Impact of digital leadership on open innovation: a moderating serial mediation model

Tasneem Fatima and Afshan Masood

Abstract
Purpose – This study aims to examine the relevant but overlooked intervening role of knowledge sharing and innovation capability between digital leadership and open innovation. This study hypothesizes that top management knowledge value (TMKV) can strengthen the relationship between digital leadership and knowledge sharing. In line with the resource- and knowledge-based views, the serial mediation model explains how organizations can achieve open innovation through knowledge sharing and innovation capability development under digital leadership.

Design/methodology/approach – The research hypotheses were tested with survey data collected in four different rounds, separated by three to four weeks each, from 250 employees working in telecom and IT companies. The statistical analyses relied on the PROCESS macro, which enabled a simultaneous estimation of the direct, mediation and moderated mediation effects that underpin the proposed theoretical framework.

Findings – Results showed good support for the serial mediation model. TMKV was found a significant factor to improve knowledge sharing among employees.

Practical implications – The role of leadership is inevitable in the journey of organizational performance, and digital leadership has become a significant phenomenon in this regard. To achieve open innovation, organizations need digital leadership that induce knowledge sharing and innovation capability.

Originality/value – This study contributes to extant research by explaining how digital leadership induces knowledge sharing and innovation capability to achieve open innovation that is highly important to compete and outperform the rivals.

Keywords Digital leadership, Knowledge sharing, Top management knowledge value, Innovation capability, Open innovation

Paper type Research paper

1. Introduction

Open innovations are a very crucial part of organizations’ digital transformation (Wiesböck and Hess, 2020) and received much academic interest in recent years (Gupta et al., 2023). The firms need to depend on external information and research collaborations (Dahlander and Gann, 2010; Popa et al., 2017; Gupta et al., 2023) for continuous innovation in processes, products and services and increase competitive advantages (Singh et al., 2021). The impact of digital transformation on organizations and markets is quite visible and acknowledged in recent years (Cortellazzo et al., 2019). Researchers stated that organizations exist in the current competitive world because of innovation (Ahmad et al., 2020). So firms and organizations bring innovation in their methods, developments, business models, products and services in the presence of digital technologies (Nambisan et al., 2017). Extant research suggests that there is a need to study more mechanisms in the context of digital transformation and digital leadership (Mihardjo et al., 2019a). Driven by the increasing influence of technology on leadership, the phenomenon of digital leadership has gained much attention and interest in organizational studies.
Digital leadership is a new concept in the corporate world where management functions are achieved through digital platforms. Digital leadership is a mixture of digital culture and digital competence (Mihardjo et al., 2019b). For digital leadership, a leader must have strong orientation towards digital aspects of computing, and communication. This is quite similar to transformational leadership style having a focus on use of digital technology (De Waal et al., 2016). Recent research urges to examine how leadership behaviors and their focus on knowledge management practices could be related to open innovation (Singh et al., 2021; Zeike et al., 2019). Digital leadership could have a great impact on organizational innovation and to development of their business model (Mihardjo et al., 2019c). Innovation can be defined from two perspectives: traditional and knowledge-based innovation. The knowledge-based innovation has been more prominent as compared to traditional innovation concepts (Shujahat et al., 2019). Open innovation is a kind of knowledge-based innovation that can be defined as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation respectively” (Chesbrough, 2006). Previous investigation in this line of research found that organizational flexibility (Hienerth et al., 2011), organizational culture and employees’ characteristics (Appu and Sia, 2017; Huizingh, 2011), innovation climate (Popa et al., 2017; Sia and Appu, 2015) and innovation strategy influence open innovation. Moreover, the effect of leaders and their directions (West et al., 2003) play critical roles in open innovation but research is scarce that which type of leadership could be more appropriate for open innovation. In this study, we aim to examine how digital leadership predicts open innovation in organizations. Researchers suggested examining new mechanism that facilitates digital and open innovations (Wiesböck and Hess, 2020; Hameed et al., 2021). Recently, it is suggested to extend the model by including the role of organizational antecedents such as leadership style on knowledge sharing (Ahmad et al., 2020; Ouakouak and Ouedraogo, 2018; Usmanova et al., 2020).

We argue that knowledge-oriented leaders support knowledge management practices and promote aligned behaviors. Recent studies also highlighted to explore antecedents and outcomes of the knowledge management process (Del Giudice and Maggioni, 2014; Zaim et al., 2019). We argue that knowledge sharing could be an important mechanism between digital leadership and open innovation. According to Allameh and Khalilakbar (2018), knowledge sharing plays a key role in enhancing organizational innovation capabilities (Crupi et al., 2020). Previous studies report that knowledge sharing influences open innovation (Lee, Ooi, et al., 2010; Liu and Tsai, 2005), but it is important to study the precursors of knowledge sharing and open innovation (Hameed et al., 2021). Top management have an immense impact on the success of managing knowledge in the organization (Nguyen and Mohamed, 2011) that may help to develop innovation capabilities which are highly required for open innovation. We argue that knowledge sharing and innovation capabilities serially mediate the relationship between digital leadership and open innovation.

