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Digital Transformation and Industry 4.0 Employees: Empirical Evidence from Top Digital Nations

Kashif Nadeem, Sut I Wong, Stefano Za, Michelina Venditti

Abstract

In the business world, Digital Transformation (DT) is being implemented enthusiastically. The current DT literature has focused much on business and strategy, but little attention has been paid to the organisation's human side. Nonetheless, employees have a crucial role to play in DT, and there is a need to explore the influence of DT on employees' attitudes, behaviour, and psychology. Taking a sample (n=320) from the top 10 digital-leading nations, we tested our model on different aspects of employee attitude, psychology, and job factors (engagement and autonomy). Our analysis reveals that DT significantly impacts the attitude, psychology, and job factors of industry 4.0 employees. This study contributes to the existing research stream discussing the effect of DT on employees related factors covering attitude, psychology, and job-associated aspects. This study presents the critical implications from theoretical and practical points of view.

Keywords: Digital transformation, industry 4.0, employee resilience, job satisfaction, self-efficacy, job autonomy. Job engagement

Introduction

Over the last decade, Digital Transformation (DT) has received worldwide attention from governments and the business community (Ghobakhloo, 2020; Nascimento et al., 2019),. DT has become a favored topic of academic scholars across all disciplines—mainly Information System (IS) (Vial, 2019), management (Kamalaldin, Linde, Sjodin, & Parida, 2020), human resources (Gekara & Thanh Nguyen, 2018), and marketing (Alavi & Habel, 2021), among others. DT, backed by modern technologies, has the power to change traditional businesses by effecting existing models, work processes, products and services, and employment (Elia, Margherita, & Passiante, 2020; Lokuge, Sedera, Grover, & Dongmin, 2019). DT is paving the way for new methods of operating, interacting, engagement, and providing value to stakeholders (Yadav & Pavlou, 2014). Consequently, DT helps with increased productivity (Shakeel, Mardani, Chofreh, Goni, & Klemeš, 2020), cost reduction, enhanced efficiency (Loebbecke & Picot, 2015) and competitive advantages (Das, Verburg, Verbraeck, & Bonebakker, 2017). Recent estimates indicate that digital technologies like artificial intelligence will support 14% (15.7 trillion USD) of the world economy (Pwc, 2017) This estimate is further evidenced by the industry 4.0 revolution, which highlights that the phenomenon of digitalization has gained momentum in business organizations around the world.

The terms “digital” or “digitalization” have been present in literature since 1950 (Heavin & Power, 2018). The cocept of DT in present literature has been revived by connecting cyber and physical environments (Kim, Choi, & Lew, 2021). DT is “a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” (Vial, 2019). DT and its associated terms, such as industry 4.0 (I4.0), industrial internet/ Internet of Things (IoT), and smart manufacturing, are profoundly adopted by manufacturing companies (Kagermann, Wahlster, Helbig, 2013). DT is not limited to individual firms but also provides horizontal and vertical integration between the production system and value chain suppliers (Tiwari, 2020). CEOs and managers now consider DT a top priority item for their companies (Fitzgerald, Kruschwitz, Bonnet, & Welch, 2014; Talafidaryani, Jalali, & Moro, 2021). Although DT is criticized for its possible threats, it presents game-changing opportunities (Brenner, 2018). Simultaneously, the pressure on management is increasing to match the skill level and competencies to meet the DT challenges (Vojvodic & Velinov, 2019).

Among the many challenges, the main challenge for human resources is to equip their employees with IT-related competencies to perform their jobs effectively after DT (Gilch & Sieweke, 2021). A recent survey indicates that 54% of organizations acknowledged that a lack of digital skills hampers the process of DT (Institute, 2017). Other surveys reported that employees reluctance, fear of losing job and task changes are major threat for DT (Microsoft, 2017). Since employees have been acknowledged as a valuable resource during the process of DT (Colbert, Yee, & George, 2016). From the employee perspective, DT often brings rigorous task monitoring, and this may cause an increase in stress, psychological strain, or decrease job satisfaction or level of commitment. DT provides a unique type of human-computer interaction, and employees play a vital role in managing and adopting modern technologies (Margherita & Bua, 2021). Similarly, Trenerry and colleagues (2021) pointed out that the focus of DT is highly on strategy and business, and there is only modest integration of employee-related factors.

DT transition systems put an extra burden on employees, and there is a need to investigate their impact on employee motivation, autonomy, and job satisfaction (Neumann, Winkelhaus, Grosse, & Glock, 2021). However, a recent study has attempted to map DT's effect on job satisfaction (Bueechl, Harting, & Schroder, (2021), but there is a lack of empirical research available on whether DT has a positive or negative impact on an employee's attitude, job and psychology. To fill this literature gap, we are interested in seeking the answer to the following research questions:

- How does DT influence the employee attitude (satisfaction, commitment) towards work in I4.0?
- How does DT influence employee psychology (self-efficacy and resilience) related to work in I4.0?
- How does DT influence employee job (engagement and autonomy) related to work in I4.0?

This study applies to policymakers and researchers as they nevigate employee factors in their organizations' digitalization. Thus, this study aims to investigate the impact of DT on employee attitudes (satisfaction, commitment), psychology (resilience, self-efficacy), and job-related factors (engagement, autonomy). The context for this study is employees working in industry 4.0 settings and dealing with digitalized operations. The findings of this study will provide significant implications for top management in organizations undergoing DT.

The structure of this paper is divided into the following four sections: the first section presents the literature review of relevant variables and formulation of the hypotheses, followed by theoretical framework. The second section presents the research methodology covering the variable operationalization, measures, sampling method, and data collection. The third section presents the data analysis and results regarding the study hypotheses. The final section presents the discussion of results and study conclusion, followed by implications, limitations, and future research directions.

