Received 20 June 2022
Revised 15 November 2022
16 March 2023
Accepted 20 March 2023

Social enablers of Industry 4.0 technology adoption: transformational leadership and emotional intelligence

Desirée H. van Dun
Department of High-tech Business and Entrepreneurship, Faculty of Behavioural, Management and Social Sciences, University of Twente, Enschede, The Netherlands, and
Maneesh Kumar
Department of Logistics and Operations Management, Cardiff Business School, Cardiff, UK

Abstract

Purpose – Many manufacturers are exploring adopting smart technologies in their operations, also referred to as the shift towards "Industry 4.0". Employees' contribution to high-tech initiatives is key to successful Industry 4.0 technology adoption, but few studies have examined the determinants of employee acceptance. This study, therefore, aims to explore how managers affect employees' acceptance of Industry 4.0 technology, and, in turn, Industry 4.0 technology adoption.

Design/methodology/approach – Rooted in the unified theory of acceptance and use of technology model and social exchange theory, this inductive research follows an in-depth comparative case study approach. The two studied Dutch manufacturing firms engaged in the adoption of Industry 4.0 technologies in their primary processes, including cyber-physical systems and augmented reality. A mix of qualitative methods was used, consisting of field visits and 14 semi-structured interviews with managers and frontline employees engaged in Industry 4.0 technology adoption.

Findings – The cross-case comparison introduces the manager's need to adopt a transformational leadership style for employees to accept Industry 4.0 technology adoption as an organisational-level factor that extends existing Industry 4.0 technology user acceptance theorising. Secondly, manager's and employee's recognition and serving of their own and others' emotions through emotional intelligence are proposed as an additional individual-level factor impacting employees' acceptance and use of Industry 4.0 technologies.

Originality/value – Synthesising these insights with those from the domain of Organisational Behaviour, propositions were derived from theorising the social aspects of effective Industry 4.0 technology adoption.

Keywords Industry 4.0, Unified theory of acceptance and use of technology, Social exchange, Transformational leadership, Emotional intelligence

Paper type Research paper

1. Introduction

The promise of Industry 4.0-type technologies to boost operational excellence has received more-and-more scholarly and practitioner attention (Calabrese *et al.*, 2022; Liao *et al.*, 2017; Tortorella *et al.*, 2019). Industry 4.0 can be seen as increasing intelligence with the help of

The authors thank Mark van Duuren for his help in the data collection, as well as the reviewers of the EurOMA 2020 and Academy of Management 2021 conferences as well as *IJOPM* for the helpful feedback.

International Journal of Operations & Production Management
Vol. 43 No. 13, 2023
pp. 152-182
Emerald Publishing Limited
0144-3577
DOI 10.1108/IJOPM-06-2022-0370

digitalisation and digitisation of products and systems (i.e. cyber-physical systems) through intra-company (i.e. micro and meso levels integration between people and machines, and across systems) and cross-company integration (i.e. macro level across factories or companies) into value creation networks (Frank *et al.*, 2019; Schneider, 2018; Tortorella *et al.*, 2019).

Digitalisation-induced transformation or change (Schneider and Sting, 2020), driven by the Industry 4.0 revolution, is disruptive change that requires leaders to recognise how the change is viewed by the employees and their general attitude towards change (Marcon *et al.*, 2022; Piderit, 2000; Schneider, 2018; Schneider and Sting, 2020). However, the majority of the Industry 4.0 studies have focused on investigating primarily the technical aspects of Industry 4.0 implementation with limited focus on addressing the acceptance problem, i.e. how to get engagement from employees to (effectively) use those high-investment technologies (Hirsch-Kreinsen, 2014; Kummer *et al.*, 2017; Pfeiffer, 2017; Schneider, 2018).

Researchers have highlighted several reasons for the lack of acceptance of technology among employees including fear of job loss, lack of appreciation of their own work by managers, fear of surveillance by digital systems and feelings of alienation due to virtualisation and dematerialisation of work processes (Cagliano *et al.*, 2019; Hirsch-Kreinsen, 2014; Kummer *et al.*, 2017; Piderit, 2000; Schneider and Sting, 2020; Strebel, 1996), which can jeopardise technology diffusion in the organisation. Most technology-driven change initiatives for driving efficiency and productivity have not struggled with technology installation or running the technology, but the success was influenced by the employees' attitude towards specific technology-driven change (Choi, 2011; Piderit, 2000; Schneider, 2018; Strebel, 1996). And yet, it has mostly been overlooked in the literature.

Leaders' socio-emotional capabilities and sensitivity to individual differences are likely to be more important than before in tailoring their approach to achieving employees' acceptance of advanced technology adoption. However, the importance of leadership in driving technology acceptance among employees has rarely been addressed, even in the highly cited Technology Acceptance Model (TAM2) or the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh *et al.*, 2003; Williams *et al.*, 2015). While there are accounts that (top) management support contributes to user adoption, leadership is rarely explicitly modelled into existing UTAUT theorising (Neufeld *et al.*, 2007). And to improve the TAM, Venkatesh and Bala (2008) advised integrating leadership theory to enrich the conceptualisation of management support. In addition, there is a lack of in-depth investigation on leaders' influences on employees' feelings regarding digitalisation-induced change driven by Industry 4.0 (Hirsch-Kreinsen, 2014; Piderit, 2000; Schneider, 2018).

Understanding employees' emotions throughout the change process, their deep-ingrained anxieties and threats towards technology acceptance and usage is not straightforward (Elrod and Tippett, 2002). It is even more complicated when investigating the adoption of the complex technologies linked to Industry 4.0 (Frank *et al.*, 2019; Schneider and Sting, 2020). Indeed, the root of UTAUT and TAM—the Theory of Planned Behaviour—has been criticised for ignoring affective reactions like emotions (Conner and Armitage, 1998; Venkatesh, 2000). To address the research gap and to further provide empirical evidence of employee's feelings regarding Industry 4.0 and its adoption, this research provides an in-depth explanation of the complex process of Industry 4.0 acceptance by the employees and how the leader's understanding of employee's emotions impact on the employee's acceptance of digitalisation-induced change. Given that managers have the power and authority to decide upon smart technology implementation, understanding employee's emotions throughout the implementation journey may help managers address job insecurity and resistance to change. Therefore, we explore the following question: *How do managers' leadership style and understanding of employees' emotions affect employee's acceptance of Industry 4.0 technology, and, in turn, Industry 4.0 technology adoption?*

Using a comparative case study approach and achieving data triangulation by adopting a mixed-methods design, this study aims to elaborate on the available theorising on effective Industry 4.0 technology adoption. Given our study's novel focus on understanding how a leader's behavioural style and handling of emotions might relate to employee's acceptance and use of such radical technologies in the workplace, an inductive approach was deemed appropriate (Edmondson and McManus, 2007). In addition, leadership scholars have called for more qualitative inductive studies to provide a greater insight into the influence of leadership on the phenomenon under investigation (Fischer and Sitkin, 2023; Siangchokyoo *et al.*, 2020). The merits of inductive reasoning based on in-depth case analysis have been described before by Ketokivi and Choi (2014). This design follows Li (2020, p. 815) who promoted qualitative case study research about digital transformation to *"conceptualize effective approaches to manage the transition"*. After describing the data collection procedure and the theme-based cross-case comparisons, in Section 5, an additional theory is synthesised to develop propositions for future research.

This study's contribution is fourfold: Firstly, it highlights the importance of focusing on the social aspects of technology adoption as it shows the inductively derived theme of transformational leadership style (Bednall *et al.*, 2018; Peng *et al.*, 2021) is an important antecedent for Industry 4.0 technology adoption. Secondly, it emphasises how inductively derived factors such as manager's and employee's emotional intelligence (EI) (Wong and Law, 2002; Zeidner *et al.*, 2004) impact the intention to use and thereby adopt Industry 4.0 technologies. Thirdly, the resulting conceptual model extends the UTAUT model and inspires future empirical studies on the edge of Operations Management, Organisational Behaviour and Change Management. Finally, it provides direction to (top) managers on how to best approach digital transformation to gain employees' approval and active participation.

2. Literature review

Literature pertaining to the enablers of employee's acceptance of Industry 4.0 adoption is reviewed in this section, including the underlying UTAUT and social exchange theories.

2.1 Industry 4.0 adoption and the role of social factors

Industry 4.0 encompasses manufacturers' digital transformation of their production systems towards more smart and dynamic versions by adopting an ever-growing list of cyber-physical system technologies, thereby enabling new and more efficient customisable and connected processes, products and services (Tortorella *et al.*, 2019). Examples of such front-end technologies are sensors, additive manufacturing, augmented reality and rapid prototyping using 3D printing (Frank *et al.*, 2019; Tortorella *et al.*, 2019), which are supported by base technologies (Frank *et al.*, 2019), such as the Internet of Things (IoT), cloud services, big data and analytics, to enable vertical, horizontal and end-to-end integration of the organisation with its supply chain (Chiarini and Kumar, 2021). In its most radical form, digital networks of technologies enable high-end production with minimal manual intervention (Olsen and Tomlin, 2020; Wagire *et al.*, 2021). The increasing attention to Industry 4.0 is primarily due to the need to overcome the inherent complexity of implementing such technologies (Hahn, 2020; Thoben *et al.*, 2017).

Since the concept was launched in 2011, a plethora of advanced/Industry 4.0/smart technology adoption and digital transformation maturity models have emerged (Colli *et al.*, 2019; Mittal *et al.*, 2018; Saabye *et al.*, 2022). These models mainly focused on the type, level, complexity and scope of technology integration into operations. The basic underlying assumption in those models is that the effectiveness of advanced technology adoption depends on the comprehensiveness of technology integration.

But the fourth industrial revolution has major implications for the work organisation (Cagliano *et al.*, 2019) and the sociotechnical aspects of advanced technology adoption are still understudied (Marcon *et al.*, 2022; Saabye *et al.*, 2022). Indeed, recent reviews on manufacturer's adoption of Industry 4.0 did not highlight the role of employees in acceptance and the effective adoption of Industry 4.0 (Schneider, 2018; Schneider and Sting, 2020), even though Industry 4.0 adoption is likely to lead to employee reorganisation and requires certain skills (Calabrese *et al.*, 2021; Srinivasan *et al.*, 2020). Similarly, Kummer *et al.* (2017) examined the use of sensor-based technologies in healthcare and reported how technology-induced anxiety creates negative emotions, apprehension and fear of using the technology and, in turn, can affect employees' decision to accept or resist a technology. Reflecting on the important role of management practices in Industry 4.0, Shamim *et al.* (2016) proposed a framework that highlighted the critical role of organisational structure, leadership and HR practices in providing an environment for learning and innovation compatible with Industry 4.0 practices. Furthermore, managers can influence innovativeness and learning among employees (Tan *et al.*, 2021), e.g. by adopting the right HR practices required for embracing Industry 4.0, but Shamim *et al.* (2016) failed to highlight how managers can influence digitalisation-induced change among employees.

A barrier to adopting Industry 4.0 may be "internal resistance to organisational changes" (Calabrese *et al.*, 2022; Da Silva *et al.*, 2020; Marcon *et al.*, 2022) as it challenges employees to relinquish the status quo in preparedness for reskilling or upskilling, apart from the financial and technological challenges (Liboni *et al.*, 2018; Srinivasan *et al.*, 2020). However, Piderit (2000) and Oreg *et al.* (2018) critiqued the "*resistance to change*" metaphor as research fails to account for good intentions of resistors and also variability in the conceptualisation of resistance. The research suggested that resistance to change can be best understood by capturing the employees' attitude towards change which can be cognitive, emotional and intentional. Even though employee's attitude towards digitalisation-induced change is critical (Schneider and Sting, 2020), scholars have paid limited attention or provided evidence to the issue of employee acceptance, with most relying on conceptual studies to allude to acceptance problems among employees (Hirsch-Kreinsen, 2014; Piderit, 2000; Schneider, 2018; Strebel, 1996). Therefore, it is important to capture employees' attitudes towards change or managers' responses to change, a growing area of interest in Organisational Behaviour studies.

Schneider (2018) and Schneider and Sting (2020) highlighted some key areas for future Industry 4.0 research including conducting exploratory qualitative in-depth case studies focusing on socio-cultural aspects including changing roles of workers in a manufacturing setting, to identify contextual factors impacting managerial decisions on using Industry 4.0 technologies and creating acceptance in employees to embrace digitalisation-induced change. In the literature review conducted by Schneider (2018), it was reported that no single contribution provided empirical evidence of employee or managers' perspectives regarding the acceptance of Industry 4.0 solutions. Similar gaps were also reported in earlier publications (Dombrowski and Wagner, 2014; Hirsch-Kreinsen, 2014; Kummer *et al.*, 2017; May, 2015). Both Schneider (2018) and Schneider and Sting (2020) called for more field research and observations to explain managers' role in convincing employees to embrace digitalisation-induced change. Furthermore, as underlined by Olsen and Tomlin (2020, p. 118), studying the acceptance of Industry 4.0-type technologies seems "*like a natural line of inquiry for the OM field*". This leads us to the literature on technology adoption and employees' acceptance of those technologies for driving technology-induced change in organisations.