We further suggest that top management’s emphasis on valuing knowledge as strategic resources enhances the relationship between digital leadership and knowledge sharing. The top management knowledge value (TMKV) creates the environments that allow employees across functions to exercise and develop their knowledge manipulation skills (Crawford et al., 2003; Politis, 2002). It is evidenced that leaders who emphasize valuing knowledge help to promote knowledge sharing in the organization (Brunsicker and Chesbrough, 2018; Jarvenpaa and Majchrzak, 2016; Singh et al., 2021). It was also suggested in recent research to further examine the new moderators in open innovation models, i.e. various managerial levels contribution to different types of innovations; that is why, TMKV has been suggested as a moderator in the proposed model (Ahmad et al., 2020; Naseer et al., 2021).

We have used the resource-based view (RBV) and the knowledge-based theory (Penrose, 1959) that explain how different resources help to build dynamic capabilities to achieve
sustainable competitive advantage for organizations. Knowledge base theory explains the importance of knowledge as the most strategically significant resource of an organization and argues that the mixture of different pieces of knowledge will lead to particularly valuable innovations (Du Plessis, 2007).

The knowledge-based theory provides a better understanding of how knowledge sharing helps to develop dynamic capabilities (innovation capabilities) and hence achieve a competitive advantage in terms of open innovation. Therefore this study extends this literature by adding digital leadership as an antecedent of knowledge sharing, innovation capabilities development and open innovation.

This study contributes to advancing knowledge in the domain of open innovation in several ways. First, it suggests the role of digital leadership, knowledge sharing and innovation capability to predict open innovation. Second, the study supports how digital leadership and knowledge-sharing behaviors help in developing innovation capabilities. Third, the study predicts the role of knowledge sharing and innovation capability as serial mediators between digital leadership and open innovation linkage. Fourth, the study contributes to organizational literature by investigating the TMKV as a moderator that will strengthen the relationship between digital leadership and knowledge sharing. Finally, the study contributes by proposing moderating serial mediation model that suggests the interactive effective effect of digital leadership and TMKV on a serial mediation through knowledge sharing, innovative capability and open innovation. The proposed research model has been given in Figure 1.

2. Literature review

2.1 Theoretical foundation of the proposed model

Using the RBV and the knowledge-based view (KBV) of the firms, this study examines how firms use their strategic resources to support open innovation which is the highly required indicator for a sustained competitive advantage over the competitors. Based on the RBV, we argue that the distribution of valued resources and capabilities by a firm that is valuable and rare results in improved open innovation (Penrose, 1959).

Organizations hold assets that are valued, rare and hard for competitors to imitate. Moreover, organizations achieve a competitive advantage over competitors due to these intangible resources, as it is challenging for the competitors to acquire or duplicate similar
values and functions (Hitt et al., 2006). Organizations need to organize and synchronize their unique resources, capabilities and strategies to come up with innovative products/services to customers and outperform their competitors (Hitt et al., 2016). Therefore we infer that resources and capabilities in terms of knowledge sharing and innovation capabilities become essential for firms to engage in open innovation (Bridoux et al., 2011).

The KBV, which was derived from a RBV, explains how organizations use strategies to achieve competitive advantage by leveraging the potential of their knowledge workers and knowledge practices to achieve organizational outcomes. The KBV claims that knowledge is an important strategic resource for organizations and varies across organizations and is associated with the desired organizational outcomes (Grant, 1996).

Based on RBV and KBV we suggest that digital leadership is an important strategic resource for organizations that promotes knowledge sharing behaviors and practices in the organizations (Spender and Grant, 1996). As knowledge sharing is an important strategic resource we speculate that knowledge sharing helps to develop innovation capabilities that further drive open innovation (Khedhaouria and Jamal, 2015; Lin, 2007a, 2007b; Oliva et al., 2018; Santoro et al., 2018) that is a highly desired outcomes for the organizations. The top management value for knowledge and knowledge sharing are also extremely valued intangible resources (Al Ahbabi et al., 2018; Lin, 2007a, 2007b) that also helps to build innovative capability that is a dynamic capability for the organization. As RBV and KBV suggest that internal resources help the organization to develop dynamic capabilities that further help the organization to achieve the required sustained organizational performance. Therefore, we further argue that it becomes imperative for top management to value the knowledge that enhances digital leadership role in developing and sustaining knowledge sharing that further enhances innovation capabilities and open innovation as given in Figure 1.

3. Hypotheses

3.1 Digital leadership and open innovation

Larjovuori et al. (2016) defined digital leadership as “the leaders’ ability to create a clear and meaningful vision for the digitalization process and the capability to execute strategies to actualize it.” Many theorists define the term of leadership influences the actions of others when trying to achieve desired goals. The role of leadership is quite prominent to achieve innovation in the way the organization operates (Cuban, 1988).

Zhu (2015) described five characteristics of digital leadership: First, they are “Thought leaders,” which refers to having the capability to be resilient and strong to face market and competition change; second, “Creative leaders,” who have the creativity and innovation mindset and can formulate the idea into reality; third, “Global Visionary Leader,” who possess the ability to give direction and practically perform the digital business transformation; fourth “Inquisitive Leader,” who can learn to deal with multifaceted and dynamic ecosystem due to volatility, uncertainty, complexity and ambiguity (VUCA) factors; fifth “Profound Leader,” who possess the knowledge and detailed understanding how to decide by interpretation, assumption and synthesizing of information in making the decision. In this digital period, digital leaders perform in the global mindset to interconnect with each other and to be more creative to support the innovation culture in firms.