2. Literature Review and Hypotheses

2.1 Digital Transformation

Within the last decade, the widespread DT among firms has outwardly transformed individual life, society, and the international economy (Kim et al.,2021). Different industries and businesses continue to consider digitalization due to stakeholder demands and customer inquiries (Tvaronavičienė, 2018). The common objective behind digital transformation is to improve business performance (Depaoli, Za, & Scornavacca, 2020). Digital technologies can improve an organization's competitiveness (Grant, Edgar, Sukumar, & Meyer, 2014) and the transformation of business models and rules (Ferreira, Fernandes, & Ferreira, 2019). Digitalization is defined as "the transformation of business models as a result of fundamental changes to core internal processes, customer interfaces, products and services, as well as the use of information and communications technologies" (Graumann et al., (2017, p8). The debate on digitalization or digital transformation has witnessed a tremendous increase in recent years (Bican & Brem, 2020) and this trend is expected to persist in the future (Nylen & Holmstroem, 2015).

Recently, the Fourth Industrial Revolution, or industry 4.0 (I4.0), based on digitalization and the use of technological applications to enhance industrial capabilities (Luthra, Kumar, Zavadskas, Mangla, & Garza-Reyes, 2020). I4.0 instilled interconnected digital and virtual technologies, providing real-time data sharing among digital devices, transactions, machines and multiple stakeholders, including buyers, customers and suppliers (de Sousa Jabbour, Jabbour, Godinho Filho, & Roubaud, 2018; Li, Hou, & Wu, 2017). Extensive digitalization, automation, customization, optimization, adaptation, human-machine interaction, automatic communication, data sharing, and value-added businesses and services are the predominant feature of the I4.0 context (Lu, 2017). The latest digital technologies support all of these I4.0 features.

DT, backed by modern digital technologies, provides flexibility, increased efficiency and speed in business operatins (Zhou, Tang, Qian, & Mardani, 2021). DT includes digital technologies such as IoT, artificial intelligence, big data analytics, cloud computing, blockchain, platforms, and cyber-physical system (CPS) (Feroz, Zo, & Chiravuri, 2021). The latest technologies, CPS and IoT, are changing products and services, markets, supply chains, business models, people and skills, working environment, markets and the entire economy (Frederico, Kumar, Garza-Reyes, Kumar, & Agrawal, 2021; Lv, Chen, & Wang, 2020; Pereira & Romero, 2017).

Digital technologies such as blockchain provide real-time traceability to the different phases of products and help protect the environment and prevent risk (Moktadir, Ali, Kusi-Sarpong & Shaikh, 2018). Blcokchain is open source distributed ledger which provides the recording, updating of real-time end to end transactions among multiple stakeholders. The blockchain provides a centralized system of transactions by defining roles and powers, maintaining record keeping, ensuring security and automation of transactions among machines and stakeholders (Upadhyay et al., 2021).

Similarly, big data analytics (BDA) or business intelligence, has become iconic for businesses and researchers worldwide (Waqas, Honggang, Ahmad, Khan, & Iqbal, 2021) and is commonly used for better decision-making (Gupta, Chen, Hazen, Kaur, & Gonzalez, 2019). The interconnectedness of new technologies generates a large volume of data, and BDA plays a crucial role in industrial growth (Nižetić, Dijali, Papadopoulos, & Rodrigues, 2019). BDA is defined as "the information assets characterized by such a high volume, velocity, and variety to require specific technology and analytical methods for its transformation into value" (De Mauro, Greco, & Grimaldi, 2015, p102). The value, volume, variety, veracity, and velocity of big data help organizations collect, store, and analyze extensive data through the cloud (Thomas & Leiponen, 2016). The predictive analytics is the main power of big data, which is used for future forecasting of events (Dubey et al., 2019).

A Cyber-Physical System (CPS) provides connectivity between the computing and communication infrastructure and physical reality operations (Lu, 2017). CPS is a complex, intelligent system based on wireless network and sensors which interact the cyberspace, processing and physical space (Abbaspour Asadollah et al., 2015). CPS is widely adopted in transport systems, smart factories, smart grids, smart cities and medical devices (Xu, He, Vijayakumar, Choo, & Li, 2020). CPS helps smooth supply chain processes through interaction with the IoT and other connected technologies, such as AI, augmented reality, robotics, and 3D

printing (Frederico et al., 2021). IoT stores the real-time information generated from CPS, which is communicable to other connected devices for decision monitoring (de Sousa Jabbour et al., 2018). Now, CPS has become the lynchpin technology for I4.0 due to its contributions to operational transparency, control of the process, and efficiency improvement (Ghobakhloo, 2018).

Generally, digitalization depends on the networking of devices, the Internet of Things (IoT). Multiple devices including sensors, 3D scanners, and cameras are interconnected (vertically and horizontally) to acquire accurate data (Müller, Kiel, & Voight, 2018). The main objective behind IoT is operational optimization, improved planning, and maintenance solutions through complex analytical approaches (Arnold, Kiel, Voight, 2016). This extensive data are also known as big data, which is a significant source of competitive advantage (Nagy, Olah, Erdei, Mate, & Popp, 2018).

The concept of cloud computing has gained noticeable attention in industry and academia (Alouffi, Hasnain, Alharbi, Aloasaimi, & Ayaz, 2021). Recently, cloud computing has introduced new markets and users in information technology (Jaeger, Lin, & Grimes, 2008). Organizations use cloud computing to facilitate the sharing of hardware and software aspects of information technology (IT) resources through Service Oriented Architecture (SOA) and ensures the re-usability and cost reduction of computing infrastructure (Bello et al., 2021). Despite its benefits, cloud computing is criticized with security and privacy issues (Khan & Al-Yasiri, 2018).

Artificial Intelligence (AI) is the prominent digital technology for business transformation. AI attempts to replicate humans inperceiving, reasoning, knowledge representation, planning, and solving complex problems in intelligent, intentional and adaptive ways (Pan & Zhang, 2021). Past research has indicated that AI improved the coordination, service quality, efficiency, productivity, and overall decision-making in business organizations (Kittur et al., 2019). Multiple fields and industries have benefitted by deploying AI in their business operations, supply chains, and processes. Precisely, DT and its associated modern technologies are bringing remarkable changes to individuals, society, and business.

