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Enhancing digital innovation in developing countries: Organizational improvisation and resource constraints in digital entrepreneurial firms

Adeel Tariq [a], Marina Dabić [b,c,d], Muhammad Saleem Sumbal [e], Syeda Nida Zaidi [f], and Muhammad Shujahat [g]

[a]Kouvola Unit, Lappeenranta-Lahti University of Technology, Finland; [b]Faculty of Economics & Business, University of Zagreb, Croatia; [c]University of Dubrovnik, Croatia; [d]University of Ljubljana School of Economics and Business, Slovenia; [e]Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hong Kong; [f]Department of HR and Management, NUST Business School, National University of Science and Technology (NUST), Pakistan; [g]Department of Strategy, Operations and Entrepreneurship, Essex Business School, The University of Essex, UK

ABSTRACT

By integrating theories of organizational dynamic capabilities and knowledge worker productivity, we explore the linkages between organizational improvisation and digital innovation performance via knowledge worker productivity, with boundary conditions of a firm's resource constraints in the context of a developing country. We collected data from 308 managers of digital entrepreneurial information technology (IT) firms in Pakistan, a developing country. We found that organizational improvisation positively influences digital innovation performance. This relationship is weaker in firms with high resource constraints. Furthermore, knowledge worker productivity mediates the relationship between organizational improvisation and digital innovation performance. The distinctive characteristics of knowledge workers in the IT sector enable them to maintain productivity by relying on improvisation despite any resource constraints, thereby, enhancing digital innovation performance. This research contributes to the intersection of dynamic capabilities and Drucker's knowledge worker productivity theories. It explores how organizational improvisation can facilitate improved digital innovation performance despite resource constraints and can build on the productivity level of knowledge workers in developing countries. Our research suggests that investing in knowledge workers facilitates the translation of organizational improvisation to improved digital innovation and mitigates resource constraints' impact on digital innovation performance in the context of developing economies.

KEYWORDS

Digital entrepreneurship; digital innovation performance; organizational improvisation; knowledge worker productivity; resource constraints

Introduction

The increasing role of emerging digital technologies, such as artificial intelligence, the Internet of Things, advanced big data, and teleworking, has created

CONTACT Marina Dabić mdabic@efzg.hr Faculty of Economics & Business, University of Zagreb, Trg J.F. Kennedy 6, Zagreb HR-10000, Croatia

new opportunities for digital entrepreneurial firms, particularly IT companies, to enhance their digital innovation performance (Appio et al., 2021, Nambisan et al., 2020). Digital entrepreneurial firms rely primarily on digital technologies as a core component of their operations, products, and services. They typically adopt innovative digital tools and platforms to improve digital innovation performance (Nambisan, 2017). However, improving digital innovation performance presents a unique challenge for digital entrepreneurial firms. Unlike traditional firms, digital entrepreneurial firms operate in a fast-evolving digital landscape wherein technology and market conditions are rapidly evolving to demand continuous adaptation and innovation pace for survival and growth (Li et al., 2018). Consequently, these firms face significant pressure to leverage resources efficiently to maintain the competitive advantage that meets the heightened demand to improve digital innovation performance—that is, by innovating with new products and developing services (Mukhopadhyay & Upadhyay, 2022).

Entrepreneurial firms often rely on organizational improvisation to capture unexpected opportunities and improve performance, which suits firms with resource constraints (Fultz & Hmieleski, 2021). Organizational improvisation refers to performance improvements attained through nontraditional novel ways that address unexpected challenges (Crossan et al., 2005) through recombining existing resources (Fultz & Hmieleski, 2021). Although termed an emergent process, this may involve some planning and could be used as a strategy to achieve a specific goal (Fultz & Hmieleski, 2021). By fostering a flexible environment and responsive approach, organizational improvisation allows entrepreneurial firms to experiment, capitalize on emerging trends, and rapidly convert unexpected opportunities into desired outcomes. For example, proactive engagement with digital technologies and tools can promote an environment within firms that encourages rapid learning and dissemination of knowledge that supports and exploits emerging opportunities by employees (Tariq et al., 2024). Existing research has mainly discussed the role of organizational improvisation concerning a firm's performance (Fisher & Barrett, 2019), a new venture's performance (Fultz & Hmieleski, 2021), innovation performance (Jun et al., 2022), and digital transformation (Soto-Acosta, 2020). Although highly significant for digital entrepreneurial firms, the relationship of organizational improvisation to digital innovation has not been explored. Several studies highlight the significance of digital innovation in achieving an organization's objectives (Nambisan, 2022, Nambisan et al., 2019, Tariq et al., 2024).

We examine how organizational improvisation can shape the digital innovation performance of entrepreneurial firms through the mediating role of knowledge worker productivity combined with the boundary condition of a firm's resource constraints. This research draws on Drucker's knowledge worker productivity theory (Drucker, 1999) and (Teece et al., 1997) organizational dynamic capabilities theory for this examination. Organizational

dynamic capabilities theory shows that firms can develop new skills and abilities through their internal and external resources in response to market changes (Teece et al., 1997). Companies struggle to acquire new digital technology because they lack necessary resources. As a firm's characteristic, dynamic capability, and suitable resource (Teece et al., 1997), organizational improvisation is likely to enable digital entrepreneurial firms to adopt and utilize existing and evolving technologies, such as AI, big data, cloud computing, and telework, to improve their digital innovation performance (Nambisan, 2022, Nambisan et al., 2019, Steininger et al., 2022). Organizations that rapidly transform digital technology assets into business procedures develop superior dynamic operational skills that improve their digital innovation performance. Through digital tools, these companies can quickly adjust their operations to meet market changes by adapting unexpected opportunities into digital solutions.

In this regard, a deeper exploration is needed to understand the mechanisms by which organizational improvisation influences digital innovation performance, particularly when highlighting the pivotal role of knowledge worker productivity, which is essential due to their contribution to entrepreneurial firms' success (Shujahat et al., 2019). The productivity of a knowledge worker refers to the efficiency of that worker, such as a software or AI engineer, to (co)create, share, and apply job-related knowledge to develop intellectual outputs, such as software solutions and patents (Tariq et al., 2024). Knowledge workers' intellectual capabilities are essential traits (Iazzolino et al., 2017; Taura & Radicic, 2019) that the workers utilize to develop innovative digital products and solutions (Palvalin et al., 2017). Based on Drucker's (1999) knowledge worker productivity theory, we argue that organizational improvisation capabilities can foster the productivity of knowledge workers (Shujahat et al., 2019). As workers' primary input is knowledge, they require timely support through resources such as digital technologies, relevant training, and a flexible environment triggered by improvisation to provide the required knowledge and enhance productivity (Drucker, 1999; Shujahat et al., 2019). In this vein, organizational improvisation can play an essential role by providing access to evolving resources, such as AI and big data technologies, and reconfiguring existing resources that knowledge workers can integrate into their workflow to drive innovation regarding their digital products and services (Fultz & Hmieleski, 2021; Nambisan et al., 2019). Based on the above, it is axiomatic that entrepreneurial firms' improvisation allows flexible and novel digital ways of working to help knowledge workers perform their tasks more innovatively or productively and exploit market opportunities. Furthermore, knowledge workers' capability to understand and adapt complex technologies and convert market opportunities into novel ideas and solutions is likely to enhance digital innovation performance (Hannola et al., 2018). Additionally, the knowledge workers' problem-solving capabilities and