The relationship between digital leadership and innovation in the disruptive era shows that digital leadership influenced innovation (Kreutzer et al., 2017; Wasono and Furinto, 2018). The finding shows that digital leadership had a direct as well as indirect impact on business model innovation as part of the digital transformation.

Open innovation involves opting for new technology, information and ideas to produce a new product, process and services. It involves the utilization of knowledge to develop novel
products by finding internal and external resources to complement R&D (Rajapathirana and Hui, 2018). Digital leaders transform the organization through technology (Li, 2018) and strongly influence open innovation that is highly desired in the current competitive scenarios in the markets. As per RBV and KBV digital leaders are important resources for organizations who transform organizational digital and knowledge resources to open innovation that is an indicator of competitive advantage nowadays (Hitt et al., 2016).

According to these considerations, this study proposed the following hypothesis:

**H1. Digital leadership is positively associated with open innovation.**

### 3.2 Digital leadership, knowledge sharing and innovation capability

Wang and Noe (2010) referred to knowledge sharing as the provision of information regarding tasks and helping and collaborating with others to resolve issues and problems, new idea development or implement procedures. Knowledge sharing takes place in the form of written or face-to-face communication using networking with experts, documenting, organizing and acquiring knowledge for others. Knowledge sharing signifies the availability of relevant knowledge to coworkers and is an important practice of knowledge management (Wang et al., 2014). Investigation into the precursors of knowledge sharing related to leadership is still scarce (Lee et al., 2016; Wang and Noe, 2010; Wong and Aspinwall, 2005). Previous research argues that digital transformation helps organizations to achieve higher efficiencies as well (Gupta et al., 2023).

Leadership style act as a key driver for the knowledge management process among employees in the organization. Digital leaders initiate knowledge management practices in the organization due to their better know-how about technology. They transform the organization in technology and promote knowledge sharing to achieve the desired performance for the organization. They believe in using the latest technology to share knowledge among employees and document required knowledge to help workers to solve problems and create new ideas:

**H2. Digital leadership is positively associated with knowledge sharing.**

According to Adler and Shenhar (1990), innovation capability is defined as “(1) the capacity of developing new products satisfying market needs; (2) the capacity of applying appropriate process technologies to produce these new products; (3) the capacity of developing and adopting new products and processing technologies to satisfy future needs; (4) and the capacity to respond.” Innovation capability has also been explained as “an ability to understand and identify future customer needs, expectations and potential customers promptly and responding appropriately” (Rajapathirana and Hui, 2018). We argue that digital leaders help to develop innovation capability in the organization because of their ability to understand the latest and relevant required technology in the market. They possess the ability to be responsive to the market needs which are more relevant to technology and innovation. In other words, digital leaders make their employees and organization capable to produce new products according to market needs.

This study uses RBV and KBV to explain how digital leaders as a strategic resource help to develop organizational innovation capability to respond to the market competition (Penrose, 1959):

**H3. Digital leadership is positively associated with innovation capability.**

### 3.3 Knowledge sharing, innovation capability and open innovation

Knowledge sharing practices and behaviors involve making relevant information available to help others in problem-solving and creating new ideas (Cummings, 2004). Organizations cannot bring out knowledge management without involving the workforce in knowledge sharing. Knowledge sharing in organizations is essential for idea generation for innovative
organizational actions to respond to evolving business opportunities in the markets (Lundvall and Nielsen, 2007). Previous research supports that knowledge sharing leads to open innovation both inbound and outbound (Kothari and Wathen, 2013; Sarala et al., 2016). When there is an environment of knowledge sharing, employees/coworker share their knowledge ideas then new ideas develop. Knowledge sharing fosters the innovation processes at the individual (Bavik et al., 2018) and the organizational level (Donnelly, 2019; Oyemomi et al., 2019). Moreover, knowledge sharing helps to improve product and process innovation as well (Chatterjee et al., 2022). We argue that there is a missing link between knowledge sharing and open innovation in terms of innovation capability. Innovation capability is the capacity to bring new ideas and respond to customer and market needs. Knowledge sharing enables collaboration among group members and they become more capable to understand the market requirement. They build the capacity to respond to market needs and try to become more competitive. Organizations that have built innovation capability respond to customer requirements at minimum costs (Sher and Lee, 2004). Therefore, we hypothesized that:

H4. Knowledge sharing is positively associated with innovation capability.

H5. Knowledge sharing is positively associated with open innovation.

