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
Employee work engagement in the digital transformation of enterprises: a fuzzy-set qualitative comparative analysis

Di Ye [1], Bin Xu[2], Bingling Wei[3], Linlin Zheng[4] & Yenchun Jim Wu [5,6]✉

Information technology has brought about significant changes in enterprises, and new work situations have led to new problems. Employee resistance to new technologies, their ability to learn, and their ability to utilize personal resources to improve work engagement in the face of technological pressure are important factors that companies need to consider when undergoing digital transformation. The influence mechanism of configuration effects on factors around employee work engagement has not been explored, and technostress creators have rarely been included in the configuration as influencing factors in previous studies. On the basis of the job demands-resources (JD-R) model and trait activation theory, this study explored the factors that affect employees' work engagement at the level of job demands and personal resources. The fuzzy-set qualitative comparative analysis (fsQCA) method was used to investigate the influence of technical stressors, self-efficacy, and the Big Five personality traits on employees' work engagement. Through a survey of 225 employees in the context of enterprise digital transformation, the results show three driving paths that promote employees' work engagement: openness to experience conscientiousness, self-efficacy driven, and inhibition to technical stressors. The study also analyzed employees' low work engagement state, which is driven by an inhibition of agreeableness and extraversion. This research enriches the study of factors influencing work engagement in the digital transformation of enterprises.

[1] College of Business Administration, Huaqiao University, Quanzhou 362021, China. [2] Business School, Zhengzhou University, Zhengzhou 450001, China. [3] School of Public Policy & Management, Tsinghua University, Beijing 100084, China. [4] Oriental Enterprise Management Research Center, Huaqiao University, Quanzhou 362021, China. [5] Graduate Institute of Global Business and Strategy, National Taiwan Normal University, Taipei 106, Taiwan. [6] Department of Hospitality Management, Ming Chuan University, Taipei 111, Taiwan. ✉email: wuyenchun@gmail.com

Introduction

The development of information technology (IT) has led to a new revolution. Blockchain, the Internet of Things, artificial intelligence, and big data have prompted the emergence of new business formats, thereby changing organizational forms, production processes, and business models (Nambisan et al. 2019). Many enterprises have embraced digital transformations to gain a competitive advantage. However, the transition is fraught with risks and difficulties. Digital transformation is a major challenge, and most problems arise at the organizational and employee levels. Hence, improving the working status of employees deserves much attention. The development of technology is challenging for employees. Additionally, employees are the key to transformation because they are the main body of the enterprise. Employees' resistance to new technology, learning ability, and mobilization of personal resources to improve work engagement in the face of pressure brought by new technology are factors that need consideration when enterprises undergo digital transformation.

Work engagement is a positive, work-related state of happiness or fulfillment that is associated with positive outcomes, such as improvement in performance, customer satisfaction, and organizational advantage (Bakker et al. 2008). The current study examines the antecedent variables of work engagement from the perspectives of job demands and personal resources. The most common example of job demand is work pressure, especially in the context of the digital transformation of enterprises. Technology has induced significant changes in the workplace. For example, remote work has blurred the boundaries between work and personal life, and technological intrusions have generated work–life conflicts. The introduction of new technologies threatens employees' jobs and creates a sense of job insecurity, which can also affect work engagement (Bosman et al. 2005). These aspects are the negative consequences of technostress creators. Simultaneously, different personality traits influence the way people respond to stressors (Khedhaouria and Cucchi, 2019). Personality traits are closely related to work engagement because people with specific personality traits associated with high work engagement (e.g., extraversion and responsibility) are more likely to mobilize work resources; however, neuroticism is negatively correlated with work engagement (Bakker et al. 2014; Mäkikangas et al. 2013; Opie and Henn, 2013). This correlation suggests that individual differences determine whether objective work situations affect work engagement. At the level of personal resources, people with high self-efficacy are likely to view their surroundings positively, which is positively correlated with work engagement (Chan et al. 2017; Vîrgă et al. 2015).

Previous studies have examined the linear relationship between some factors and employee work engagement. However, the influence mechanism of configuration effects on factors around employee work engagement has not been explored, and technostress creators have rarely been included in the configuration as influencing factors. Various factors, such as employees' resistance to new technologies, learning abilities, attitudes toward coping with the pressures of new technologies, and their work states, are all critical considerations during a company's digital transformation. This study argues that in the digital age, where IT has a profound impact on corporate change, the impact of technological stressors on employees must be examined. Existing studies have mostly focused on individual factors and situational factors. The complexity of the practical field has caused difficulty in explaining the causes of phenomena from a single perspective (Galanakis and Tsitouri, 2022).

To address this research gap, this study combines individual and environmental factors and explores the configurations that affect employee work engagement through the linkage and matching of various variables, thus further enriching and enhancing the research outcomes in related fields. In the study of factors affecting employee work engagement, most studies in the literature have traditionally employed linear regression methods to construct mediating or moderating effects. Considering the complexity of antecedent conditions and the potential interdependencies among them, the current study adopts a configurational perspective and uses the fuzzy-set qualitative comparative analysis (fsQCA) to explore the synergistic effects of multifaceted antecedent conditions. This approach facilitates a comprehensive analysis of the pathways influencing employee work engagement. This study further explores the driving mechanism of low work engagement from the perspective of "causal asymmetry," thus broadening the applicability of the method.

On the basis of the job demands-resources (JD-R) model and trait activation theory, this study proposes a holistic analysis framework for employees' work engagement based on the specific situation in China. This work aims to identify the factors that affect employees' work engagement and make relevant recommendations for business management activities. This study posits that employees' states and behaviors play a crucial role in the process of enterprise digital transformation. Therefore, we have selected employee work engagement as the dependent variable and, starting from environmental factors in the digital transformation process, such as technological stressors, and individual factors, such as personality traits and self-efficacy, we explore the mechanisms that influence employee work engagement. Specifically, this study examines the impact of technological stressors, self-efficacy, and the big five personality traits, namely, openness, agreeableness, neuroticism, conscientiousness, and extraversion, on employee work engagement. The research employs the fsQCA to investigate how individual traits, self-efficacy, and technological stressors affect work engagement.

Literature review

Work engagement. With the rise of positive psychology, work engagement has grown because of the increased emphasis on human strength and best behavior. Work engagement is conceptualized as a positive, fulfilling, and work-related state of mind (Schaufeli et al. 2010; Van Wingerden et al. 2017). On the basis of the perspectives of self-role and job role, Lodahl and Kejnar (1965) defined work engagement as the degree to which an individual considers the importance of work in their self-image. In addition, Lawler and Hall (1970) defined it as whether an individual believes that work has a significant influence on their image. Work engagement is considered an essential element that contributes to the organization's performance (Shuck and Herd, 2012; Wibawa and Takahashi, 2021). Kahn (1990) believed that an employee's job role and self can be mutually transformed; when an employee's work engagement is high, the degree of integration between the self and the job role is superior. Research has revealed that high levels of work engagement have positive effects on various outcomes. Moreover, studies have highlighted that the compatibility between the person and the environment positively influences engagement (Fu et al. 2022; Perera et al. 2018; Srimulyani and Hermanto, 2022). Maslach et al. (2001) defined burnout as the opposite of job engagement. Employees who experience job burnout are less engaged in work. Meanwhile, according to Schaufeli et al. (2002), work engagement and job burnout are not diametrically opposed concepts. Notably, various factors can influence work engagement. At the individual level, studies have confirmed that age, personality traits, occupation, religious beliefs, and personality have an impact on work

engagement. Langelaan et al. (2006) analyzed the characteristics of employees' personalities (neuroticism and extraversion) and temperaments (excitement intensity, inhibition intensity, and mobility) that would produce high engagement. Given its importance, exploring the antecedents of work engagement is of theoretical significance (Deci et al. 2017). However, little is known about the profiles of the personal characteristics of individuals who express a high level of work engagement.