collaborative skills can enable them to collaborate across their networks and continuously improve their skills to successfully design and implement digital innovation solutions. Despite knowledge workers' importance in enhancing organizational adaptability and performance under constrained conditions, only limited research exists to shed light on their role as mediators. Thus, this research has examined the mediating role of knowledge workers' productivity in the relationship between organizational improvisation and firm digital innovation.

Organizational improvisation can equip knowledge workers with new, efficient, and effective resources, including emerging digital technologies like AI and big data. However, whether or not organizational improvisation can enable digital innovation performance with or without its impact on knowledge workers depends on the boundary condition of the degree of resource constraints a firm faces (Ciuchta et al., 2021). It is especially pertinent for small entrepreneurial firms, as they have limited resources and must introduce innovative solutions to stay competitive. Small businesses with limited resources need to rely more on creativity combined with improvisation to achieve the desired innovation outcomes (Faiz, Sarwar, Tariq, & Memon, 2024. Moreover, knowledge workers with limited resources must often make informed and timely decisions to optimize their digital innovation performance. When knowledge workers manage improvised processes efficiently, their productivity can turn instinctive and flexible actions into structured, improved innovation outcomes. Thus, resource constraints act as a vital boundary condition as they can limit knowledge workers' productivity, creative thinking, and full utilization of their cognitive capabilities. However, resource constraints may not limit knowledge workers' overall productivity as they can channel improvisation to recombine existing resources to achieve the desired outcomes.

For this research, we have focused on Pakistan, as a developing country undergoing digital transformation. Pakistan has a burgeoning entrepreneurial ecosystem, with over 5 million micro-, small-, and medium-sized enterprises (SMEs). They contribute nearly 40% to the country's gross domestic product (GDP), account for 25% of overall exports, and employ 80% of the nonagricultural workforce (SBP, 2022). However, these firms often face significant challenges, including limited access to financial resources, underdeveloped infrastructure, and resource constraints, making them ideal subjects to study the dynamics of organizational improvisation and resource constraints in digital innovation. Pakistan's IT exports increased from $2.596 billion in the previous fiscal year to $3.223 billion from July 2023 to June 2024 (SIFC, 2024). Entrepreneurial firms, with special reference to Pakistan's IT industry, reveal an important level of environmental complexity, uncertainties in the resource environment, and limited resources that challenge the organizational capabilities of these firms to innovate and become competitive. The challenges such

entrepreneurial firms face include institutional voids, resource constraints, and considerations regarding employees' low productivity, which are not unique and are in fact prevalent in other developing countries. Thus, by examining the interplay of organizational improvisation, resource constraints, and digital innovation performance in Pakistan, our research aims to contribute to the growing body of knowledge regarding digital innovation performance in emerging economies. Therefore, we aimed to examine the direct and indirect role of organizational improvisation on digital innovation performance via knowledge workers' productivity, such that resource constraints moderate the relationship between organizational improvisation and knowledge workers' productivity and digital innovation performance (Figure 1).

RQ 1: What is the influence of organizational improvisation on digital innovation performance by entrepreneurial firms in Pakistan, and does the level of knowledge workers' productivity mediate this relationship?

RQ 2: To what extent do resource constraints moderate the relationship between organizational improvisation and digital innovation performance by entrepreneurial firms in Pakistan?

This research offers a three-fold contribution to the literature on digital entrepreneurial firms by specifically focusing on enhancing digital innovation performance in small businesses. Firstly, we contribute to the literature on managing small businesses by explaining how organizational improvisation improves digital innovation performance in the context of Pakistan's digital entrepreneurial firms. To this end, we build on the dynamic capability theory. Accordingly, we advance the literature by offering insights into how firms may leverage the instinctive reconfiguration of resources, a flexible environment, and digital technologies to drive continuous innovation. By highlighting the dynamic and adaptive nature of organizational improvisation, this study

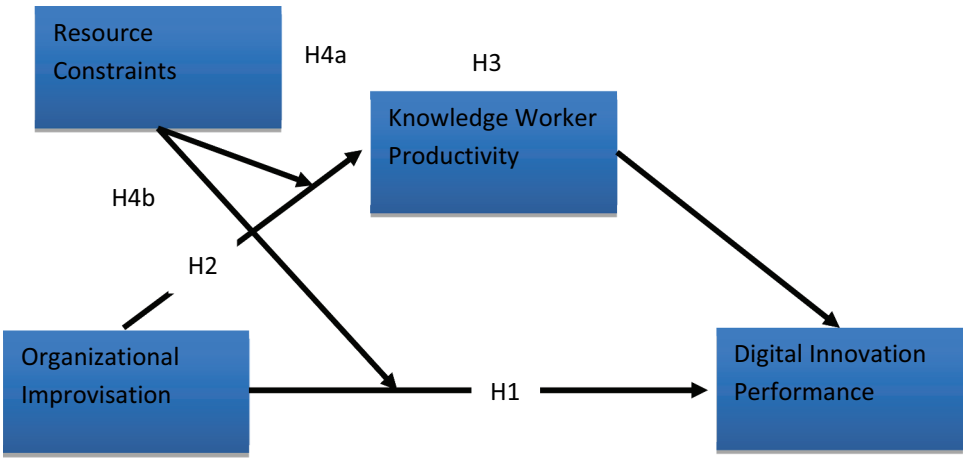

Figure 1. Research model.

explains how organizations can leverage improvisation to foster innovation in digital technologies and processes. Secondly, this research highlights the pivotal role of knowledge workers' productivity in organizations' improvisation capabilities to enhance their decision-making agility and conversion of opportunities into improved innovation outcomes. Furthermore, this study contributes to the literature about small businesses and entrepreneurship by explaining the critical role of knowledge workers as change agents who can convert spontaneous organizational opportunities and actions into organized digital innovation. Lastly, this research explains the critical role of resource constraints in shaping organizational efforts to enhance digital innovation in small businesses, as higher resource constraints can limit knowledge workers' improvisational attempts to improve creativity and agility required for higher innovation achievement. Accordingly, our study addresses a significant research gap by understanding how resource-scarce entrepreneurial firms can build on organizational improvisation and optimize knowledge workers' productivity to enhance digital innovation performance.