2.2 Factors influencing employee acceptance and use of technology

One of the existing theories regarding employee's acceptance of technology is the extended *Technology Acceptance Model* (TAM2), coined by Venkatesh and Davis (2000). The original TAM demonstrates three important factors that influence one's usage of new technology,

namely, perceived ease of use, perceived usefulness and intention to use (Davis *et al.*, 1989). This model is strongly built upon the theory of reasoned action (Fishbein and Ajzen, 1975). The extended TAM (labelled as "TAM2") adds social influence processes (e.g. subjective norm, the voluntariness of technology usage and image) and cognitive processes (job relevance, output quality, result demonstrability and perceived ease of use) (Venkatesh and Davis, 2000). The integrated TAM model (i.e. "TAM3") then further reduced so called "crossover effects" between the various antecedents of behavioural intention (Venkatesh and Bala, 2008), while adding to the determinants of perceived ease of use (based on Venkatesh, 2000).

Synthesising the aforementioned and other existing models related to technology acceptance, the *UTAUT model* was introduced (Venkatesh *et al.*, 2003; Williams *et al.*, 2015). UTAUT distinguishes four antecedents of people's intention to adopt technology, and, in turn, usage behaviour: performance expectancy, effort expectancy, social influence and facilitating conditions (Williams *et al.*, 2015). Following the UTAUT model, people will embrace technology when they have a reasonable expectation that using the technology: 1) will lead to favourable results; 2) will not cost too much effort; 3) will be supported by others; and 4) will have enough resources and guidance for implementation. Hence, a supportive environment for innovation is key. This corresponds with the main tenets of employee innovation literature. A psychologically-safe climate for innovation must exist for employees' innovative work behaviour to occur (Scott and Bruce, 1994). Leaders are crucial in enabling the creation of such a climate (Anderson *et al.*, 2014).

Nonetheless, the different versions of UTAUT nebulously identify managers' role in positively influencing workers' acceptance of technological adoption (Vidyarthy *et al.*, 2014). Only recently, a meta-analysis and conceptual paper identified the need to expand the UTAUT model and analyse multi-level variables, like leadership (Blut *et al.*, 2022; Venkatesh *et al.*, 2016). In addition, the UTAUT model failed to account for how to effectively deal with employee's emotions and how it affects employee's adoption and acceptance of new practices (Venkatesh, 2000), which may be especially harmed when those practices may affect job or status loss. Although the UTAUT model has its limitations, a variety of Operations Management studies on Industry 4.0 have used it as a fundamental, ranging from understanding employees' blockchain technology adoption (Pieters *et al.*, 2022; Queiroz *et al.*, 2021) to the adoption of electronic marketplaces (Collignon and Sternberg, 2020) and the use of big data (Aloysius *et al.*, 2018). This study, therefore, explores how managers can effectively facilitate employees' acceptance of Industry 4.0 technology adoption using the UTAUT model as a springboard for a further model extension.

2.3 Manager's leadership style and employee's acceptance and use of Industry 4.0 technology

Leadership support for digital transformation activities has been ranked as one of the key criteria for a firm to mature its Industry 4.0 technology adoption (Wagire *et al.*, 2021). As noted by Da Silva *et al.* (2020, p. 12), the role of *"leadership will be instrumental in conducting changes in the company"* as Industry 4.0 technology adoption affects both the organisational structure and culture. The plethora of publications on effective leadership in the past decades of increasing industrialisation introduced many leadership theories (Lord *et al.*, 2017). As elaborated below, among the most prevalent are leader–member exchange, transformational leadership, transactional leadership and shared leadership (Lord *et al.*, 2017).

Venkatesh and Bala (2008) suggested *leader–member exchange theory* (Liden *et al.*, 1997) to better understand the impact of management support on information technology adoption. Leader–member exchange proposes that the quality of the dyadic relationship between managers and their subordinates differs per individual, and, as such, managers have a different impact on different employees (Lord *et al.*, 2017). Based on cross-sectional survey data, such dyadic differences have indeed been found to impact TAM's perceived usefulness

variable (Magni and Pennarola, 2008). Therefore, these studies assume a personalised leadership approach is most effective in the context of technology adoption.

A leadership style that follows a personalised approach entails *transformational leadership* which was first introduced by Burns (1978) and then further developed by, most prominently, scholars like Bass and Avolio (Avolio *et al.*, 1999; Bass, 1985, 1990, 1999). Transformational leadership theory states that managers, through their leadership behaviours, impact (or 'transform") their employee's collective identification, value internalisation and self-efficacy (Siangchokyoo *et al.*, 2020). These leader behaviours have been summarised in the following four subdimensions, namely, manager's provision of idealised influence (i.e. charisma), inspirational motivation, intellectual stimulation and individualised consideration (Bednall *et al.*, 2018; Peng *et al.*, 2021). It is through these behaviours that transformational leaders are suggested to impact their followers' motivation for (organisational) change and innovation (Tan *et al.*, 2021, in press). Shamim *et al.* (2016) also noted that transformational leadership had been associated with innovation and learning, which are relevant to Industry 4.0 technology adoption. Schepers *et al.* (2005) noticed that especially the intellectual stimulation subdimension might boost employee's perception of the usefulness of technology at work by encouraging their imagination and innovative thinking. Still, not only Shamim *et al.* (2016) but also Schepers *et al.* (2005, p. 505) called for the investigation of *"other leadership theories and constructs (e.g. leader characteristics) to TAM"*.

In particular, Shamim *et al.* (2016) suggested including, next to transformational leadership, also *transactional leadership* in studies on Industry 4.0 adoption. Transactional leadership is grounded in the idea of an exchange relationship with followers (Burns, 1978) and based on contingent reward, meaning that effective leaders are thought to provide rewards to their employees when they achieve specified goals (Bednall *et al.*, 2018; Lord *et al.*, 2017). In addition to contingent reward, transactional leadership also contains two management-by-exception subdimensions: an active, more proactive way of dealing with issues and a passive, more reactive one (Anderson and Sun, 2017; Avolio *et al.*, 1999). Transactional leaders are thus primarily focused on employees' (correct) task execution. The augmentation hypothesis states that a combination of both transformational leadership and transactional leadership is most effective in many contexts (Lord *et al.*, 2017). Indeed, Schneider (2018) proposed that leaders of Industry 4.0 initiatives must not only govern, control and coordinate the transformation process (behaviours that are associated with transactional leadership), but also create acceptance for the change and establish a culture of experimentation, risk-taking, and collaboration (behaviours that strongly resemble transformational leadership). Yet, another cross-sectional survey, by Schepers *et al.* (2005), on technology acceptance, found that transactional leadership did not relate to service agent's technology acceptance, while transformational leadership was positively associated with the technology's perceived usefulness. Hence, it is still unclear whether both styles are still relevant and equally effective when a firm wants to adopt major digitalisation-induced change like Industry 4.0 technology adoption.

Finally, Yammarino (2013) added that a more collectivistic, shared leadership style would best fit the typically flat organisational structures of technology-driven organisations. Shared, or distributed, leadership considers the sharing of formal leadership tasks among team members (Anderson and Sun, 2017). How such a shared leadership style could benefit Industry 4.0 technology adoption has not yet been studied though. Thus, our review of the available literature highlighted the lack of conclusive evidence on how different leadership styles impact employee's Industry 4.0 technology adoption. Together with the general recent call of leadership scholars for more qualitative studies (Fischer and Sitkin, 2023; Siangchokyoo *et al.*, 2020), this study explores the role of leadership more broadly to provide more direction for future studies on this topic.

2.4 Role of manager's understanding of emotions in the adoption of Industry 4.0 technology

Next to manager's leadership style, this study explores an aspect of their leadership that has hardly been incorporated in studies on Industry 4.0 technology adoption, namely, manager's sensitivity to and ability to act upon employee's feelings vis-à-vis the desired change (Harlan, 2020). The acceptance, resistance, disengagement or proactivity to the change by the recipients is inherently an affective process (Oreg *et al.*, 2018) that greatly impacts the smoothness and success of the Industry 4.0 technology implementation process. One of the explaining mechanisms for these effects stems from the *Social Exchange theory "which describes the exchange of socio-emotional resources between leaders and followers"* (Vidyarthy *et al.*, 2014, p. 233). Following this theory, *"employees who perceive supportive relationships with the organization* [or: leader] *have favourable attitudes and engage in positive extra-role behaviours that help it to succeed"* (Gibney *et al.*, 2009, p. 666). Yet, we still know very little about the role of leaders' behaviours in shaping employees' responses to change, including how they impact employees' emotions (Oreg and Berson, 2019). Oreg *et al.* (2018) argued that employee's change coping potential, which can be activated by social support and perceived control of the change, might help them control their emotional responses to change. Such a coping mechanism can help employees facilitate adaptation and embrace change instead of resisting it (Huy, 1999; Wiens and Rowell, 2018). Indeed, the following quote from Marcon *et al.* (2022, p. 279) justifies the focus of our study on employee's acceptance of technology: *"manufacturing companies that focus on workers' operational processes and social needs (i.e. organizational and social subsystems) as preconditions for Industry 4.0 implementation are more prone to achieve higher levels of maturity in technology implementation"*. The summarised literature leads us to empirically explore the role of leadership in employees' acceptance of Industry 4.0 technology, and consequently, their actual usage of the Industry 4.0 technology.

3. Methodology

3.1 Research design

Comparative case studies with two firms leading Industry 4.0 technologies implementation were adopted. We used multiple qualitative methods, including site visits and interviews with managers and their employees. These different observations were collected and integrated to permit complete and synergistic data utilisation (Fetters *et al.*, 2013). By associating multiple types of qualitative data, one can better explain the phenomena under consideration through triangulation (Edmondson and McManus, 2007). This process, whereby complementary perspectives are combined, increases the external validity and construct validity (Edmondson and McManus, 2007). Consequently, befitting the inductive nature of the present study, a mixed-methods approach can expand and strengthen the theoretical and practical implications, thus answering the research question more rigorously (Johnson *et al.*, 2007).

3.2 Sampling and sample description

A purposive sampling strategy was followed (Yin, 2011). To answer our research question, we identified companies that implemented Industry 4.0 technologies on their work floor, thus involving frontline employees. The database of the 2,200 firms that were members of the largest employer association for the Dutch technology industry was utilised to select the cases. Their members account for a sixth of the Netherland's total export earnings. In the years prior to our study, the employer association had installed so-called "ambassador groups" consisting of firms deemed frontrunners for industry-specific developments such as Industry 4.0. These ambassador firms were selected by the employer organisation based on

their self-nomination and the level of progress made. Activities were organised among these ambassador groups meant to share experiences and best practices. From the firms labelled in the database as "Industry 4.0 ambassadors' we selected 12 companies that the employer association saw as best practices that were actively implementing one or more Industry 4.0 technologies in their daily operations. Similar to Schneider and Sting (2020), we rejected those firms in the database that were still in the (strategic) preparation phase of Industry 4.0 technology adoption, despite their strong interest in participating in the study. The premises of those 12 firms were then visited to further assess the level of Industry 4.0 technology adoption within their firm. During those visits, interviews were held with key informants and each factory was toured. Eight firms were excluded because their Industry 4.0 technology adoption initiative was too nascent. Four manufacturing firms fit our selection criteria and were selected to participate in the study. Two of those firms had to opt out at the last minute because they could not participate due to other priorities. The other two manufacturing firms agreed to participate in the study.

The two sampled firms were large-sized, with 250 and 700 employees, respectively, and had existed for more than 45 years (see Table 1 which summarises the commonalities and differences). The two multinational firms worked in different, non-competing industries: One produced metalworking machinery, whereas the other was engaged in design and engineering. Both firms actively worked with smart intuitive machine operations, multi-system integration, innovative technologies and integrated production lines with flexible productions. Both firms had a history of adopting new technologies, including recently implemented Enterprise Resource Planning packages, without laying off people. The case studies focused on introducing two particular Industry 4.0 technologies:

The first firm adopted a large autonomous robot called here "Creator". The Creator introduction was prepared over multiple years and aimed at enabling a more efficient production system. The Creator constitutes a full-automatic robot, which autonomously calculates the slopes/angles and welds pre-assembled parts into a final product based on customer-tailored 3D models fed into the system by operators. The robot had been placed immediately after a fully automatic production line that prepared the separate parts by

Company	Creator case	HoloLens case
Industry	Metalworking machinery	Design and engineering
Size	~700 employees	~250 employees
Company age	>45 years	>45 years
Company location	The Netherlands (headquarter and plant)	The Netherlands (headquarter and plant)
Level of automation	Medium labour intensive	Medium labour intensive
Category and type of Industry 4.0 technology adopted (based on Frank *et al.*, 2019)	Smart working front-end technology: Cyber-physical Systems	Smart working front-end technology: Augmented reality
Aim of Industry 4.0 technology adoption	Staying ahead of their competitors by upscaling their production capacity, delivering a constant quality level, while dealing with an increasingly tight labour market for highly skilled operators	Replace bureaucratic processes with high-tech ones, which they expected to be an attractive feature for new hires
No. of interview participants	3 employees; 2 managers	5 employees; 4 managers
No. of field visits	2 visits	2 visits

Source(s): Authors own creation

Table 1. Case company commonalities and differences and data sources

sawing and drilling them. The Creator replaced a set of machines previously operated by frontline workers, who became responsible for operating the Creator instead and keeping in contact with software programmers to optimise the Creator's settings.

