support mediator is not a variable on its own but rather mergeable with both instrumental leadership and leader emotional intelligence. For a future study a factor analysis should be conducted in order to find whether perceived management support has any cross-loadings with other constructs.

Moreover, we would propose in an additional study to research the relation between emotional intelligence and the playful frame of Schneider and Sting (2020) which could be operationalized through Venkatesh and Bala (2008) their computer playfulness scale. As Schneider and Sting (2020) linked their playful frame to emotional resonance, appealing to feelings, passion and aspirations. We believe that in line with Nordin (2011), Van Dun and Kumar (2023), and Venkatesh and Bala (2008) emotions do have its place within technology acceptance. Which too is voiced by Hornbaek and Hertzum (2017) who found that perceived ease of use and perceived usefulness relate to user experience which is influenced by a user's emotions. As well as Venkatesh et al. (2012) who found that emotions do indeed relate to the intention to use technology. The challenge is to find whether emotional intelligence does indeed also influence any of the antecedents of the UTAUT(2) model.

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Appendix I

Acceptance of Smart Industry Technologies in Organisations

The University of Twente (Netherlands) and Cardiff University (United Kingdom) have joined forces in international field research on the factors influencing the effective adoption of Smart Industry Technologies, also known as 'Industry 4.0'. The research examines how soft factors such as *leadership* and *emotional intelligence* contribute to the acceptance of Industry 4.0. The participating companies will receive a benchmark report. More information is below.

Does your company work on Industry 4.0?

The term Industry 4.0 covers many different technologies that are used to radically innovate the organisational work processes. As the name suggests, we are currently in the 'fourth industrial revolution' in which after, steam power, electricity and assembly lines, and computing/digitization, organisations now apply technology that unites the physical and digital world. Among the most prominent smart technologies are: big data, autonomous robots, cloud technology, simulation, internet of things, additive manufacturing, augmented reality, business intelligence, and cybersecurity applications. If you recognize any of the technologies in your organisation, your company is catching up with the fourth industrial revolution!

for more information on Industry 4.0

What will the participation mean to your organisation?

Participation is relatively easy. We will distribute an *online survey amongst the managers and employees, which takes roughly 15 minutes to complete*. The views of the managers and employees on how they experience the different aspects of Industry 4.0 technologies in their daily work will help us understand what factors influence their acceptance and effective adoption. Moreover, if the situation permits, a researcher will come over for a half-day *field visit* to see your companies' adoption of Industry 4.0 in real life. This study is a follow-up on a previous international field study

What are the benefits of participation?

In return, your organisation will receive a *benchmark report* that maps your company's results against the other participating, anonymised companies. This will bring valuable information on how your company currently deploys new technologies and how this adoption could be further optimized, also taking into account soft factors like leadership and employees' skills.

How is the research data treated?

Following the strict university ethical research protocols and European GDPR regulations, each survey participant will be informed about the purpose of the study and asked to give consent to the gathering and processing of their data. Their participation is entirely voluntarily and the survey will be anonymous. The survey will be administered via the university-based safe and secure survey platform and data will be stored, anonymously, on encrypted university drives.

Interested to join our study, or would you like more information?

The international research team is presented below and can be contacted for further questions that may have arisen while reading this document. If you are interested to join our study please let us know!

Dr. Maneesh Kumar
Full Professor

Dr. Desirée van Dun
Assistant Professor

Scott Mulder, BBA
Master Business Administration
graduate student

Appendix II

Demographics	
Gender	Demographics
Age	Demographics
Position	Demographics
Years in current position	Demographics
Years in organisation	Demographics
Highest level of education	Demographics
Questions about yourself	
I always know my friends' emotions from their behaviour	Others emotional appraisal
I am a good observer of others' emotions	Others emotional appraisal
I am sensitive to the feelings and emotions of others	Others emotional appraisal
I have good understanding of the emotions of people around me	Others emotional appraisal
I am able to control my temper and handle difficulties rationally	Regulation of emotions
I am quite capable of controlling my own emotions	Regulation of emotions
I can always calm down quickly when I am very angry	Regulation of emotions
I have control of my own emotions	Regulation of emotions
I always know whether or not I am happy	Self-emotional appraisal
I always set goals for myself and then try my best to achieve them	Self-emotional appraisal
I have a good sense of why I have certain feelings most of the time	Self-emotional appraisal
I have good understanding of my own emotions	Self-emotional appraisal
I really understand what I feel	Use of emotion
I always tell myself I am a competent person	Use of emotion
I am self-motivated person	Use of emotion
I would always encourage myself to try my best	Use of emotion