2.1 DT and Employee Attitude

Generally, attitude represents psychological inclination and has an enormous impact on productivity, organizational goals, and job success overall. Employees' positive and negative attitudes directly contribute to achieving goals, success, and failure (Otchere-Ankrah,

Tenakwah, & Tenakwah, 2016). Several dimensions of employee attitude, including job satisfaction, organizational commitment, turnover intentions, and organizational citizenship behaviour, have received considerable attention in business organizations. During DT, organizations must inspire a proactive and visionary attitude (Blanka, Krumay, & Rueckel, 2022). Much research is available on these dimensions and their roles in organizational outcomes. Recently, employee attitude has been studied during the planned organizational change in general (Onyeneke & Abe, 2021), but we have witnessed scarce research discussing affect of DT and employee attitude specifically. Our study focuses on two essential dimensions of employee attitude: job satisfaction and organizational commitment.

Job satisfaction is labelled as an individual's feelings (positive and negative) about their job and its other related aspects (Spector, 1997). Job satisfaction is a critical organizational outcome (Judge & Watanabe, 1994), and abundant determinants have been recognized in past research (Chen & Silverthorne, 2008). Kabir and Parvin (2011) argued that job satisfaction is a complex concept that is strongly associated with performance, motivation, leadership, conflict, and attitude. Job satisfaction directly contributes to value addition (Edmans, 2012) and organizational performance (Melián-González, Bulchand-Gidumal, & López-Valcárcel, 2015). The literature on job satisfaction is well established, but there is a lack of empirical evidence exploring DT and job satisfaction. A recent study by Neumann and colleagues (2021) stressed the investigation of DT and job satisfaction. In the context of I4.0, DT puts an extra burden on employees and requires a new skill set for the continuity of business operations. We assume that DT can positively or negatively affect the job satisfaction level of employees. Thus, we aim to test the following hypothesis:

H1: *DT is significantly associated with the job satisfaction of I4.0 employees.*

Job satisfaction, turnover intentions, absenteeism, and performance are predicted by organizational commitment (Brett, Cron, & Slocum, 1995; Yousef, 2000). The widely accepted definition of organizational commitment is "an affective or emotional attachment to the organization such that the strongly committed individual identifies with, is involved in, and enjoys membership in the organization (Allen & Meyer, 1990)". They further categorized organizational commitment into affective, normative, or continuance. Among these three dimensions, affective commitment is much desired and pushed by the intrinsic motivation of individual employees and is strongly associateds with absenteeism and turnover (Somers, 1995). In the past literature, similar concepts (e.g., employee commitment, affective

commitment and affective organizational commitment) have been used synonymously to organizational commitment (Karatepe & Uludag, 2007). DT or I4.0 brings drastic changes to a the business and employees. DT also affects the nature of work by deploying new digital technologies in business operations and processes. There is the possibility that DT can have the positive or negative affect on the affective commitment. In lieu of this, we propose to test the following hypothesis:

H2: *DT is significantly associated with the affective commitment of I4.0 employees.*

2.2 DT and Psychological capacities

The employee-employer relationship is primarily judged through the psychological contract and focuses on achieving organizational outcomes by simultaneously satisfying employee expectations (Aggarwal & Bhargava, 2009). A recent study found that DT or I4.0 increases management control and undermines the employee's authority (Cirillo, Rinaldini, Staccioli, & Virgillito, 2021). Past literature established the consensus about the role of technology and its consequences related to individuals, work, and organizations (Ragu-Nathan Tarafdar, Ragu-Nathan, & Tu, 2008; Tarafdar, Pullins, & Ragu-Nathan, 2015). We believe that high psychological capacities provide the immunity to absorb organizational changes and adverse life experiences in general . Recent literature has started to consider the role of DT on employee health (Dengler, Hiesinger, & Tisch, 2022), however, there is a lack of discussion on how DT may affect the employee's psychological capacities in I4.0. Following this research line, we identified employee resilience and self-efficacy, which are considered crucial during the transitional phase or turbulent situation.

The concept of employee resilience is rooted in positive and clinical psychology (Norman, Luthans, & Luthans, 2005) and is now extensively discussed in human resource literature (Bardoel, Pettit, De Cieri, & McMillan, 2014). In gerneal, resilience is viewed as a individual's ability to stay positive and quickly reverse back to its normal state in turbulent circumstances (Bonanno, 2004). In organizational settings, resilience is considered "the developable capacity to rebound or bounce back from adversity, conflict, and failure, or even positive events, progress, and increased responsibility (Luthans, 2002b, p702)" The core of this definition is that resilience can be developed and sustained among employees (Malik & Garg, 2018). Later, employee resilience emerged as an essential dimension of psychological capital (Luthans, 2002a). Resilient employees encounter an adverse situation and divert their energy, time, and resources required to normalize the situation (Youssef & Luthans, 2007).

Resilience is acknowledged as an effective tool in managing stress and is helpful in adverse events, especially in job-related challenges (Luthans, Norman, Avolio, & Avey, 2008). DT affects the entire business model and involves the automation of occupations (Dengler & Matthes, 2018). The wide application of digital technologies increases job insecurity, stress, and fear of unemployment (Dengler et al., 2022).. Similarly, a recent study stressed the development of employee resilience, considering it an important asset to DT (Trenerry et al., 2021). . Thus, resilient employees who can effectively address these challenges are much needed during DT. In this study, we aimt to investigate whether DT affects employee resilience working in I4.0. We established the following hypotheses:

H3: *DT is significantly associated with the resilience of I4.0 employees.*

An additional crucial psychological capacity for DT is employee self-efficacy. Generally, self-efficacy represents the individual belief about their ability to find a solution to upcoming problems by understanding its consequences (Judge & Bono, 2001). Self-efficacy is "the employee's conviction or confidence about his or her abilities to mobilize the motivation, cognitive resources or courses of action needed to successfully execute a specific task within a given context (Stajkovic & Luthans, 1998, p4)". Self-efficacy is a context-specific concept which is explained by applying social cognitive theory in the workplace (Newman Obschonka, Schwarz, Cohen, & Nielsen, 2019). High-efficacy individuals exert their maximum effort for task completion compared to low-efficacy individuals (Bandura, 1986). Individuals with low self-efficacy tend to cease their efforts at the initial stage and usually end up in failure (Bandura, Freeman, & Lightsey, 1999). From the lens of social cognitive theory, self-efficacy beliefs, particularly about one's abilities, affect the outcomes of tasks and impact their pervasiveness towards task completion (Bandura, 2001)