Firm number two integrated augmented reality in its design process using the "Microsoft HoloLens". This technology was piloted into the firm via a student's internship to gradually move away from the traditional production approach in their sector towards more high-end customer service and attract new customers and employees. The HoloLens constituted a pair of augmented reality glasses that, together with a tailored software application integrating spatial mapping and holograms, enables both design engineers and sales agents to portray the firm's products at the customer's location. In addition, maintenance engineers can remotely check a machine's settings or status and immediately fill out the maintenance form. As such, the HoloLens supports customers' decision-making and a more efficient design and maintenance process.

In both firms, these technologies were implemented to make the business more "future proof" and aimed to optimise work-floor operations and make them more attractive in the tight labour market (see Table 1). Both technologies, therefore, belong to the "smart working" group of "front-end" Industry 4.0 technologies (Frank *et al.*, 2019). At the time, and to this date, both firms actively communicated about their application of these technologies on their company websites, confirming their long-term strategic goal of integrating Industry 4.0 technologies into their daily business. The two cases can be considered as polar from the perspective that in the Creator's case, the technology implementation was driven following a more bottom-up approach, whereas in the case of Hololens, it was a top-down approach to technology implementation (a proxy for potentially finding different leadership styles).

The participants involved managers responsible for implementing Industry 4.0 technologies in their production lines and their employees working directly with Industry 4.0 technologies. All managers had leadership responsibilities. The participants' job positions ranged from operations manager or production manager to technical advisor and technical maintenance engineer. In terms of demographics: all respondents were male, on average 31–40 years old, and holding a Bachelor's degree. Most of them held their current job position between 4 and 8 years (employees) and 9–12 years (managers). These demographics were equally distributed among both cases, enabling the cross-case comparison. Furthermore, following the university's ethical committee's approval for this study, each participant signed an informed consent form and individually agreed to participate in the study.

3.3 Qualitative data collection

Both cases were visited multiple times by the research team. During those site visits, the work floor was toured to observe the focal Industry 4.0 technologies' application in real-time and understand each case's production processes in which the technologies were embedded. This enabled the researchers to gain first-hand insight into the workings and verify the level of Industry 4.0 technology integration in the operator's daily work (Voss *et al.*, 2002). Field notes were taken to capture the observations (Eisenhardt, 1989). During these shop-floor visits, participant observation and informal conversations helped create trust and a safe climate between the researcher and the respondents required to discuss also more sensitive, affective elements of the Industry 4.0 technology implementation process (Yin, 2011). After each field visit, the research team members individually shared and discussed their observations, thereby enriching each other's insights and enhancing validity and reliability of the reported data.

Furthermore, during those field visits, 14 one-hour interviews were held with eight employees and six managers in both companies (see, Table 1). The employees worked directly with the new Industry 4.0 technologies, while the managers were involved in the implementation of those advanced technologies. Pilot interviews with Industry 4.0 technology experts from similar companies were performed, after which the semi-

structured interview guide (Appendix) was finalised. This interview guide included open-ended questions and the critical incidents technique (CIT) (Flanagan, 1954). The CIT enables detailed and structured exploration of people's behaviour and feelings in key situations by first asking for those key moments and then probing through follow-up questions (Bott and Tourish, 2016; Flanagan, 1954). As noted by Bott and Tourish (2016, p. 276): *"CIT potentially offers the kind of 'thick description' that is particularly useful in theory building"*. This interview method thus fits the exploratory nature of our study. Example questions are: "What change has the company experienced regarding Industry 4.0 adoption?", "How did the managers communicate about these changes?" and "How did this change affect your job or you personally?". All interviews were audio recorded and then transcribed verbatim.

3.4 Data analysis

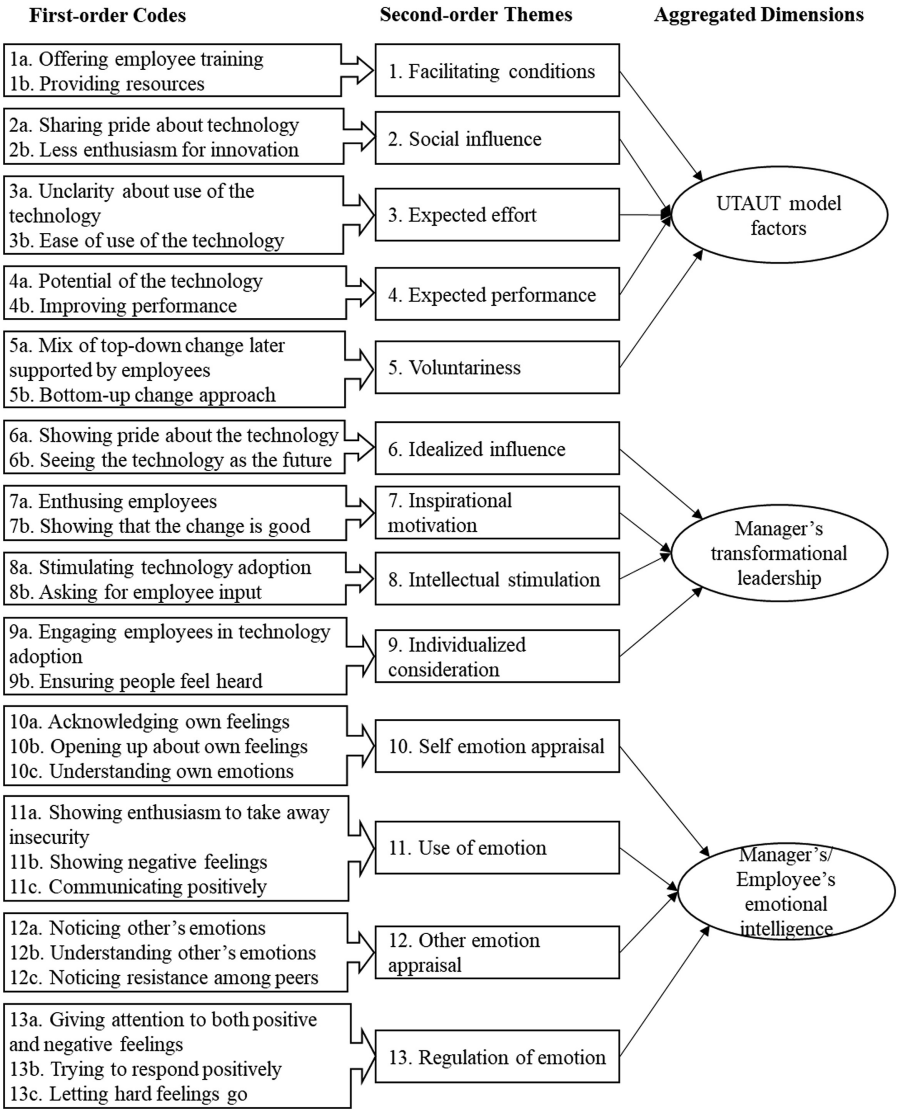
The interview transcriptions were content analysed in ATLAS.ti, following Strauss and Corbin's open, axial and selective coding phases (Ketokivi and Choi, 2014). Two Master students supported the authors in the coding process, whereby the first author monitored the code-development process and then double-checked and fine-tuned the coding that was initially performed by the Master students. Developing the code labels was done based on a group discussion among the coders and the first author to arrive at a common understanding, and corroborating with the field observation notes during the coding process.

We followed a "ground-up" approach to coding the data whereby the language used by the interviewees formed the basis for finding themes and developing a theory closely linked to the data (Caldwell *et al.*, 2017). Thus, after the initial screening of the transcriptions, the data was coded in an open manner, thereby using first-order code labels that closely aligned with the actual quotes, following a "ground-up" approach whereby the actual language used by our interviewees was used to find patterns and closely linking it to developing theory. In two consecutive axial and selective coding rounds, second-order codes and aggregate dimensions were developed that corresponded with partially theory-based (sub) dimensions, as we were going back and forth between the literature and our emerging data structure (Strauss and Corbin, 1990). As mentioned by Grodal *et al.* (2021, p. 13), in qualitative data analysis, *"past research serves as a springboard for asking questions to spur new lines of research"*. Thus, in line with the rationale of inductive research, the first-round coding was not limited to the previous theory. For example, in terms of leadership style, the first-order codes were developed from scratch. After scrutinising this first round of data analysis, we compared the codes to the subdimensions of the leadership styles described in Section 2.3. In doing so, whereas personalised leader-member exchange or the transactional and shared leadership styles were less prevalent, we did recognise the four theory-based subdimensions of transformational leadership in the interview data. We, therefore, adopted these theoretical subdimensions as second-order code labels and took "transformational leadership" as the aggregate dimension. In Section5, the theoretical underpinnings are elaborated.

The various data sources—the data structure based on the coded interview transcriptions and our experiences during the field visits—were then initially integrated into two case narratives, which followed a *"weaving approach"* to link the various qualitative findings (Fetters *et al.*, 2013, p. 2142). These detailed case write-ups helped compare and contrast the emerging patterns (Barratt *et al.*, 2011). The patterns based on which the two cases can be compared were then elaborated below, illustrated by the available quotes.

4. Results

This section compares both cases based on the resulting data structure and presents the key themes found in the data (Figure 1, with the exemplary quotes presented in Table 2). In both



Note(s): The first-order codes were inductively generated from the interview and field observation data and then labelled, matching the available theory, as we were going back and forth between the literature and our emerging data structure (Strauss and Corbin, 1990)

Source(s): Authors own creation

Figure 1.
Data structure

firms, employees eventually accepted the Industry 4.0 technologies as part of their daily work routines. Nevertheless, the path both firms took in implementing the respective new technologies differed which led the Creator's implementation to go smoother than the HoloLens adoption process. We did notice differences in terms of the UTAUT model factors,

First-order codes	Quotes
1a. Offering employee training	"We were informed about the machine, its precise workings, and we saw it in action." (Emp, Creator)
1b. Providing resources	"I think it is positive that they provide energy and resources to do it. This way we can move forward, we have to." (Emp, HoloLens)
2a. Sharing pride about technology*	"Employees are also quite proud of the [Creator]. They say: 'This is what we developed.' [. . .] We talk about what we are proud off and that we have the [Creator]. This is basically what every employee does." (Emp, Creator)
2b. Less enthusiasm for innovation*	"I always feel that we tend to quickly switch back to the old stuff that is functioning for 20 years now." (Emp, HoloLens)
3a. Unclarity about use of the new technology	"What I noticed, and this does not regard me, but when we are working on this, when it had not yet been communicated, people were indeed a bit worried. Like: 'What is going to happen?' and 'How should I apply that?'." (Emp, Creator)
3b. Ease of use of the technology	"Well, it is kind of a big unit on your head, but if it would be a little bit smaller (Emp, HoloLens)
4a. Potential of the technology	"I want to get it to work to the best of its potential. When there are problems, I always report them and they pick it up immediately to solve these issues. I hope it will run smoothly in a few months from now." (Emp, Creator)
4b. Improving performance	"You can work much faster, you save time and are less likely to forget something or make mistakes." (Emp, HoloLens)
5a. Mix of top-down change later supported by employees	"I mean, we were involved; we have visited the facility on the other side of the street because we were curious too. [. . .] As such, together with senior management, we moved towards accepting, in the sense that we wanted to bring the advanced technology in to further develop it." (Emp, Creator)
5b. Bottom-up change approach	"It is now up to the department maintenance engineering to integrate the HoloLens." (Mgr, HoloLens)
6a. Showing pride about the new technology*	"I really like the development. I am proud to have this [Creator] as the first steel-based production facility. So yes, I stimulate that, both in relation to the guys as well as internally." (Mgr, Creator)
6b. Seeing the technology as the future*	"Yes, personally I am confident that this road will be successful and important." (Mgr, HoloLens) "I like this [adopting the HoloLens] but I always have the feeling that it [innovations like the HoloLens] tend to be stalled a bit over time. [. . .] So I definitely see that this is the future but it [the HoloLens adoption] but there is a long journey ahead." (Emp, HoloLens)
7a. Enthusing employees*	"We are now at the point of what is the next step? [. . .] We have tried to plant a seed and enthuse people." (Mgr, HoloLens) "And by showing this [positivity] to people, employees become more positive and see the benefits [of adopting the HoloLens]." (Emp, HoloLens)
7b. Showing that the change is good	"People's mindset is slowly starting to change into 'it is not that bad'. But that took a trajectory of about two years, to show them it is not bad for them [. . .] that we do things with their ideas." (Mgr, Creator) "The support from management is quite strong. I think it [the Creator implementation] is working out well." (Emp, Creator)
8a. Stimulating technology adoption	"Through these glasses we try to force them a bit to work with the system and optimise the process. Well, it is a bit pushing them to work in a standardised and efficient way. [. . .] you hope to stimulate multi-tasking, and thereby the speed of work." (Mgr, HoloLens) "I am always stimulated by these kinds of things [the HoloLens]." (Emp, HoloLens)

(*continued*)