Digital transformation. The foundation of digital transformation is technology, and every technological development is a disruptive change in human life. From the process and outcome levels, digital transformation is based on the combination of information, computing, communication, and connectivity technologies, which usher changes in products, organizational structures, business processes, and industries. These facets are the combined effects of digital innovation (Baiyere et al. 2020; Hess et al. 2016; Hinings et al. 2018; Vial, 2019). Multiple factors affect the digital transformation of enterprises, such as internal factors, leadership characteristics, enterprise characteristics, and strategy (Ferreira et al. 2019; Porfírio et al. 2021; Verhoef et al. 2021; Vial, 2019). External factors include the industry-competitive environment, changes in consumer demand, digital infrastructure, digital platforms, digital components, and environmental factors (Hanelt et al. 2021; Nambisan, 2017). The impact of digital transformation is multifaceted, thus reducing information asymmetry and improving the efficiency of the value chain. However, companies also face various risks during the transformation process, such as a new competitive landscape, technical complexity, and faster research and development (R&D) cycles (Li, 2020; Reddy and Reinartz, 2017).

Technostress creators. Tarafdar et al. (2007) defined technological stress as the pressure that new ICTs put on users. Technological pressure negatively impacts employees. Many scholars understand the sources of technical stress and the resulting stress from the perspective of the pressure-interaction model proposed by Lazarus and Folkman (1984). Fuglseth and Sørebø (2014) argued that this theory is reflected in the relationship between people and the environment, which brings stress when the needs of the environment exceed the capabilities of the individual. Pirkkalainen et al. (2020) emphasized the positive and negative aspects of IT engagement. Increased work-related IT usage can benefit employees because it indicates user interest and commitment to using technology while also pressuring individuals. Ayyagari et al. (2011) explored the relationship between technological characteristics, such as availability, invasiveness, dynamics, and technostress creators. Ninaus et al. (2021) analyzed the use of ICT at work from a JD-R perspective; a survey of employees in different industries during the pandemic revealed that ICT has mostly contributed to job burnout and impacted work-life balance and job satisfaction.

Theoretical model development
Job demands-resources model. The JD-R model was proposed to explain the mechanism of work engagement, where job demands refer to the psychological, social, or organizational aspects of work that require sustained physical or psychological (cognitive and emotional) effort and skills. Therefore, these aspects are associated with certain physical or psychological costs. Work engagement is determined primarily by personal and work resources. Work resources are mostly organizational, such as positive leadership behavior, managerial support, and performance feedback, which help employees reduce the negative impact of work requirements. Personal resources are positive self-

evaluations, which refer to an individual's sense of the ability to control and influence the environment successfully. These evaluations are derived from individuals' psychological states, such as self-efficacy and optimistic attitudes. Job demands are associated with low work engagement, both of which lead to low task performance; conversely, job resources are related to high work engagement, both of which are associated with high task performance (Tu et al. 2022).

The main points of Bakker's model are as follows. First, work resources, such as support from colleagues or supervisors, performance feedback, and autonomy, play a motivating role. A resource-rich work environment enhances employees' willingness to dedicate their efforts and abilities to work, thus resulting in improved performance. Furthermore, employees with higher levels of personal resources, such as optimism and self-efficacy, actively mobilize resources for work. Second, work and personal resources, independently or in combination, predict work engagement. When job demands are high, job and personal resources have positive effects on work engagement. Simultaneously, work engagement has a positive impact on job performance, and employees with higher work engagement can create their own resources (Bakker and Demerouti, 2007; Bakker et al. 2008).

Trait activation theory. Personality traits are consistent within individuals, and different tendencies between individuals manifest in identifiable ways. However, this behavior occurs only in certain situations. Trait activation theory states that a trait's expression can only be awakened in a context related to that trait. Trait activation is the process through which individuals express their traits when confronted with trait-related situations. Tett and Burnett (2003) divided situations in the work environment related to the expression of personal traits into three categories, namely, task, social, and organizational. The task level mainly refers to daily work activities, and the social level refers to interpersonal interactions, such as cooperation and communication with others at work. The organizational level refers to the organization's atmosphere and culture, as well as its characteristics, such as organizational structure and related policies. The underlying personality trait expresses itself in work behavior only when trait-related cues are present at these levels. The theory also emphasizes the role of context in individual traits and activation and aids in the discovery of individual trait mechanisms influencing work outcomes. The research variable of work engagement in this study indicates employees' attitudes and behaviors, which may be activated in specific environments but not manifested in others. As such, trait activation theory provides good theoretical support for explaining employees' behavior, that is, their work engagement (Tett and Burnett, 2003; Tett and Guterman, 2000).

Variable selection and measurement. This study selected the following variables for analysis.

Personality traits. The Big Five personality traits include five dimensions: openness to experience, neuroticism, agreeableness, extraversion, and conscientiousness. Many scholars have recognized the use of these five traits to provide a comprehensive description of personality (Asselmann and Specht, 2021; Li et al. 2017; Şahin et al. 2019). Referring to Srivastava et al.'s (2015) construct of personality traits, our study makes appropriate modifications to suit the research background (see Table 1). We used a five-point Likert scale with higher ratings representing a better match with the description.

Self-efficacy. Self-efficacy refers to the set of beliefs held by individuals about their ability to complete a particular task. This study used the general self-efficacy scale developed by Schwarzer et al. (1997), which has been widely accepted by scholars. After appropriate modifications, five questions were designed. We used a five-point Likert scale, where higher scores indicate a higher match (see Table 2).

Technostress creators. Technostress creators causes an individual technological stress and are associated with the specific context in which the technology is used. Technostress creators are composed of five parts: techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. The structure proposed by Tarafdar et al. (2007) has been widely used in research related to technostress. This study made relevant

modifications on the basis of the digital transformation of enterprises. In addition, a five-point Likert scale was used (see Table 3).

Work engagement. Schaufeli et al. (2006) defined work engagement as a positive work-related state of fulfillment characterized by vigor, dedication, and absorption. The USWS-9 scores developed by Schaufeli have been widely used in research studies. In this study, we used this structure and adopted a five-point Likert scoring system (see Table 4).

Personality traits and employee work engagement. Different personality traits can lead to different perceptions of technological stress because personality traits influence users to think and behave differently. These factors include the user's interaction with ICT, the user's executive functions, such as control over ICT

Table 1 List of constructs and items about personal traits.		
Variable		**Items**
Personal traits	Openness to experience	I am creative when faced with the problem of new technologies at work.
		I am imaginative when faced with the problem of new technologies at work.
		When solving the challenges of new technologies at work, I see myself as unconventional.
	Neuroticism	Due to the difficulties caused by the work environment and technology, I am moody.
		When faced with difficulties at work, I easily get upset.
		I get nervous when faced with difficulties at work.
	Agreeableness	I see myself as sympathetic.
		I see myself as warm and often help my colleagues with technical difficulties.
		I see myself as kind.
	Conscientiousness	I see myself as dependable when it comes to handling things at work.
		I see myself as self-disciplined when it comes to handling things at work.
		I see myself as organized when it comes to handling things at work.
	Extraversion	I see myself as extroverted.
		I see myself as enthusiastic and often share my work experience with my colleagues.
		I see myself as talkative and communicate with my colleagues a lot.