3.4 Innovation capability and open innovation

Innovation capacity refers to an overall capability of acquiring, developing and converting technology to innovations (Demirkan, 2018; O’Cass and Sok, 2014; Zawislak et al., 2012). An organization’s survival in a competitive market depends on its use of innovative capability to produce distinctive products and responsiveness to customer requirements (Aljanabi, 2020). Innovative capacity has been considered as an important antecedent of market competitiveness and performance (Wang et al., 2008). Innovation capability incarnates both technological developments which are manifested by operations capabilities and, managerial developments which are depicted in management and transaction capabilities (Lang et al., 2012; Zawislak et al., 2012). Both of these capabilities complement each other for new product development which is a source of the organization’s competitive advantage (Lang et al., 2012; Liao et al., 2007). The misalignment between technological and managerial capabilities (Teece et al., 1997) may result in impediments to new product development. Innovative firms constantly keep abreast of their rivals and market themselves through different organizational competencies that enable the development of innovative and new products that form the competitive landscape (Laforet, 2011; Tavassoli, 2017). Open innovation involves inbound and outbound innovations. Inbound open innovation involves scanning the environment for technology, information and ideas to supplement organizations’ R&D for new and novel product development. Whereas outbound open innovation explains how organizations collaborate outside the organization to use the latest technology and new product development (Sisodiya et al., 2013). The innovation literature argues that greater interaction with customers in the initial stages of product design leads to the acquisition of more knowledge that can be used to satisfy customers’ needs (O’Cass and Sok, 2014). In this line, Colombo et al. (2015) argued that innovation capability provides deep insights that allow firms to take advantage of current knowledge and skills and expand horizons to better understand potential customers’ needs required for new product development. Holtzman (2014) confirmed the significant role of IC in NPD within firms. Therefore, firms with high IC are more flexible in their responses to the constantly changing demands of the market (Sok et al., 2013) and are more likely to excel in NPD (Laforet, 2011; O’Cass and Sok, 2014). In line with the extant literature, we suggest that:

H6. Innovation capability is positively related to open innovation.
3.5 Mediating role of knowledge sharing between digital leadership and open innovation

Knowledge sharing is an essential part of knowledge management practices that enables the transfer of knowledge between different entities in an organization to use and generate knowledge that is required for innovative ideas generation. Knowledge sharing becomes more effective when maximum employees get involved in sharing and transferring their knowledge, thoughts, Understandings and experiences. Top leadership support, organizational norms and values can be antecedents of knowledge sharing (Shujahat et al., 2019). We suggest a leader having a transformational style with knowledge and experience of digital technologies like digital leaders could be an effective enabler of knowledge sharing practices and behaviors in the organization. Digital leaders are supposed to be more effective in the innovative performance of the organization. They are visionary and foresee technological transformations in the present and future and can make better decisions toward innovation. Due to their better understanding of internal and external potential factors that can better contribute to open innovation. This kind of leader uses digital transformational strategies to make learning organization which are better able to manage knowledge to achieve competitive performance too (Ruel et al., 2021).

The literature on open innovation suggests that knowledge sharing promotes innovation in organizations. In the same manner, studies also supported the role of knowledge sharing practices in open innovation (Cavaliere et al., 2015). We argue that digital leadership promotes open innovation by enabling knowledge sharing practices and behaviors. It is also suggested that through knowledge sharing enables learning in the organization that is highly required for innovative performance (Meher and Mishra, 2022). Furthermore, Digital leaders understanding and focus on the importance of knowledge sharing (Nguyen and Mohamed, 2011) makes it an important strategy to achieve open innovation. Therefore we suggest:

H7. Knowledge sharing mediates the relationship between digital leadership and open innovation.

3.6 Mediating role of innovation capability between digital leadership and open innovation

Leadership is one of the key elements and enabler of the knowledge management process required for innovation (Theriou et al., 2011). Leaders are the source to create an environment that allows participants to exercise and foster their knowledge management skills, to contribute their knowledge resources. Digital leaders are better able to build the capacity of the employees to understand the market demand for innovation and the capacity to respond to customer requirements. Recent research advocates the significant role of innovative capability in new product development and innovation (Holtzman, 2014). We suggest that digital leaders have a better understanding of technological developments in the market and help to build the innovative capability of employees to respond to the changing demand of the market (Sok et al., 2013) and be more likely to outperform in innovative performance (O’Cass and Sok, 2014). In line with the extant literature, we suggest that:

H8. Innovative capability mediates the relationship between digital leadership and open innovation.

3.7 Mediating role of innovation capability and open innovation

Digital leaders transform the organization with their digital competence and focus on knowledge management practices with a major focus on innovation (De Waal et al., 2016). Digital leadership has been more pronounced for its profoundness for innovation (Zhu, 2015; Mihardjo et al., 2019a). Digital leadership promotes digital culture and digital competence in the organization (Mihardjo et al., 2019b). The latest research suggests
explaining the underlying mechanisms of how digital leaders bring innovation prominently (Mihardjo et al., 2019c; Zeike et al., 2019).

We suggest the mechanism and argue that these leaders promote knowledge sharing practices by making knowledge available to all employees. They provide an opportunity for employees to discuss their experiences, thoughts and competencies. Digital leaders focus on digital aspects of internet computing, communication and have relevant content that is highly required for knowledge sharing. We further suggest that these practices help to further develop innovation capability more specifically the capacity of employees to know about the rapidly changing market demands of the customers and technology and make them competent to respond with innovative ideas. In the competitive landscape, innovative organizations outperform their competitors through their competencies and capabilities that enable them to produce innovative products (Tavassoli, 2017). Knowledge sharing helps to build both managerial and technological capacities. Sulistyo and Siyamtinah (2016) inferred that both managerial and technological innovation capabilities promote open innovation. In line with these arguments, we suggest:

H9. Knowledge sharing and innovation capability serially mediate the relationship between digital leadership and open innovation.