Table 2.
Example quotes for first-order codes

First-order codes	Quotes
8b. Asking for employee input*	"Like with the guys I can ask them, during our daily meeting, like what do we need to improve upon and what are the issues? This also makes the guys proud again of their product." (Mgr, Creator) "In fact they should put more employees together [in a room] to discuss the next steps [of the HoloLens). [. . .] And when you discuss those things, people will cooperate and think along." (Emp, HoloLens)
9a. Engaging employees in technology adoption	"Before we start using such a new machine, we always sit with the guys." (Mgr, Creator) "When I explain my suggestions to my supervisor they will take further actions." (Emp, Creator)
9b. Ensuring people feel heard	"We always try to understand the resistance. [. . .] You first need to know what the resistance is about, why do people resist and then you could, potentially but not always, turn it around into embracing the new technology. [. . .] I think the effect is that people feel heard and feel we do not disregard their viewpoints." (Mgr, HoloLens) "So if you have an innovative idea for a new product, they [management] can be a bit reserved." (Emp, HoloLens)
10a. Acknowledging own feelings*	"I always tend to be positive about change. [. . .] I am open to it." (Mgr, Creator)
10b. Opening up about own feelings*	"I don't like change. I like things to stay as they were. [. . .] I just don't like change." (Mgr, HoloLens)
10c. Understanding own emotions	"That gives a positive feeling. [. . .] But I think I tend to be less extraverted in those kinds of things. Like, I will not start to cheer immediately." (Emp, HoloLens)
11a. Showing enthusiasm to take away insecurity*	"Sometimes they fear that the [Creator] will steal their jobs. And then [. . .] So I respond immediately, like: 'This is total nonsense!' They probably notice my enthusiasm about the Fabricator." (Mgr, Creator)
11b. Showing negative feelings*	"Well, I felt mainly frustration. [. . .] Banging my hands on the table like 'Just start! Make a few mistakes but please start if you think it is that important'." (Mgr, HoloLens)
11c. Communicating positively*	"I always try to communicate things in a positive way, so people collaborate." (Emp, Creator)
12a. Noticing other's emotions	"When I walk around all day with bad temper, they [management] notice." (Emp, Creator)
12b. Understanding other's emotions	"You understand the emotions of your colleagues." (Mgr, Creator)
12c. Noticing resistance among peers	"They used to be able to adjust more on the machine. This is much more restricted now and that is how people start to resist a little." (Emp, HoloLens)
13a. Giving attention to both positive and negative feelings*	"The negative feelings would need to get more attention than the positive ones. But the positive feelings do confirm it is a good design." (Mgr, HoloLens)
13b. Trying to respond positively*	"You always try to communicate, together with the management, like the machine is standing there and when you hear people's responses you try to [. . .] You try to always respond to them in a positive way." (Mgr, Creator)
13c. Letting hard feelings go	"Others sometimes sleep bad. [. . .] I sometimes find that hard, but this is something you need to let go off." (Emp, HoloLens)

Note(s): * These codes were also verified through observations during the field visits
Source(s): Authors own creation

Table 2.

managers' leadership style related to the introduction of the technologies in the workplace, and managers' and employees' way of dealing with emotions throughout this change process.

4.1 UTAUT model factors

The different UTAUT dimensions (Venkatesh *et al.*, 2003, 2016; Williams *et al.*, 2015) were perceived differently in both cases. In terms of *facilitating conditions*, training and other types of resources were offered (Table 2). An initial version of the Creator was developed at a neighbouring company's facilities specialising in developing such high-tech machines. Before its introduction, a wider group of managers and employees participated in a factory tour and various demos. An operator recalled: *"We were informed about the machine, its precise workings, and we saw it in action."* The training enabled both operators and managers to work with the new machine, reducing the expected effort of using it. The prior engagement and consultation with employees and providing them with training instilled confidence in employees. In addition, frontline supervisors held daily meetings with their employees to discuss points for improving the Creator. At HoloLens, the management invested in a scrum team [1] of six people from different departments that worked with the intern in a series of two-week sprints to test and implement the HoloLens in other work areas. To convince people to participate, the operations manager held individual face-to-face meetings with selected employees to invite them into the scrum team; one of the maintenance engineers shared with us that he appreciated getting the opportunity to be a part of this scrum team. Apart from the HoloLens, managers also worked with other advanced technologies, such as remote desktops and software which enabled more detailed management reports. One of the in-company technical advisors illustrated the high level of facilitating conditions perceived as follows: *"I think it is positive that they provide energy and resources to do it. This way we can move forward, we have to."*

Both firms also had considerable *social influence* to adopt the new technology. In the Creator case, there was considerable support from work-floor employees to adopt the Creator. An employee noted that people were quite proud of the machine and said things like *"This is what we developed ourselves"* and *"we talk about what we are proud off and that we have the* [Creator]. *This is basically what every employee does."* In the HoloLens case, there was less enthusiasm for innovations in general. An employee complained: *"I always feel that we tend to quickly switch back to the old stuff that is functioning for 20 years now."* Another employee illustrated his reservation regarding the HoloLens: *"I support it to some extent."* Thus, in the HoloLens case, there was less social influence to adopt the Industry 4.0 technology compared to what we had observed in the Creator case.

Regarding the *expected effort,* in both firms, employees were initially uncertain, despite the training they had received. At the Creator, we experienced that, initially, employees were unsure how to use the new technology: *"People were indeed a bit worried. Like: 'What is going to happen?' and 'How should I apply that?'."* By the time we visited them on-site, the Creator had been fully integrated into their regular way of working. An operator stated that he expected the Creator to run smoothly relatively soon: *"I want to get it to work to the best of its potential. When there are problems, I always report them and they pick it up immediately to solve these issues. I hope it will run smoothly in a few months from now."* In other words, employees had a relatively *high future performance expectation* of adopting the Creator.

Also in the HoloLens case, the employees had *high-performance expectations* of the HoloLens, although the ease of use was not optimal given the *high expected effort*. One of the maintenance engineers illustrated this as follows: *"Well, it is kind of a big unit on your head, but if it would be a little bit smaller* [. . .] *you can work much faster, you save time and are less likely to forget something or make mistakes."* The project coordinator stated: *"While wearing the glasses, they* [maintenance engineers] *can move through the workspace, stand next to the*

machine, do all the checks. By making gestures and saying things like 'OK' they can fill out the maintenance forms. [. . .] *Normally we used to do that on paper or a laptop. This is of course, much easier. And more fun!"*. An employee confirmed that *"You can work much faster, you save time and are less likely to forget something or make mistakes."* Thus, in both cases, employees (and managers alike) expected reasonable effort in adopting the new technology and positive performance effects after adopting the new technology.

And regarding *voluntariness*, in the Creator's case, management followed a top-down approach to implementing the new technology, which essentially reduced the level of voluntariness of adopting the new technology. This was compensated for by the fact that management informed staff about its introduction, personally invited a couple of volunteers to develop it further, and organised well-appreciated training and demos. An operator reflected: *"I mean, we were involved* [. . .] *As such, together with senior management, we moved towards accepting, in the sense that we wanted to bring the advanced technology in to further develop it."* Thus, despite reduced voluntariness, employees were optimistic about adopting the new technology. In contrast, the HoloLens case managers adopted a more gradual, bottom-up implementation approach, giving more freedom to their employees. This sign of voluntariness also led to some unclarity whether employees were going to follow up on further integrating the HoloLens in their daily operations; a manager noted: *"It is now up to the department maintenance engineers to integrate the HoloLens."*

4.2 Leadership style throughout the introduction of new technologies in the workplace

The way managers introduced the new technologies in the workplace certainly also played a role in employees' intention to adopt the digital work-floor transformation. Their leadership style was characterised by a strong vision, challenging employees in working with high-end Industry 4.0 technologies and consideration for employees' views. As illustrated below, the quotes and observations show us clear signs of managers' "idealised influence", "inspirational motivation", "intellectual stimulation" and "individualised consideration" (Table 2). These themes are key parts of transformational leadership theory (Avolio *et al.*, 1999; Bass, 1985, 1999; Bednall *et al.*, 2018; Peng *et al.*, 2021): Idealised influence is typically operationalised as providing vision and instilling pride; inspirational motivation concerns a leader's emotional qualities and building employees' confidence in the change; intellectual stimulation is manager's behaviour to motivate employees to see and deal with challenges in novel ways; and individualised consideration consists of providing personal support for employees (Bednall *et al.*, 2018).

Managers enacted *idealised influence* by showing pride in the new technology and communicating their vision about seeing it as the future. For instance, in the Creator case, the operations manager stated, *"I am proud to have this* [Creator] *as the first steel-based production facility. So yes, I stimulate that, both in relation to the guys as well as internally."* Later on, he proudly stated: *"There is nothing better than this.* [. . .] *This is smart industry."* He continued by providing his vision on the Creator's importance in enabling the firm to stay ahead of its competitors by upscaling their production capacity, delivering a constant quality level, while dealing with an increasingly tight labour market for highly skilled operators. The pride exhibited by managers also spilled over to the employees and instilled a similar sense of pride about the new advanced technology among employees. The operations manager illustrated: *"When I ask employees in the hallway what they think of it, I feel they are quite proud of being able to work with the* [Creator]. *They do no longer see it as a threat, it is really like 'We are* [Firm name] *and we already work with the* [Creator]*, ahead of our competitors'."* In contrast, at HoloLens, despite the fact that the operations manager was *"confident that this road will be successful and important"*, his communication about the new technology was more practical. For instance, he explained management's intention to adopt the HoloLens was to replace

bureaucratic processes with high-tech ones: *"Through the HoloLens we expected to speed up certain processes that were initially based on paper files or opening a laptop."* Through this they expected to be an attractive feature for new hires (Table 1): *"Instead of dull paperwork, you get interesting goggles to execute your job in a futuristic way"*. However, although being supportive of the HoloLens, employees seemed a bit skeptical about how fast the management would pursue the technology adoption as it was their experience that innovations like the HoloLens *"tend to be stalled a bit over time."*

In terms of *inspirational motivation*, the managers in the Creator case understood that the journey towards full integration of the machine in their operations would take quite some time and that, throughout, they had to keep motivating their people by showing that the change could turn out to be positive. A manager said: "[. . .] *that took a trajectory of about two years, to show them it is not bad for them.* [. . .] *that we do things with their ideas."* In more practical terms, he stated that when workers voiced concerns of (future) job loss due to the Creator, he would repeat that this was not the goal and, instead, *"we want to increase output and revenue with the* [Creator] *working alongside our people"*. Employees at the Creator case also confirmed that *"the support from management is quite strong"*, which further motivated them to accept the Creator. In the HoloLens case management had chosen a bottom-up approach and had not dictated its use in daily work; employees also noticed managers' positive attitude, which spilled over to employees and made them *"see the benefits"* of adopting the HoloLens. In reflection, one of the managers noted: *"We are now at the point of: what is the next step?]. . .] We have tried to plant a seed and enthuse people.]. . .] It is now up to the department maintenance engineering to integrate the HoloLens."*

In the Creator case, we also found examples of managers' *intellectual stimulation* of employees. The Creator's adoption was a gradual process: First, managers had selected and invited several operators to be involved in earlier stages of the development; they personally invited them during face-to-face meetings. And one of the managers explained he always seeks employees' ideas: *"Like with the guys I can ask them, during our daily meeting, what do we need to improve upon and what are the issues? This also makes the guys proud again of their product."* Altogether, employees felt professionally challenged; one of the operators stated: "*The* [Creator] *immediately appealed to me. I liked the challenge. Good that they build such a smart machine."* At HoloLens, though, the adoption was not so much intellectually stimulated but more about the need for internal efficiency, as noted by one of the operational managers: *"Through these glasses we try to force them a bit to work with the system and optimise the processes. Well, it is a bit pushing them to work in a standardised and efficient way.* [. . .] *You hope to stimulate multi-tasking, and thereby the speed of work."* Indeed, employees felt more stimulated by the HoloLens itself than management *per se*: *"I always get stimulated by these things."* Employees even suggested that management could do more to ask for employees' input about the technology adoption: *"In fact, they should put more employees together [in a room] to discuss the next steps* [of the HoloLens]*."*

Finally, regarding *individualised consideration*, we found that the managers in the two cases took rather different approaches. In the Creator case, employees were involved during the director's annual presentation of the yearly objectives and financial results. Afterwards, there was a drinks session where all employees could ask questions to the director. The manager confirmed that he took the employees' voices and input seriously: *"Before we start using such a new machine, we always sit with the guys."* This personal approach to change characterised their care for the people working in their firm and their opinions. Employees confirmed their managers' engaging attitude: *"When I explain my suggestions to my supervisor they will take further actions."* In the HoloLens case, however, we found that the managers were trying to make employees feel heard throughout the technology adoption process, including the ones who were not part of the initial scrum team: *"I think the effect is that people feel heard and feel we do not disregard their viewpoints"* one of the managers said.