Table 2 List of constructs and items about self-efficacy.	
	Items
Self-efficacy	I can always manage to solve difficult problems if I try hard enough.
	I am confident that I could deal efficiently with unexpected events.
	When I am confronted with a problem, I can usually find several solutions.
	I can remain calm when facing difficulties because I can rely on my coping abilities.

Table 3 List of constructs and items about technostress creators.		
Variable		**Items**
Technostress creators	Techno-overload	I am forced by this technology to work much faster.
		I have a higher workload because of increased technology complexity.
		I am forced by this technology to do more work than I can handle.
	Techno-invasion	I spend less time with my family due to this technology.
		I have to be in touch with my work even during my vacation due to this technology.
		I have to sacrifice my vacation and weekend time to keep current on new technologies.
		I feel my personal life is being invaded by this technology.
	Techno-complexity	I need a long time to understand and use new technologies.
		I do not know enough about this technology to handle my job satisfactorily.
		I often find it too complex for me to understand and use new technologies.
	Techno-insecurity	I feel a constant threat to my job security due to new technologies.
		I feel there is less sharing of knowledge among co-workers for fear of being replaced.
		I have to constantly update my skills to avoid being replaced.
	Techno-uncertainty	There are always new developments in the technologies we use in our organization.
		There are constant changes in computer hardware and computer software in our organization.

Table 4 List of constructs and items about work engagement.		
		Items
Work engagement	Vigor	At work, I always persevere, even when things do not go well.
		At my job, I feel strong and vigorous.
		I can continue working for very long periods.
	Dedication	To me, my job is challenging.
		I am enthusiastic about my job.
		I find the work that I do full of meaning and purpose.
	Absorption	My job inspires me.
		I feel happy when I am immersed in my work.
		Time flies when I am working.

Below, we illustrate how each variable relates to work engagement.

use, and the user's susceptibility to ICT threats (Pflügner et al. 2021). Interactions emerge between individual personality traits, which depend on each other to influence individual perceptions (Witt, 2002). Pflügner et al. (2021) considered the interdependence between personality traits. On the basis of the correlation of users' personality characteristics with their perception of technological pressure, a fsQCA was used to explore which personality traits are more likely to make users perceive technological pressure. Khedhaouria and Cucchi (2019) used fsQCAs to illustrate the interaction, mutual influence, and relationship between technostress creators and personality traits, as well as their relationship with job burnout.

Self-efficacy and employee work engagement. Bandura (1977) defined self-efficacy as "the belief that an individual can effectively take a series of necessary actions to deal with certain future situations to a certain extent." Schwarzer et al. (1997) explained that self-efficacy reflects the belief that individuals can control the demands of challenging environments by taking adaptive actions. This notion can be viewed as a confident view of one's ability to deal with certain life stressors. People with high self-efficacy are motivated to engage in relevant activities and have more positive attitudes when facing difficulties. When solving problems and overcoming difficulties, their initial sense of efficacy is confirmed, and their motivation is maintained. Therefore, when confronted with difficulties again, people have the ability and confidence to overcome these challenges.

Existing research has confirmed the relationship between self-efficacy and employee work engagement. Llorens et al. (2007) believed an interaction exists between self-efficacy and work engagement. Leiter (1991) proposed that self-efficacy directly affects employees' choices to face stress. Employees with high self-efficacy adopt positive attitudes and behaviors during stressful situations. They will improve their self-efficacy because of feedback after their stress is resolved. By contrast, employees who adopt a negative approach not only slack but also develop deep self-doubt, which leads to lower self-efficacy. The three dimensions of vigor, dedication, and absorption performed well and showed positive work engagement in innovation activities. Furthermore, self-efficacy is related to individual choices in the face of stress. Tarafdar et al. (2019) proposed that people with low self-efficacy are likely to perceive high job demands as a threat. Therefore, low-tech self-efficacy may reduce individuals' confidence in dealing with characteristics of information systems, such as flexibility and speed of change, and increase the perception of threats associated with them.

Technostress creators and employee work engagement. Some scholars have argued that not all stressors are detrimental to employees. Work stressors were divided into challenging and obstructive stressors. The study revealed that these types of stressors had positive and negative effects on work engagement, respectively. However, employees experience negative emotions when faced with both stressors, which are detrimental to the individual in the long run. An appropriate provision of a challenging work environment can improve employees' work engagement.

Research method. The fsQCA method was selected on the basis of the following considerations. Qualitative comparative analysis (QCA) is a research method that combines case-oriented (qualitative method) and variable-oriented (quantitative method) research strategies. The traditional linear regression method assumes that variables are independent of each other and solves the problem of the net effect of a single explanatory variable on the explanatory variable. By contrast, qualitative comparative analysis explores the effects of multiple conditions concurrently. FsQCA provides configurations that generate outcomes and their absences, which is an improvement compared with traditional quantitative statistical methods, such as regression analysis and structural equation modeling (Frösén et al. 2016; Rasoolimanesh et al. 2021). Latif et al. (2020) emphasized the importance of analyzing configurations using fsQCA to gain a deeper insight into the interconnected structures of the constructs. This usage indicates that fsQCA complements other methods such as PLS-SEM in providing a comprehensive understanding of complex relationships. While PLS-SEM analyzes the net impact of independent variables on the outcome, fsQCA focuses on identifying the complex causal combinations of conditions that lead to a particular outcome. SEM assumes that variables are measured with error and that relationships are linear, which may not always hold true in real-world settings (Skarmeas et al. 2016). This shortcoming suggests that fsQCA offers a unique perspective in understanding complex relationships that may not be captured by linear methods such as PLS-SEM. FsQCA allows for addressing multiple contextual causes and identifying combinations of multiple causes, thus providing a more detailed and systematic analysis of complex causality compared to regression analysis (Beynon et al. 2016). The comparison of results also echoes the viewpoint of complexity theory that the relationship between variables may be non-linear in a particular situation, that is, the same antecedent condition may have different effects on the outcome variable (Gligor and Bozkurt, 2020). Conjunctural causation (cause conditions are combined in different ways to produce different wholes), equifinality (multiple paths can produce the same result), and asymmetry (the reason for a specific result being high or low is different) between variables are the focus of the research (Fiss, 2011; Ragin, 2008). FsQCA assumes that causal relationships are not necessarily linear and that different combinations of conditions can lead to the same outcome. It is particularly useful when studying complex phenomena with multiple causal pathways and when the sample size is limited (Beynon et al. 2016).

The research process revealed that the separate effects of various factors, such as self-efficacy, personality traits, and technostress creators, cannot fully explain the mechanism behind employees' work engagement. As such, the mechanism of multiple factors must be investigated from an overall perspective. QCA is a good solution to this problem because it measures the complexity and diversity of variables, focusing on the conditions implicit in the structure of the case itself and how these conditions combine with each other to influence an outcome.

QCA has obvious advantages in dealing with the problem of causal asymmetry. This study demonstrated a non-linear, asymmetric relationship among self-efficacy, technical stressors, personality traits, and work engagement. In other words, although high self-efficacy may increase employee work engagement, low self-efficacy does not necessarily reduce the level of employees' work engagement. QCA can solve this causal asymmetry problem effectively.

Model setting. On the basis of the literature review and considering that the fsQCA method is more suitable for studying four to seven variables, seven research variables were selected. At the level of job demands, combined with the background of digital transformation, this research selects technostress creators as the research variable. At the level of personal resources, self-efficacy was selected as the research variable. Further, at the level of personal characteristics, this study selected five dimensions of the Big Five personality traits: openness to experience, neuroticism, agreeableness, conscientiousness, and extraversion. The Big Five personality traits provide a thorough description of personality traits (see Fig. 1).

