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Digitalization for Sustainable Working Environments: The Role of Job Crafting and Job Resources on Employees Engagement

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ABSTRACT

With the rapid expansion of digitalization, banks are transitioning from traditional financial intermediaries to proactive agents, increasing operational efficiency and playing a critical role in improving sustainability across multiple industries. As digital tools transform work environments, they also reshape employee engagement dynamics, influencing how employees interact with their roles. This study examines the relationship between digitalization and employee engagement through the lens of the job demands-resources (JD-R) model and job crafting. Survey data collected from remote workers suggest that digitalization improves job resources, resulting in increased engagement. The findings reconcile the contradictory results of prior research, indicating that the relationship between digitalization and engagement is mediated by job resources and job crafting. Moreover, job crafting, facilitated by the flexibility enabled by digitalization, significantly improves employee well-being. The study highlights how digitization enhances organizational sustainability by promoting employee well-being and tackling social issues.

1 | Introduction

The banking sector has been historically associated with financial performance; however, the increasing recognition of its intangible flows and indirect environmental impacts reveals that banks are not merely passive financial intermediaries (Gallego-Álvarez and Pucheta-Martínez 2020). Rather, they are actively involved in the creation of a sustainable economic environment (Weber 2012; Centobelli et al. 2016; Centobelli et al. 2022; Cerchione et al. 2025), whereby their indirect effects, often more considerable than their direct ones, are derived from intangible assets such as expertise, policies, and values (Lundgren and Catasús 2000). As a matter of fact, the sustainability of numerous sectors can be greatly influenced by these regulations, and banking activities, especially in lending practices, can either promote or hinder sustainable development. Moreover, in promoting effective environmental stewardship, banks also impact the stakeholders within

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their networks, including employees, suppliers, and clients (Coulson 2009). Consequently, a strong reputation for corporate sustainability (RCS) has gained momentum, as it bolsters trust and serves as a critical factor in the long-term financial performance and stability of the banking institutions (Gallego-Álvarez and Pucheta-Martínez 2020).

Digitalization within organizations has progressed at a pace 20%–25% faster than expected (Wang et al. 2020), leading to a significant shift of work practices, especially the rise of remote work (Zeshan et al. 2024), which offers an unprecedented chance for banks to improve their sustainability practices. Recent research by Irajifar et al. (2023) reveals an ever-growing body of literature at the intersection of digital technology and sustainability, with over 3400 journal papers that investigate this twin transition. Digital technologies, such as IoT, big data analytics, and smart systems, are emerging as enablers of sustainable business performance across economic, environmental, and social dimensions (Bindeeba et al. 2025). For instance, the effective utilization of digital tools and platforms has been shown to enhance resource efficiency and reduce waste (Fang and Li 2024), thereby fostering more sustainable operations and facilitating the implementation of circular business models (Ghobakhloo et al. 2021; Ardito 2023; Neligan et al. 2023). Nonetheless, the mere application of digital tools is inadequate to fully realize their potential as a dual accelerator for environmental sustainability and operational efficiency (Hellemans et al. 2022; Luo et al. 2023; Lu et al. 2024). Its successful integration requires careful consideration of organizational culture, employee engagement, and strategic alignment with environmental goals. Frameworks such as "Industry 5.0" emphasize the importance of human-centric design, adaptability, and environmental stewardship in the digital transformation of workplaces (Longo et al. 2020; Gladysz et al. 2023), wherein employee engagement is a crucial element for turning the sustainability goals into actionable steps. Primary factors influencing pro-environmental behavior encompass environmental concern, perceived organizational support for sustainable activities, and a robust organizational commitment (Temminck et al. 2015). Moreover, job crafting, that is, the process by which people customize their professional responsibilities to align with personal values and sustainability objectives, enhances the beneficial impacts of employee engagement. These aspects emphasize the need for cultivating a supportive workplace that empowers people to engage in sustainability initiatives. However, existing research demonstrates contradictory results concerning the effects of digitalization on employee well-being and engagement throughout digital workplace transformations (Baumeister et al. 2021). Despite increasing interest in such a topic, the literature within the broader business strategy domain remains fragmented, especially concerning the influence of digital technology on employee well-being via organizational processes. Previous research has frequently examined this subject in relation to corporate sustainability, human resource management, or organizational behavior, without offering a unified framework integrating these perspectives. This fragmentation poses challenges in developing coherent strategies that involve digital transformation and employee engagement into broader sustainability agendas. Wang et al. (2020) suggest that concentrating exclusively on the direct correlation between digitalization and well-being may elucidate these discrepancies. Instead, the influence of digitalization on work design, particularly on job needs and resources, provides a clearer explanation (Parker and Grote 2022). Digitalization improving job resources generally increases well-being and engagement, while heightened job pressures may produce the contrary effect.

The impact of digitalization on job design is not predefined; it is influenced by organizational strategy (Parker and Grote 2022). Hence, organizations may strategically utilize technology to either control people or empower them to perform jobs efficiently (Adler and Borys 1996; Zeshan et al. 2021). When technology is engineered to empower employees, it augments their capacity to shape their responsibilities, therefore improving access to job resources (Liu et al. 2022). Consequently, digitalization indirectly influences employee engagement by promoting job crafting and enhancing accessible resources. Drawing upon the job demands–resources (JD-R) model and job crafting theory, our research, which focuses on the influence of digitalization on employee engagement, seeks to examine the impact of these interconnections on employee well-being from a social sustainability perspective. Through the proper integration of digital technologies, the promotion of transparency in governance, and the consideration of the social and institutional settings in which banks operate, the banking sector can significantly contribute to the establishment of a sustainable working environment. This study aims to synthesize three primary objectives: to elucidate the mediating role of job resources in the relationship between digitalization and employee engagement, to highlight the function of job crafting in mitigating the effects of digitalization on employment resources, and to examine how digitalization promotes environmentally sustainable practices within organizations by enhancing employee engagement (Figure 1).