However, the manager also openly reflected upon the initial resistance the HoloLens had caused among employees; he noted: *"It really struck me that there were a couple of people who resisted the plans directly.* [. . .] *Apparently more energy was needed to enthuse people for the product."* Management was well aware of the (theoretical) effects of creating a better understanding of employees' concerns, although they had more difficulties realising such an individualised approach: *"I think the effect is that people feel heard and feel we do not disregard their viewpoints."* Employees at the HoloLens case stated that their managers' attitude towards their ideas was a point for improvement because they did not always perceive that management was receptive to their ideas: *"So if you have an innovative idea for a new product, they* [management] *can be a bit reserved."* This thus confirms that employees in the HoloLens case felt less heard by their managers, which impacted their appetite to adopt the new technology.

4.3 Managers' and employees' way of dealing with emotions throughout the change process

The data also revealed various examples of how managers and employees dealt with their feelings about the technology adoption. For instance, we found various examples of managers showing signs of "understanding their own emotions" and "understanding emotions of their employees", "using their emotions" well, as well as "regulating their own emotions" (Table 2). These elements are strongly linked to a phenomenon in Organisational Behaviour literature identified as "emotional intelligence" (EI), defined as the ability to recognise and regulate one's own and other's emotions (Wong and Law, 2002; Zeidner *et al.*, 2004). EI tends to be operationalised in four subdimensions, whereby self-emotional appraisal refers to an *"individual's ability to understand their deep emotions"*, others' emotional appraisal stands for *"peoples' ability to perceive and understand the emotion of those people around them"*, use of emotion relates to *"the ability of individuals to make use of their emotions by directing them towards constructive activities and personal performance"* and regulation of emotions is seen as peoples' ability *"to regulate their emotions, which will enable a more rapid recovery from psychological distress"* (Mayer and Salovey, 1997; Salovey and Mayer, 1990; Wong and Law, 2002, p. 246).

In terms of the Creator case, for instance, managers acknowledged that they *"tend to be positive about change"* and also used this enthusiasm to take away any employee feelings of job insecurity about the Industry 4.0 technology adoption: *"Sometimes they fear that the* [Creator] *will steal their jobs. And then* [. . .] *So I respond immediately, like: 'This is total nonsense!' They probably notice my enthusiasm about the* [Creator]." On the contrary, at HoloLens a manager confessed that he did not like change: *"I like things to stay as they were."* In addition, he responded in a frustrated manner to employees' resistance to the technology adoption: *"Well, I felt mainly frustration.* [. . .] *Banging my hands on the table like 'Just start!'* [. . .]". Thus, although managers showed signs of self-emotion appraisal in both cases, the effective use of their own emotions differed considerably given that the latter example did not reduce employees' resistance to change.

We also identified in the data *other-emotion appraisal* as the Creator managers explained that they, over time, had developed an awareness of employees' emotions. An operator confirmed that management was sensitive about employees' feelings at work: *"When I walk around all day with bad temper, they* [management] *notice."* Indeed, managers showed their understanding of employees' attitudes towards the Creator: *"It helps that André* [one of the operators] *supports it; he is open to the development and welcomes change and says: 'Yes, please let's get started, what can I do?'."* Another manager also showed to be sensitive to employees' feelings related to the implementation of the Creator: *"I noticed that* [. . .] *when it had not yet been communicated, that there was a bit of unrest among staff, like 'What will happen?' and 'How does this affect me?'."* This awareness helped the manager effectively respond to their

employees by addressing their concerns about the Industry 4.0 technology adoption. The HoloLens managers showed a somewhat less developed radar for others' emotions, although they could identify, in their eyes, rather *"cynical"* employees.

Finally, the Creator management tried to consciously *regulate their own feelings*: *"You try to always respond to them in a positive way."* One of the managers noted that the management also betterunderstood people's feelings regarding the Creator because of the joint demo and training sessions they had participated in with employees. This led management to respond better to employee feelings in relation to the Creator: *"Yes, we symphathise with them."* In the HoloLens case, managers also understood the need to give attention to both negative and positive feelings, although we found fewer examples of them regulating their feelings effectively.

Next to managers' way of dealing with their own and employees' feelings, we also found similar themes in the quotes related to employee responses to adopting the Industry 4.0 technology, although a bit less pronounced. In the Creator case, some employees noticed that other peers initially feared job loss and were worried about the use of the Creator, whereas the interviewed operators themselves did not perceive such insecurities and stated that they were able to *regulate their emotions* and subsequently support the technology adoption. One operator noted: *"I knew everything would be fine."* These positive feelings also stemmed from the fact that the Creator's high-tech possibilities enthused operators. In the HoloLens case, the interviewed operators reflected more on their affective responses throughout the technology adoption process. One of them, for instance, shared that he was *"less extraverted in those kind of things. Like, I will not start to cheer immediately",* showing he understood his feelings. In addition, he noticed that other peers started *"to resist a little"* because the HoloLens were restricting them in task execution. Another added that, even though others slept badly, *"this is something you need to let go of."* One of the other technical advisors illustrated employees' relatively rational way of regulating their response to change: *"the first response* [to changes at work] *is to let it sink in and think about the underlying reasons for change."* In other words, managers and employees showed to acknowledge and deal with their emotions throughout the change process, which impacted their intention to adopt the Industry 4.0 technology in their daily jobs.

5. Discussion

Using mixed-methods comparative case studies, we explored how managers affect employees' acceptance of the adoption of Industry 4.0 technologies and, in turn, Industry 4.0 technology adoption. Both cases were actively implementing their respective Industry 4.0 technology and employee technology adoption levels were similar. However, the employees' enthusiasm for the technologies differed across both cases, as were the generally accepted conditions offered in the UTAUT model. The UTAUT model factors were not the only predictors of employees' intentions. The findings extend the UTAUT model with two key aggregated dimensions we had identified in the data: 1) managers' leadership behaviours which closely resembled the transformational leadership style in both cases; and 2) manager's and employee's abilities to understand and handle their own and employees' feelings during the digital transformation process, i.e. EI. Both elements are thus proposed as important antecedents of employee's Industry 4.0 technology adoption. The rationale behind the theory-elaborating propositions for future research is expanded on below.

Firstly, the *Transformational Leadership theory* is proposed to enrich our modelling of the enablers of employees' acceptance of Industry 4.0 technology adoption (Avolio *et al.*, 1999; Bass, 1985, 1999; Peng *et al.*, 2021). Transformational leadership induces the process of follower transformation in the sense that leaders can influence employees to embrace group goals through collective identification and value internalisation and build self-efficacy to adjust to the change (Siangchokyoo *et al.*, 2020). This process is suggested to take place

through specific leader behaviours. A leader's charisma, or "idealised influence", is a component of transformational leadership that, together with 'inspirational motivation", utilises emotions to direct followers (Lord *et al.*, 2017). In previous studies, charismatic leadership has been considered an antecedent of all four UTAUT dimensions (Neufeld *et al.*, 2007). Other studies have linked transformational leadership to creativity, radical innovation and employees' innovative work behaviour (Bednall *et al.*, 2018; Hughes *et al.*, 2018; Le, 2020; Tan *et al.*, 2021, in press). As noted in the cross-case analysis, the managers in both cases (but especially in the Creator case) displayed transformational leader behaviours which may have contributed to employee's positive expectations about the effects of adopting Industry 4.0 technology in their jobs. Because in both cases, employees initially worried about the impact of the adoption of the Industry 4.0 technology, managers' transformational leadership behaviours helped them see the benefits and let go of their fears and build self-efficacy about the new technology instead. Thus, adopting transformational leadership may contribute to people's performance expectancy of the Industry 4.0 technology.

In addition, the compelling top-down vision for the future and pride in the new technology the managers communicated helped internalise the value of adopting the technology, which may have led to more clarity among employees regarding the perceived ease of use and usefulness of the technology. Indeed, Schepers *et al.* (2005) linked transformational leadership to perceived ease of technology use, which resembles UTAUT's effort expectancy. Thirdly, the transformational leaders in our sample created groups of ambassadors or pilot scrum teams and, in doing so, developed a supportive environment for employees that boosted, also bottom-up, collective identification: this way peers, but also leaders, were able to learn from one another in the transformation process (i.e. UTAUT's social influence). Finally, aligned with their strong vision, managers invested in facilitating conditions, such as providing relevant information about Industry 4.0 technology and offering training to employees. In turn, employees voiced their willingness to adopt the new technologies in their workplace operations. This study thus sees the UTAUT subdimensions as mediating the employee's acceptance of Industry 4.0 (Venkatesh *et al.*, 2016). Indeed, previous studies have identified the promise of contextual organisational-level attributes, like transformational leadership, as exogenous antecedents to the UTAUT baseline model (Venkatesh *et al.*, 2016). Hence:

P1. Transformational leadership positively relates to the employee's (a) expectation that adopting the Industry 4.0 technology will lead to higher performance; (b) expectation that adopting the Industry 4.0 technology will not cost too much effort; (c) perception of social influence; and (d) perception of having access to facilitating conditions like resources and guidance for adopting those Industry 4.0 technologies, leading, in turn, to employee's Industry 4.0 technology acceptance.

Another exogenous antecedent identified in this study answers the call to integrate employees' emotions in management research (Ashkanasy *et al.*, 2017). EI, i.e. one's ability to understand and handle their own and others' feelings towards the change, were identified herein as a critical element in the transition towards Industry 4.0 technology adoption. Industry 4.0 technologies are disruptive and require new ways of working and thus need leaders to win acceptance of change by getting more buy-in from the employees to embrace and immerse in the change process. Here the leader's EI is key in understanding how the employees feel about the change, as stated by Strebel (1996, p. 87): *" They must put themselves in their employees' shoes to understand how change looks from that perspective"*. Manager's EI has been positively related before to employee's innovative work behaviour (Zhou and George, 2003), assembly line worker's performance (Vidyarthy *et al.*, 2014) and high-tech project success in the Australian defence industry (Rezvani *et al.*, 2016). Managers with high EI may also be able to spot more easily the propensity of their employees to change and innovate (Zeidner *et al.*, 2004) and may stimulate employees' creativity (Rego *et al.*, 2007).

The literature distinguishes "ability-based" and "mixed-based" EI, where the first *"pertains to the recognition and control of personal emotion"* and the latter mixes EI traits with abilities (Joseph and Newman, 2010, p. 55). Most scholars deem ability-based EI more scientifically rigorous because it is based on measurable subdimensions (Joseph and Newman, 2010). A popular operationalisation of ability-based EI we have followed has four subdimensions: appraisal and expression of emotion in the self, and in others, regulation of emotion in the self and use of emotions (Mayer and Salovey, 1997; Salovey and Mayer, 1990; Wong and Law, 2002).

Such individual psychological characteristics could be integrated into UTAUT modelling as an exogenous antecedent, similar to what was proposed by Brown *et al.* (2010) and Venkatesh (2022). High EI managers have been associated with generating excitement, enthusiasm and optimism at work and can anticipate and soften employees' initial negative responses to change (Zeidner *et al.*, 2004). Managers' EI can thus strengthen the part of the UTAUT model grounded in the Motivational theory, which states that extrinsic motivation can reinforce a user's willingness to perform an activity (Venkatesh *et al.*, 2003). Their direct supervisor's support may propel the strength of existing determinants of employees' motivations to embrace drastic work-floor changes. This motivation-strengthening effect of a manager's EI may occur when managers recognise and regulate their subordinate's initial scepticism of the balance between their required effort and performance after adopting the technology.

Building upon the earlier mentioned *Social Exchange theory* (Cropanzano *et al.*, 2017; Vidyarthy *et al.*, 2014), we expect the effects of managers' EI to play out primarily (but not exclusively) on the softer side of the model, in terms of the effects of social influence on employee's intention to use the new technology. Social Exchange theory posits that employees are more inclined to reciprocate the supportive behaviours of their bosses or co-workers (Cropanzano *et al.*, 2017). EI-induced supportive relationships contribute to, for instance, employees' extra-role behaviours, such as working on high-tech change projects (Rezvani *et al.*, 2016). Manager's additional support, provided through emotionally-intelligently spotting and acting upon employee's true feelings vis-à-vis the Industry 4.0 technology adoption, is thus expected to intensify the social influence as well as soften employees' concerns regarding the feasibility and value of adopting the new technology (i.e. perceived expected effort and perceived expected performance). As a result, employees will perceive more social influence and act upon them when treated with such care (Schneider and Sting, 2020; Strebel, 1996). Vice versa, when managers display a lower level of EI, this may reduce the effects of perceived social norms and perceived performance. At the same time, it may increase the perceived effort required to use the focal technology. As such, Social Exchange theory can help explain the socio-emotional sides of digital transformation. Thus, the following proposition was formulated with the manager's EI as a new antecedent in the UTAUT model:

P2. Manager's EI positively relates to the employee's (a) expectation that adopting the Industry 4.0 technology will lead to higher performance; (b) expectation that adopting the Industry 4.0 technology will not cost too much effort; (c) perception of social influence; and (d) perception of having access to facilitating conditions like resources and guidance for adopting those Industry 4.0 technologies, ultimately leading to Industry 4.0 technology adoption.