Questions about your direct supervisor

My direct supervisor is a good observer of other peoples' emotions	Others emotional appraisal
My direct supervisor understand the emotions of people around them well	Others emotional appraisal
My direct supervisor can always infer the emotions of their friends from their behaviour	Others emotional appraisal
My direct supervisor is sensitive to feelings and emotions of others	Others emotional appraisal
My direct supervisor has good control over their own emotions	Regulation of emotions
My direct supervisor can always calm themselves when they are very angry	Regulation of emotions
My direct supervisor is very capable of controlling their own emotions	Regulation of emotions
My direct supervisor is able to keep their calm so that they can deal difficulties rationally	Regulation of emotions
My direct supervisor usually has a good sense of why they have certain feelings	Self-emotional appraisal
My direct supervisor understand their own emotions well	Self-emotional appraisal
My direct supervisor really understands what they are feeling	Self-emotional appraisal
My direct supervisor always knows whether they are happy or not	Self-emotional appraisal
My direct supervisor is a self-motivating person	Use of emotion
My direct supervisor always tells themselves or others that they are a competent person	Use of emotion
My direct supervisor always sets goals for themselves or others and tries their best to achieve them	Use of emotion
My direct supervisor will always encourage themselves or others to do their best	Use of emotion

Questions about your direct supervisor

My direct supervisor understands the constraints of our organization	Environmental Monitoring
My direct supervisor senses what needs to be changed in our organization	Environmental Monitoring
My direct supervisor recognizes the strengths of our organization	Environmental Monitoring
My direct supervisor capitalizes on opportunities presented by the external environment	Environmental Monitoring
My direct supervisor develops specific policies to support his/her vision	Strategy formulation and implementation
My direct supervisor sets specific objectives so that the mission can be accomplished,	Strategy formulation and implementation
My direct supervisor ensures that his/her vision is understood in specific terms	Strategy formulation and implementation
My direct supervisor translates the mission into specific goals	Strategy formulation and implementation
My direct supervisor removes obstacles to my goal attainment	Path–goal facilitation
My direct supervisor ensures that I have sufficient resources to reach my goals	Path–goal facilitation
My direct supervisor clarifies the path to my goal attainment	Path–goal facilitation

My direct supervisor facilitates my goal achievement	Path–goal facilitation
My direct supervisor helps me correct my mistakes	Outcome monitoring
My direct supervisor assists me to learn from my mistakes	Outcome monitoring
My direct supervisor provides me with information concerning how mistakes can be avoided	Outcome monitoring
My direct supervisor provides me with constructive feedback about my mistakes.	Outcome monitoring
Questions about perceived support	
Our senior leaders have encourages all of us to embrace new technology	Perceived Management Support
Our organisation's top decision makers have put all their support behind new technology efforts	Perceived Management Support
Every senior manager has stressed the importance of new technology	Perceived Management Support
Our organisation's most senior leader is committed to new technology	Perceived Management Support
I think we are spending a lot of time investing in new technology changes when the senior managers don’t even want it	Perceived Management Support
Management has sent a clear signal that this organisation is going to change	Perceived Management Support
Your perception of new technologies	
New technologies do not scare me at all	anxiety
Working with a new technology makes me nervous	anxiety
New technologies make me feel uncomfortable	anxiety
New technologies make me feel uneasy	anxiety
I find using the new technology to be enjoyable	Perceived Enjoyment
The actual process of using the technology is pleasant	Perceived Enjoyment
I have fun using the new technology	Perceived Enjoyment

Your opinion on new technology

I plan to continue using this new technology frequently	Behavioral Intention
I intend to use this new technology assuming I have access to it	Behavioral Intention
I will always try to use this new technology in my daily workload	Behavioral Intention
I find it easy to use this new technology and achieve the desired results	Perceived Ease of Use
It is clear how I am meant to use this new technology	Perceived Ease of Use
I find this new technology simple and easy to use	Perceived Ease of Use
I find that using this new technology is beneficial to my work it doesn't take much head space to use this new technology	Perceived Ease of Use
I have noticed a performance increase since working with this new technology	Perceived Usefulness
Using this new technology increases my productivity	Perceived Usefulness
I have noticed that using this new technology improves my performance	Perceived Usefulness
Using this new technology improves my effectiveness in my job	Perceived Usefulness
The senior management of this business has been helpful in the use of this new technology	Subjective Norm
People who are important to me think that I should use this new technology	Subjective Norm
In general, the organization has supported the use of this new technology	Subjective Norm
People who influence my behaviour think that I should use this new technology	Subjective Norm
My supervisor does not require me to use this new technology	Voluntariness
Using this new technology may have its advantages but it is certainly not mandatory for me to do my job	Voluntariness
My use of this new technology is entirely voluntary and I feel no pressure to use it	Voluntariness