This study contributes to enrich the existing literature on digitalization and well-being by underscoring the importance of employment resources and by clarifying the mechanisms by which digitalization affects job engagement. Additionally, it illustrates how job crafting may mitigate the consequences of digitalization on employment resources. The findings of this research may benefit both organizations and employees: managers aiming to digitalize their processes to improve workers capabilities and employees by increasing their engagement through effective job resource optimization and proactive role design.

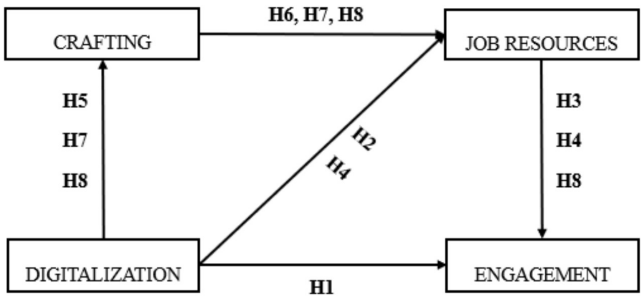

FIGURE 1 | Conceptual model.

2 | Literature Review and Hypotheses Development

2.1 | Digitalization and Engagement

Before the COVID-19 pandemic, only 2.8% of the total workforce in the United States and 2% in Europe used to work remotely (Wang et al. 2021). In a post-pandemic world, digitalization has become indispensable, and remote work has swiftly emerged as the new standard.

Following government mandates, most banks have gone online. Branchless banks, which operate remotely, have gained popularity in the market, alongside traditional banks that have focused on reducing staff at physical branches. In Pakistan, where remote or hybrid employment has been fostered (Zeshan et al. 2024), digitalization has been frequently employed to automate banking procedures. Banks undertake daily operations using a variety of software, including core banking applications (CBA), Temenos 24 (T 24), and Auto banker.

Digitalization refers to "the extent to which information (big data and analytics) and communication technologies (networks) are used in an organization" (Zeshan et al. 2021). Information technology is used for analysis, prediction, and storage, while communication technology is used to integrate the data. Recent research shows that digitalization may increase employee engagement while also supporting environmental goals, such as lowering travel-related emissions through virtual communication as part of a broader sustainability strategy (Cascio and Montealegre 2016; Dreichuk and Sytnyk 2024). Notwithstanding its advantages, digitally enabled working poses many challenges to organizations. Historically, organizations employed measures to cultivate corporate culture among workers, including office design and the frequency of interactions with their colleagues. However, these approaches are impracticable in remote or hybrid work environments. In this scenario, it is crucial to design a job that maintains employees' engagement, as this aspect may contribute to the growth of organizational culture in the lives of employees. Although work engagement may be used as a tool to inculcate organizational culture, there is little research demonstrating how the engagement may be achieved in a context where tasks are highly digitalized.

Job engagement may be defined as "a positive, fulfilling, work-related state of mind that is characterized by vigour, dedication, and absorption" (Schaufeli et al. 2002; Bakker et al. 2008). It is composed of three components: the first element is vigor, which indicates a high level of energy, mental resilience, willingness to effort, and persistence in the face of difficulties; the second component is dedication, which shows a sense of enthusiasm and inspiration for work. Finally, the third component is absorption, which shows a full concentration in one's work. Since digitalization may help employees in completing different tasks automatically, it may increase employees' vigor through the maintenance of energy levels. Moreover, technology may add vigor to the employees by allowing them to learn different skills to perform different tasks in a better way (Ter Hoeven et al. 2016).

Technology may enhance the dedication of employees by providing them with a sense of purpose, similar to an increase in vigor. The enterprise-level programs generate a variety of reports that exhibit the employees' contributions to the organization. The employees' commitment may be enhanced by this performance feedback. Like vigor and dedication, technology may also improve employees' absorption. As automation is a result of digitalization, employees may be relieved of various repetitive duties, thereby enabling them to focus on decision-making. For instance, in the banking sector, Business Intelligence (BI) tools can assist managers in more efficiently assessing credit risk by automating data analysis, reducing reliance on intuition, and improving the accuracy of loan decisions (Alzeaideen 2019).

Based on the above discussion, it can be assumed that digitalization may positively affect all three components of employee engagement (i.e., absorption, dedication, and vigor). Extant research also shows a positive relationship between digitalization and job engagement (Ter Hoeven et al. 2016; Jha et al. 2019; Baumeister et al. 2021; Lee 2023). Therefore, it may be believed that there is a positive relationship between digitalization and engagement.

H1. *Digitalization positively affects employees' engagement.*

2.2 | Digitalization, Engagement, and Mediation of Job Resources

Extant research shows the paradoxical effects of digitalization on employee outcomes (Baumeister et al. 2021). On the one hand, a stream of research suggests that digitalization may result in positive employee outcomes like employee engagement, autonomy, and commitment (Cascio and Montealegre 2016; Zeshan et al. 2021). On the other hand, many authors show that digitalization causes negative employee outcomes, such as employee burnout, employee control, and a reduction in job satisfaction and work-life balance (Day et al. 2012; Wright et al. 2014; Ninaus et al. 2021).

Wang et al. (2020) suggest that these paradoxical results are the result of the focus on the direct relationship between digitalization and employee outcomes ignoring the underlying process that links the digitalization with employee outcomes. Research emphasizes that this process may be understood by considering the effect of digitalization on work design (Parker and Grote 2022; Wang et al. 2020), which is defined as "the content and organization of one's work tasks, activities, relationships, and responsibilities" (Parker 2014).

Depending on the work design, a job may increase job demands for the employee or it may increase job resources for the employees (Parker and Grote 2022). Job demands are "those physical, social, or organizational aspects of the job that require sustained physical and/or psychological (i.e., cognitive or emotional) effort on the part of the employee and are therefore associated with certain physiological and/or psychological costs" (Bakker et al. 2007, 275). Contrary to job demands, job resources are those physical, psychological, social, or organizational aspects of the job that (a) reduce job demands and the associated physiological and psychological costs, (b) are functional in achieving work goals, or (c) stimulate personal growth, learning, and development (Demerouti et al. 2001).