Next to the manager's EI, we also identified the employee's *own* EI as a factor. Indeed, Venkatesh *et al.* (2016) and Venkatesh (2022) also pointed to possible individual-level user attributes that can influence the UTAUT baseline model as endogenous moderating variables and, in some cases, act as exogenous antecedents to the UTAUT model. Building upon the *Job Demands-Resources theory*, an employee's own EI entails an individual-level

psychological resource to accomplish work goals (Lee *et al.*, 2020; Schaufeli and Taris, 2014). Job Demands-Resources theory states that demanding job characteristics—e.g. in this case, the need to change towards Industry 4.0 technology adoption radically—must be balanced by job or personal resources to avoid potentially negative psychological employee outcomes and strengthen employee's work engagement (Schaufeli and Taris, 2014). EI can help employees deal with job demands such as high levels of perceived social pressure—or absence of social support—to comply with adopting the new technology (Venkatesh *et al.*, 2003). Employees' own EI has been suggested before to moderate the relationship between perceived job insecurity and aspects such as organisational commitment and dealing with job-related tensions (Zeidner *et al.*, 2004). Indeed, people with high EI are deemed more capable of controlling negative emotions, including those related to job insecurity (Wong and Law, 2002; Zeidner *et al.*, 2004). EI can also enable employees to sense the various, albeit sometimes implicit, ways in which their managers or co-workers communicate about the norms to adopt the new technology. In both cases studied herein, managers kindly invited, and not summoned, employees to participate in the Industry 4.0 technologies. The high-EI employees in the case companies could have understood that their participation could lead to social status gain; indeed, both projects turned out to be showcase projects within the organisation that led them into the new Industry 4.0 era. Employee's EI levels helped them foresee the merits of adopting Industry 4.0 technologies beyond initially perceived job loss risks. Hence, beyond the theories identified during our initial literature review stage, Job Demands-Resources theory might explain some emerging findings from the exploratory research. Although our study could not identify whether an employee's EI should be seen as a moderator in the relationship between social influence and Industry 4.0 technology adoption, or as an antecedent to the UTAUT model. Both functions of individual user characteristics have been identified before (Venkatesh, 2022; Venkatesh *et al.*, 2016) and need to be tested in future research. Hence we propose the following:

P3. Employee's EI either moderates or precedes the relationship between employee's (a) expectation that adopting the Industry 4.0 technology will lead to higher performance; (b) expectation that adopting the Industry 4.0 technology will not cost too much effort; (c) perception of social influence; and (d) perception of having access to facilitating conditions like resources and guidance for adopting those Industry 4.0 technologies and their intention to use Industry 4.0 technologies, ultimately leading to Industry 4.0 technology adoption.

Previous studies have found interactions between transformational leadership and managers' EI (Kim and Kim, 2017). Thus, the fact that our propositions add both concepts to the existing UTAUT model leads to contemporary future research avenues for the emerging field of Industry 4.0 technology adoption.

6. Practical implications

This study underlines the importance of the manager's role at various organisational levels in supporting employees to realise their strategic ambitions towards "Industry 4.0". In particular, managers are advised to adopt or develop four types of transformational leadership behaviour, namely: (1) offer a clear and compelling reason why the Industry 4.0 technology is introduced and how employees can benefit from it ("inspirational motivation"); (2) proudly communicate this vision about the future workplace ("idealised influence"); (3) actively invite employees to provide input to the preparation and implementation process ("intellectual stimulation"); and (4) offer personalised opportunities for employees to raise their potential concerns ("individualised consideration"). The transformation process starts by ensuring that the plans to adopt advanced Industry 4.0 type technologies are firmly

embedded in the organisational strategy as well as the manager's development and communication of a clear and compelling narrative of *why* such a transformation is necessary and *how* it can benefit employees. For optimal results, this top-down approach, as adopted by the Creator case, needs to be flanked by bottom-up idea-sharing and employee engagement (Kim *et al.*, 2014; Van Beers *et al.*, 2022). Such a dual top-down and bottom-up approach could be realised by installing an Industry 4.0 technology implementation team consisting of leaders and front-line staff.

In addition, before introducing employees to Industry 4.0-type technologies, the two case companies' managers addressed the socio-emotional side by involving their employees in the development process. The study revealed the need for managers to be (more) attentive to their own and employees' emotions that inevitably occur throughout the change process, regulate their own emotions to effectively respond to potential employee resistance and make good use of their emotions in their workplace interactions. Such EI type abilities can best be developed through hands-on and individualised workplace learning interventions—including practice, feedback and coaching—which allows for deeper learning experiences and adjusting the intervention to the manager's socio-cultural context (Clarke, 2006; Goleman, 2004). In addition, if managers primarily focus on their people in the digital transformation, the desired change may be realised quicker (Marcon *et al.*, 2022; Schneider, 2018; Schneider and Sting, 2020).

Another way to foster employee's acceptance to change is to provide them with upskilling or reskilling training to boost their confidence and efficacy in using the Industry 4.0 technology (Srinivasan *et al.*, 2020). We suggest Human Resources managers co-develop action learning-based training curricula including EI (Mattingly and Kraiger, 2019) and target both managers and employees for optimal workplace learning. EI does not come instantly though and it is therefore important that workplace interventions are given appropriate time for managers' and employees' EI to blossom. Such organisation-wide EI capability development, besides building managers' and employees' digital know-how and savviness (Sousa-Zomer *et al.*, 2020; Weritz, 2022), may help increase employees' intention to try and use new technologies.

Thirdly, new staff recruitment should be based not only on people's technical knowledge or skills but also on socio-emotional antennas and change skills (Srinivasan *et al.*, 2020). These criteria are not restricted to leaders only: employees are likely to need a certain level of EI to put the ongoing (technological) workplace transformations in perspective, remain agile and spot new opportunities. Also, with the rapid technological changes, education and employment should have a constant relationship (Rappolt, 2018; Srinivasan *et al.*, 2020). The list of new technologies is only growing and those organisations that recruit employees with life-long learning skills and capabilities will be able to keep pace with the evolving technological landscape.

7. Strengths, limitations and future research

This is one of the first in-depth field explorations of managers' role in adopting Industry 4.0 technologies in manufacturing firms. The nascent stage of the field inspired an inductive line of reasoning to answer the research question and employ a mixed-methods research design (Edmondson and McManus, 2007; Ketokivi and Choi, 2014). The validity of the findings was protected by combining the corroborating insights gained from field visits and interviews with managers and their employees. We also used two coders and checked the "face validity" of our main findings by presenting and discussing them with our key contact person at the largest employer association for the Dutch technology industry. Although limitations remain, the rich dataset pointed to various new inquiry lines that will advance our insight into the effective adoption of Industry 4.0 technologies in manufacturing firms.

Firstly, the study incorporates a few cases in one country with a feminine culture (Taras *et al.*, 2012). This may have made the leaders more open about their feelings, reducing the finding's generalisability. In addition, the qualitative approach meant that some of the proposed linkages were established after data analysis, through theory elaboration. Thus, through large-scale, multi-source surveying of more gender-diverse samples, testing those propositions is advised in multiple countries.

Another restriction concerns the cross-sectional design: People's feelings about major changes are considered emergent states and are likely to fluctuate (Ashkanasy *et al.*, 2017). Similarly, managers may (gradually) adapt their leadership style and either strengthen their support for the Industry 4.0 technology adoption initiative or withdraw their support due to a lack of short-term benefits. Particularly longitudinal ethnographies, interventions or process studies can advance our understanding of the evolution and hurdles in the Industry 4.0 technology adoption over time (see, for inspiration, De Mast *et al.*, 2022; Narasimhan, 2014; Oliva, 2019). Alternatively, a multi-wave longitudinal survey study could be a fruitful avenue to establish the possible causal links between transformational leadership and employees' acceptance and use of Industry 4.0 technologies.

Because we only select more effective and advanced cases of Industry 4.0 technology application, future studies may explore the earlier readiness and piloting stages of Industry 4.0 technology implementation. This will help understand how guiding coalitions are built to support the digital transformation (Stouten *et al.*, 2018; Weritz *et al.*, 2020), before (top-) managerial decisions are made to invest in them at a larger scale. Also, studies involving more polar cases might help to confirm the differences determined by different leadership styles. While both cases studied herein had a positive attitude towards the introduction of the technology and did not (yet) lay off any staff, it would be a good idea to explore the determinants of acceptance and use of Industry 4.0 technologies when such technologies indeed threaten employment or requires employees to master new complex skills they might not be able to pick up so well. Possibly, some of the other companies in the database that were still in a (too) nascent stage and were therefore excluded could be interesting cases as well, as it would allow for the real-time capturing of the implementation process, including (employee and/or manager) resistance and emotions. In addition, the future study may also focus on the impact of education and training, as well as the recruitment process for new employees (based on technical as well as life-long learning skill-sets) on acceptance of new technology adoption by employees. Such studies might also compare the impacts of employees' differing attitudes towards advanced technology adoption, which might vary between traditional defiance or functional scepticism and approaching advanced technology adoption more playfully (Schneider and Sting, 2020).

Finally, while we initially started theorising and operationalising the variables based on UTAUT and TAM2 modelling, TAM3 emerged from our unfolding literature review. Still, to date, UTAUT or TAM2 are more prevalent in the literature than TAM3 (Williams *et al.*, 2015), also in recent publications on the adoption of Industry 4.0-type technology, such as blockchain (Queiroz *et al.*, 2021; Wamba and Queiroz, 2022) and production robots and 3D printing (Berlak *et al.*, 2021). In light of the digital transition, TAM3 incorporates relevant variables such as the user's computer playfulness, computer anxiety, and computer self-efficacy (Venkatesh and Bala, 2008). These variables could help uncover the role of individual cognitive frames of Industry 4.0 technology adoption, ranging from anxiety to a more playful and optimistic view (Schneider and Sting, 2020). We can also explore how emotionally intelligent transformational leaders might detect and act upon such different individual standpoints among their staff.

Since the Industry 4.0 manufacturing era will drastically change operations and supply chains, employees must deal with this major change. Therefore, future studies may explore how employee's adoption of high-tech, intelligent systems can be supported by their own and their transformational leader's *emotional intelligence*.

Note

1. A scrum team has pre-defined roles and aims to deliver a product innovation (Franken *et al.*, 2021).

References

Aloysius, J.A., Hoehle, H., Goodarzi, S. and Venkatesh, V. (2018), "Big data initiatives in retail environments: linking service process perceptions to shopping outcomes", *Annals of Operations Research*, Vol. 270, pp. 25-51.

Anderson, M.H. and Sun, P.Y.T. (2017), "Reviewing leadership styles: overlaps and the need for a new 'full-range' theory", *International Journal of Management Reviews*, Vol. 19 No. 1, pp. 76-96.

Anderson, N., Potočnik, K. and Zhou, J. (2014), "Innovation and creativity in organizations: a state-of-the-science review, prospective commentary, and guiding framework", *Journal of Management*, Vol. 40 No. 5, pp. 1297-1333.

Ashkanasy, N.M., Humphrey, S.E. and Huy, Q.N. (2017), "Integrating emotions and affect in theories of management", *Academy of Management Review*, Vol. 42 No. 2, pp. 175-189.

Avolio, B.J., Bass, B.M. and Jung, D.I. (1999), "Re-examining the components of transformational and transactional leadership using the Multifactor Leadership Questionnaire", *Journal of Occupational and Organizational Psychology*, Vol. 72 No. 4, pp. 441-462.

Barratt, M., Choi, T.Y. and Li, M. (2011), "Qualitative case studies in operations management: trends, research outcomes, and future research implications", *Journal of Operations Management*, Vol. 29 No. 4, pp. 329-342.

Bass, B.M. (1985), *Leadership and Performance beyond Expectations*, Free Press, New York.

Bass, B.M. (1990), "From transactional to transformational leadership: learning to share the vision", *Organizational Dynamics*, Vol. 18 No. 3, pp. 19-31.

Bass, B.M. (1999), "Two decades of research and development in transformational leadership", *European Journal of Work and Organizational Psychology*, Vol. 8 No. 1, pp. 9-32.

Bednall, T.C., Rafferty, A.E., Shipton, H., Sanders, K. and Jackson, C.J. (2018), "Innovative behaviour: how much transformational leadership do you need?", *British Journal of Management*, Vol. 29 No. 4, pp. 796-816.

Berlak, J., Hafner, S. and Kuppelwieser, V.G. (2021), "Digitalization's impacts on productivity: a model-based approach and evaluation in Germany's building construction industry", *Production, Planning and Control*, Vol. 32 No. 4, pp. 335-345.

Blut, M., Chong, A.Y.L., Tsigna, Z. and Venkatesh, V. (2022), "Meta-analysis of the unified theory of acceptance and use of technology (UTAUT): challenging its validity and charting a research agenda in the red ocean", *Journal of the Association for Information Systems*, Vol. 11, pp. 1-139.

Bott, G. and Tourish, D. (2016), "The critical incident technique reappraised: using critical incidents to illuminate organizational practices and build theory", *Qualitative Research in Organizations and Management*, Vol. 11 No. 4, pp. 276-300.

Brown, S.A., Dennis, A.R. and Venkatesh, V. (2010), "Predicting collaboration technology use: integrating technology adoption and collaboration research", *Journal of Management Information Systems*, Vol. 27 No. 2, pp. 9-53.

Burns, J.M. (1978), *Leadership*, Harper & Row, New York.