The context of I4.0 provides opportunities for digitalization, intelligence, connectivity and decentralization (de Sousa Jabbour et al., 2018). The employees working under I4.0 context required more cognitive skills in their task completions and more use of congnition may lead to psychological strain (Issa, 2022). Employees are expected to perform their tasks independently with greater authority and flexibility in the I4.0 context (Kaasinen et al., 2020). These researchers further argued that the industrial environment is now highly uncertain and complex, but provides self-development opportunities. Self-efficacy is a prominent determinant of learning effectiveness and is discussed in many disciplines and contexts (Prior, Mazanov, Meacheam, Heaslip, & Hanson, 2016). During DT, the employee's beliefs about

their learning abilities and implementation at the workplace become significant. As a result, we argue that either DT affects workers' self-efficacy in I4.0. Following this assumption, we propose to test the following hypothesis:

H4: *DT is significantly associated with the self-efficacy of I4.0 employees.*

2.3 DT and Job Factors

Employee engagement indicates the involvement and commitment to organizational goals, values, and beliefs. Initially, Kahn, (1990, p694) termed employee engagement as "the harnessing of organization members' selves to their work roles; in engagement, people employ and express themselves physically, cognitively, and emotionally during role performances." Kahn (1990) further added that engaged employees involved themselves emotionally, cognitively, and physically in task completion. Job engagement instils employees' enthusiasm, energy, and activation (Macey & Schneider, 2008). Past researchers reported that engagement is declining, and the engagement gap is causing a $300 billion annual loss to organizations in the USA in terms of less productivity (Bates, 2004; Richman, 2006). Engaged workers tend to perform tasks which are beyond their formal job descriptions. Job characteristics are the main antecedents of employee engagement, whereas its predictors include several desired behaviours like organizational commitment, organizational citizenship behaviour, job satisfaction, and turnover intentions (Anitha, 2014; Saks, 2006). Individuals with high engagement tend to apply emotional, cognitive and behavioural energy to their job tasks. Consequently, employee engagement directly contributes to increased work performance and organizational goals (Rich, Lepine, & Crawford, 2010).

In the DT era, technologies provide modern tools for data collection about employee feedback and related business outcomes (Burnett & Lisk, 2019). Similarly, Ślusarczyk, Nathan, & Pypłacz, (2021) argued that I4.0 is changing the workplace tremendously and introducing new jobs, skills and competencies. Likewise, these workplace changes will demand highly skilled, dynamic, innovative, and multidisciplinary (IT, engineering, operation, management etc.) competencies (Bag, Yadav, Dhamija, & Kataria, 2021; Sima, Gheorghe, Subić, & Nancu, 2020). Burnett & Lisk, (2019) further argued that digital technologies would make it easy to observe the extent of engagement, satisfaction and commitment at the individual, team and organizational levels. We assume that DT will affect employee engagement. Thus, we intended to test the following hypotheses:

H5: *DT is significantly associated with job engagement of I4.0 employees.*

Job autonomy is an essential factor of the job demand-resource (JD-R) model (Bakker & Demerouti, 2007). Typically, job autonomy refers to the extent of discretion, independence and freedom an individual is granted in allocating time, determining methodology, and other job-related tasks (Hackman & Oldham, 1975). Previous literature indicates that higher autonomy provides the energy, time, and freedom needed to adopt positive behaviours and decision-making about how, when, and what to do to perform job tasks (Fried & Ferris, 1987; Humphrey, Nahrgang, & Morgeson, 2007). Individuals with high autonomy tend to be actively involved in proactive activities and provide an advanced response (Parker, Bindl, & Strauss, 2010). Past studies indicated that job autonomy increases job performance, job satisfaction, commitment, motivation, and psychological well-being, and reduces stress, burnout and absenteeism (Deci et al., 2001; Humphrey et al., 2007). Employees working in the autonomy-supportive environment were found to be more confident in technology use than those working in a controlling environment (Roca & Gagné, 2008). A recent study reported that job autonomy significantly supports intrinsic motivation and long-term sustainable development (Zhou, Li, & Gong, 2019).

In the business world, DT and new technologies foster the perception of depression, cynicism, increased turnover, lowered career satisfaction and organizational commitment (Brougham & Haar, 2018; Li, Bonn, & Ye, 2019). A recent study stressed the preparation of employees to meet the I4.0 challenges at the workplace (Ślusarczyk et al., 2021).. They further argued that these challenges are not limited to technology-related skills and knowledge, but also involve introducing and preparing I4.0 concepts to mitigate the negative effect of changes. Similarly, Schwarzmüller, Brosi, Duman, & Welpe (2018) argued that DT offers a highly autonomous environment which ultimately drives participatory behaviour and increases employee influence at work. They contended that DT demands more participation in decision-making, and autonomy can reduce the uncertainties and complexities. In this scenario, we believe that job autonomy can increase the effectiveness of DT. We proposed to test the following hypothesis:
H6: *DT is significantly associated with the job autonomy of I4.0 employees.*

2.5 Theoretical Framework

In this study, we are interested in examining the impact of DT on attitudes (satisfaction, affective commitment), psychology (resilience, self-efficacy) and job (autonomy, engagement) of employees working in I4.0 organizations. For this, *Figure* 1. presents the conceptual model of this study. In this research model, we have one independent variable (DT) assumed to significantly impact the six dependent variables: job satisfaction, affective commitment,

resilience, self-efficacy, job autonomy, and job engagement. The context of this study is industry 4.0 organizations that have partially or wholly digitalized their business operations.