The effect of digitalization on employee well-being varies with its effect on job design. If digitalization increases job demands, it will negatively affect well-being. On the opposite, an increase in job resources will result in a positive effect on employee well-being (Parker and Grote 2022). Extant research on the JD-R model has proved that only job resources are related to job engagement (Bakker et al. 2008). Consequently, this research sought to investigate the impact of digitalization on job resources. Job resources may include performance feedback, communication, participation in decision-making, employee colleague relationship, employee supervisor relationship, remuneration, and autonomy (Lequeurre et al. 2013). Recent literature suggests that these resources are positively affected by digitalization. For instance, Zeshan et al. (2021) illustrate that digitalization positively affects autonomy, feedback, and participation in decision-making. Research indicates that digitalization positively influences interactions between employees and their colleagues, as well as between employees and supervisors (Cascio and Montealegre 2016). Based on these studies anticipating the beneficial impact of digitalization on various aspects of employee resources, it is reasonable to assume that digitalization will lead to an increase in employee resources.

H2. *Digitalization positively affects job resources.*

Job resources may result in an increase in employee engagement. Autonomy of employees and cordial relations at the workplace may increase employee motivation (Deci et al. 2017). Similarly, participation in decision-making and feedback may increase the motivation of the employees (Zeshan et al. 2022). This motivation should result in employee engagement. Extant research also shows a positive relationship between employee resources and their engagement (Albrecht et al. 2021; Baumeister et al. 2021). Therefore, it may be assumed that more employee resources will result in more engagement.

H3. *Job resources positively affect employee engagement.*

The effect of digitalization on employees depends upon its ability to influence the work design (Parker and Grote 2022), which can be adjusted to increase employee resources, hence augmenting employee engagement. Therefore, it may be assumed that digitalization enhances job engagement by increasing employee resources.

H4. *Job resources mediate the relationship between digitalization and employee engagement.*

2.3 | Digitalization, Job Resources, and Mediation of Job Crafting

Similar to the relationship between digitalization and well-being, the relationship between digitalization and job resources is also paradoxical. For instance, research suggests that digitalization may decrease as well as increase the autonomy of the employees (Bader and Kaiser 2017; Zeshan et al. 2021). The effect of technology on work design (i.e., job demands or job resources) depends upon the way it is used in the organization (Parker and Grote 2022). Hence, technology may be used in the organization in two ways, that is, to control the employees or to enable them to craft their jobs to complete their tasks (Adler and Borys 1996; Zeshan et al. 2021).

Job crafting may be defined as "the ways in which employees take an active role in initiating changes to the physical, cognitive, and social features of their jobs" (Slemp and Vella-Brodrick 2013). There are three forms of job crafting, that is, task crafting, relational crafting, and cognitive crafting. Task crafting allows the employees to initiate change in the number or type of tasks that they perform on the job. Relational crafting is the discretion of the employees to select the people to interact with (interacting with people with similar values). Cognitive crafting predicts one's ability to change his perspective about his job to make the job more meaningful (considering that one's job is meaningful for the performance of the organization). These three forms of job crafting may be positively impacted by the digitalization.

Given the numerous learning sources that digitalization provides, it may be advantageous for employees to acquire a variety of skills by using various online resources. These new skills subsequently enable the employees to modify the number or type of tasks they perform on the job (task crafting). Similar to task crafting, relational crafting ability may also be enhanced by digitalization. Indeed, digitalization provides multiple channels of communication, whose availability enables the employees to interact with different people on the job (Lee 2023). Finally, since digitalization enables the employees to generate different real-time reports about the work, for example, by using BI, it may provide a clear picture of the worth of each employee's work. This real-time feedback may help in the cognitive crafting of the employees.

The above discussion suggests that digitalization may positively affect task crafting, relational crafting, and cognitive crafting. Extant research also predicts a positive association between digitalization and job crafting (Tarafdar et al. 2011; Li et al. 2022). Therefore, it may be assumed that there is a positive relationship between digitalization and job crafting.

H5. *Digitalization positively affects job crafting.*

Job crafting may positively affect employee resources. It has been discussed above that relational crafting allows an employee to interact with people with similar values. Communication and interaction between people with similar interests will probably result in more cordial relations. Therefore, it may be assumed that relational crafting will result in an increase in job resources like employee-colleague relationships and employee-supervisor relationships. These cordial relationships may further result in employee participation in decision-making and stronger communication, which are also a part of employee job resources. Furthermore, crafting ability signals to the employee that he is more independent and autonomous in his job.

The above discussion on the relationship between job crafting and different types of job resources predicts that more crafting of the employees will result in increased job resources. Extant research also indicates this positive relationship (Tims et al. 2013; Lee and Lee 2018). Therefore, it may be believed that there is a positive association between job crafting and job resources.

H6. *Job crafting positively affects job resources.*

Employee perception of their crafting ability affects the relationship between digitalization and job resources (Parker and Grote 2022; Ninaus et al. 2021). Moreover, it has been discussed above that digitalization does have a positive relationship with job crafting, which is also positively related to job resources. Therefore, it may be assumed that

H7. *Job crafting mediates the relationship between digitalization and job resources.*

Based on its effect on work design (i.e., job resources), digitalization may either increase or decrease employee engagement. However, the effect of digitalization on job resources also depends upon the crafting ability of the employees. Therefore, it may be assumed that digitalization affects employee engagement through crafting ability and employee resources.

H8. *Job crafting and job resources serially mediate the relationship between digitalization and employee engagement.*

3 | Methodology

3.1 | Context, Sample, and Procedure

This research was undertaken in the banking sector of Pakistan, selected for its distinctive socio-cultural dynamics and swiftly advancing digitalization environment. The banking sector in Pakistan is defined by a centralized decision-making culture, as shown by Hofstede's (1983) high-power distance paradigm, which affects staff conduct and organizational procedures.

The initial phase of the data gathering process was defining the population of interest (Eisenhardt 1989). The population comprised commercial banks operating in Islamabad, Pakistan, where digital banking is widespread. Subsequently, private-sector banks that implemented remote working methods were chosen to align with the study's objectives. The principle of transparent observability (Eisenhardt 1989) informed the selection of remote workers, guaranteeing their capacity to offer the necessary insights.