3.8 Moderation role of top management knowledge value

Delegating leaders are supposed to be effective in knowledge sharing practices as compared to directive leadership. In this study, we have suggested a positive relationship between digital leadership and knowledge sharing. Digital leadership is a combination of transformation and competency in digital technologies. We suggest that if the leader gives more value to knowledge management practices, the digital leaders will be better able to promote knowledge sharing practices in the organization. Recent research suggested TMKV is an essential precondition for knowledge sharing practices in the organization (Singh et al., 2021). Leaders who have knowledge orientation emphasize that knowledge management practice plays a prominent role in the organization, take advantage of opportunities for innovation (Donate and de Pablo, 2015) and are better able to respond to the dynamic competitive market. These leaders promote knowledge sharing practices and initiatives for knowledge exploration and exploitation (Donate and de Pablo, 2015) for open innovation. TMKV believes that knowledge sharing could be very effective for open innovation which is an indicator of competitive advantage for the organizations. Leaders who have a high value for knowledge in the organization have a strong tendency to create an internal environment in a manner that allows coworkers to exercise and nurture their knowledge sharing and manipulation abilities (Crawford et al., 2003; Del Giudice and Maggioni, 2014; Politis, 2002), which have been perceived vital for open innovation.

According to the RBV and KBV, knowledge as a unique strategic resource and organization as a dynamic entity continuously evolves through knowledge production and utilization (Spender and Grant, 1996). Therefore, if knowledge is the key strategic resource and allows firms to compete in the dynamic environment (Grant, 1996; Spender and Grant, 1996), it becomes important for top management to value knowledge and create and sustain knowledge sharing practices that foster open innovation. In line with this, we suggest that:

H10. TMKV will moderate the relationship between digital leadership and knowledge sharing such that the positive relationship will be strong in case of high TMKV.

4. Methodology

4.1 Participants and procedures

For data collection, a self-administered questionnaire was distributed among different telecom and IT-based organizations. The respondents were conveyed that they will
participate in the survey with their free will and consent. Even they could quit the survey at any time lag. Non-probability convenience sampling technique was used because the population was not known and accessible to the researcher. Moreover to have time-lagged data convenience sampling to assure multi responses of the same respondent at different time intervals. These participants were selected from different areas of Pakistan by using personal references that assured the four-time responses. The study intended to use a multi-wave research design where our independent, mediator, moderator and dependent variables were measured with a minimum gap of approximately seven days. This was done on the recommendations of Podsakoff et al. (2012) who believe that time-lagged research design reduces avoid common method bias. At the first time interval 300 self-administered questionnaires were distributed, of which 291 were received back. At time two, these 291 respondents were approached again to take responses for knowledge sharing and we got 275 responses. At the third time lag, we could receive 271 for innovative capability, and at the last time interval, we got 263 responses for open innovation. After excluding 13 responses of missing values, the final sample was 250 and the response rate was 75%. The sample size was adequate to analyze the model (Faul et al., 2009). Using the rule of thumb of five (no. of items in questionnaire × 5 = 28 *5) which is 140. Therefore sample of 250 is adequate because this is more than the required number of 140 responses. Among these participants, most were male (60%), having at least an undergraduate degree and average work experience of 5.81 years (SD = 3.06) years. A time-lagged design was used for this study, conducted four times, with a minimum gap of 7 days. In the first wave, we collected data for digital leadership (IV), TMKV (Mod) and demographic information. Knowledge sharing (Med 1) and innovation capability (Med 2) were measured at times 2 and 3, respectively. Finally, at time 4, responses for the dependent variable (open innovation) were collected. All the variables were measured as self-reported. To ensure a common method bias issue statistically, we used Harman’s single factor test. The analysis was done without rotations. The result revealed that the total variance extracted by a single factor for the sample was 39.21%, which was lower than the recommended threshold of 50%; therefore, there were no issues with common method bias in this research.

4.2 Measures

4.2.1 Digital leadership. Digital leadership was measured with a six-item scale drawn from Larjovuori et al. (2016) and were assessed by a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The sample item is, “He thinks using digital tools is fun.” Alpha reliability of this digital leadership was 0.74.

4.2.2 Top management knowledge value. The TMKV was measured by a six-item scale adapted from Davenport et al. (1998), Husted and Michailova (2002) and Cabrera and Cabrera (2002). Participants’ response rate was on a five-point Likert-type scale (1 = strongly disagree to 5 = strongly agree). Alpha reliability of this variable was 0.91.

4.2.3 Knowledge sharing. Knowledge sharing was measured by five-item scale referenced by Connelly and Kelloway’s (2003). Participants’ response rate was on a five-point Likert-type scale (1 = strongly disagree to 5 = strongly agree). Alpha reliability for knowledge sharing was 0.76.