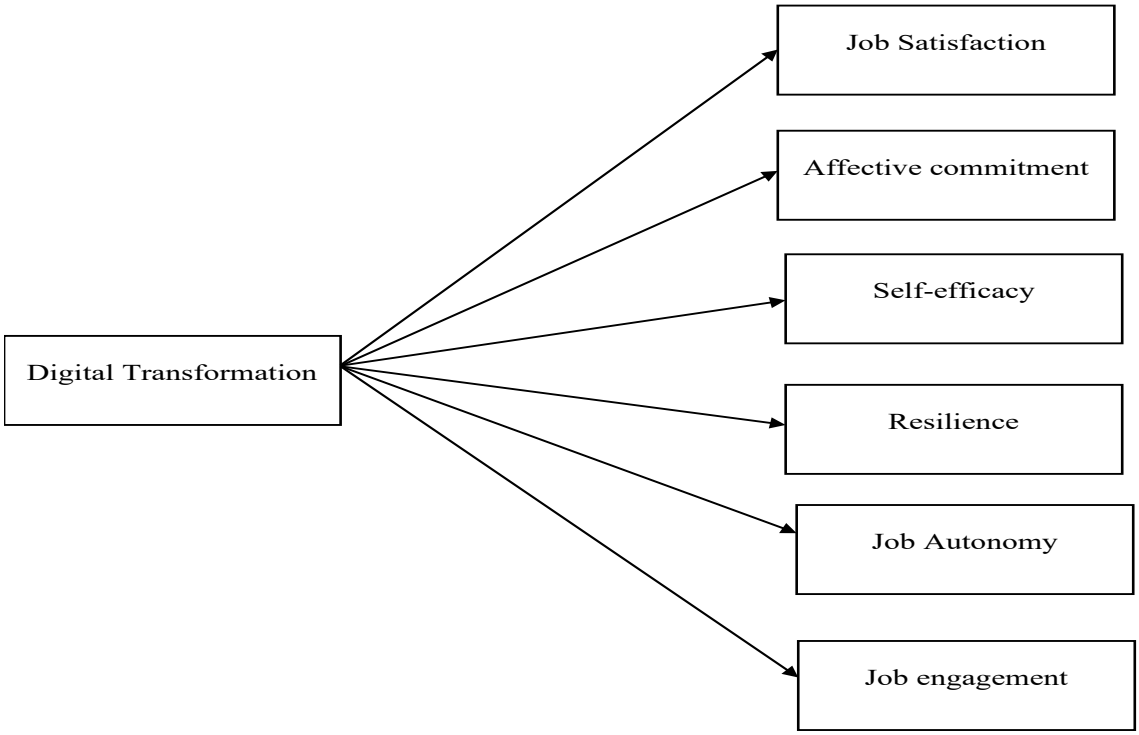

Figure 1. **Theoretical Framework**

3. Research Methodology

In this section, we explained the sampling method, data collection, and information about the measurement variables.

3.1 Sample Selection and Procedure

In accordance with the IMD digital competitive 2021 ranking, we collected our sample from the top 10 digital nations. As per the ranking, Demark, Finland, Sweden, the United Staes of America (USA), Singapore, Taiwan, Switzerland, Norway, the Netherlands, and the United Arab Emirates (UAE) were the top digital nations (IMD, 2021). We administered an online survey through the platform, Prolific. Initially, after setting the study protocol, we retrieved 4,328 participants. The unit of analysis of this study are the individual employees working in I4.0 industries. For this, we further screened out participants by including questions in our survey such as"Has your organization digitalized its manufacturing, business operations and

supply chain?" or "Is your organization working in an I4.0 context? Based on population size, we employed the method of Krejcie and Morgan (1970) for the appropriate sample size selection. Following this method, we invited 383 participants working in I4.0 contexts within digitalized businesses. We returned the 337 questionnaires. After exclusion of non-valid (missing, repetitive responses, etc.), 320 participants fulfilled our study criteria. Thus, overall, we received an 83 per cent response rate.

3.2 Measurement of Variables

We used an already established and well-recognized measurement scale to measure study variables. We measured DT with a 7-item scale based on the conception made by the earliest literature (Hagberg, Sundstrom, & Egels-Zandén, 2016; Li, Su, Zhang, & Mao, 2018; Pramanik, Kirtania, & Pani, 2019). This scale has been used in recent studies as well (Nayal, Raut, Yadav, Priyadarshinee, & Narkhede, 2022; Saunila, Nasiri, Ukko, & Rantala, 2019). Sample items include "My organization's digitalized IT system collects large amounts of data from different sources" and "The activities and processes in the supply chain of my organization are automated as much as possible".

To measure employee attitude, we selected two main dimensions: job satisfaction and affective commitment. For the job satisfaction scale, we measured through a one-item scale: "Taking everything into account, I am satisfied with my job." The use of a single item is prescribed by Nagy (2002) and has been utilized in recent past studies (Stankevičiūtė, Staniškienė, & Ramanauskaitė, 2021; Steijn & Van der Voet, 2019). We measured the affective commitment with a 3-item scale (Allen & Meyer, 1990). Sample items include: "I really feel as if this organization's problems are my own" and "I feel like 'part of the family at my organization".

We selected two main psychological capacities to measure psychological affect: resilience and self-efficacy. We measured employee resilience with a 6-item scale adapted from Wagnild and Young (1993). Sample items include "I usually manage difficulties one way or another at work" and "I can be "on my own," so to speak, at work if I have to". The instrument contains one reverse coded item. We used a 6-item scale to measure self-efficacy. This scale is developed by Parker (1998). The sample items are "I feel confident analyzing a long-term problem to find a solution" and "I feel confident helping to set targets/ goals in my work area".

Similarly, we measured job autonomy with a 6-item scale developed by (Price, 1997). This scale contains the three reverse-coded items. The sample items include "I am able to choose the way to go about my job" and "I have no control over the sequencing of my work activities (R)". For the measurement of job engagement, we used the 3-item scale, also known

as the ultra-short measure work engagement scale (UWES). This version of the scale was developed by Schaufeli, Shimazu, Hakanen, Salanova, & De Witte (2019). The items measure the vigour, dedication, and absorption aspects of job engagement. The sample items include “At my work, I feel bursting with energy” and “I am immersed in my work”.