Convenience sampling was utilized to collect data owing to restricted accessibility to respondents and the lack of a comprehensive sampling frame. Branch managers authorized access to participants, while two doctoral students, proficient in data gathering techniques, aided in executing the procedure. Participants were informed of the study's objective and guaranteed that their responses would be kept anonymous. Participation was completely voluntary.

Data was gathered by using a conventional pen-and-paper approach during four periods, each separated by 1 week, to mitigate typical technique variance as advised by Conway and Lance (2010). In the initial phase, data regarding respondents' demographics and digitalization were gathered. The second phase concentrated on job crafting, followed by job resources in the third phase, and employee engagement in the fourth phase. Such a method has been followed to avoid common method bias (Podsakoff et al. 2003).

Soper's (2020) calculator determined the minimum sample size for this study to be 208, based on an effect size of 0.3 and a statistical power of 0.8. In the initial phase, 400 questionnaires were disseminated, producing 237 completed responses, which correspond to a response rate of 59.25%. In following waves, only the initial respondents were contacted, and all participated. The demographic information of the respondents is displayed in Table 1, indicating that the participants' ages varied from 21 to 60 years. Male respondents constituted 63.71%, and female respondents accounted for 36.29%. Furthermore, 68% of participants possessed a bachelor's degree, while 32% held a master's degree. The survey was conducted in English, the official language of Pakistan, which is mandated as a compulsory subject in educational institutions.

3.2 | Measures

The items have been measured by using a five-point Likert scale ranging from "*strongly disagree*" (1) to "*strongly agree*" (5). Digitalization has been measured through a 4-item scale as developed by Zeshan et al. (2021); job crafting has been measured by using the scale established by Slemp and Vella-Brodrick (2013) consisting of three subscales, that is, task crafting, cognitive crafting, and relational crafting; job resources have been measured by using the scale developed by

TABLE 1 | Demographic characteristics of the sample.

Characteristics	Percentage	Frequency
Gender		
Male	63.71%	151
Female	36.29%	86
Education		
Bachelor	68.00%	161
Masters	32.00%	76
Age		
21–30	55.60%	132
31–40	31.40%	74
40–50	09.60%	25
51–60	02.90%	5
Experience in the organization		
0–5	63.29%	150
6–10	12.65%	30
11–15	10.54%	25
16–20	4.21%	10
21–25	6.32%	15
26–30	2.95%	7

Lequeurre et al. (2013), comprising seven subscales, that is, feedback, communication, participation in decision-making, relationship with colleagues, relationship with supervisor, remuneration, and autonomy. Lastly, job engagement has been assessed by using the scale developed by Schaufeli et al. (2006), which comprises three subscales: vigor, devotion, and absorption.

All questionnaires are presented in Appendix A.

4 | Results

The structural equation modeling (SEM) approach has been utilized through Smart PLS to assess the structural model. It has been employed as it facilitates the simultaneous testing of multiple equations (Hair et al. 2010). The results have been discussed below.

4.1 | Common Method Bias

The absence of common method bias has been validated through the calculation of full collinearity variance inflation factor (VIF) values. As all values are below the threshold of 3.3 (Table 2), it may be argued that common method bias is absent (Kock 2015; Hair 2014).

4.2 | Measurement Model

The initial phase of assessing the measurement model involves the verification of item reliability via factor loading. All displayed variables exhibit an acceptable value of 0.7 (Table 3), thereby confirming the reliability of the items (Hair et al. 2019). Conversely, the item reliability of SPVSR4, TCRAFT1, and RELCRAFT5 is below 0.7; therefore, they have been excluded from the analysis.

Upon verifying the items' reliability, the subsequent stage has been to ascertain the internal consistency reliability. The reliability has been validated with Jöreskog's (1971) composite reliability (CR). The CR values for all variables are satisfactory (i.e., $CR > 0.70$) (Hair et al. 2019).

To validate the internal consistency reliability, Cronbach's alpha has also been employed. Alpha values for all the variables exceed 0.70, indicating internal consistency reliability for all the latent variables (Hair et al. 2010).

Subsequently, convergent validity has been evaluated by using the analysis of average variance extracted (AVE) values. The AVE values for all latent variables are satisfactory (i.e., $AVE > 0.50$) (Hair et al. 2010). Table 3 presents the values for several indicators employed to evaluate the measurement model.

Since the square root of the AVE of each variable is greater than its correlation with other latent variables (Table 4), it may be confirmed that discriminant validity does exist in the measurement model (Fornell and Larcker 1981).

4.3 | Structural Model

Smart PLS3 has been used to assess the structural model. Given the limited sample size in comparison with the model's complexity, partial least squares structural equation modeling (PLS-SEM) was employed rather than covariance-based structural equation modeling (CB-SEM) (Hair 2014). Another rationale for employing PLS-SEM is its superior statistical power compared to CB-SEM (Hair 2014). In accordance with Hair et al. (2014), a bootstrapping procedure with 5000 samples was implemented to evaluate the structural model's outcomes.

Hypothesis H1 proposes that digitalization is positively associated with job engagement. The result for H1 ($\beta = 0.36$, $p < 0.000$) suggests that the relationship between digitalization and job engagement is significant. Therefore, H1 is accepted.

Hypothesis H2 predicts that digitalization also positively affects job resources. This hypothesis is also accepted because the results ($\beta = 0.39$, $p < 0.000$) show a significant relationship between digitalization and job resources.

Hypothesis H3 predicts that job resources positively affect engagement. Based on the results ($\beta = 0.72$, $p < 0.000$), H3 is also accepted.

Hypothesis H4 predicts that job resources mediate the relationship between digitalization and engagement. H4 is rejected due to the presence of a zero between the upper and lower intervals following bootstrapping.

Hypothesis H5 proposes that digitalization positively affects job crafting. Results ($\beta = 0.45$, $p < 0.000$) show a positive relationship between digitalization and job crafting. Hence, H5 is also accepted.