4.2.4 Open innovation. The open innovation scale consisted of five items for inbound O.I. and four items for outbound O.I. adopted from and Sisodiya et al. (2013). The participants’ response rate was on a five-point Likert-type scale (1 = strongly disagree to 5 = strongly agree). Cronbach’s alpha reliability of this variable was 0.78.

4.2.5 Innovation capability. Innovation capability was measured by six-item scale (Adopted and modified from Lin, 2007a, 2007b). Each of the items had to be answered on a five-point Likert scale ranging from 1 “disagree completely” to 5 “agree on completely.” Alpha reliability of this construct was 0.82.
4.3 Data analysis for validity of measures

First of all CFAs were conducted for all possible pairs as recommended by to determine the best fit model. It was done to establish the convergent and discriminant validity of the measures. Results in Table 1 showed better fit for multiple factors ($\chi^2 = 726.40$, df = 451, $p < 0.001$; CFI = 0.90, GFI = 0.85, NFI = 0.78, RMESA = 0.05) as compared to one factor ($\chi^2 = 1261.67$, df = 447, $p < 0.001$; CFI = 0.71, GFI = 0.72, NFI = 0.62, RMESA = 0.08). These results established that all study variables are discriminant from each other having adequate convergent validity too.

5. Results

The mean (M) results, standard deviation (SD) and alpha reliabilities of all the study variables are given in Table 2. No controls were used in the study as ANOVA did not identify any considerable difference in our dependent variables (innovation capability and open innovation) concerning demographics more specifically firm size, firm age and industry. Therefore the study did not use any controls. It also addresses the presence of any possible endogeneity bias as well.

For testing hypothesized relationships, the study used SPSS 21 and AMOS 21. We used PROCESS macro to analyze all direct, mediation and moderation relationships. Model no. 6 and model 1 were used for sequential mediation and moderation, respectively.

As depicted in Table 3, our first direct hypothesis was about the relationship between digital leadership and open innovation. Based on the study results, the proposed relationship was significant ($B = 0.20$, $p = 0.001$). After that, $H2$ was proved, which was about the positive direct relationship between digital leadership and knowledge sharing as per the significant results ($B = 0.27$, $p = 0.00$). $H3$ suggested a positive relationship between digital leadership and innovation capability and results supported this hypothesis as well ($B = 0.21$, $p = 0.00$). $H4$ found also supported showing a significant relationship between knowledge sharing and innovative capability ($B = 0.17$, $p = 0.01$). Further, $H5$ predicted the positive relationship between knowledge sharing and the dependent variable. Results supported this hypothesis as the relationship of knowledge sharing with open innovation ($B = 0.34$, $p < 0.001$).

Table 1: Confirmatory factor analysis results

<table>
<thead>
<tr>
<th>Measurement models</th>
<th>$\chi^2$</th>
<th>df</th>
<th>$\chi^2$/df</th>
<th>CFI</th>
<th>NFI</th>
<th>GFI</th>
<th>RMR</th>
<th>RMSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 factor (DL,KS,TKMV)</td>
<td>178.946</td>
<td>116</td>
<td>1.543</td>
<td>0.962</td>
<td>0.900</td>
<td>0.924</td>
<td>0.049</td>
<td>0.04</td>
</tr>
<tr>
<td>1 factor (DL,KS,TKMV)</td>
<td>349.184</td>
<td>113</td>
<td>3.090</td>
<td>0.857</td>
<td>0.805</td>
<td>0.849</td>
<td>0.076</td>
<td>0.09</td>
</tr>
<tr>
<td>5 factor (DL,TKMV,KS,IC,OI)</td>
<td>726.395</td>
<td>451</td>
<td>1.611</td>
<td>0.903</td>
<td>0.783</td>
<td>0.854</td>
<td>0.054</td>
<td>0.05</td>
</tr>
<tr>
<td>1 factor (DL,TKMV,KS,IC,OI)</td>
<td>1261.67</td>
<td>447</td>
<td>2.823</td>
<td>0.714</td>
<td>0.623</td>
<td>0.718</td>
<td>0.096</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Notes: $N = 250$, where DL = digital leadership; TMKV = top management knowledge value; IC = innovation capability; OI = open innovation; KS = knowledge sharing
Source: The results are based on the survey done for this study

Table 2: Means, standard deviations, correlations and reliabilities for key study variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Digital leadership (Time 1)</td>
<td>4.12</td>
<td>0.59</td>
<td>(0.74)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. TMKV (Time 1)</td>
<td>4.14</td>
<td>0.83</td>
<td>0.19** (0.91)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3. Knowledge sharing (Time 2)</td>
<td>4.16</td>
<td>0.63</td>
<td>0.25** (0.76)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Innovation capability (Time 4)</td>
<td>4.37</td>
<td>0.55</td>
<td>0.28** (0.82)</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>5. Open innovation (Time 4)</td>
<td>4.03</td>
<td>0.60</td>
<td>0.20** (0.78)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: $N = 250$; Cronbach's alpha reliabilities are given in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's own
was significant. The results were also found significant for $H6$ that suggests a positive relationship between innovative capability and open innovation ($B = 0.16$, $p = 0.01$).