Theory and hypotheses development

The dynamic capabilities theory, as proposed by Teece et al. (1997), postulates that a firm can build, reconfigure, and integrate internal and external competencies to address emerging opportunities and challenges, such as digital innovation performance. In this regard, considering the increased importance of dynamic capability in management research, Wang and Ahmed (2007, p. 35) advanced the dynamic capability concept as "a firm's behavioral orientation up-grade and reconstruction of its core capabilities in response to the changing environment to attain and sustain competitive advantage." For this study, we apply dynamic capability theory to understand how organizational adaptation affects digital innovation performance. Through this study, we understand organizational improvisation as the ability of businesses to adapt their processes and innovation methods when market conditions remain uncertain (Wang & Ahmed, 2007). Through improvisational practices, organizations can identify new growth areas and technology to create better outcomes from ongoing technology changes (Fultz & Hmieleski, 2021). Through its adaptive capabilities, a company can balance digital change opportunities to boost its digital innovation performance. Moreover, to transform improvised actions into digital innovation, a firm relies heavily on the productivity of its knowledge workers. Their role is critical in applying their expertise to develop digital solutions for firm performance (Hannola et al., 2018). Organizations need successful knowledge workers to translate their spontaneous actions into digital innovation. They need to turn their specialized knowledge into digital solutions that drive business results. Therefore, the relationship between improvisation and digital innovation performance is mediated by knowledge

workers' productivity, which helps digital entrepreneurial firms transform their actions into well-structured and significant innovation outcomes. Furthermore, resource limitations affect how entrepreneurial firms can improve innovation performance by improvisation. Relying on dynamic capability, we argue that resource constraints increase the need for knowledge workers in terms of adaptation, flexibility, and effective resource allocation to achieve higher innovation outcomes (Steininger et al., 2022).

The Drucker's knowledge worker productivity theory (Drucker, 1999) complements the dynamic capabilities theory by emphasizing the role of knowledge workers. In a knowledge-intensive industry, improvisation is linked with workers' skill application and informed decision-making (Vera et al., 2016). Companies should support knowledge workers with digital tools to offer relevant work information at the right time and place to create solutions in a limited resources environment (Shujahat et al., 2019). Organizational improvisation can help knowledge workers become more productive. Enabled by digital resources and improvisational capabilities, knowledge workers can translate firm opportunities into digital innovation performance. Thus, knowledge workers' productivity (e.g., high-impact decision-making and knowledge application) within a resource-constrained environment mediates the relationship between improvisation and innovation.

Organizational improvisation and digital innovation performance

Organizational improvisation focuses on performance improvement by an organization or its members through the use of novel or nonconventional ways to address specific or unexpected challenges (Hadida et al., 2015; Hmieleski & Corbett, 2006; Hmieleski et al., 2013). The characteristics of dynamic capability enable firms to reorganize resources and incorporate them into processes that foster adaptability to address uncertainties in market demands, emerging technologies, and competitors' actions (Teece et al., 1997). This approach encourages experimental problem-solving and supports a culture of leveraging emerging tools and technologies that enhance the performance of digital innovation (Vera & Crossan, 2005). Aligning innovation with market needs through adaptable practices does lead to improved digital innovation performance by entrepreneurial firms (Sambamurthy et al., 2003). Adaptable improvisation characteristics allow firms to adapt processes, integrate feedback, and make more informed decisions (M. P. Cunha et al., 2010). Organizational improvisation improves and expands joint efforts by increasing the interaction among a firm's staff. As a result of these combined actions, organization employees are likely to achieve more advantageous encounters (Bandura, 1998). Such interaction is considered the essential driver for digital innovation (Fultz & Hmieleski, 2021).

Furthermore, organizational improvisation enables knowledge workers to understand and examine a firm's decision-making within uncertain environments; also, they require agility and intuitive action (Hadida et al., 2015). This enables knowledge workers to improve their intuition and expertise, enhancing organizational engagement and productivity. Additionally, the staff can make better use of existing resources by leveraging advanced digital technologies. This includes utilizing insights from big data reports to understand customer preferences; applying analytics to improve decision-making; and, in the health care setting, implementing telemedicine to extend health care services to remote rural areas within the public health care system (Fultz & Hmieleski, 2021). Knowledge workers can integrate their digital work and processes to develop innovative products and services. Such knowledge workers' productivity utilizing different supporting factors and methods, such as the provision of digital job resources, can ultimately lead to improved organizational innovation performance and creativity (Kianto et al., 2019). An essential principle of the staff's productivity is their effective utilization of knowledge to bring about ground-breaking innovations that satisfy the customers' requirements (Tariq et al., 2024).

H1: *Organizational improvisation has a significant impact on digital innovation performance.*

H2: *Organizational improvisation has a significant impact on knowledge workers' productivity.*

The mediating role of knowledge workers' productivity

Organizational improvisation significantly influences innovation performance by enhancing the workforce's productivity. Because of discontinuities in organizations' work procedures and operations due to digital transformation and other market disruptions (Jancenelle & Buccieri, 2023), organizations have improvised and developed new ways of working (Amankwah-Amoah et al., 2021). The improvisational capabilities of a firm create a flexible environment that enables the knowledge workers to apply their cognitive skills effectively (Vera & Crossan, 2005). This environment empowers knowledge workers to create and implement ideas emerging from internal sources and unforeseen external market conditions (Amabile & Kramer, 2011). Eventually, they contribute innovative ways of performing business operations, such as delivering online lectures in the education sector, using telemedicine in the health care sector, and providing online customer services in retail and IT. Thus, organizational improvisation enables knowledge workers to improve

their idea generation and productivity and enhance digital innovation performance.

As the driving force behind innovation, knowledge workers' productivity plays a crucial role in creating new knowledge, manifesting in developing innovative products and services (Nisula & Olander, 2023; Tariq et al., 2024). Cognitive abilities and intellect are the knowledge workers; attributes (Iazzolino et al., 2017; Taura & Radicic, 2019), which they utilize in combination with continued organizational improvisation to exploit the opportunities that emerge from unforeseen market conditions (Palvalin et al., 2017). In this regard, Tortora et al. (2021) argue that knowledge creation by knowledge workers is a crucial capability that plays a pivotal role in digital innovation. If knowledge workers are more productive, they can contribute more to organizational innovation objectives and operational efficiency (Gil-Gomez et al., 2020). Knowledge workers‘ use of existing knowledge and creation of new knowledge by paves the way for innovation performance (Eerme & Nummela, 2019). However, these sources of knowledge need effective organizational support through continuous improvement and reconfiguration of resources—organizational improvisation—to generate effective new knowledge (Song et al., 2022). Moreover, knowledge workers are well integrated in the market, in which they can access their network, within or outside the organization, and access the resources needed for innovation (Grant, 1996). In addition, relying on their network, knowledge workers can seek solutions to emerging opportunities more effectively, opening the door to improve and provide better digital innovation solutions.