H6 suggests that job crafting positively affects job resources. H6 is also accepted because of the significant relationship shown by the results ($\beta = 0.67$, $p < 0.000$).

Hypothesis H7 proposes that job crafting mediates the relationship between digitalization and job resources. Bootstrapping results confirm this mediation. Therefore, hypothesis H7 is also accepted. Hypothesis H8 predicts that job crafting and job resources serially mediate the relationship between digitalization and employee engagement. Based on the bootstrapping results, H8 is also accepted.

The summary of hypotheses and results has been provided in Table 5.

The R^2 values are 21% for crafting, 46% for job resources, and 56% for engagement. Hair et al. (2019) classify R^2 values of 0.75, 0.50, and 0.25 as large, medium, and small, respectively. Consequently, the value of R^2 for crafting is small, whereas the values for job resources and engagement are medium. The summary of accepted and rejected hypotheses has been provided in Table 6.

The relationships between digitalization, job crafting, job resources, and engagement are depicted in the structural model (Figure 2).

TABLE 2 | Factor level VIF for common method bias.

	Cognitive crafting	Communication	Crafting	Digitalization	Independence	Job resources	Participation	Relationship crafting	Task crafting
Cognitive crafting									
Communication									
Crafting	1.00					1.26		1.00	1.00
Digitalization			1.00			1.26			
Independence									
Resources		1.00			1.00		1.00		
Participation									
Relationship crafting									
Task crafting									
Absorption									
Colleagues									
Dedication									
Engagement									
Feedback									
Remuneration									
Supervisor									
Vigor									

	Absorption	Colleagues	Dedication	Engagement	Feedback	Remuneration	Supervisor	Vigor
Cognitive crafting								
Communication								
Crafting								
Digitalization				1.18				
Independence								
Resources		1.00		1.18	1.00	1.00	1.00	
Participation								
Relationship crafting								
Task crafting								

(Continues)

TABLE 2 | (Continued)

	Absorption	Colleagues	Dedication	Engagement	Feedback	Remuneration	Supervisor	Vigor
Absorption								
Colleagues								
Dedication								
Engagement	1.00		1.00					1.00
Feedback								
Remuneration								
Supervisor								
Vigor								

4.4 | Mediation Analysis

This study demonstrates a serial mediation of job crafting and job resources in the relationship between digitalization and engagement. Moreover, the analysis reveals two simple mediations. First, job crafting mediates the relationship between digitalization and job resources. Second, job resources mediate the relationship between digitalization and engagement. These mediations have been analyzed using the variance accounted for (VAF) method as prescribed by Hair et al. (2014). The value of VAF is derived by dividing the indirect effect by the total effect. The mediation is deemed full if the outcome exceeds 0.80. In a similar manner, a value between 0.20 and 0.80 signifies a partial mediation, whereas a value below 0.20 indicates the absence of mediation. Based on this criterion, the results indicate a partial serial mediation of job crafting and job resources in the relationship between digitalization and engagement. Similarly, the mediation of job crafting between digitalization and job resources is also partial. Nonetheless, there is no mediation of job resources in the relationship between digitalization and engagement (Table 6).

5 | Discussion

This study corroborates the hypothesis that digitalization positively influences job engagement (H1), thus confirming previous research that demonstrates a positive correlation between these constructs (Ter Hoeven et al. 2016; Baumeister et al. 2021; Lee 2023). However, many studies also indicate a negative relationship between digitalization and employee engagement. According to Parker and Grote (2022), this paradoxical relationship is the result of the focus on the direct relationship between the two constructs. They claim that comprehending the impact of digitalization on employees necessitates an examination of its influence on job design (job demands/job resources). Following their recommendation, this research proves that digitalization positively affects job resources (H2), and these resources are also positively associated with job engagement (H3). The results for H2 and H3 are consistent with the previous research (Cascio and Montealegre 2016; Albrecht and Marty 2020; Zeshan et al. 2021). While the results contradict the mediation of job resources (H4), the presence of job crafting in the model is the cause of the increased employee resources that job crafting generates.

This research has employed job crafting theory to explain also the paradoxical relationship between digitalization and job resources, which is similar to the interaction between digitalization and engagement. It has been proved that digitalization increases job crafting (H5) and through job crafting employees increase their job resources (H6). Consistent with previous research, this study also proves H5 and H6 (Tarafdar et al. 2011; Tims et al. 2013; Lee and Lee 2018; Li et al. 2022). Furthermore, it reveals that job crafting mediates the relationship between digitalization and job resources (H7). By combining the job crafting theory and JD-R model, this research proves that job crafting and job resources serially mediate the relationship between digitalization and job engagement (H8). This demonstrates the collective influence of proactive behaviors (job crafting) and institutional support (job resources) in maintaining engagement, highlighting a multi-stage psychological mechanism that enhances employees' capacity to adapt to digitally transformed work environments.

TABLE 3 | Properties of the final measurement model.

				Cronbach's alpha	CR	(AVE)
1	Digitalization	DIG1	0.71	0.78	0.86	0.60
		DIG2	0.81			
		DIG3	0.76			
		DIG4	0.82			
2	Crafting	TCRAFT	0.78	0.86	0.88	0.71
		COGCRAFT	0.89			
		RELCRAFT	0.85			
(i)		TCRAFT2	0.71	0.65	0.79	0.50
		TCRAFT3	0.71			
		TCRAFT4	0.67			
		TCRAFT5	0.70			
(II)		COGCRA1	0.64	0.79	0.85	0.54
		COGCRA2	0.76			
		COGCRA3	0.77			
		COGCRA4	0.74			
		COGCRA5	0.77			
(III)		RELCRA1	0.77	0.70	0.82	0.53
		RELCRA2	0.76			
		RELCRA3	0.75			
		RELCRA4	0.61			
3	Resources	FEEDBACK	0.81	0.93	0.91	0.60
		COMMUNICATION	0.80			
		PARTICIPATION	0.79			
		COLLEAGUE	0.84			
		SUPERVISOR	0.79			
		REMUNERATION	0.64			
		AUTONOMY	0.72			
(i)		FEED1	0.76	0.81	0.88	0.64
		FEED2	0.78			
		FEED3	0.83			
		FEED4	0.83			
(ii)		COMUNI1	0.78	0.70	0.82	0.53
		COMUNI2	0.72			
		COMUNI3	0.68			
		COMUNI4	0.72			
(iii)		PARTICI1	0.76	0.79	0.87	0.62
		PARTICI2	0.81			
		PARTICI3	0.82			