Data source. The fsQCA method is suitable for small sample studies of between 10 and 14, medium-sized samples of 15–50, and large sample studies of more than 100. With the help of the Credamo online platform, questionnaires were distributed to employees of various companies, such as state-owned enterprises, private enterprises, and joint ventures, which have undergone digital transformation and innovated their production activities by relying on IT. This advancement has changed the way enterprises create value and brought about changes in organizational structure and management activities. When designing the questionnaire, the respondents' level of education, age, marital status, and job type were also surveyed because these factors objectively have an impact on the level of engagement of employees at work. The variables involved in this study, including self-efficacy, personality traits, and technostress creators, were measured using a five-point Likert scale. A total of 230 questionnaires were distributed, and 225 valid questionnaires were collected based on the respondents' completion time and other criteria.

Data analysis. A frequency analysis of demographic variables was performed using the collected questionnaires. Among the respondents, 45.3% were male, and 54.7% were female. Most respondents were under the age of 45, with 37.3% being 25 years old or younger, 34.3% being 26–35 years, and 19.1% being 36–45 years. The respondents had a relatively high level of education, with more than 70% having a bachelor's degree or higher. Most respondents worked for private enterprises, and the majority of them held ordinary employee positions (76.9%). The reliability and validity analyses were conducted using the Statistical Package for the Social Sciences (SPSS) and AMOS software packages. Reliability refers to the consistency of results measured using a test or scale tool. The greater the reliability of the scale is, the smaller the error in the measurement standard will be. One of the commonly used reliability test methods for the Likert scale is Cronbach's alpha coefficient. The reliability test of each scale was conducted using SPSS 23.0. The results are shown in Table 5. The Cronbach's α coefficient of each subscale, such as openness to experience and neuroticism, was above 0.77, and that of the total scale was 0.982, thus indicating that the reliability of the overall scale and subscales of the questionnaire in this study was good.

Confirmatory factor analysis. Confirmatory factor analysis was performed on the scale in this study using AMOS 24.0. It was
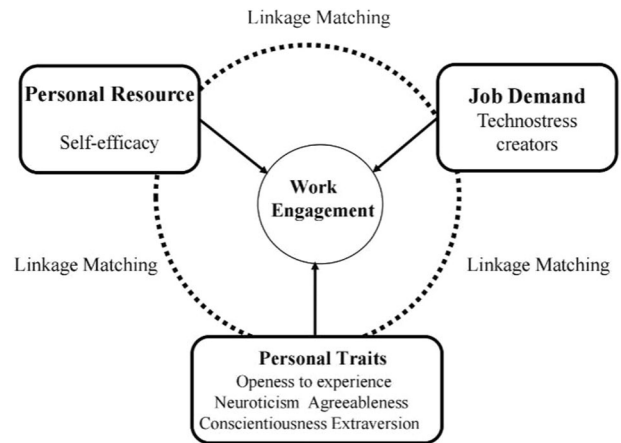

Fig. 1 Research model: a model of drivers influencing employee work engagement in the digital transformation of enterprises. At the level of job demands, combined with the background of digital transformation, this research selects technostress creators as the research variable. At the level of personal resources, self-efficacy was selected as the research variable. Further, at the level of personal characteristics, this study selected five dimensions of the Big Five personality traits to explore the impact of employees' personality traits, self-efficacy, and technostressors on their work engagement.

Table 5 Cronbach's alpha coefficient.

Variable	Number of items	Partial Cronbach's alpha coefficient	Overall Cronbach's alpha coefficient
Openness to experience	3	0.770	0.982
Neuroticism	3	0.853	
Agreeableness	3	0.870	
Conscientiousness	3	0.875	
Extraversion	3	0.859	
Self-efficacy	5	0.935	
Technostress creators	15	0.970	
Work engagement	9	0.955	

tested from two perspectives: construct validity and convergent validity. Construct validity refers to the extent to which a questionnaire measures theoretical structure and traits. Convergent validity refers to the similarity of the measurement results when different measurement methods are used to measure the same characteristic, that is, different measurement methods should be aggregated to determine the same characteristic. For convenience, this study used KFX and numbers to represent items of openness to experience; SJZ and numbers to represent items of neuroticism; YRX and numbers to represent items of agreeableness; JZX and numbers to represent items of conscientiousness; WXX and numbers to indicate extraversion; GS and numbers to indicate self-efficacy; TC and numbers to indicate technostress creators; and WI and numbers to indicate items of work engagement. The output results for construct validity are presented in Table 6. The value of $X2/df$ is 1.666, which is less than 3, thus indicating a good fit. The value of RMESEA is 0.055, which is close to 0.05, thereby indicating that the fit is good. The GFI and AGFI are 0.761 and 0.729, respectively, thus indicating an acceptable fit. The CFFI, IFI, and TLI values were all greater than 0.9, thus indicating a good fit. In general, the model fits well.

Convergent validity results are presented in Table 7. Fornell and Larcker (1981) proposed that the factor loading value of an

item should be greater than 0.5, the combined reliability value should be greater than 0.8, and the average variance extraction value (AVE) should be greater than 0.5, which is the reference standard for testing the aggregate validity of the scale. After calculation using AMOS 24.0, the factor loading values of each variable were between 0.65 and 0.902, the AVE was 0.5761 or higher, and the combined reliability was 0.8015 or higher, thus indicating that the scale had good convergent validity.

Data calibration and analysis. The process of assigning membership scores to obtained cases is an integral aspect of QCA, which is referred to as the calibration process. The data calibration process involves converting the data into fuzzy membership degrees for variable attribute sets based on fuzzy membership functions. Following the concept of fuzzy membership (Shie et al. 2021), an element is characterized by its membership to a set and its complement. Several methods can be used for data calibration, including direct and indirect methods. In this study, a direct calibration method is used to convert the data into fuzzy-set membership scores. The direct calibration method is more widely employed and primarily revolves around the utilization of three anchor points. It entails the use of the "calibrate" function within the "compute" feature of the fsQCA software to calibrate the cases. In this study, we applied the direct calibration method to facilitate the transformation of membership values for antecedent conditions and outcome variable data. Specifically, we employed the 95, 50, and 5% percentiles as the three anchor points.

To calibrate the variables into sets, three critical values must be set according to the corresponding standards: complete membership, no membership, and intersection. The criterion for complete

Table 6 Overall fit coefficient.

X2/df	RMSEA	GFI	AGFI	CFI	IFI	TLI
1.666	0.055	0.761	0.729	0.943	0.944	0.938

Table 7 Convergent validity results.