$H7$ proposed the mediation effect of knowledge sharing between digital leadership and open innovation; the results depicted a significant indirect effect for this hypothesis (indirect effect $= 0.09$; CI $[0.046, 0.168]$). Additionally, we hypothesized ($H8$) the mediating effect of innovation capability (second med) between digital leadership and open innovation. The indirect effect model supported this hypothesis as well (indirect effect $= 0.03$, CI $[0.006, 0.085]$).

Finally, the study proposed the serial mediation hypothesis, $H9$, depicting that knowledge sharing and innovation capability sequentially mediate digital leadership’s relationship with open innovation. Results in Table 3 illustrate that this sequential effect proved significant, i.e. (indirect effect $= 0.01$, CI $[0.001,0.024]$).

Finally, our last hypothesis $H10$ predicted that a positive relationship between digital leadership and knowledge sharing would be conditional upon TMKV. According to Table 4, DL × TMKV interaction was significant for knowledge sharing ($B = 0.11$, SE $= 0.05$, $p < 0.05$) with an incremental variance of 1.7%. The slope test reveals that this relationship is stronger at a high value of TMKV as suggested and shown in Figure 2.

6. Discussion and theoretical implications

The current study provides various theoretical contributions to existing research. First, we presented a positive relationship between digital leadership and outcomes, i.e. innovation capability and open innovation. Second, by using the sequential mechanism, this study suggests that organizational innovation cannot occur directly; it takes some time to create an environment of knowledge sharing and open innovation capability. Third, the study illustrated that knowledge sharing in an organization enhances employees’ innovation capability that may produce other positive outcomes. Fourth, this study contributed to knowledge management literature by examining the TMKV as a moderator between Digital leadership and knowledge sharing. Based on the resource-based theory and knowledge-based theory, results suggest that when there is a high level of TMKV, the positive relation between digital leadership and knowledge sharing will be more substantial and therefore it increases the innovative capability that give rise to the open innovation. The study also presented a theory-based mechanism to explain how digital leaders transform their organizations toward open innovation that is highly required in challenging and fast-paced business environment.

With an increase in the need for digital technology and innovation for the organization’s survival and growth, the research interest in the role of digital leadership in enhancing

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Regression analysis results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H no.</strong></td>
<td><strong>Effects</strong></td>
</tr>
<tr>
<td>$H1$</td>
<td>DL $\rightarrow$ OI</td>
</tr>
<tr>
<td>$H2$</td>
<td>DL $\rightarrow$ KS</td>
</tr>
<tr>
<td>$H3$</td>
<td>DL $\rightarrow$ IC</td>
</tr>
<tr>
<td>$H4$</td>
<td>KS $\rightarrow$ IC</td>
</tr>
<tr>
<td>$H5$</td>
<td>KS $\rightarrow$ OI</td>
</tr>
<tr>
<td>$H6$</td>
<td>IC $\rightarrow$ OI</td>
</tr>
<tr>
<td>$H7$</td>
<td>DL $\rightarrow$ KS $\rightarrow$ OI</td>
</tr>
<tr>
<td>$H8$</td>
<td>DL $\rightarrow$ IC $\rightarrow$ OI</td>
</tr>
<tr>
<td>$H9$</td>
<td>DL $\rightarrow$ KS $\rightarrow$ IC $\rightarrow$ OI</td>
</tr>
</tbody>
</table>

Notes: $N = 250$. DL = digital leadership; KS = knowledge sharing; IC = innovation capability; OI = open innovation; bootstrap sample size = 5,000. LL = lower limit, CI = confidence interval, UL = upper limit

Source: The results are based on the survey done for this study
innovation is burgeoning. Keeping in view its importance, researchers have called for more research to shed light on the effect of digital transformation, both at the organizational and individual level (Cortellazzo et al., 2019). Similarly, innovation researchers have also recommended conducting studies on important factors that might affect innovation in the current digitalized workplace (Popa et al., 2017; Bhatti et al., 2021). Another study suggested a need to shed further light on the intermediate links or mediated moderation relationships between leadership and innovation (Chang et al., 2019). We have responded to these calls by investigating the underlying mechanisms and boundary conditions that exist between digital leadership and open innovation.

**Table 4** Hierarchical moderated regression analysis

<table>
<thead>
<tr>
<th>Predictors</th>
<th>R</th>
<th>R²</th>
<th>Knowledge sharing Estimate</th>
<th>SE</th>
<th>LLCI</th>
<th>ULCI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.59</td>
<td>0.35</td>
<td>4.15***</td>
<td>0.03</td>
<td>4.09</td>
<td>4.22</td>
</tr>
<tr>
<td>DL</td>
<td>0.19</td>
<td>0.06</td>
<td>0.080</td>
<td>0.04</td>
<td>0.339</td>
<td>0.509</td>
</tr>
<tr>
<td>TMKV</td>
<td>0.42</td>
<td>0.04</td>
<td>0.339</td>
<td>0.309</td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>ΔR²</td>
<td>0.017</td>
<td>0.11</td>
<td>0.05</td>
<td>0.009</td>
<td>0.212</td>
</tr>
<tr>
<td>DL × TMKV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conditional direct effect of DL on KS at different moderator values (slope test results)**