3.3 Data Collection

Before launching our study, we conducted pilot testing of our research. We distributed our questionnaire to fifteen independent experts, including the researchers, who proposed valuable suggestions to improve and make it further meaningful. Accordingly, we incorporated and altered our questionnaire. We designed our questionnaire clearly and understandably, and ensured participants' data anonymity and confidentiality. In the survey cover letter, we explained the objectives and procedure of data handling. We collected the data from a single source to minimize the problem of common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). We arranged the variables items differently to reduce the chances of participants anticipating causalities. Our cover letter referred to the weblink of relevant data protection and privacy laws.

4. Data Analysis and Results

We executed our data analysis via four different but interconnected sub-sections. The first section presented the demographic characteristics of respondents. The second section introduced the descriptive analysis comprising mean, standard deviation, correlation and normality checks. The third section measures the reliability and validity of our measurement scales. Finally, we presented the results of our study hypotheses.

4.1 Demographic Characteristics

Initially, we presented the descriptive analysis of demographic variables. Table 4.1 describes the study participants' complete information by indicating each category's frequency, percentage, mean and standard deviation. We found the highest age group (43%) were those between 30 and 39, followed by 20-29 (27%), 40-49 (21%) and 50-59 (09%). The participants of this study were male (64%) and female (36%). As far as the education of respondents, we found that they mostly held bachelor's (74%), master's (20%) and higher studies (06%) education levels. We found that 51 % of respondents worked with large organizations with more than 500 employees and 26% with small organizations under 100 employees. The remaining 23% of participants belong to middle-sized organizations operating with employees between 100 and 500.

Next, we observed that a large percentage (49%) are highly experienced with more than 12 years of experience. The rest of the participants possessed working experience of fewer than three years (6%), between 3 to 6 years (15%), between 7-9 years (13%) and between 10-12 years (17%). Our participants belong to multiple industries, including service (44%), manufacturing (20%), telecommunication or information technology (16%), healthcare (04%), education (05%) and others (11%).

4.2 Descriptive Analysis

Initially, we observed the descriptive statistics comprising mean, standard deviation and normality of data. Table 4.1 shows that the mean of DT, job autonomy, job satisfaction, resilience, self-efficacy, job engagement, and affective commitment are 3.98, 3.74, 3.75, 3.79, 4.03, 3.75 and 3.81, respectively. Self-efficacy has the highest value and job autonomy has the lowest. Similarly, standard deviation values of DT, job autonomy, job satisfaction, resilience, self-efficacy, job engagement and affective commitment are .67, .78, .97, .67, .70, .74 and .70. These values are within the prescribed range of -2 and +2 (Huber, 2018).

Table 4.1 Demographic Characteristics

Variable	*Categories*	*Frequency*	*Percentage*	*Mean*	*SD*
Age	20-29	88	27	2.11	.907
	30-39	138	43		
	40-49	66	21		
	50-59	28	9		
Gender	Male	204	64	1.36	.481
	Female	116	36		
Qualification	Bachelor	236	74	1.33	.588
	Master	64	20		
	Higher studies	20	6		
Company Size (No. of employees)	Less than 100	82	26	2.25	.839
	101-500	75	23		
	More than 500	163	51		
Total working experience	Less than 3 years	19	6	3.87	1.328
	3-6 Year	50	15		
	7-9 years	41	13		
	10-12 years	54	17		
	More than 12 years	156	49		
Industry	Manufacturing	63	20	2.62	1.510
	Services	141	44		
	Telecommunication/IT	53	16		
	Healthcare	14	4		
	Education	15	5		
	Others	34	11		
Total		320	100		

SD= Standard Deviation

Table 4.2 Mean, Standard Deviation, Normality

Variables	Mean	SD	Skewness	Kurtosis
DT	3.98	.67	-.718	-.144
Job Autonomy	3.74	.78	-.850	.268
Job Satisfaction	3.75	.97	-.862	-.265
Resilience	3.79	.67	-.641	-.244
Self-efficacy	4.03	.70	-.973	.355
Job engagement	3.75	.74	-.677	.504
Affective commitment	3.81	.70	-.466	.236

The data normality was observed through the analysis of skewness and kurtosis values. We found the minimum and maximum values -.89 and .50 within the range of -2 and +2, confirming the data normality (George & Mallery, 2019). This fulfils the prerequisite condition and further endorsement to proceed with the SEM model to observe the relationship between variables.

4.3 Correlation Matrix

The following table 4.3 presents the correlations among study variables. We have observed a significant positive correlation among the all variables.

Table 4.3 Correlation Matrix

Variables	1	2	3	4	5	6
Self-efficacy						
Resilience	.63**					
Job satisfaction	.39**	.24**				
Job autonomy	.61**	.45**	.56**			
Job engagement	.58**	.54**	.36**	.55**		
Affective commitment	.52**	.43**	.40**	.51**	.47**	
Digital Transformation	.69**	.60**	.40**	.62**	.46**	.49**

**. Correlation Significant at the 0.01 level (2-tailed).

Finally, the correlations between the variables indicates strong significant positive relationships between digital transformation and self-efficacy (.69), resilience (.60), and job autonomy (.62). A moderate correlation was found between DT and affective commitment (.49), job satisfaction (.40) and job engagement (.46). We observed a highly significant correlation between self-efficacy and resilience (.63), job autonomy (.61), job engagement (.58) and affective commitment (.52). We see a weaker correlation between job satisfaction

and resilience (.24) and job engagement (.36). The correlation coefficient signifies the absence of a multicollinearity problem.