(Continues)

TABLE 3 | (Continued)

				Cronbach's alpha	CR	(AVE)
		PARTICI4	0.75			
(iv)		COLEG1	0.77	0.74	0.84	0.56
		COLEG2	0.74			
		COLEG3	0.73			
		COLEG4	0.76			
(v)		SPVSR1	0.75	0.69	0.83	0.62
		SPVSR2	0.76			
		SPVSR3	0.84			
(vi)		REMR1	0.82	0.81	0.88	0.64
		REMR2	0.82			
		REMR3	0.82			
		REMR4	0.75			
(vii)		IND1	0.79	0.80	0.87	0.63
		IND2	0.80			
		IND3	0.86			
		IND4	0.71			
4	Engagement	VIGOR	0.88	0.86	0.91	0.78
		DEDICATION	0.91			
		ABSORPTION	0.86			
(i)		VIGR3	0.78	0.68	0.82	0.61
		VIGR1	0.75			
		VIGR2	0.81			
(ii)		DEDI1	0.84	0.69	0.83	0.62
		DEDI2	0.77			
		DEDI3	0.75			
(iii)		ABDORB5	0.68	0.68	0.82	0.61
		ABSORB1	0.82			
		ABSORB4	0.84			

These findings suggest that digital transformation initiatives are more effective when they prioritize contextual facilitators and encourage the proactive role of employees, rather than relying solely on technology implementation.

Besides its influence on employee engagement, digitalization has considerable relevance for promoting organizational, social, and environmental sustainability. The shift to hybrid and remote work models has increased personal autonomy and flexibility, enabling workers to tailor their work schedules to meet their personal and professional needs, thereby improving work-life balance and job satisfaction. Simultaneously, it substantially decreases carbon emissions, thus promoting broader environmental goals (Babapour Chafi et al. 2021). These modern technologically advanced approaches facilitate self-leadership and job creation, allowing individuals to adjust their duties and encouraging behavioral changes, including the use of digital tools for asynchronous communication and paperless operations. When adequately supported by leadership and infrastructures, these activities strengthen personal well-being and organizational commitment to overarching sustainability objectives.

5.1 | Theoretical Contribution

The study contributes to the existing body of literature by offering new theoretical insights on the convergence of digital transformation and sustainable work design. First, it elucidates

TABLE 4 | Fornell–Larcker criterion.

Variables	Cognitive crafting	Communication	Digitalization	Independence	Participation	Relationship crafting	Task crafting
Cognitive crafting	**0.74**						
Communication	0.51	**0.73**					
Digitalization	0.41	0.28	**0.77**				
Independence	0.51	0.41	0.30	**0.79**			
Participation	0.50	0.63	0.32	0.44	**0.79**		
Relationship crafting	0.64	0.43	0.38	0.44	0.45	**0.73**	
Task crafting	0.54	0.43	0.33	0.46	0.43	0.55	**0.70**
Absorption	0.41	0.50	0.33	0.59	0.46	0.31	0.35
Colleagues	0.46	0.64	0.26	0.51	0.61	0.41	0.39
Dedication	0.50	0.49	0.33	0.62	0.51	0.37	0.38
Feedback	0.52	0.67	0.34	0.48	0.58	0.45	0.43
Remuneration	0.32	0.41	0.28	0.45	0.41	0.26	0.27
Supervisor	0.43	0.52	0.30	0.54	0.55	0.38	0.32
Vigor	0.50	0.41	0.29	0.60	0.50	0.44	0.36

Variables	Absorption	Colleagues	Dedication	Feedback	Remuneration	Supervisor	Vigor
Cognitive crafting							
Communication							
Digitalization							
Independence							
Participation							
Relationship crafting							
Task crafting							
Absorption	**0.78**						
Colleagues	0.55	**0.75**					
Dedication	0.68	0.53	**0.79**				
Feedback	0.48	0.59	0.53	**0.80**			
Remuneration	0.34	0.40	0.40	0.39	**0.80**		
Supervisor	0.56	0.73	0.55	0.53	0.47	**0.78**	
Vigor	0.61	0.52	0.71	0.47	0.39	0.58	**0.78**

Note: The highlighted values are the square root of AVE and are compared with the corresponding correlation values to confirm the discriminant validity.

TABLE 5 | Structural model results.

Hypothesis	Relationships	β	p values	Confidence intervals		Results
				2.5%	97.5%	
H1	*Digitalization → Engagement*	0.36	0.00	0.23	0.48	Accepted
H2	*Digitalization → Job resources*	0.39	0.00	0.26	0.51	Accepted
H3	*Resources → Engagement*	0.72	0.00	0.62	0.78	Accepted
H4	*Digitalization → Job resources → engagement*	0.07	0.07	−0.01	0.15	Rejected
H5	*Digitalization → Crafting*	0.45	0.00	0.33	0.57	Accepted
H6	*Crafting → Resources*	0.67	0.00	0.58	0.77	Accepted
H7	*Digitalization → Crafting → Resources*	0.28	0.00	0.20	0.40	Accepted
H8	*Digitalization → Crafting → Job resources → engagement*	0.20	0.00	0.13	0.29	Accepted

Note: R-square value for *crafting* is 21%, for *resources* is 46%, and for *engagement* is 56%.

TABLE 6 | Summary of hypotheses with results.