H3: *Knowledge workers' productivity mediates the relationship between organizational improvisation and digital innovation performance.*

Resource constraints and knowledge workers' productivity

Previous research has implied that plentiful resources are vital for entrepreneurial innovation (Kanze et al., 2018). Established firms and new ventures face a scarcity of resources, such as finances, aptitudes, time, investigation, and execution (Levallet et al., 2023; Yang et al., 2020), that are needed for organization improvisation. Better performance can be achieved through efficient resource utilization (Grimmer et al., 2017). In line with existing research, we argue that limited resource availability inspires employees to develop creative options leading to a robust workplace culture for new ideas (Acar et al., 2019; Deakins & Bensemann, 2019). Moreover, limited resources encourage workers to develop innovative solutions based on their knowledge, skills, and capabilities to recombine existing resources. This encourages knowledge workers to utilize existing resources within the organization and find solutions to digital

innovation challenges while delivering better performance despite resource limitations (Ravishankar & Gurca, 2015). Additionally, resource constraints inspire knowledge workers to improve processes, recombine existing resources, and utilize their collaborative networks in a way that facilitates organizations to overcome resource barriers and achieve the desired outcomes. Suppose there are limited resources for the organizations to apply improvisational measures. In that case, knowledge workers can perform their tasks better through efficient knowledge acquisition and creation and the sharing of the reconfigured resources that improve productivity (Ahmed et al., 2021).

However, limited resources can organizations' ability to improve, which may negatively impact the productive organizational behavior of knowledge workers (Shujahat et al., 2019). Lack of resources stops knowledge workers from staying true to their creative nature and bringing better work results. For instance, a lack of resources to properly store and share knowledge (Sumbal et al., 2021) leads to nonsupportive job design practices and a lack of the proper training. Essential resource shortages create bigger performance problems for knowledge workers at work. Having limited resources reduces an individual's capacity to use their strengths at work and results in anxiety, stress, and frustration that harms their job performance (Levallet et al., 2023). Thus, having more-limited resources hinders the positive effect that improvisation may produce on knowledge workers' productivity. M. P. E. Cunha et al. (2017) viewed higher resource constraints as an obstacle to improvisation and a condition that lessens the degree of freedom; whereas, having more resources brings greater opportunities to pursue the innovative ideas that the workers create.

H4a: *Higher resource constraints weaken the effect of organizational improvisation on digital innovation performance.*

H4b: *Higher resource constraints weaken the effect of organizational improvisation on digital innovation performance via knowledge workers' productivity.*

Methodology

For three reasons, we collected data from 308 managers of digital (IT and software industry) entrepreneurial firms in Pakistan. Firstly, the IT sector in Pakistan is one of the fastest-growing segments of the economy, contributing substantially to the GDP and employment. Moreover, the IT and software industries contribute significantly to the country's exports. Accordingly, many international companies have established their offices in Pakistan to access the benefits of enhanced digital innovation performance at the expense of the

lower cost for highly skilled workers (Faiz, Sarwar, Tariq, & Memon, 2024; Jahan et al., 2019). Small firms (IT and software) are important in today's landscape of billion-dollar startups (Faiz, Sarwar, Tariq, Jordao, et al., 2024). Pakistan's entrepreneurial businesses have grown significantly, with a 63% increase in deals between 2020 and 2021. In 2021, ventures raised $350 million through 83 deals (Faiz, Sarwar, Tariq, Jordao, et al., 2024). Thus, this study's focus on the IT and related software industry is appropriate, given that most high-value entrepreneurial firms belong to the tech sector and tend to have significant growth potential (Faiz, Sarwar, Tariq, Jordao, et al., 2024). Secondly, creative solutions provided by Pakistani IT entrepreneurial enterprises are an mportant force behind the digital transformation of a wide range of industries, facilitating the improvement of their productivity and efficiency. Additionally, they are essential in helping Pakistan establish itself as a strong competitor in the international technology market and attract partnerships and foreign investment (Shujahat et al., 2019). Thirdly, the unique challenges and opportunities these firms face, such as international competition, regulatory environments, and having to secure talent and finances, provide a rich context for studying entrepreneurial dynamics. Therefore, the concept and practice of organizational improvisation can be easily observed in this sector. Similarly, knowledge workers' productivity is relevant to this sector as it requires them to create and deliver innovative products and services with limited resources per the customers' demands (Tariq et al., 2024).

To pretest the survey's questionnaire, industry and subject-matter academic experts from relevant fields were asked to share their feedback. Using such feedback, we adjusted the survey according to the industry context and established the content validity. A pilot survey was then conducted, and responses from 35 professionals in the IT industry were collected to check the employed scales' reliability. We found that the constructs' reliability values exceed the threshold level of 0.7. Thus, we then launched the full-scale survey (Faiz, Sarwar, Tariq, & Memon, 2024). To select the sample, we focused on IT firms in cities in which such firms are mostly entrepreneurial and introduce novel products and solutions following customized solutions required by their customers. These entrepreneurial firms also permit the emergence of different viewpoints and various aspects of entrepreneurship and flexibility. These include particular attention to processes that clarify the acceptance of ideas and an adaptable, agile structure for the adoption and application of digital innovation (Mehmood et al., 2021). Thus, based on the above, we focused on IT firms that promote the emergence and development of novel ideas and take a flexible approach to encouraging creativity and digital innovation.

We collected data from 308 middle- and senior-level managers of IT firms because they were the best informants to evaluate their firm's degree of organizational improvisation, resource constraints, and innovation performance and how resource constraints impact their productivity. Due to the

strategic role of translating organizational vision into operational realities, middle and senior managers are well-placed to evaluate the extent of improvisation and resource scarcity (Hornsby et al., 2002). The dual perspective allows them to understand how resource constraints influence the organization's higher-level objectives and day-to-day operations. Moreover, these managers are frequently involved in providing leads for improvisation and their experience and higher decision-making authority enable them to make faster but well-coordinated decisions in times of greater uncertainty (Huy, 2002). Their holistic view, gained from access to cross-departmental insights and performance metrics, enables them to evaluate how constraints or improvisation affect the outcome across different organizational levels. These special roles and tasks make them best suited to evaluating the organizational improvisation and resource constraints (Ahearne et al., 2014).