Cagliano, R., Canterino, F., Longoni, A. and Bartezzaghi, E. (2019), "The interplay between smart manufacturing technologies and work organization: the role of technological complexity", *International Journal of Operations and Production Management*, Vol. 39 Nos 6/7/8, pp. 913-934.

Calabrese, A., Levialdi Ghiron, N. and Tiburzi, L. (2021), "Evolutions' and 'revolutions' in manufacturers' implementation of industry 4.0: a literature review, a multiple case study, and a conceptual framework", *Production, Planning and Control*, Vol. 32 No. 3, pp. 213-227.

Calabrese, A., Dora, M., Ghiron, N.L. and Tiburzi, L. (2022), "Industry's 4.0 transformation process: how to start, where to aim, what to be aware of", *Production, Planning and Control*, Vol. 33 No. 5, pp. 492-512.

Caldwell, N.D., Roehrich, J.K. and George, G. (2017), "Social value creation and relational coordination in public-private collaborations", *Journal of Management Studies*, Vol. 54 No. 6, pp. 906-928.

Chiarini, A. and Kumar, M. (2021), "Lean six sigma and industry 4.0 integration for operational excellence: evidence from Italian manufacturing companies", *Production, Planning and Control*, Vol. 32 No. 13, pp. 1084-1101.

Choi, M. (2011), "Employees' attitudes toward organizational change: a literature review", *Human Resource Management*, Vol. 50 No. 4, pp. 479-500.

Clarke, N. (2006), "Emotional intelligence training: a case of caveat emptor", *Human Resource Development Review*, Vol. 5 No. 4, pp. 422-441.

Colli, M., Berger, U., Bockholt, M., Madsen, O., Møller, C. and Vejrum Wæhrens, B. (2019), "A maturity assessment approach for conceiving context-specific roadmaps in the Industry 4.0 era", *Annual Reviews in Control*, Vol. 48, pp. 165-177.

Collignon, S.E. and Sternberg, H.S. (2020), "Adoption of multiple electronic marketplaces: antecedents from a grounded theory study", *Journal of Business Logistics*, Vol. 41 No. 4, pp. 310-333.

Conner, M. and Armitage, C.J. (1998), "Extending the theory of planned behavior: a review and avenues for further research", *Journal of Applied Social Psychology*, Vol. 28 No. 15, pp. 1429-1464.

Cropanzano, R., Anthony, E.L., Daniels, S.R. and Hall, A.V. (2017), "Social exchange theory: a critical review with theoretical remedies", *Academy of Management Annals*, Vol. 11 No. 1, pp. 1-38.

Da Silva, V.L., Kovaleski, J.L., Pagani, R.N., Silva, J.D.M. and Corsi, A. (2020), "Implementation of Industry 4.0 concept in companies: empirical evidences", *International Journal of Computer Integrated Manufacturing*, Vol. 33 No. 4, pp. 325-342.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1989), "User acceptance of computer technology: a comparison of two theoretical models", *Management Science*, Vol. 35 No. 8, pp. 982-1003.

De Mast, J., Lameijer, B.A., Linderman, K. and Van de Ven, A.H. (2022), "Exploring the process of management system implementation: a case of Six Sigma", *International Journal of Operations and Production Management*, Vol. 42 No. 13, pp. 1-24.

Dombrowski, U. and Wagner, T. (2014), "Mental strain as field of action in the 4th industrial revolution", *47th CIRP Conference on Manufacturing Systems*, Vol. 17, pp. 100-105.

Edmondson, A.C. and McManus, S.E. (2007), "Methodological fit in management field research", *Academy of Management Review*, Vol. 32 No. 4, pp. 1155-1179.

Eisenhardt, K.M. (1989), "Building theories from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.

Elrod, P.D. II and Tippett, D.D. (2002), "The 'death valley' of change", *Journal of Organizational Change Management*, Vol. 15 No. 3, pp. 273-291.

Fetters, M.D., Curry, L.A. and Creswell, J.W. (2013), "Achieving integration in mixed methods designs: principles and practices", *Health Services Research*, Vol. 48 No. 6, pp. 2134-2156.

Fischer, T. and Sitkin, S.B. (2023), "Leadership styles: a comprehensive assessment and way forward", *Academy of Management Annals*, Vol. 17 No. 1, pp. 331-372.

Fishbein, M. and Ajzen, I. (1975), *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Addison-Wesley, Reading, MA.

Flanagan, J.C. (1954), "The critical incident technique", *Psychological Bulletin*, Vol. 51 No. 4, pp. 327-358.

Frank, A.G., Dalenogare, L.S. and Ayala, N.F. (2019), "Industry 4.0 technologies: implementation patterns in manufacturing", *International Journal of Production Economics*, Vol. 210 April, pp. 15-26.

Franken, J.C.M., Van Dun, D.H. and Wilderom, C.P.M. (2021), "Kaizen event process quality: towards a phase-based understanding of high-quality group problem-solving", *International Journal of Operations and Production Management*, Vol. 41 No. 6, pp. 962-990.

Gibney, R., Zagenczyk, T.J. and Masters, M.F. (2009), "The negative aspects of social exchange: an introduction to perceived organizational obstruction", *Group and Organization Management*, Vol. 34 No. 6, pp. 665-697.

Goleman, D. (2004), "What makes a leader?", *Harvard Business Review*, Vol. 82 No. 1, pp. 82-91.

Grodal, S., Anteby, M. and Holm, A.L. (2021), "Achieving rigor in qualitative analysis: the role of active categorization in theory building", *Academy of Management Review*, Vol. 46 No. 3, pp. 591-612.

Hahn, G.J. (2020), "Industry 4.0: a supply chain innovation perspective", *International Journal of Production Research*, Vol. 58 No. 5, pp. 1425-1441.

Harlan, J. (2020), "Change, employee resistance to change, and emotional intelligence: a meta-analysis", PhD dissertation, Northcentral University, available at: https://www.proquest.com/openview/06c4ba1d20f2364dfb9519b50ad6b883/1?pq-origsite=gscholar&cbl=51922&diss=y

Hirsch-Kreinsen, H. (2014), "Smart production systems: a new type of industrial process innovation", *Paper presented at the DRUID Society Conference 2014*, Copenhagen Business School, Copenhagen, 16 June-18 June, available at: https://www.researchgate.net/profile/Hartmut-Hirsch-Kreinsen/publication/286929599_Smart_production_systems_a_new_type_of_industrial_process_innovation_Smart_production_systems_a_new_type_of_industrial_process_innovation/links/56707ab908ae0d8b0cc0f198/Smart-production-systems-a-new-type-of-industrial-process-innovation-Smart-production-systems-a-new-type-of-industrial-process-innovation.pdf (accessed 12 March 2023).

Hughes, D.J., Lee, A., Tian, A.W., Newman, A. and Legood, A. (2018), "Leadership, creativity, and innovation: a critical review and practical recommendations", *The Leadership Quarterly*, Vol. 29 No. 5, pp. 549-569.

Huy, Q.N. (1999), "Emotional capability, emotional intelligence, and radical change", *Academy of Management Review*, Vol. 24 No. 2, pp. 325-345.

Johnson, R.B., Onwuegbuzie, A.J. and Turner, L.A. (2007), "Toward a definition of mixed methods research", *Journal of Mixed Methods Research*, Vol. 1 No. 2, pp. 112-133.

Joseph, D.L. and Newman, D.A. (2010), "Emotional intelligence: an integrative meta-analysis and cascading model", *Journal of Applied Psychology*, Vol. 95 No. 1, pp. 54-78.

Ketokivi, M.A. and Choi, T. (2014), "Renaissance of case research as a scientific method", *Journal of Operations Management*, Vol. 32 No. 5, pp. 232-240.

Kim, H. and Kim, T. (2017), "Emotional intelligence and transformational leadership: a review of empirical studies", *Human Resource Development Review*, Vol. 16 No. 4, pp. 377-393.

Kim, Y.H., Sting, F.J. and Loch, C.H. (2014), "Top-down, bottom-up, or both? Toward an integrative perspective on operations strategy formation", *Journal of Operations Management*, Vol. 32 Nos 7-8, pp. 462-474.

Kummer, T.F., Recker, J. and Bick, M. (2017), "Technology-induced anxiety: manifestations, cultural influences, and its effect on the adoption of sensor-based technology in German and Australian hospitals", *Information and Management*, Vol. 54 No. 1, pp. 73-89.

Le, P.B. (2020), "How transformational leadership facilitates radical and incremental innovation: the mediating role of individual psychological capital", *Asia-Pacific Journal of Business Administration*, Vol. 12 Nos 3/4, pp. 205-222.

Lee, J.Y., Rocco, T.S. and Shuck, B. (2020), "What is a resource: toward a taxonomy of resources for employee engagement", *Human Resource Development Review*, Vol. 19 No. 1, pp. 5-38.

Li, F. (2020), "Leading digital transformation: three emerging approaches for managing the transition", *International Journal of Operations and Production Management*, Vol. 40 No. 6, pp. 809-817.

Liao, Y., Deschamps, F., Loures, E.D.F.R. and Ramos, L.F.P. (2017), "Past, present and future of Industry 4.0: a systematic literature review and research agenda proposal", *International Journal of Production Research*, Vol. 55 No. 12, pp. 3609-3629.

Liboni, L.B., Cezarino, L.O., Jabbour, C.J.C., Oliveira, B.G. and Stefanelli, N.O. (2018), "Smart industry and the pathways to HRM 4.0: implication for SCM", *Supply Chain Management: An International Journal*, Vol. 24 No. 1, pp. 124-146.

Liden, R.C., Sparrowe, R.T. and Wayne, S.J. (1997), "Leader-member exchange theory: the past and potential for the future", in Ferris, G.R. (Ed.), *Research in Personnel and Human Resources Management*, Elsevier Science/JAI Press, pp. 47-119.

Lord, R.G., Day, D.V., Zaccaro, S.J., Avolio, B.J. and Eagly, A.H. (2017), "Leadership in applied psychology: three waves of theory and research", *Journal of Applied Psychology*, Vol. 102 No. 3, pp. 434-451.

Magni, M. and Pennarola, F. (2008), "Intra-organizational relationships and technology acceptance", *International Journal of Information Management*, Vol. 28 No. 6, pp. 517-523.

Marcon, É., Soliman, M., Gerstlberger, W. and Frank, A.G. (2022), "Sociotechnical factors and Industry 4.0: an integrative perspective for the adoption of smart manufacturing technologies", *Journal of Manufacturing Technology Management*, Vol. 33 No. 2, pp. 259-286.

Mattingly, V. and Kraiger, K. (2019), "Can emotional intelligence be trained? A meta-analytical investigation", *Human Resource Management Review*, Vol. 29 No. 2, pp. 140-155.

May, C.R. (2015), "Making sense of technology adoption in healthcare: meso-level considerations", *BMC Medicine*, Vol. 13, p. 92.

Mayer, J.D. and Salovey, P. (1997), "What is emotional intelligence?", in Salovey, P. and Sluyter, D. (Eds), *Emotional Development and Emotional Intelligence: Educational Implications*, Basic Books, New York, pp. 3-34.

Mittal, S., Khan, M.A., Romero, D. and Wuest, T. (2018), "A critical review of smart manufacturing and Industry 4.0 maturity models: implications for small and medium-sized enterprises (SMEs)", *Journal of Manufacturing Systems*, Vol. 49 October, pp. 194-214.

Narasimhan, R. (2014), "Theory development in operations management: extending the frontiers of a mature discipline via qualitative research", *Decision Sciences*, Vol. 45 No. 2, pp. 209-227.

Neufeld, D.J., Dong, L. and Higgins, C. (2007), "Charismatic leadership and user acceptance of information technology", *European Journal of Information Systems*, Vol. 16 No. 4, pp. 494-510.

Oliva, R. (2019), "Intervention as a research strategy", *Journal of Operations Management*, Vol. 65 No. 7, pp. 710-724.

Olsen, T.L. and Tomlin, B. (2020), "Industry 4.0: opportunities and challenges for operations management", *Manufacturing and Service Operations Management*, Vol. 22 No. 1, pp. 113-122.

Oreg, S. and Berson, Y. (2019), "Leaders' impact on organizational change: bridging theoretical and methodological chasms", *Academy of Management Annals*, Vol. 13 No. 1, pp. 272-307.

Oreg, S., Bartunek, J.M., Lee, G. and Do, B. (2018), "An affect-based model of recipients' responses to organizational change events", *Academy of Management Review*, Vol. 43 No. 1, pp. 65-86.

Peng, J., Li, M., Wang, Z. and Lin, Y. (2021), "Transformational leadership and employees' reactions to organizational change: evidence from a meta-analysis", *The Journal of Applied Behavioral Science*, Vol. 57 No. 3, pp. 369-397.

Pfeiffer, S. (2017), "The vision of "Industrie 4.0" in the making: a case of future told, tamed, and traded", *NanoEthics*, Vol. 11, pp. 107-121.

Piderit, S.K. (2000), "Rethinking resistance and recognizing ambivalence: a multidimensional view of attitudes toward an organizational change", *Academy of Management Review*, Vol. 25 No. 4, pp. 783-794.