<table>
<thead>
<tr>
<th>Moderator</th>
<th>Effect</th>
<th>SE</th>
<th>LLCI</th>
<th>ULCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMKV – 1 SD (−0.83)</td>
<td>0.10</td>
<td>0.06</td>
<td>−0.023</td>
<td>0.229</td>
</tr>
<tr>
<td>TMKV mean (0.00)</td>
<td>0.19</td>
<td>0.06</td>
<td>0.079</td>
<td>0.309</td>
</tr>
<tr>
<td>TMKV + 1 SD (0.83)</td>
<td>0.29</td>
<td>0.08</td>
<td>0.129</td>
<td>0.442</td>
</tr>
</tbody>
</table>

**Notes:** N = 250. DL = digital leadership; KS = knowledge sharing; TMKV = top management knowledge value; bootstrap sample size = 5,000. LL = lower limit, CI = confidence interval, UL = upper limit. *p < 0.05, **p < 0.01, ***p < 0.001

**Source:** The results are based on the survey done for this study

**Figure 2** Interactive effects of digital leadership and top management knowledge value on knowledge sharing

**Notes:** n = 250; TMKV = top management knowledge value; slope for low TMKV, (β = 0.13, ***p < 0.000); slope for high TMKV, (β = 0.26, ***p < 0.000)

**Source:** The graph is based on the survey done for this study
Based on the knowledge-based theory (Penrose, 1959), this study presented a sequential mediation model which anticipated the positive relationship between digital leadership and organizational outcomes (i.e. innovation capability, open innovation) through the dual mediating effect of knowledge sharing and knowledge utilization on the contingent effect of TMKV. This study supports the mediating mechanism of the knowledge management process and its constituencies (Le and Lei, 2018). These results are consistent with other studies that showed a positive association between positive leadership styles and innovation (Supermane, and2019; Wasono and Furinto, 2018; Zeike et al., 2019). This study further tested the moderating role of top management’s knowledge value between digital leadership and knowledge sharing. The results supported the moderation hypothesis leading to the conclusion that knowledge sharing enhances manifolds under the digital leadership if the top management gives high value to the knowledge. These results are consistent with existing literature which has highlighted the importance of TMKV in promoting positive employee outcomes (Singh et al., 2021).

To summarize, the results of the current study give strength to the notion that digital leadership is crucial to open innovation mainly because it not only promotes knowledge sharing which is crucial in today’s rapidly changing marketplace but also further enhances innovation capability which ultimately makes organizations the powerhouse for open innovation. The results of this study have also highlighted the significance of top management’s knowledge value in enhancing knowledge sharing under digital leadership.

7. Practical implications

The current study also provides several practical implications. It is evidenced that in the fourth industrial revolution is not possible without digital transformation which is essential for organizational performance (Marino-Romero et al., 2022). Organizational innovation in general and open innovation, in particular, has become strong indicator of organizational performance. The study suggests an effective path to achieve open innovation that helps the leaders and managers to adopt to achieve open innovation. Results suggest how leadership, mainly digital leadership contributes to organizational innovation and how it leads to knowledge sharing and knowledge utilization. Digital leadership is not always the same as digital; research says that a leader does not have to know digital in digital leadership. Because the leaders who are not very fluent or understand digital techniques but can create work related to technology, able to manage, to move highly competent people in the digital field to realize their goals, can be considered as the leader who has digital leadership spirit especially if they can balance the involvement between human resources and technology. Such leaders can make the technology useful for many people and the organization. It means that a great degree of such practicing leaders creates the organizational environment so that they give value to the knowledge and develop an environment in which knowledge sharing and its utilization are essential for organizational innovation. These leaders use digital transformational strategies to manage knowledge to achieve competitive performance toward innovation (Ruel et al., 2021).

Further, this study suggests that managers and leaders and top management should value the knowledge more to promote knowledge sharing in the organization to transform this important intangible resource into innovation capability which is dynamic in nature. It is also evidenced from the results that organizations having more innovative capabilities are better able to show open innovation which is highly demanded in the highly competitive business environment.

8. Limitations and future research directions

This study also has certain limitations. For future research, this study has some recommendations based on these limitations. First, the data about innovation and knowledge was taken only from
employees about their leaders and organization. Data should also be collected from leaders about their organizational innovation, knowledge sharing and innovation capability behavior. Second, data were collected in a time-lagged design to address common method bias but future studies should opt for a longitudinal design to examine causal relationships. Third, future researchers should study other mediating and moderating mechanisms in the relationship between digital leadership and outcomes such as contextual factors as moderators may play an effective role. For example, learning climate and relational climate could be effective boundary conditions that may work as a catalyst in the process of knowledge sharing and open innovation.

Few other variables may be considered related to the knowledge management process such as knowledge acquisition and knowledge utilization as underlying mechanisms as well. More specifically strategic agility should be studied as a mediator to foster strategic outcomes related to organizational innovation. Few more processes related to absorptive capacity should also be studies to explain leader’s important role in digital transformation. The study also suggests exploring more underlying mechanisms toward open innovation that is highly critical in the challenging business environment and economic pressures. In the future, multilevel models should also be studied to analyze individual contributions of knowledge acquisition and learning toward organizational learning and open innovation.

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Further reading


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