We collected data for almost three months at the end of 2022 using the following strategy. First, we collected data by sending an online questionnaire to the managers of the IT firms. However, we received only a limited number of responses. Next, to collect a satisfactory number of responses for reliable data analysis, we manually collected the data by personally visiting the offices of these SMEs. The participants were informed that their answers in this study would remain anonymous and confidential and that their participation was voluntary and subject to informed consent (Faiz, Sarwar, Tariq, & Memon, 2024). Finally, 308 valid responses were used for data analysis. Table 1 provides the characteristics of the respondents, who have a wide range of experience and educational backgrounds.

We applied different methods to minimize any possible difficulties caused by common method bias. Initially, preremedial measures were implemented during the data-gathering stage. As a result, we attached a cover to each questionnaire to explain the study's goal, assure data confidentiality, and ask the respondents to answer truthfully because there is no true or wrong response. Moreover, a single Harman test was used to determine that no common method bias existed. The information

Table 1. Respondent characteristics.

Demographic Variable	Code	Number
Qualification	Bachelors	92
	Masters/MS/MPhil	200
	Others	16
Years of experience in the current company	0–2	96
	2.5–5	91
	5.5–10	74
	10.5–15	39
	>15.5	8
Years of experience in the position	0–2	164
	2.5–5	105
	5.5–10	26
	10.5–15	13

indicated that a single component could only account for 36.79% of the variation, which is less than the 50% cutoff number, confirming that there is no issue of common technique bias (Faiz, Sarwar, Tariq, & Memon, 2024. Additionally, the indices of model fitness by the four-factor model are greater than the recommended value (Hair et al., 2014) compared to the single-factor model. These three techniques demonstrate that the current study does not suffer from common method bias.

Measurement

We applied existing validated measurement scales from literature using a 5-point Likert scale from 1 = low agreement to 5 = high agreement. Complete measurement scales for each construct of this research are given in Appendix A. The scales and measurements used exhibited satisfactory reliability values (Table 1).

Organizational improvisation (α = 0.872)

The Fultz and Hmieleski (2021) scale for organizational improvisation was adopted. A sample is "We develop and execute novel strategies/approaches for our work at the moment."

Knowledge worker productivity (α = 0.851)

We used Palvalin et al.'s (2015) scale to measure knowledge worker's productivity. A sample is "I can use the majority of my working time to conduct relevant tasks related to my goals." A 5-point Likert scale is used where 1 = strongly disagree and 5 = strongly agree.

Resource constraints (α = 0.926)

We adopted the Desa and Basu (2013) six-item scale to measure the tangible resource constraints (physical and financial resources) and the intangible ones (organizational, reputational, human, and social resources). A 5-point Likert scale was utilized where 1 = strongly disagree and 5 = strongly agree.

Digital innovation performance (α = 0.879)

We measured digital innovation performance using the six-item scale from Khin & Ho (2018) and Tariq et al. (2024) who adopted the measures of Paladino (2007). The changes were made to the measure based on the suggestions from pretesting panels to fit the measured items in the research context.

Data analysis technique

We employed Hayes' conditional process modeling technique in IBM AMOS 23.0 software. This technique is appropriate for testing our research model, composed of mediation and moderated-mediation hypotheses. Hayes's process analysis has an advantage over other approaches as it does not require the selection of potentially arbitrary conditional values (Hayes, 2017). This data analysis technique has been used in recent and renowned subject matter

Table 2. Conditional process analysis.

Variable	Model (1) (SE) Dependent Variable (DIP)	Model (2) (SE) Dependent Variable (KWP)	Model (3) (SE) Dependent Variable (DIP)
Constant	3.042 (0.272)***	4.456 (0.025)***	2.578 (0.356)***
OI	0.256 (0.061)	0.298 (0.041)***	0.075 (0.061)
RC		−0.161 (0.030)	−0.255 (0.044)***
KWP			0.351 (0.080)***
OI x RC		−0.070 (0.047)	−0.213 (0.065)**
F	17.544***	37.038***	29.958***
R square	0.233	0.2677	0.2778
Δ *R* Square			0.042

	RC	Effect	SE	LLCI	ULCI
Conditional direct effect of OI on KWP	−0.892	0.264	0.092	0.084	0.445
	−0.058	0.087	0.062	−.035	0.209
	0.868	−.110	0.075	−.257	0.038
	RC	Effect	BootSE	BootLLCI	BootULCI
Conditional indirect effect of OI on DIP via KWP	−0.892	0.126	0.0389	0.059	0.210
	−0.058	0.106	0.0297	0.051	0.167
	0.868	0.083	0.0282	0.031	0.141

Note. $n = 308$, OI = organizational improvisation, RC = resource constraints, KWP = knowledge worker productivity, DIP = digital innovation performance, SE = standard error, LLCI: lower level of the 95% confidence interval; ULCI: upper level of 95% confidence interval; *$p < .05$; **$p < .01$, ***$p < .001$.

studies (Faiz, Sarwar, Tariq, & Memon, 2024; Sharma et al., 2022). To observe the direct effect, we employed linear regression in addition to Hayes, as given in Table 2, Model 1. This technique allowed us to examine the indirect effects of organizational improvisation on digital innovation performance via the mediating role of knowledge workers' productivity at various levels of resource constraint.

Results

Measurement model

Table 3 shows values for the standardized loadings from the confirmatory factor analysis (CFA), composite reliability (CR), Cronbach's α, and the average variance extracted (AVE) that provides evidence of sufficient reliability and convergent validity of the constructs. We did not find any issue in terms of construct validity, and all the items were loaded in the corresponding constructs (refer to Table 3). Also, we ensured convergent validity through the average variance extracted (AVE) (refer to Table 3). The AVE values of all the constructs exceeded the threshold value of 0.5 (refer to Table 3). Moreover, the composite reliability of all the variables exceeded 0.7, which confirms adequate convergent validity and reliability. Furthermore, the measurement model shows a good fit—that is, the data fit well with the study's research model in Figure 1 ($\chi 2 = 356.244$, df = 162, RMSEA = 0,062, CFI = 0.950, and GFI = 0.898) (Majid et al., 2023).

Table 3. Convergent validity analysis.

Construct	Label	Loadings	Cronbach's α	CR	AVE
Organizational Improvisation	OI1	0.83	0.872	0.876	0.64
	OI2	0.84			
	OI3	0.73			
	OI4	0.8			
Knowledge Worker Productivity	KWP1	0.69	0.851	0.845	0.523
	KWP2	0.77			
	KWP3	0.82			
	KWP4	0.7			
	KWP5	0.62			
Digital Innovation Performance	DI1	0.9	0.879	0.876	0.591
	DI2	0.89			
	DI3	0.71			
	DI4	0.64			
	DI5	0.65			
Resource Constraints	RC1	0.83	0.926	0.928	0.684
	RC2	0.74			
	RC3	0.79			
	RC4	0.86			
	RC5	0.82			
	RC6	0.91			

Composite reliability (CR) and average variance extracted (AVE).