Path			Estimate	AVE	Combined reliability
KFX3	<—	Openness to experience	0.805	0.5761	0.8015
KFX2	<—	Openness to experience	0.65		
KFX1	<—	Openness to experience	0.811		
SJZ3	<—	Neuroticism	0.781	0.6599	0.8532
SJZ2	<—	Neuroticism	0.797		
SJZ1	<—	Neuroticism	0.857		
JZX1	<—	Agreeableness	0.855	0.7007	0.8754
JZX2	<—	Agreeableness	0.825		
JZX3	<—	Agreeableness	0.831		
WXX1	<—	Extraversion	0.803	0.6771	0.8628
WXX2	<—	Extraversion	0.817		
WXX3	<—	Extraversion	0.848		
YRX3	<—	Agreeableness	0.857	0.6898	0.8696
YRX2	<—	Agreeableness	0.82		
YRX1	<—	Agreeableness	0.814		
TC15	<—	Technostress creators	0.821	0.6847	0.9701
TC14	<—	Technostress creators	0.879		
TC13	<—	Technostress creators	0.83		
TC12	<—	Technostress creators	0.716		
TC11	<—	Technostress creators	0.78		
TC10	<—	Technostress creators	0.781		
TC9	<—	Technostress creators	0.742		
TC8	<—	Technostress creators	0.884		
TC7	<—	Technostress creators	0.812		
TC6	<—	Technostress creators	0.863		
TC5	<—	Technostress creators	0.852		
TC4	<—	Technostress creators	0.887		
TC3	<—	Technostress creators	0.816		
TC2	<—	Technostress creators	0.89		
TC1	<—	Technostress creators	0.835		
GS1	<—	Self-efficacy	0.878	0.745	0.9359
GS2	<—	Self-efficacy	0.808		
GS3	<—	Self-efficacy	0.902		
GS4	<—	Self-efficacy	0.866		
GS5	<—	Self-efficacy	0.859		
WI1	<—	Work engagement	0.865	0.7059	0.9558
WI2	<—	Work engagement	0.842		
WI3	<—	Work engagement	0.831		
WI4	<—	Work engagement	0.852		
WI5	<—	Work engagement	0.845		
WI6	<—	Work engagement	0.836		
WI7	<—	Work engagement	0.838		
WI8	<—	Work engagement	0.822		
WI9	<—	Work engagement	0.83		

membership was the 0.95th percentile, the criterion for complete no membership was the 0.05th percentile, and the calibration criterion for the intersection was the 0.5th percentile. Openness to experience, neuroticism, agreeableness, conscientiousness, extraversion, self-efficacy, and technostress creators were calibrated and named KFX1, SJZ1, YRX1, JZX1, WXX1, GS1, and TC1, respectively. After calibration, the cases appeared as partial 0.5 in terms of fuzzy-set membership. Such a situation can impede the categorization of cases that are not included in the analysis, thereby affecting the results. Therefore, after data calibration, 0.001 was added to the fuzzy-set membership degree of 0.5 to avoid the above situation (Fiss, 2011).

Further, necessary condition analysis explored the extent to which the result set constituted a subset of the condition set. Ragin (2008) pointed out that consistency is an important detection criterion for necessary conditions; when consistency is greater than 0.9, the condition is regarded as a necessary condition for the results. The necessary condition analysis using fsQCA found that the consistency of the seven condition variables was less than 0.9, thus indicating that none of these factors could independently affect employee work engagement. From this outcome, we can deduce that work engagement is jointly affected by seven variables. This study conducted a configuration analysis of these variables. Table 8 presents these results.

The fsQCA software was used to construct the truth table. It includes seven conditional variables: openness to experience, neuroticism, agreeableness, conscientiousness, extraversion, self-efficacy, and technostress creators, thus resulting in 2^7 or 128 configurations in the truth table, which reflect all possible condition combinations. The selection of thresholds depends on the number of cases and the researcher's judgment, with a general recommendation to retain 75% of the cases. On the basis of the aforementioned criteria and the sample size of this study, this work sets the original consistency threshold at 0.95 and the frequency threshold at 3. Additionally, we apply a condition that requires PRI consistency to be greater than 0.75 for filtering.

After a standardized analysis of the perfect truth table, the fsQCA software derives three solutions: complex, parsimonious, and intermediate. Complex solutions exclude any logical remainders and usually include more configurations and antecedents. The intermediate solution refers to only including logical remainders that meet the theoretical direction expectations and empirical evidence. Meanwhile, the parsimonious solution includes all logical remainders without evaluating their rationality. In addition, the number of configurations and conditions is small. Intermediate solutions with moderate complexity are often reported in QCA studies. Therefore, this study reports intermediate solutions.

Results and discussion

Configurational analysis of high work engagement. Through a cross-sectional analysis of various configurations (see Table 9), this study categorizes the configurations of high employee job engagement into three groups based on the core conditions of the eight configurations, namely, configurations H1a and H1b; configurations H2a and H2b; and configurations H3a, H3b, and H3c. In conjunction with Table 9, within the configurations explaining high employee job engagement, the solution consistency is 0.96, thus exceeding the minimum requirement of 0.75. Meanwhile, the coverage rate reaches 0.721, thus indicating that these seven configurations account for 72.1% of the cases.

Configurations H1a (~SJZ*YRX*WXX*GS* ~ TC) and H1b (~SJZ*JZX*WXX*GS* ~ TC) share the same core condition, namely, the absence of technological pressure sources plays a crucial role in driving high job engagement among employees.

Table 8 Univariate necessity analysis.

Variable	High work engagement (WI1)		Low work engagement (~WI1)	
	Consistency	Coverage	Consistency	Coverage
KFX1	0.649142	0.834750	0.542105	0.582971
~KFX1	0.675699	0.638281	0.846334	0.668571
SJZ1	0.558568	0.571973	0.875733	0.749926
~SJZ1	0.755787	0.879121	0.500168	0.486532
YRX1	0.873869	0.866662	0.606934	0.503375
~YRX1	0.499245	0.602986	0.839230	0.847659
JZX1	0.832124	0.889689	0.592842	0.530073
~JZX1	0.560478	0.622082	0.876626	0.813673
WXX1	0.849402	0.876040	0.566873	0.488927
~WXX1	0.504468	0.582071	0.856278	0.826235
GS1	0.860550	0.884115	0.564248	0.484786
~GS1	0.498519	0.577708	0.865120	0.838398
TC1	0.514665	0.526394	0.834372	0.713662
~TC1	0.720042	0.838670	0.446286	0.434704

Table 9 Condition configuration of employees' high work engagement.

	Solution						
	H1a	H1b	H2a	H2b	H3a	H2b	H3c
Openness to experience (KFX)			●		⬤	⬤	⬤
Neuroticism (SJZ)	⊗	⊗			⬤		⊗
Agreeableness (YRX)	⬤		●	●	⬤	●	●
Conscientiousness (JZX)		●	●	●	●	●	⊗
Extraversion (WXX)	⬤	●		●	⬤	⬤	●
Self-efficacy (GS)	●	●	⬤	⬤		●	
Technostress creators (TC)	⊗	⊗	⊗	⊗			⊗
Consistency	0.980	0.982	0.987	0.982	0.976	0.982	0.991
Raw coverage	0.551	0.533	0.438	0.537	0.418	0.546	0.332
Unique coverage	0.022	0.014	0.008	0.010	0.009	0.015	0.003
Overall solution consistency	0.960						
Overall solution coverage	0.721						

Note: In the table, "●" represents the presence of a condition as a core condition, "⊗" represents the absence of a condition as a core condition, " ● " represents the presence of a condition as a peripheral condition, "⊗" represents the absence of a condition as a peripheral condition, and a blank space indicates that the presence or absence of a condition has no impact on the occurrence of the outcome. If all preceding conditions are blank, the configuration is considered a logical remainder.

Additionally, extraversion, self-efficacy, and the absence of neuroticism all play supportive roles in both configurations. However, they differ in other contextual conditions. Among other contextual conditions, the presence of agreeableness plays a supportive role in configuration H1a, whereas the presence of conscientiousness plays a supportive role in configuration H1b. Furthermore, openness to experience and conscientiousness play non-significant roles in configuration H1a, while openness to experience and agreeableness play non-significant roles in configuration H1b.

Configurations H2a (KFX*YRX*JZX*GS* ∼ TC) and H2b (YRX*JZX*WXX*GS* ∼ TC) share the same core condition, namely, the presence of self-efficacy plays a central role in driving high employee job engagement. Furthermore, the presence of agreeableness and conscientiousness, as well as the absence of technological pressure sources, all serve as supporting conditions in both configurations. The difference lies in the presence of openness to experience, which acts as a supporting condition in configuration H2a. Meanwhile, extraversion plays this role in configuration H2b. Additionally, neuroticism and extraversion are non-significant conditions in configuration H2a, while openness to experience and neuroticism play non-significant roles in configuration H2b.