4.4 Reliability and Validity Analysis

Following the method of Hair (2009), we examined the validity and reliability of our scales. Cronbach's alpha, average variance extracted (AVE), and composite reliability (CR) values were used to examine the discriminant and convergent validity. Table 4.4 revealed that values of CR, AVE > 0.50 and Cronbach alpha are> 0.70 for all measurement scales, indicating excellent reliability and convergent validity. The overall Cronbach alpha for all the scales was .89. Table 4.3 shows that the inter-scale correlation is well below the threshold of 0.70 (Fornell & Larcker, 1981), confirming the discriminant validity. As already mentioned, we applied both statistical and procedural methods for common method bias. We used Harmon's one-factor test through the confirmatory factor analysis. We noted that the first extracted factor accounts for 33.51% of the total variable, less than 40%. This indicates that there is no problem of common method bias (Podsakoff et al., 2003). .

Moreover, we validated our model as a single construct and performed a Confirmatory Factor Analysis (CFA). For the measurement model, we included all variables with all dimensions. To assess the model fitness, we removed one item of job autonomy due to weak regression weight (< .40). After removing this item, we achieved the acceptable model fitness for our measurement model. The model produced that the value of CMIN/DF is 2.25, which is < 3 (Hair, 2009). Other parameters of model fitness include GFI (.93), CFI (.91), and AGFI (.89) achieved acceptable values (close or above .90) recommended by Hair (2009). additionally, the RMR and RMSEA were .054 and .059, respectively, which were below the recommended threshold of .080 (Hair, 2009). All of the remaining factors achieved significantly loading ($p < .01$) into their corresponding scales (see table 4.4). We have not included job satisfaction in our structure model due to single items measurement. We measured the reliability and validity of job satisfaction using the SPSS separately.

Table 4.4 Items factor loading, Reliability and Validity

Variable	*Items*	*Loading*	*Cronbach Alpha*	*CR*	*AVE*
Digital Transformation	DT1	0.73	.78	.93	.54
	DT2	0.62			
	DT3	0.68			
	DT4	0.82			
	DT5	0.73			
	DT6	0.78			
	DT7	0.76			
Self-efficacy	SE1	0.67	.81	.90	.51
	SE2	0.78			
	SE3	0.69			
	SE4	0.72			
	SE5	0.62			
	SE6	0.78			
Resilience	RE1	0.85	.76	.94	.64
	RE2	0.79			
	RE3	0.72			
	RE4	0.83			
	RE5	0.81			
	RE6	0.79			
Job Autonomy	JA2	0.87	.82	.88	.54
	JA3	0.75			
	JA4	0.69			
	JA5	0.68			
	JA6	0.69			
Affective Commitment	AC1	0.81	.73	.68	.52
	AC2	0.72			
	AC3	0.63			
Job Engagement	JE1	0.74	.78	.71	.60
	JE2	0.81			
	JE3	0.78			

4.4 Hypothesis Testing

After checking the normalcy, construct validity etc., we checked the validity of our structured model by using the maximum likelihood estimates approach. Table 4.5 presents the standardized coefficients, standard error, p-values and decisions of our structural model hypothesis. By using the AMOS version 26, we measured the structural model. We measured the model fitness and tested our study hypothesis in this model. We calculated the model fitness ratios and found that the value of CMIN/DF is 2.37, which is < 3 (Hair, 2009). Other parameters of model fitness include GFI (.88), CFI (.87), and AGFI (.86) achieved acceptable values (close or above .90) recommended by Hair (2009). Additionally, the RMR and RMSEA were .061 and .065, respectively, which were below the threshold of .080 (Hair, 2009).

Our model contains only a direct path from the independent variable (DT) to all other dependent variables. Our analysis revealed that DT is significantly associated with affective commitment ($\beta = .81$, $P \leq .01$), resilience ($\beta = .78$, $P \leq .01$), self-efficacy ($\beta = .91$, $P \leq .01$), job engagement ($\beta = .87$, $P \leq .01$) and ($\beta = .83$, $P \leq .01$). Conclusively, H2, H3, H4, H5 and H6 were supported, and the null hypothesis was rejected against these alternative hypotheses. As we measured job satisfaction with one item, the impact of DT on job satisfaction was measured using SPSS separately. We found that DT was positively and significantly related to job satisfaction ($\beta = .40$, $P \leq .01$). Hence, the null hypothesis was rejected, and H1 was supported.

Table 4.5 Hypothesis Testing

Hypothesis	Model Link	β	S.E	p-value	Decision
H1	DT→ JS	.40	.078	***	Supported
H2	DT→AC	.81	.095	***	Supported
H3	DT→RE	.78	.087	***	Supported
H4	DT→SE	.91	.090	***	Supported
H5	DT→JE	.87	.126	***	Supported
H6	DT→JA	.83	.113	***	Supported

Significant at the 0.01 level (2-tailed).

5. Discussion and Conclusion

This study aimed to develop the link between organizations' technical and human sides. Pragmatically, the technical side is going through a digital transformation that directly impacts an organization's human side. Businessess are keen to deploy the latest digital technologies such as AI, IoT platforms, cloud computing, cyber-physical system, and big data analytics in

their daily business operations. In reference to these developments, this study empirically tested the model exploring the impact of widespread DT on the employee's attitude, psychology, and job in the I4.0 context. We presented the unique empirical findings often available in emerging literature discussing DT and employee issues.

5.1 Discussion of Results

We selected two critical aspects of an employee's attitude (job satisfaction and affective commitment), psychological capacities (resilience and self-efficacy) and job-related factors (job autonomy and engagement). H1 and H2 tested the impact of DT on job satisfaction and affective commitment of employees working in I4.0. Our analysis confirms the positive affect of DT on employees' job satisfaction and affective commitment. Contrary to past views that DT increases stress and job insecurity, these findings support the evidence that DT also brings satisfaction and increases employees' affective commitment levels. Results indicate that motivation, commitment, and satisfaction are important factors for managing the change process.