Table 4. Descriptive analyses and correlations.

	Mean	SD	1	2	3	4
1. OI	4.41	0.62	**0.8**			
2. KWP	4.46	0.49	0.436**	**0.723**		
3. DIP	4.17	0.68	0.233**	0.402**	**0.769**	
4. RC	1.89	0.83	−0.256**	−0.372**	−0.428**	**0.827**

OI = organizational improvisation, RC = resource constraints, KWP = knowledge worker productivity, DIP = Digital Innovation Performance, SD = Standard Deviation, $n = 308$.
$p < .1$; **$p < .05$; ***$p < .001$.

Descriptive statistics and correlations

The descriptive statistics and relationships for each variable are shown in Table 4. All variables' correlation values are below the 0.7 threshold level, supporting the hypotheses. Moreover, the research did not find any multicollinearity issues, as all the variables' variance inflation factor (VIF) values are between 1.181 and 1.464, well below the threshold level of 10 (Tariq et al., 2023). Moreover, the correlation values show initial support for the result, as knowledge workers' productivity is strongly linked with organizational improvisation and digital innovation performance.

Hypotheses testing

The hypotheses testing results are presented in Table 2, consisting of three parts. Results are presented for three models. Model 1 reports the direct effect of organizational improvisation on digital innovation. In contrast, in Model 2, the impact of organizational improvisation, resource constraints, the interaction of organizational improvisation, and resource constraints are observed

relative to knowledge workers' productivity. In Model 3, the influence of all the variables and the interaction of organizational improvisation and resource constraints is provided regarding digital innovation performance. As recorded in Model 1, organizational improvisation positively influences digital innovation performance ($\beta = 0.256$, $p < .000$), which supports Hypothesis 1. The results in Model 2 show that organizational improvisation positively influences knowledge workers' productivity ($\beta = 0.298$, $p < .000$), which confirms Hypothesis 2. Higher knowledge workers' productivity leads to better digital innovation performance ($\beta = 0.351$, $p < .000$), as in Model 3. However, by including knowledge workers' productivity in Model 3, organizational improvisation does not lead to a significantly positive influence on digital innovation performance ($\beta = 0.075$, $p > .05$), which shows that knowledge workers' productivity fully mediates the relationship between organizational improvisation and digital innovation performance, thus, confirming H3. The results show that resource constraints' interaction with organizational improvisation significantly influences digital innovation performance ($\beta = -0.213$, $p < .001$) in Model 3. However, this interaction does not influence knowledge workers' productivity ($\beta = -0.047$, $p > .1$) indicated in Model 2. Additionally, Model 3 in Table 2 has a higher explanatory power, as shown by its R-square value of 0.2778, which suggests that organizational improvisation and knowledge workers' productivity, along with resource constraints, are key factors explaining digital innovation performance by entrepreneurial firms.

The second part of Table 2 provides the conditional direct effect of organizational improvisation on digital innovation at three levels of resource constraint (low, moderate, and high). The results indicate that the influence of organizational improvisation on digital innovation is only significant at a low level of resource constraint −0.892 and confidence interval [0.084, 0.445], which does not include zero. However, with an average and higher value of resource constraint, the influence of organizational improvisation on digital innovation is not significant, as the confidence interval at both levels includes zero. With an increase in resource constraints, the positive impact of organizational improvisation on digital innovation performance diminishes, even turning negative at higher levels of constraints. As hypothesized in H4a, based on the results in Table 2 and Figure 2, we revealed that increasing resource constraints reduces the strength of the positive indirect effect of organizational improvisation on digital innovation performance.

In the third part of Table 2 the conditional indirect effect of organizational improvisation through knowledge workers' productivity is provided for the case of digital innovation performance with a moderation of resource constraints. The results indicate that the indirect effect of organizational improvisation on digital innovation performance combined with the mediating role of knowledge workers' productivity is significant at all three levels of resource constraint. The results indicate that as resource constraints increase, the

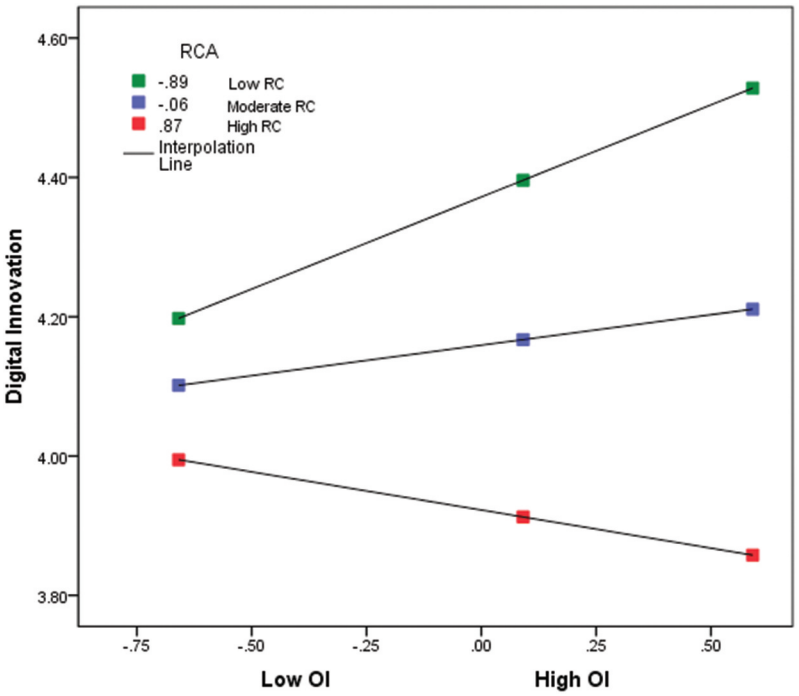

Figure 2. Interaction of organizational improvisation with resource constraints on digital innovation performance.

positive indirect effect of organizational improvisation on digital innovation performance through knowledge workers' productivity diminishes. Although the effect value remains positive, it decreases with increased resource constraints. As hypothesized in H4b, we reveal in Table 2 and Figure 3 that increasing resource constraints reduces the strength of the positive effect of organizational improvisation on knowledge workers' productivity. In other words, when resource constraints are lower, organizational improvisation enhances digital innovation performance more effectively via knowledge workers' productivity.