Configurations H3a (KFX*SJZ*YRX*JZX*WXX), H3b (KFX*YRX*JZX*WXX*GS), and H3c (KFX* ∼ SJZ*YRX* ∼ JZX*WXX* ∼ TC) share the same core conditions. Specifically, the presence of openness to experience and extraversion plays a central role in driving high employee job engagement. Additionally, the presence of agreeableness serves as a supporting condition in all three configurations, while other contextual conditions differ. Neuroticism and conscientiousness are supporting conditions in configuration H3a, conscientiousness, and self-efficacy play this role in configuration H3b, and neuroticism, conscientiousness, and the absence of technological pressure sources act as supporting conditions in configuration H3c. Moreover, self-efficacy and technological pressure sources are non-significant conditions in configuration H3a, neuroticism, and technological pressure sources are non-significant in configuration H3b, and self-efficacy is non-significant in configuration H3c.

Through an analysis of the composition of various configurations of antecedent conditions and based on the characteristics exhibited by the seven configurations, three pathways driving high employee job engagement are identified. In the following sections, we will describe these pathways in the context of digital transformation.

Openness to experience conscientiousness: extraversion-driven (KFX*WXX). Employees with openness to experience tend to be creative, flexible, and receptive to new knowledge and technologies. Therefore, they are proactive in learning about new technologies. Conscientious employees are intrinsically motivated to reach high-performance levels. In the face of learning new technologies, they become more serious and learn more efficiently internally. Therefore, they adapt more easily to the environment under technological iteration. Their abilities enable them to be recognized by the organization, and they become more motivated to work.

Simultaneously, digital transformation is not only related to the innovation of business models, products, and services, among others but also triggers fundamental changes from production activities to management activities. Traditional bureaucratic organizational structures, such as linear, matrix, and divisional systems, lack flexibility. Moreover, less collaboration occurs between the functional departments of an enterprise. The cross-departmental collaboration brought about by digital transformation will lead to changes in the organizational structure and management activities. For example, the concept of an ecosystem was introduced into enterprises' internal management innovation, which is the core of various enterprises' activities. Regarding the supply of user value, the production model is modularized and flexible, the R&D design is open, the product design is iterative, and the user model tends to be diversified and flexible. Correspondingly, organizational boundaries are gradually blurring, talent flow becomes the norm, and organizational structures tend to flatten and become networks. As such, the division of labor among employees deepens. Decision-making is decentralized, connections, and combinations become more extensive. Moreover, information flow speed accelerates, and value creation efficiency increases. In this context, higher demands are placed on the employees. Extraversion is a social, positive, and outgoing individual trait, with a high emphasis on interpersonal relationships. In the organization's network node, communicating and cooperating with other departments are more efficient. Moreover, this trait is easily valued internally. Under such incentives, employees are more motivated to work, thus providing positive feedback.

Self-efficacy-driven (GS). Employees with strong self-efficacy in digital transformation enterprises tend to exhibit higher job engagement. Their confidence in their abilities and belief in their competence to fulfill job tasks motivate them to accept challenges, engage actively, and utilize their skills fully, thereby contributing to the transformation and development of the organization. These employees display a high level of work enthusiasm. Furthermore, they willingly assume responsibilities and embrace new work challenges. Consequently, they proactively acquire new knowledge and skills to adapt to the changes brought about by transformation. Moreover, they possess strong resilience, remaining composed in the face of difficulties and pressure and actively seeking solutions to problems. This trait enables them to cope with potential issues and challenges better during the transformation process. They also demonstrate a strong growth mindset. In particular, they display a willingness to learn and improve continuously, thus enhancing their job capabilities and qualities. Therefore, throughout the digital transformation, they pay significant attention to their personal growth and development by continually acquiring new knowledge and skills to meet the evolving needs of the organization (Knight et al. 2017). Additionally, employees with strong self-efficacy typically excel in teamwork. As such, they willingly share knowledge and experiences with others to solve problems collaboratively. This participation enhances their ability to work effectively with other team members, thus facilitating the smooth progression of the enterprise's digital transformation.

Technostress creator suppression type (∼TC). The inhibitory category corresponds to configurations H1a and H1b, where the absence of technological pressure sources is responsible for the state of high employee job engagement. Configuration is caused by the lack of technostressors to bring about a state of employee work engagement. Stress can cause employees to experience physical and emotional burnout, which can reduce their work engagement. Combining the process of digital transformation, this study explains why the absence of technostress creators leads to high employee work engagement from five perspectives: techno-overload, uncertainty, invasion, overload, and insecurity.

Configurational analysis of low work engagement. Based on the characteristic of causal asymmetry in fsQCA, this study also identified six condition configurations associated with low employee job engagement (see Table 10). Through an analysis of the core condition compositions of these configurations, we distilled them into two pathways: self-efficacy-inhibitory and

Table 10 Condition configuration of employees' low work engagement.

	Solution					
	NH1a	NH1b	NH1c	NH2a	NH2b	NH2c
Openness to experience (KFX)		●	●	⊗	●	●
Neuroticism (SJZ)	●	●	⊗	●	●	●
Agreeableness (YRX)	●	●	●	⊗		●
Conscientiousness (JZX)	●	●	⊗		⊗	●
Extraversion (WXX)		●	●	⊗	⊗	⊗
Self-efficacy (GS)	⊗	⊗	⊗	⊗	⊗	●
Technostress creators (TC)	●		⊗	●	●	⊗
Consistency	0.926	0.876	0.868	0.985	0.945	0.860
Raw coverage	0.361	0.330	0.266	0.589	0.335	0.262
Unique coverage	0.008	0.001	0.035	0.280	0.006	0.033
Overall solution consistency	0.901					
Overall solution coverage	0.796					

Note: In the table, "●" represents the presence of a condition as a core condition, "⊗" represents the absence of a condition as a core condition, "●" represents the presence of a condition as a peripheral condition, "⊗" represents the absence of a condition as a peripheral condition, and a blank space indicates that the presence or absence of a condition has no impact on the occurrence of the outcome. If all preceding conditions are blank, the configuration is considered a logical remainder.

neuroticism presence—extraversion absence. In both pathways, the core conditions are characterized by states of absence.

The self-efficacy-inhibitory pathway corresponds to configurations NH1a (SJZ*YRX*JZX* ~ GX*TC), NH1b (KFX*SJZ*YRX*JZX*WXX* ~ GS), and NH1c (KFX* ~ SJZ*YRX* ~ JZX*WXX* ~ GS* ~ TC). In these three configurations, the absence of self-efficacy plays a central role, thus signifying that the absence of self-efficacy leads to low employee job engagement. Furthermore, the presence of agreeableness serves as a supporting condition in all three configurations. The differences lie in the remaining contextual conditions. In configuration NH1a, the remaining conditions include neuroticism, conscientiousness, and the presence of technological pressure sources, while non-significant conditions are openness to experience and extraversion. In configuration NH1b, the remaining conditions consist of openness to experience, neuroticism, conscientiousness, and the presence of extraversion, with technological pressure sources being non-significant. In configuration NH1c, the remaining conditions encompass the presence of openness to experience and extraversion, as well as neuroticism, conscientiousness, and the absence of technological pressure sources, with non-significant conditions being absent.