In this respect, DT provides employees ease and comfort, mainly due to reduced physical tasks. Based on social exchange theory (Blau, 2017), it is possible that the development of new skills, knowledge, and health and safety measures may lead employees to demonstrate emotional attachment and satisfaction with their organizations.After DT, employees may be willing to contribute vigorously towards the organizational success and want to return their investment.. Moreover, the participatory nature of working in I4.0 is also the primary source of increased affective commitment. Employees tend to think participation will overcome their problems and increase their work effectiveness. We we argue that organizations should invest largely in training and digital skill development of employees for the smooth transition and promotion of participatory culture.

Our H3 and H4 are related to the impact of DT on two essential psychological capacities, self-efficacy and resilience of employees working in I4.0 firms. Our findings show the significant effect of DT on both self-efficacy and resilience. The concept of resilience is rooted in positive and clinical psychology, but its role has now extended to organizational settings. The need for resilient employees has become imperative, especially in the spread of digitalization. The impact of technology has been studied in organizational behaviour and psychology (Venkatesh, Morris, Davis, & Davis, 2003). Since the pandemic, the implementation of DT has increased exponentially, and there is an urgent need for resilient

employees (Trenerry et al., 2021). . Our findings empirically indicate that DT increases employee resilience and supports the individual-level implications made in their literature review (Trenerry et al., 2021).. Past literature has highlighted that employee resilience is an emerging challenge for human resource management (Bardoel et al., 2014). . Following the social cognitive theory, higher self-efficacy beliefs provide psychological strength and high persistence toward completing current work roles and accepting more challenging tasks (Bandura, 2006).

DT helps make employees more resilient because changing tasks and technology-driven work allow them to use their abilities, demonstrate confidence (self-efficacy) and bounce back in consistent turbulence. DT provides the exact context where the individual faces adverse circumstances (risks and threats), uses resources, energy, and time, and succeeds in returning to a normal situation (Bonanno, 2004; Luthans, Youssef, & Avolio, 2007). The changing work conditions provide a high level of human resilience and confidence (self-efficacy) in tackling daily work challenges.

H5 examined the impact of DT on the job autonomy of I4.0 employees. Job autonomy is essential to the job design model (Hackman & Oldham, 1975). Past literature indicates that technology use causes depression and decreases career satisfaction and organizational commitment (Brougham & Haar, 2018; Li et al., 2019). Contrary to these arguments, study findings are consistent and support the theoretical argument that DT provides autonomy and increases employee effectiveness (Schwarzmüller et al., 2018). . The study findings also support that the DT under I4.0 revolution enhances the qualitative enrichment of jobs by providing greater autonomy, self-development, and an enjoyable working environment (MacDougall, 2014). It is therefore recommended that organizations prepare their employees to encounter the I4.0 challenges, and autonomy can be helpful in the mitigation of complexities.

Finally, H6 investigated the impact of DT on job engagement in I4.0 employees. Our results show that DT is significantly associated with job engagement in I4.0 employees. Although I4.0 working environment is often negatively characterized as stressful and causing other mental stressors, overall, it increases job engagement and empowerment (Kaasinen et al., 2020). . This study hinted that one possible reason for the positive affect of DT on job engagement is the wide use of simulation, visualization technologies. Our study confirms these assumptions empirically that DT increases the job engagement of I4.0 employees. Thus, engaged employees are likely to have high senses of responsibility and become sources of

motivation for other working colleagues (Anitha, 2014). Indirectly, engagement supports the management initiative during the change process.

5.2 Study Implications

This study presented significant implications from a theoretical and practical point of view. From a theoretical lense, the study contributes to existing literature and theory to understand DT and its impact on employees. First, we attempted to integrate the employee-related factors into the DT literature, which has mainly focused on business and strategy aspects (Trenerry et al., 2021). . Secondly, human-centricity is a vital factor for DT or Industry 4.0, and there is a need to understand the influence of technologies on human attitude, behavior, psychology, and job-related factors. We found less empirical research on the DT impact from employees' perspectives and responded to a recent research call (Neumann et al., 2021).. Finally, we extended existing literature on the job-design model with empirical evidence and presented the DT as an antecedent of job autonomy and job engagement in industry 4.0.

This study presented important managerial implications that need to be considered by the organization striving to digitalize their business. Our study invited the leading role of human resource professionals to play their part in current industry digitalization. First, we recommend an employee training program with particular focus on building resilience, which can be helpful in the reduction of stress, openness to change, and technology acceptance (Hartmann, Weiss, Newman, & Hoegl, 2020; Molino, Cortese, & Ghislieri, 2020). Second, we recommend participatory work design and well-designed training programs to bolster motivation, learning, and mindful use of technology. Third, our study confirms that DT positively impacts employees' attitudes, psychology, and job factors. There remains a need for technology-driven programs for mental and physical health.

5.3 Future Research Directions and Study Limitations

This study has a few limitations which can be addressed in future research. First, this study has provided the ideal context, but we encourage future research to replicate this study within different contexts. Second, we collected data from the top 10 digital nations, following by IMD ranking of 2021. We recommend future researchers to collect data from other countries with a vast digital gap. Third, our analyses are based on cross-sectional data, making it difficult to establish causality. We recommend longitudinal future research studies to validate the finding of this study. Fourth, financial incentives increase the response rate without compromising the result's biasness (Singer & Ye, 2013). This is not applicable in all contexts.

Therefore, we recommend future researchers to replicate studies without offering incentives. Fourth, we only covered a few aspects of employees' attitudes, psychology, and job-related factors. Future researchers should examine the impact of DT on other behavioural aspects, such as intention to quit, turnover, burnout, stress, happiness, wellbeing, organizational citizenship behaviour, and performance.

5.4 Conclusion

DT and the I4.0 revolution is bringing drastic changes for individuals, society, and businesses. Human-centricity is key to success for digital transformation and the industry 4.0 revolution. We extended the debate on the emerging literature discussing the impact of DT on the human side of an organization. This study empirically confirmed that DT is significantly related to employee attitude (satisfaction, commitment), psychology (resilience, self-efficacy) and job factors (autonomy, engagement) in the context of I4.0. We argue that DT positively impacts the employee's related aspects, but also demands a significant contribution from the human resource professionals in developing motivation, readiness, and aligning challenges.

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