Discussion and implications

Organizational improvisation is discouraged in traditional command and control organizations that pursue higher profitability (Fisher & Barrett, 2019). However, it has gained attention in entrepreneurial set-ups to capture unexpected opportunities with limited resources (Fultz & Hmieleski, 2021). Drawing on the dynamic capability theory, we examined how organizational improvisation as an organization's dynamic, adaptive capability in the digital entrepreneurial context leads to higher digital innovation performance. The results indicate that organizational improvisation generates improved digital

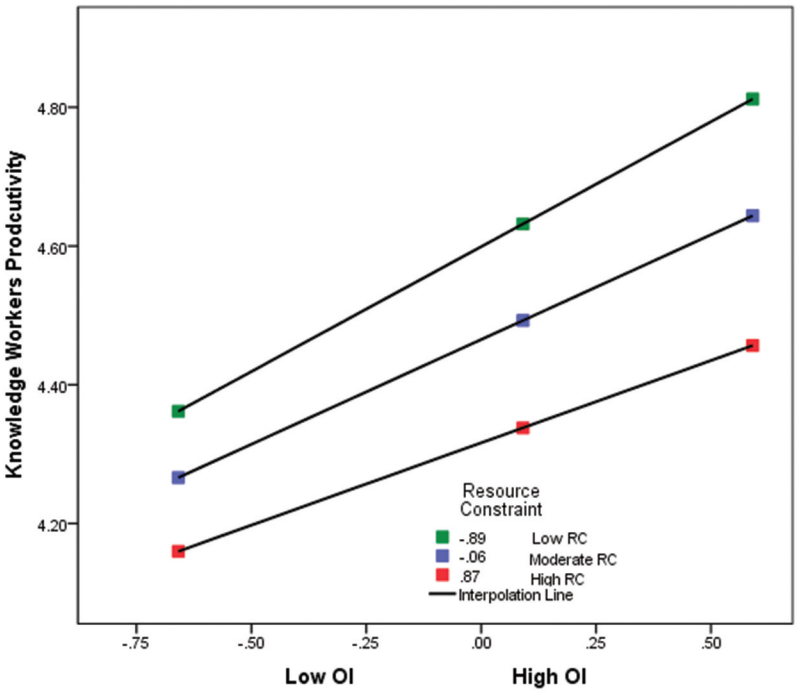

Figure 3. Interaction of organizational improvisation with resource constraints on knowledge worker productivity.

innovation performance by enabling entrepreneurial firms to respond actively and seize opportunities through integrating feedback, increasing interaction, improvising processes and resources, and making decisions in informal settings. This finding aligns with the literature, which consistently highlights the positive impact of organizational improvisation on various organizational outcomes, particularly within entrepreneurial settings (Fultz & Hmieleski, 2021). Research suggests that organizational improvisation fosters adaptability and responsiveness by allowing some recombination of existing resources and increasing interaction among the workforce to capitalize on emerging opportunities (Baker, 2007; Fultz & Hmieleski, 2021; Moorman & Miner, 1998).

Secondly, small business success depends on knowledge workers who introduce novel ways to create value and use organizational adaptability to create new products, processes, and methods (Ali et al., 2022; Amabile & Kramer, 2011; Tariq et al., 2024). Research findings indicate that organizational improvisation leads to better digital innovation performance through knowledge worker productivity improvements, as they help to shape the value of improvisation in digital entrepreneurial firms. Thus, this study explains how improvisation improves the performance of smaller firms in digital innovation. These results are consistent with research emphasizing the

beneficial mediating and enabling role of knowledge workers' productivity in the relationship between improvisation and digital innovation performance (Ali et al., 2022; Tariq et al., 2024). The way knowledge workers handle uncertain tasks helps small digital businesses achieve better digital innovation results through improvisation strategies (Fultz & Hmieleski, 2021; Hmieleski et al., 2013).

Thirdly, literature has recognized the significance of resource constraints in small organizations. It especially notes that improvisation can reshape, recombine, and improvise existing resources to utilize them more effectively (Baker, 2007; Baker et al., 2003). When resources are limited, employees must be innovative by using available resources better and transforming them into effective solutions (Acar et al., 2019; Deakins & Bensemann, 2019; Ravishankar & Gurca, 2015); however, a higher level of resource constraint can reduce the impact of productive behavior. Research shows that resource limitations decrease both organizational improvisation's direct impact on digital innovation results and its influence on performance through knowledge workers' productivity. When resource constraints are higher, they limit the positive impact of organizational adaptability and increased productivity on digital innovation. These results are opposite to those of previous studies indicating that under higher resource constraints, start-up ventures' greater improvisation is associated with their higher serendipity (Fultz & Hmieleski, 2021; Lynn & Reilly, 2008). Nevertheless, we studied organizational digital innovation performance, which, in contrast to organizational serendipity, requires conscious deliberation and effort by firms. Even with limited internal resources, knowledge workers can create or acquire the necessary knowledge individually or collaboratively. However, higher resource constraints impact the knowledge workers' capability to translate organizational improvisation into higher digital innovation performance.

Theoretical implications

Organizational improvisation is an important factor driving firms' digital innovation performance (Fisher & Barrett, 2019; Fultz & Hmieleski, 2021). We explore and contribute knowledge to the literature concerning organizational improvisation (Crossan et al., 2005) and the dynamic capabilities theory (Teece et al., 1997) that shows that organizational improvisation provides reconfigured resources with effective and efficient resources, such as digital technologies—AI, big data, and teleworking solutions—that enable organizations to pursue digital innovation performance. We initiate a new line of inquiry in digital entrepreneurship literature about how firms' dynamic capabilities, such as organizational improvisation, can use such firms' digital human resources to enhance digital innovation performance. By doing so, this research has contributed to literature that regards improvisation as an

important factor driving performance, particularly, in the context of entrepreneurial firms.

We have also contributed to the literature by explaining the mechanism that knowledge workers' productivity fully mediates the positive influence of organizational improvisation on digital innovation performance. It is an important line of research, and explaining how improvisation enhances digital innovation performance is pivotal. We have added to Drucker's knowledge workers' productivity theory (Drucker, 1999) which proposes that organizational improvisation leads to digital innovation performance via enhanced knowledge workers' productivity and does so by providing knowledge workers access to reconfigured resources, a flexible environment, and increased collaboration, and by by facilitating knowledge acquisition, (co-)creation, application, and codification. We implicate the importance of knowledge workers such that the introduction and use of digital resources, such as AI and big data, cannot replace them. They have a role in adopting and integrating such digital resources. Knowledge workers would still be crucial to the management of digital technologies and to knowledge creation and application in the outcome of digital innovation. Thus, our research extends prior research by integrating knowledge workers' productivity as an important mediator to explain organizational improvisation's influence on digital innovation performance.