Pieters, J.J., Kokkinou, A. and Van Kollenburg, T. (2022), "Understanding blockchain technology adoption by non-experts: an application of the unified theory of acceptance and use of technology (UTAUT)", *Operations Research Forum*, Vol. 3, p. 1.

Queiroz, M.M., Wamba, S.F., De Bourmont, M. and Telles, R. (2021), "Blockchain adoption in operations and supply chain management: empirical evidence from an emerging economy", *International Journal of Production Research*, Vol. 59 No. 20, pp. 6087-6103.

Rappolt, N. (2018), "How to keep learning in a rapidly changing technological world", *Forbes*, available at: https://www.forbes.com/sites/forbestechcouncil/2018/06/06/how-to-keep-learning-in-a-rapidly-changing-technological-world/?sh=38b2437e377e

Rego, A., Sousa, G., Cunha, M.P., Correia, A. and Sair-Amaral, I. (2007), "Leader self-reported emotional intelligence and perceived employee creativity: an exploratory study", *Creativity and Innovation Management*, Vol. 16 No. 3, pp. 250-264.

Rezvani, A., Chang, A., Wiewiora, A., Ashkanasy, N.M., Jordan, P.J. and Zolin, R. (2016), "Manager emotional intelligence and project success: the mediating role of job satisfaction and trust", *International Journal of Project Management*, Vol. 34 No. 7, pp. 1112-1122.

Saabye, H., Kristensen, T.B. and Vejrum Wæhrens, B. (2022), "Developing a learning-to-learn capability: insights on conditions for Industry 4.0 adoption", *International Journal of Operations and Production Management*, Vol. 42 No. 13, pp. 25-53.

Salovey, P. and Mayer, J.D. (1990), "Emotional intelligence", *Imagination, Cognition and Personality*, Vol. 9 No. 3, pp. 185-211.

Schaufeli, W.B. and Taris, T.W. (2014), "A critical review of the job demands-resources model: implications for improving work and health", in Bauer, G.F. and Hämmig, O. (Eds), *Bridging Occupational, Organizational and Public Health: A Transdisciplinary Approach*, Springer Science+Business Media, Dordrecht, pp. 43-68.

Schepers, J., Wetzels, M. and De Ruyter, K. (2005), "Leadership styles in technology acceptance: do followers practice what leaders preach?", *Managing Service Quality*, Vol. 15 No. 6, pp. 496-508.

Schneider, P. (2018), "Managerial challenges of Industry 4.0: an empirically backed research agenda for a nascent field", *Review of Managerial Science*, Vol. 12 No. 3, pp. 803-848.

Schneider, P. and Sting, F.J. (2020), "Employees' perspectives on digitalization-induced change: exploring frames of industry 4.0", *Academy of Management Discoveries*, Vol. 6 No. 3, pp. 406-435.

Scott, S.G. and Bruce, R.A. (1994), "Determinants of innovative behavior: a path model of individual innovation in the workplace", *Academy of Management Journal*, Vol. 37 No. 3, pp. 580-607.

Shamim, S., Cang, S., Yu, H. and Li, Y. (2016), "Management approaches for industry 4.0: a human resource management perspective", *IEEE Congress on Evolutionary Computation (CEC)*, Vancouver, BC, pp. 5309-5316.

Siangchokyoo, N., Klinger, R.L. and Campion, E.D. (2020), "Follower transformation as the linchpin of transformational leadership theory: a systematic review and future research agenda", *The Leadership Quarterly*, Vol. 31 No. 1, pp. 1-18.

Sousa-Zomer, T.T., Neely, A. and Martinez, V. (2020), "Digital transforming capability and performance: a microfoundational perspective", *International Journal of Operations and Production Management*, Vol. 40 Nos 7/8, pp. 1095-1128.

Srinivasan, R., Kumar, M. and Narayanan, S. (2020), "Human resource management in an industry 4.0 era: a supply chain management perspective", in Choi, T.Y., Li, J.J., Rogers, D.S., Schoenherr, T. and Wagner, S.M. (Eds), *The Oxford Handbook of Supply Chain Management*, Oxford University Press, Oxford.

Stouten, J., Rousseau, D.M. and De Cremer, D. (2018), "Successful organizational change: integrating the management practice and scholarly literature", *Academy of Management Annals*, Vol. 12 No. 2, pp. 752-788.

Strauss, A.L. and Corbin, J. (1990), *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*, Sage, Newbury Park, CA.

Strebel, P. (1996), "Why do employees resist change?", *Harvard Business Review*, Vol. 74 No. 3, pp. 86-92.

Tan, A.B.C., Van Dun, D.H. and Wilderom, C.P.M. (2021), "Innovative work behavior in Singapore evoked by transformational leaders through innovation support and readiness", *Creativity and Innovation Management*, Vol. 30 No. 4, pp. 697-712.

Tan, A.B.C., Van Dun, D.H. and Wilderom, C.P.M. (In press), "Lean innovation training and transformational leadership for employee creative role identity and innovative work behavior in a public service organization", *International Journal of Lean Six Sigma*, doi: 10.1108/IJLSS-06-2022-0126/full/html.

Taras, V., Steel, P. and Kirkman, B.L. (2012), "Improving national cultural indices using a longitudinal meta-analysis of Hofstede's dimensions", *Journal of World Business*, Vol. 47 No. 3, pp. 329-341.

Thoben, K.D., Wiesner, S. and Wuest, T. (2017), "Industrie 4.0' and smart manufacturing: a review of research issues and application examples", *International Journal of Automation Technology*, Vol. 11 No. 1, pp. 4-16.

Tortorella, G.L., Giglio, R. and Van Dun, D.H. (2019), "Industry 4.0 adoption as a moderator of the impact of lean production practices on operational performance improvement", *International Journal of Operations and Production Management*, Vol. 39 Nos 6/7/8, pp. 860-886.

Van Beers, J.J.C.A.M., Van Dun, D.H. and Wilderom, C.P.M. (2022), "Effective hospital-wide lean implementation: top-down, bottom-up or through co-creative role modeling?", *International Journal of Lean Six Sigma*, Vol. 13 No. 1, pp. 46-66.

Venkatesh, V. (2000), "Determinants of perceived ease of use: integrating control, intrinsic motivation, and emotion into the technology acceptance model", *Information Systems Research*, Vol. 11 No. 4, pp. 342-365.

Venkatesh, V. (2022), "Adoption and use of AI tools: a research agenda grounded in UTAUT", *Annals of Operations Research*, Vol. 308, pp. 641-652.

Venkatesh, V. and Bala, H. (2008), "Technology acceptance model 3 and a research agenda on interventions", *Decision Sciences*, Vol. 39 No. 2, pp. 273-315.

Venkatesh, V. and Davis, F.D. (2000), "A theoretical extension of the technology acceptance model: four longitudinal field studies", *Management Science*, Vol. 46 No. 2, pp. 186-204.

Venkatesh, V., Long, J.Y.L. and Xu, X. (2016), "Unified theory of acceptance and use of technology: a synthesis and the road ahead", *Journal of the Association for Information Systems*, Vol. 17 No. 5, pp. 328-376.

Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D. (2003), "User acceptance of information technology: toward a unified view", *MIS Quarterly*, Vol. 27 No. 3, pp. 425-478.

Vidyarthy, P.R., Anand, S. and Liden, R.C. (2014), "Do emotionally perceptive leaders motivate higher employee performance? The moderating role of task interdependence and power distance", *The Leadership Quarterly*, Vol. 25 No. 2, pp. 232-244.

Voss, C., Tsikriktsis, N. and Frohlich, M. (2002), "Case research in operations management", *International Journal of Operations and Production Management*, Vol. 22 No. 2, pp. 195-219.

Wagire, A.A., Joshi, R., Rathore, A.P.S. and Jain, R. (2021), "Development of maturity model for assessing the implementation of Industry 4.0: learning from theory and practice", *Production, Planning and Control*, Vol. 32 No. 8, pp. 603-622.

Wamba, S.F. and Queiroz, M.M. (2022), "Industry 4.0 and the supply chain digitalisation: a blockchain diffusion perspective", *Production, Planning and Control*, Vol. 33 Nos 2-3, pp. 193-210.

Weritz, P. (2022), "Hey leaders, it's time to train the workforce: critical skills in the digital workplace", *Administrative Sciences*, Vol. 12 No. 3, p. 94.

Weritz, P., Braojos, J. and Matute, J. (2020), "Exploring the antecedents of digital transformation: dynamic capabilities and digital culture aspects to achieve digital maturity", *Paper presented at the Americas Conference on Information Systems (AMCIS)*, Salt Lake City, UT, 10 August-14 August, available at: https://aisel.aisnet.org/amcis2020/org_transformation_is/org_transformation_is/22 (accessed 12 March 2023).

Wiens, K. and Rowell, D. (2018), "How to embrace change using emotional intelligence", available at: https://hbr.org/2018/12/how-to-embrace-change-using-emotional-intelligence (accessed 9 June 2022).

Williams, M.D., Rana, N.P. and Dwivedi, Y.K. (2015), "The unified theory of acceptance and use of technology (UTAUT): a literature review", *Journal of Enterprise Information Management*, Vol. 28 No. 3, pp. 443-488.

Wong, C.S. and Law, K.S. (2002), "The effects of leader and follower emotional intelligence on performance and attitude: an exploratory study", *The Leadership Quarterly*, Vol. 13 No. 3, pp. 243-274.

Yammarino, F.J. (2013), "Leadership: past, present, and future", *Journal of Leadership and Organizational Studies*, Vol. 20 No. 2, pp. 149-155.

Yin, R.K. (2011), *Qualitative Research from Start to Finish*, The Guilford Press, New York, NY.

Zeidner, M., Matthews, G. and Roberts, R.D. (2004), "Emotional intelligence in the workplace: a critical review", *Applied Psychology: An International Review*, Vol. 53 No. 3, pp. 371-399.

Zhou, J. and George, J.M. (2003), "Awakening employee creativity: the role of leader emotional intelligence", *The Leadership Quarterly*, Vol. 14 No. 4, pp. 545-568.

Appendix

Semi-structured Interview Guide

The interview starts with an informal chat during which a current radical, Industry 4.0-type technological change within the company is selected, on which the interview will focus. Furthermore, the data-collection consent form is signed.

Introduction

(1) Could you please introduce yourself and your position within the company?

(2) How would you describe the company, its type of products and the organisational culture?

General Organisational Changes

(3) Which (technological) changes were implemented in the organisation in the past years?

(4) How do you typically respond to change within your organisation? Why?

Industry 4.0-related Changes

(5) What change has the company experienced regarding Industry 4.0 adoption?

(6) Why were those radical technological changes implemented?

(7) How were those changes communicated within the organisation?

(8) How did this change affect your job or you personally?

(9) How did the managers communicate these changes?

(10) How did this way of communicating affect your own personal feelings regarding the Industry 4.0 adoption?

(11) To what extent do you support the Industry 4.0 adoption within your organisation? Can you give an example?

(12) How did the change itself affect your feelings?

(13) To what extent did your supervisors and colleagues recognise and acknowledge your feelings?

(14) How did your supervisors and colleagues act upon these feelings?

(15) How did their response affect you?

Conclusion

(16) Is there anything else you would like to discuss regarding the Industry 4.0 adoption?

Thanks for your time. The interview will be transcribed anonymously; you can still add any points if you like.

About the authors

Dr Desirée H. van Dun is Assistant Professor in Organisational Behaviour, Change Management and Consultancy at the University of Twente and Visiting Researcher at Cardiff Business School, Cardiff University. Besides having 10 years of lean management consulting experience, she has a cum laude PhD degree in Organisational Behaviour and Operations Management (2015); the thesis won various local and international awards. Her research has appeared in journals such as the *International Journal of Operations and Production Management, European Management Journal, Journal of Manufacturing Technology Management, International Review of Industrial and Organizational Psychology, Creativity and Innovation Management* and *International Journal of Qualitative Methods*. She serves as Associate Editor for *Creativity and Innovation Management* and reviews for various other international journals. Van Dun is currently studying effective human behavioural dynamics for digital and green organisational transformation, including leading lean (and green), agile and Industry 4.0 technology adoption. https://people.utwente.nl/d.h.vandun Desirée H. van Dun can be contacted at: d.h.vandun@utwente.nl

Dr. Maneesh Kumar is Professor in Service Operations at Cardiff Business School, Cardiff University. He also holds an honorary Visiting Professor role at Cardiff and Vale University Health Board. He conducts cross-disciplinary applied research on topics such as Quality Management, Lean Six Sigma (LSS), Lean, Green, and Innovation (iLEGO), Lean and Industry 4.0 Integration (called Lean 4.0), High Reliability Organisations (HRO) and Healthcare Process/Service Innovation. This has resulted in the publications of over 165 journal and conference papers, edited books and conference proceedings. His current research interests are the integration of operations excellence with Industry 4.0, building resilient healthcare models and innovative circular economy business models. In 2020, he was recognised with the "Business Innovation" Award at Cardiff University's Innovation and Impact Awards 2020 for the project with Siemens Logistics. He has been recognised for his outstanding contributions to teaching at Cardiff University's Celebrating Excellence Awards 2018 in the category of "Excellence in Teaching including Training and Development". https://www.cardiff.ac.uk/people/view/598290-kumar-maneesh