Hypotheses	Results
H1: *Digitalization positively affects employee engagement.*	Accepted
H2: *Digitalization positively affects job resources.*	Accepted
H3: *Job resources positively affect employee engagement.*	Accepted
H4: *Job resources mediate the relationship between digitalization and employee engagement.*	Rejected
H5: *Digitalization positively affects job crafting.*	Accepted
H6: *Job crafting positively affects job resources.*	Accepted
H7: *Job crafting mediates the relationship between digitalization and job resources.*	Accepted
H8: *Job crafting and job resources serially mediate the relationship between digitalization and engagement.*	Accepted

the reasoning underlying the contradictory impacts of digitalization on employee engagement. Extant research shows both positive and negative effects of digitalization on employee engagement (Baumeister et al. 2021). Therefore, based on the theoretical research by Parker and Grote (2022), this study proves that the effect of digitalization on job engagement depends upon the effect of digitalization on the work design (job demands or resources). Thus, the engagement of employees will be improved if digitalization improves their job resources.

Second, this research underscores the significance of job crafting. In line with prior literature, extant research shows the paradoxical effect of digitalization on job resources. For instance, there is a plethora of research that shows that digitalization may positively as well as negatively affect employees' autonomy (Bader and Kaiser 2017; Gerten et al. 2019; Zeshan et al. 2021). This study contends that the effect of digitalization on job resources depends upon its effect on job crafting by the employee. Hence, if digitalization allows employees to craft their job, it will enhance their job resources.

By integrating job crafting theory, work design theory, and the JD-R model, this study elucidates the process by which digitalization influences employee engagement. It empirically validates a serial mediation mechanism linking digitalization to job engagement through job crafting and job resources, thereby enhancing the JD-R model in digitally enabled environments. By adjusting the focus of digital transformation from technological or organizational performance to employee experience and well-being as essential components of sustainability, it posits that sustainability-oriented HRM strategies must facilitate both resource availability and employee proactivity to be effective.

5.2 | Practical Contribution

This research provides significant insights for the organizations' managers. First, when implementing digitalization within their organization, managers should consider its effect on employee resources, including autonomy, feedback, communication, participation, and relationship with colleagues and supervisors. If digitalization positively affects these job resources, it will also positively affect employee well-being. Nonetheless, managers should also be aware that the effect of digitalization on job resources depends upon the crafting capability of the employee, which is enhanced by digitalization. Enabling individuals to craft their job will increase their job resources, which will, in turn, positively impact their well-being.

Overall, this study demonstrates how managers can foster favorable employee attitudes in a digitalized work environment. Managers should prioritize digital solutions that improve productivity and promote environmentally friendly practices, such as remote meetings and paperless processes. Fostering an eco-innovation culture can help organizations boost employee

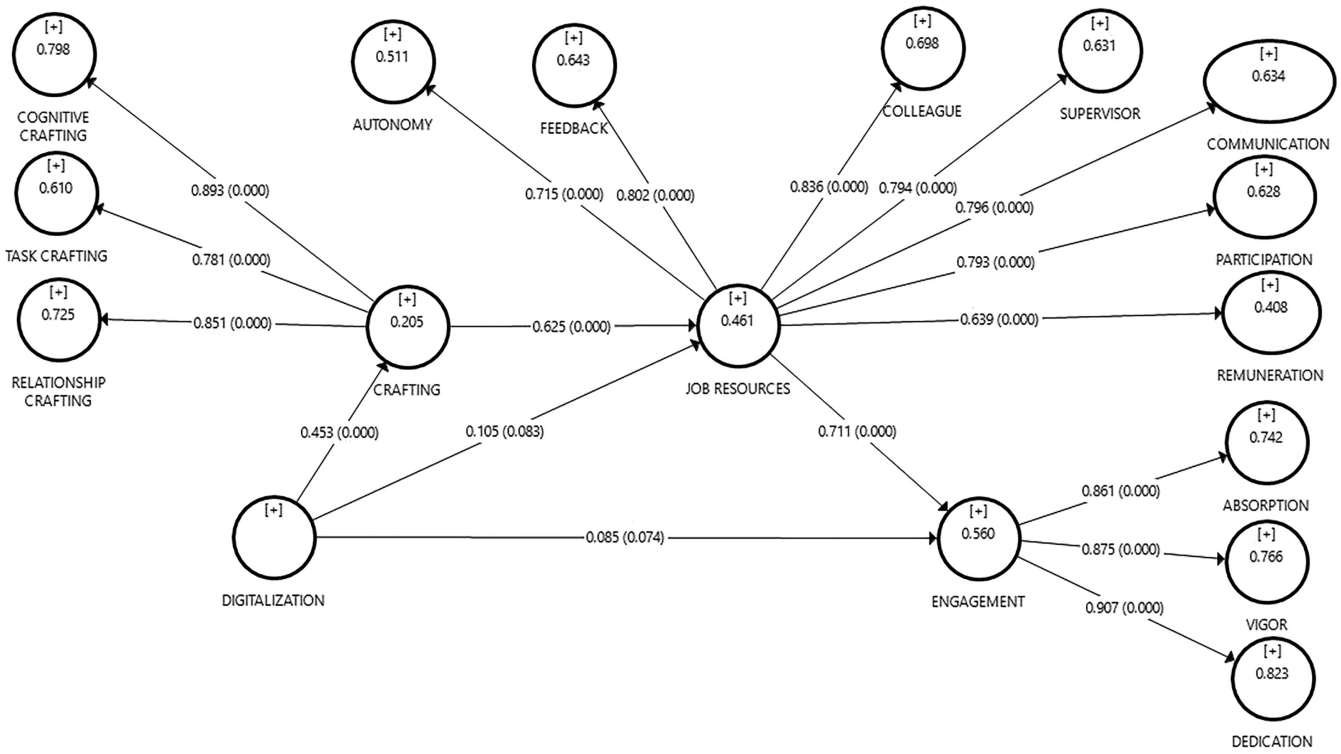

FIGURE 2 | Structural model.

engagement and achieve their sustainability goals. On the other hand, policymakers should encourage businesses to embark on such a technological transformation.