The neuroticism presence - extraversion absence pathway corresponds to configurations NH2a (~KFX*SJZ* ~ YRX* ~ WXX* ~ GS*TC), NH2b (KFX*SJZ* ~ JZX*WXX* ~ GS*TC), and NH2c (KFX*SJZ*YRX*JZX* ~ WXX*GS* ~ TC). In these three configurations, the presence of neuroticism and the absence of extraversion both serve as core conditions, thus signifying that the coexistence of neuroticism and the absence of extraversion collectively lead to low employee job engagement. The differences lie in the remaining contextual conditions. In configuration NH2a, the remaining conditions include openness to experience, agreeableness, the absence of self-efficacy, and the presence of technological pressure sources. In configuration NH2b, the remaining conditions consist of openness to experience, the presence of technological pressure sources, conscientiousness, and the absence of self-efficacy. In configuration NH2c, the remaining conditions encompass openness to experience, agreeableness, conscientiousness, the presence of self-efficacy, and the absence of technological pressure sources.

Robustness analysis. Robustness analysis is employed to examine the resilience of research findings to variations in the conditions employed in the use of alternative discriminant norms. This analysis involves recalculating results by adjusting the anchor point system in data calibration or modifying the consistency level and case truncation values. If the recalculated results, with core conditions being a subset of the previous results' core conditions, demonstrate consistency, the findings can be considered robust (Fiss et al. 2013). In this study, robustness analysis was conducted by improving the case truncation value, changing it from 3 to 4. Through the software's reoperation, Tables 11 and 12 were obtained. By comparing Table 9 with Table 11, we can observe that Configuration 1 and Configuration H2b are entirely consistent. Configuration 2 and Configuration 3, building on Configurations H3b and H3c, respectively, convert the presence of openness to experience from a core condition to a contextual condition. Configuration 4, an extension of Configuration H2a, adds a contextual condition of the presence of neuroticism. Configuration 5, based on Configuration H3a, shifts the presence of openness to experience from a core condition to a contextual condition and introduces the contextual condition of the presence of technological pressure sources.

Furthermore, comparing the data in Table 10 with Table 12 demonstrates that Configuration 4' is entirely consistent with NH1c, Configuration 1' is an adaptation of Configuration NH2b, where the contextual condition of the presence of openness to experience is replaced by the contextual condition of the absence of agreeableness. Moreover, the core condition of the presence of neuroticism becomes a contextual condition. Configuration 2' is an adaptation of Configuration NH2a, where the contextual condition of the absence of agreeableness is substituted with the presence of conscientiousness. Additionally, the core condition of the presence of neuroticism becomes a contextual condition. Configuration 3' is an adaptation of Configuration NH1a with the addition of the contextual condition of the presence of openness to experience. All other conditions remain consistent. Configuration 5' is an adaptation of Configuration NH2c, where the core condition of the presence of neuroticism is transformed into a contextual condition.

In both scenarios, the overall consistency of the solutions improved compared with the original results, while the coverage decreased slightly. This outcome demonstrates the robustness of the findings, which can be relatively robustly discussed in terms of the asymmetry of configurations and the pathways to high/low employee job engagement.

Conclusions

This study is based on the background of enterprise digital transformation, considering employees as research objects, to

Table 11 Robustness analysis of employees' high job engagement configurations.

	Solution				
	Configuration 1	Configuration 2	Configuration 3	Configuration 4	Configuration 5
Openness to experience (KFX)		●	●	●	●
Neuroticism (SJZ)			⊗	●	●
Agreeableness (YRX)	●	●	●	●	●
Conscientiousness (JZX)	●	●	⊗	●	●
Extraversion (WXX)	●	●	●		●
Self-efficacy (GS)	●	●		●	
Technostress creators (TC)	⊗		⊗	⊗	●
Consistency	0.982	0.982	0.991	0.993	0.975
Raw coverage	0.537	0.546	0.332	0.311	0.334
Unique coverage	0.107	0.015	0.014	0.004	0.008
Overall solution consistency	0.969				
Overall solution coverage	0.679				

Note: In the table, "●" represents the presence of a condition as a core condition, "⊗" represents the absence of a condition as a core condition, " ● " represents the presence of a condition as a peripheral condition, "⊗" represents the absence of a condition as a peripheral condition, and a blank space indicates that the presence or absence of a condition has no impact on the occurrence of the outcome. If all preceding conditions are blank, the configuration is considered a logical remainder.

Table 12 Robustness analysis of employees' low job engagement configurations.

	Solution				
	Configuration 1'	Configuration 2'	Configuration 3'	Configuration 4'	Configuration 5'
Openness to experience (KFX)		⊗	●	●	●
Neuroticism(SJZ)	●	●	●	⊗	●
Agreeableness (YRX)	⊗		●	●	●
Conscientiousness (JZX)	⊗	●	●	⊗	●
Extraversion (WXX)	⊗	⊗		●	⊗
Self-efficacy (GS)	⊗	⊗	⊗	⊗	●
Technostress creators (TC)	●	●	●	⊗	⊗
Consistency	0.986	0.945	0.915	0.868	0.860
Raw coverage	0.647	0.308	0.310	0.266	0.262
Unique coverage	0.317	0.004	0.012	0.045	0.039
Overall solution consistency	0.914				
Overall solution coverage	0.804				

Note: In the table, "●" represents the presence of a condition as a core condition, "⊗" represents the absence of a condition as a core condition, " ● " represents the presence of a condition as a peripheral condition, "⊗" represents the absence of a condition as a peripheral condition, and a blank space indicates that the presence or absence of a condition has no impact on the occurrence of the outcome. If all preceding conditions are blank, the configuration is considered a logical remainder.

explore the impact of employees' personality traits, self-efficacy, and technostressors on their work engagement. Table 9 demonstrates that seven distinct configurations and pathways ultimately lead to high employee job engagement. The research findings primarily emphasize the following three points:

Reducing the impact of technostressors can improve employee engagement. This study concludes that inhibiting technostressors promotes employees' high work engagement through the first set of core conditions of the driving path of employees' high work engagement. As digital transformation advances, businesses must continually adopt new technologies and processes, and employees must continuously acquire new knowledge and skills to adapt to these changes. Mitigating the impact of technological stressors can help employees learn new skills in a more relaxed environment, thus enabling them to keep pace with the digital transformation and, consequently, enhance their job engagement. In the process of enterprise digital transformation, the source of technological pressure affects employee well-being in five aspects: techno-overload, uncertainty, invasion, overload, and insecurity. The sense of being replaced and the difficulties brought about by

new technologies during the transformation may discourage employees, and frequent iterative system upgrades will leave employees with little time to respond. In the transformation process, enterprises should reduce the impact of technostressors on their employees and create a positive atmosphere.

Employee self-efficacy affects work engagement. Examining the second set of core conditions within the pathway driving high employee job engagement reveals the crucial role played by self-efficacy. The introduction of new technologies and work processes through digital transformation requires employees to adapt and master new skills, cope with new work contexts, and autonomously tackle problems while exploring innovative solutions. In this context, employees with strong self-efficacy feel more confident in facing these challenges. They believe in their ability to think independently, innovate, and actively engage in their work. They also assume responsibility willingly, proactively participate in team efforts, offer creative ideas and suggestions, and readily embrace new tasks and changes.

Moreover, during the digital transformation process, work tasks and roles may continually evolve and adjust, thus

necessitating employees to exhibit resilience and adaptability. Employees with high self-efficacy possess superior adaptability to new circumstances, thus enabling them to acclimate swiftly to and address changes while maintaining consistent and proactive job engagement.