The results concerning resource constraints contribute to recent discussions on integrating digital technologies and other resources for enhanced innovation performance in different theoretical fields (for example, corporate digital entrepreneurship, knowledge management, and digital technologies). These results indicate that providing resources to workers can facilitate their work to improve processes that can enhance productivity and digital innovation performance. In this regard, we contribute to the literature that supports the idea that higher resource constraints weaken organizational improvisation's positive direct and indirect effects on digital innovation via knowledge workers' productivity. Knowledge workers generate higher digital innovation with improvisation, even in limited resource settings; however, higher resource constraints weaken these relationships. Knowledge workers' productivity persists through collaboration and individual ingenuity; nonetheless, resource constraints are recognized as an important boundary condition to utilize the benefits of improvisation. Our overall research findings indicate that the influence of organizational improvisation on digital innovation performance is not straightforward and depends on the mediating mechanisms and boundary conditions.

Practical implications

These research findings have practical implications for digital entrepreneurial firms to want to maximize available resources through improvisation and

knowledge workers' productivity. Firstly, considering the positive impact of improvisation on digital innovation performance, leaders and managers of smaller firms may utilize improvisation effectively to explore and seize unexpected market opportunities. Improvisation should be considered a strategic dynamic capability enhancing the prospective benefits, as it is likely to provide the workforce environment required to improve processes and resources and generate the outcome of higher innovation. Improvisation could enable small enterprises to deal with unexpected challenges emerging from technology, markets, and customers. Furthermore, small enterprises may achieve benefits from knowledge workers' productivity through improvisation, as such knowledge workers are likely to be productive for small enterprises with semiformal or flexible environments. This requires entrepreneurs to gain some advantage by focusing on planned outcomes, such as higher digital innovation performance, rather than establishing a rigid structure and routine that discourages productivity (Fultz & Hmieleski, 2021). Such flexible environments also support knowledge workers in accessing the necessary tools, training, and collaborative opportunities that foster productivity. Entrepreneurs and leaders should also encourage a flexible environment for knowledge workers to overcome limited resource constraints as small enterprises typically have more-limited resources than larger firms. Knowledge workers can create novel ideas, and their knowledge is likely to overcome such constraints; however, it should not be confused with higher resource constraints, as that could be discouraging and have negative consequences. A lack of access to essential tools, training, and other resources may weaken the influence of improvisation on digital innovation performance via knowledge workers' productivity.

Conclusion

The ability to adapt and find innovative solutions in unpredictable conditions is essential for the success of entrepreneurial firms. We explore and find at the intersection of the dynamic capability theory and Drucker's knowledge worker productivity theory that organizational improvisation and knowledge workers' productivity are crucial to enhancing digital innovation performance. We reveal that organizational improvisation enables digital innovation performance by enhancing knowledge workers' productivity such that they do not let firms' resource constraints get in the way of productivity. We also find that the positive effect of organizational improvisation on digital innovation performance via knowledge workers' productivity varies depending on the resource constraints that firms face. High resource constraints mitigate the strength of the positive effect of organizational improvisation on digital innovation performance by entrepreneurial firms. Therefore, we recommend improvising as a strategic dynamic capability to achieve potential benefits and

enhance digital innovation performance. In addition, firms should invest in human digital capital so that knowledge workers in digital working environments can overcome any adverse effects of firms' resource constraints on workers' productivity.

Limitations and future research

We caution that this study's context of Pakistan's software and IT industry limits the generalizability of the findings. We offer the following avenues for future research. Firstly, our study context is the IT industry of Pakistan, which is a developing economy. Future studies may replicate our findings in developed economies and other industries for better generalizability. Secondly, future research may use the case study method to explore the intricacies, causes, and effects of digital organizational improvisations on firms' digital innovation performance. We recommend a longitudinal research design with a large data set providing more generalizable research findings that establish a better causal direction. Future studies are encouraged to run controlled experiments that establish better causation and should include essential control variables. Thirdly, we focus on knowledge workers' productivity as an intervening variable to explain the relationship between network capabilities and digital innovation performance. Future research can explore other important intervening factors in this relationship. It would be particularly intriguing to investigate if the interaction between knowledge workers and knowledge acquisition through artificial intelligence and other emerging technologies positively and considerably delineates this relationship. Fourthly, future work can go beyond resource constraints and explore other boundary conditions, such as ecosystem leadership and e-leadership. Moreover, future studies may differentiate between intangible and tangible resource constraints, the quality and quantity of knowledge workers' productivity, the ex ante aspect of knowledge workers' productivity regarding knowledge workers' personal knowledge management, and (counter) productive behavior. Lastly, we suggest that future studies may evaluate the effectiveness of and pursue the different ways of dealing with the challenge of resource constraints that every entrepreneurial SME faces more or less at the employee level (for example, employee empowerment to deal with resource scarcity), managerial level (for example, prioritization of technological innovation adoption), and firms' technical level (for example, leveraging the expertise of external partners and improving sustainable organizational performance).

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ORCID

Adeel Tariq http://orcid.org/0000-0002-4147-884X
Marina Dabić http://orcid.org/0000-0001-8374-9719

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Appendix A. Constructs and items

		Strongly Agree				Strongly Disagree
Organizational Improvisation						
1	We improvise solutions to problems.	5	4	3	2	1
2	We figure out actions as we go along.	5	4	3	2	1
3	We respond in the moment to unexpected problems.	5	4	3	2	1
4	We develop and execute novel strategies/approaches for our work in the moment.	5	4	3	2	1
Knowledge Worker Productivity						
1	I achieve satisfactory results in relation to my goals.	5	4	3	2	1
2	I am usually able to carry out my work tasks efficiently (smoothly, without problems).	5	4	3	2	1
3	My job mainly includes tasks in which I am able to exploit my knowledge and skills efficiently.	5	4	3	2	1
4	The quality of my work outputs is high.	5	4	3	2	1
5	The work group I work in works efficiently as a whole.	5	4	3	2	1
Digital Innovation Performance						
1	The quality and features of our digital solutions are superior compared to our competitors'.	5	4	3	2	1
2	The applications of our digital solutions are totally different from our. competitors'	5	4	3	2	1
3	Our digital solutions are different from our competitors' in terms of product platform (product platform is a collection of common technology elements that are used across multiple products to achieve competitive advantage).	5	4	3	2	1
4	Our new digital solutions are improvements of existing products.	5	4	3	2	1
5	Some of our digital solutions are new to the market at the time of launching.	5	4	3	2	1
Resource Constraints						
1	In general, our firm lacks sufficient . . .					
	Physical resources (e.g., equipment, technology, raw materials, physical location).	5	4	3	2	1
2	Financial resources.	5	4	3	2	1
3	Reputation resources (e.g., positive firm image, brand loyalty, brand equity).	5	4	3	2	1
4	Organizational resources (e.g., quality control systems, formal and informal planning systems, routines).	5	4	3	2	1
5	Human resources (e.g., individuals' education, training, experience, skills).	5	4	3	2	1
6	Social resources (e.g., useful relationships with other people or firms).	5	4	3	2	1