5.3 | Limitations and Future Research Directions

Notwithstanding its contribution to the existing literature, this study presents some limitations that offer opportunities for future research. First, the employment of convenience sampling, while pragmatic and cost-effective (Etikan 2016), constrains the generalizability of the results. Future research may include a variety of sampling techniques to further enhance the validity of the findings. Moreover, the reliance on self-reported data precludes the analysis of causal correlations (Podsakoff et al. 2003), indicating the need for longitudinal study design or mixed-method techniques in subsequent investigations. Third, the findings underscore the significance of examining how organizational and contextual facilitators affect the identified linkages. The model may be extended to include additional constructs such as individual competencies, personality traits, leadership styles, and HRM frameworks, which might potentially influence the observed dynamics and employee reactions to digital transformation. Additionally, the conceptual framework presented in this study may also be relevant to other firms undergoing the twin transition in other geographic contexts, even though the current research focuses on the banking industry. The transition to smart factories and the adoption of Industry 5.0 technologies is resulting in complex digital upskilling initiatives that may be more effectively managed when employees actively participate in job crafting (Xu et al. 2020). For instance, wearable sensors have been employed to assess worker interactions and well-being in logistics, suggesting that job design interventions and tailored job crafting can preserve autonomy and skill variety while simultaneously improving performance and health outcomes (Aloini et al. 2021). In such a scenario, this research may be further expanded to assess the impact of technologies on sustainability outcomes in line with emerging industry needs (Cascio and Montealegre 2016; Li et al. 2022). Furthermore, it is essential to evaluate the enduring organizational implications of human-centered digitalization initiatives, including their influence on innovation capacity, talent retention, and environmental, social, and governance (ESG) performance.

Finally, the model's explanatory power could be further enhanced by incorporating the sociomateriality theory (Orlikowski 2007), which emphasizes the interdependence of human agency and technology. This viewpoint may provide a deeper understanding of the outcomes of digitalization in a variety of contexts by clarifying the dynamic interaction between material artifacts and social practices that influence employees' engagement with digital tools.

6 | Conclusion

By combining JD-R and job crafting theories, this research aims to clarify the process behind the paradoxical relationship between digitalization and employee well-being. More precisely, the study investigates the effects of digitalization through the serial mediation of job crafting and job resources within the banking sector. The findings indicate that digitalization improves job crafting among employees. An increase in job crafting increases the employee resources, hence fostering greater engagement with their job.

The study offers valuable insights for firms addressing the challenges and opportunities of the twin transition, which encompasses the concurrent simultaneous digital and sustainable transformation. Our results suggest that firms cannot regard employee engagement and well-being as ancillary concerns while adopting advanced technologies and attempting to conform to the increasing demands of ESG standards. Rather, they are essential drivers of sustainable transformation. Managers play a pivotal role in such a process, empowering employees to actively craft their roles and leverage new digital technologies, therefore promoting the development of bottom-up sustainability practices. Job crafting serves as a strategic mechanism that allows workers to assimilate and implement environmental and social goals in their everyday tasks, thus establishing a strong connection between organizational purpose and individuals' behavior.

Author Contributions

Muhammad Zeshan: conceptualization, data curation, methodology, and writing – original draft. **Hira Khalid:** data curation, methodology, investigation, visualization, writing – original draft, and writing – review and editing. **Shahid Rasool:** conceptualization, data curation, investigation, methodology, software, and validation. **Piera Centobelli:** conceptualization, formal analysis, supervision, and writing – review and editing. **Roberto Cerchione:** conceptualization, formal analysis, writing – review and editing, and supervision. **Mariarosaria Morelli:** formal analysis, visualization, writing – original draft, and writing – review and editing.

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Appendix

Construct and Measurement Items

Digitalization	DIGI 1: I rely on Corporate IS extensively for solving problems in my job. DIGI 2: I depend on Corporate IS extensively to carry out my job responsibilities. DIGI 3: Corporate IS is really indispensable for my work. DIGI 4: Without Corporate IS, it would be very difficult for me to do my job.
Job crafting	*Task crafting* You introduce new approaches to improve your work. You Change the scope or types of tasks that you complete at work. You introduce new work tasks that you think better suit your skills or interests. You choose to take on additional tasks at work. You give preference to working tasks that suit your skills or interests. *Cognitive crafting* You think about how your job gives your life purpose. You remind yourself about the significance your work has for the success of the Organization. You remind yourself of the importance of your work for the broader community. You think about the ways in which your work positively impacts your life. You reflect on the role your job has for your overall well-being. *Relationship crafting* You make an effort to get to know people well at work. You Organize or attend work-related social functions. You organize special events in the workplace (e.g., celebrating a co-worker's birthday). You choose to mentor new employees (officially or unofficially). You make friends with people at work who have similar skills or interests.
Job resources	*Feedback* Your work gives you the opportunity to check on how well you are doing work. Your work provides you with direct feedback on how well you are doing your work. You receive sufficient information on the results of your work. Your superior informs you about how well you are doing your work. *Communication* The company's decision-making process is clear to you. You hear enough about how the company/business is running. It is clear to you whom you should address within the company for specific problems. You adequately kept up to date about important issues within the company/business. *Participation in decision making* You can participate in decisions about what your job does or does not entail. You can participate in decisions affecting issues related to your work. You can participate in decisions about the nature of your work, You have a direct influence on your department's/company's decisions. *Relationship with colleagues* In your work, you feel appreciated by your colleagues. You get on well with your colleagues. You count on your colleagues when you encounter difficulties in your work. There is a good atmosphere between you and your colleagues. *Relationship with supervisor* In your work, you feel appreciated by your superior. You count on your superior when you come across difficulties in your work. You get on well with your superior. There is a good atmosphere between you and your superior. *Remuneration* You think your company pays good salaries. You think you are paid enough for the work that you do. You think you are fairly paid in comparison with other people in your department. You live comfortably on your pay. *Autonomy* You have an influence on the pace of work. You personally decide how much time you need for a specific activity. You decide the order in which you carry out your work on your own. You participate in the decision about when something must be completed.
Job engagement	*Vigor* At your work, you feel bursting with energy. At your job, you feel strong and vigorous. When you get up in the morning, you feel like going to work. *Dedication* You are enthusiastic about your job. My job inspires me. You are proud of the work that I do. *Absorption* You feel happy when I am working intensely. You are immersed in your work. You get carried away when you are working.