Individual employee factors affect work engagement. The third set of core conditions within the pathway driving high employee job engagement demonstrates that both core conditions are related to employee personality traits, specifically openness to experience and extraversion. Employees with high levels of openness to experience and extraversion exhibit greater adaptability, thus allowing them to adjust swiftly to themselves during the digital transformation process, accommodating new work environments and demands. This adaptability helps maintain employee job engagement while reducing feelings of uncertainty and stress stemming from the transformation. Furthermore, individuals with a strong openness to experience and extraversion often possess remarkable innovation capabilities, which enable them to propose new ideas and solutions during digital transformation. This innovation capability contributes to heightened employee job engagement and, concurrently, brings additional value to the organization's digital transformation efforts.

Literature has also shown that personality influences the way positive and negative emotions are experienced. For example, extraversion is positively associated with positive emotions, and conscientious people prefer to respond positively. Personality traits contribute to an individual's perception of their ability to cope with technostress. Extroverts are more natural at using ICT to communicate with others and actively maintain social relationships. Thus, they are more willing to communicate with colleagues when they experience the digital transformation of enterprises and provide feedback. As such, they are immensely helpful when solving problems at work. Enterprises undergoing digital transformation may create information overload or require employees to be more responsive. Highly conscientious individuals tend to have the confidence to persist in solving problems, have self-discipline, and work hard. When they face enterprise digital transformation requirements, their attitudes are positive, and they have great work engagement. People who are open see the changes that occur during digital transformation as a challenge rather than a burden. Therefore, this type of employee is in a state of high work engagement.

The greatest challenge in the digital transformation process is the lack of talent. The speed of technology updates and iterations is accelerating, which also prompts enterprises to continue to innovate. Furthermore, the lack of talent with relevant skills has become a pain point for enterprises. The main reasons for the shortage of talent are the long learning cycle, difficulty in meeting the speed of enterprise transformation, poor learning effects of employees, interdisciplinarity, and a large knowledge system. These factors have resulted in a high cost of human resources for enterprises. However, employees with certain characteristics have strong learning abilities and high work engagement, and enterprises can identify and reuse these employees.

Managerial implications. Along with the research conclusions, this study provides suggestions and countermeasures for management-related activities from the five aspects of technostress creators.

As an enterprise, the right employees must be assigned to the right jobs to ensure that the company is utilizing its human resources efficiently. Stress is an individual's psychological, behavioral, and physical response to environmental demands. When faced with the same environmental and technostressors, proactive personalities have a higher tolerance for using technology and for the resulting stress than other personalities. Enterprises can conduct stress or related psychological tests to understand employees' personality traits better. These enterprises must raise awareness of the relationship between employees' personality traits and work engagement (Chen et al. 2020; Zecca et al. 2015). Simultaneously, combined with the inspection of skills, personality traits, and other aspects, appropriate employees are arranged in corresponding positions to maximize their abilities. Employees should also be provided with more freedom in job selection and set up a job rotation plan. Facing the same work content for a long period may cause employees to become tired or even slack. A new job position refreshes employees, and varying challenging work contents give them a greater sense of accomplishment, thus encouraging high work engagement.

An organization should ensure technological stability by reducing the impact of technical failures. Relevant statistics show that technical failures interfere with employees' work performance by up to 30%. When employees use efficient software, work efficiency can be significantly improved, and the workload of a day can increase by 37%. Employee stress is caused by technology glitches, which affect not only employee productivity but also employee mental health. Under the influence of COVID-19, remote work has become the norm, and employees are easily disturbed by the surrounding environment. Moreover, technical failures increase the difficulty of using technology, thereby increasing stress levels. Therefore, technological stability must be ensured.

Enterprises can provide skills training and formulate relevant training plans. Specialized training programs should be provided to employees in need to enhance their ability to work and close gaps with other employees. When setting the relevant content of the training plan, the enterprise should communicate with the employees in advance to understand their needs, and individual differences of the employees, such as their learning ability, should be considered. When conditions permit, employees can be involved in the design of training programs. Considering technology's continuous updating and iteration, training content should be updated in time to meet employees' work needs. Enterprises should also pay attention to employees' learning feedback and make continuous adjustments based on it.

Employers and companies should draw a clear line between work and leisure and refrain from using work-related software, such as DingTalk, to assign additional tasks to employees during non-working hours or using social software, such as WeChat, to put employees in a "dilemma" when facing tasks assigned by their bosses during non-working hours. By encouraging employees' family members to participate in the company's team-building activities, the human resources department can set up events for employees' family members to visit the company during holidays, explain the company culture and work content, and so on. In doing so, family members can further understand the employees' daily work activities. A greater sense of family support helps employees engage in work.

The introduction of technology may intensify employee competition and lead to polarization. Therefore, the management should promote cooperation and teamwork actively among employees to counteract these potential negative effects and create a positive and collaborative organizational atmosphere. The threat to work brought about by technology makes employees who master technology reluctant to share and communicate with other employees to maintain their competitiveness. This reluctance is a loss for the enterprise, and the insecurity and negative competition caused by the elimination mechanism should be avoided. Simultaneously, additional meetings for exchange and sharing should be held to encourage communication between employees and create a positive organizational atmosphere.

Limitations. This study only considered the main drivers affecting work engagement to analyze the work engagement path of employees. However, the impact of other drivers cannot be excluded. Future research can summarize and analyze other possible drivers to enrich the research conclusions further.

This study adopted a questionnaire survey method. Most of the questions were somewhat subjective, which may have resulted in a certain deviation in the measurement. The questionnaire was designed to consider that many questions could affect the accuracy of the results. Hence, some modifications were made to the maturity scale, which may have implications for the study. In addition, when conducting surveys, this study adopted the method of employees' "self-assessment" of their personality traits, that is, respondents answered questions about their perceived self-personality traits. However, some scholars have suggested that self-rating underestimates personality traits and that observers' ratings of personality traits are more favorable predictors of behavior. Even if the observer is unable to understand others completely, they may have a clearer view of certain personality traits than the self-evaluator. Therefore, future research can use a combination of self-evaluation and evaluation by others for the assessment of personality traits. Furthermore, the diversity of sample sources can be further improved in the process of data collection.

Data availability

Data are included in the published paper.

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Acknowledgements

Author contributions
Conceptualization: D.Y.; Methodology: D.Y. and B.X; Validation: B.L.W and L.L.Z.; Formal analysis: B.X.; Investigation: B.X.; Resources: D.Y. and Y.W.; Data curation: B.X.; Writing—original draft: D.Y. and B.X; Writing—review and editing: D.Y. and Y.W; Funding acquisition: D.Y. and L.L.Z. All authors have read and agreed to the published version of the manuscript.

Competing interests
The authors declare no competing interests.

Ethical approval
The approval of the Institutional Review Board is not required by the institutional and local regulations. The methods and techniques employed in this study adhere to universally accepted scientific and research ethical standards without any ethical controversies. The purpose of this study is purely academic research aimed at advancing knowledge and understanding in the field, without any commercial or other interest-driven motives. Participants involved in this study have been explicitly informed about the purpose, procedures, and potential outcomes of the research. They have voluntarily participated without any form of coercion or undue pressure. This study has followed the ethical guidelines and norms of the academic community, strictly adhering to the requirements of academic integrity and ethical conduct.

Informed consent
Informed consent was obtained in online written form in March 2022 from all participants in the study prior to data collection. We confirm that all participants were fully informed of the purpose, process, potential risks, and benefits of the study before participating, as well as their right to withdraw consent and discontinue participation in the study at any time. The respondents understand the purpose of the research and have given their consent. All information was communicated in a language they could understand.

Additional information