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Article

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Cogent Business & Management

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Suggested Citation: Nguyen, Nguyen Phong; Hoai, Tu Thanh (2022) : The impacts of digital transformation on data-based ethical decision-making and environmental performance in Vietnamese manufacturing firms: The moderating role of organizational mindfulness, Cogent Business & Management, ISSN 2331-1975, Taylor & Francis, Abingdon, Vol. 9, Iss. 1, pp. 1-20, <https://doi.org/10.1080/23311975.2022.2101315>

This Version is available at:

<https://hdl.handle.net/10419/289069>

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To cite this article: Nguyen Phong Nguyen & Tu Thanh Hoai (2022) The impacts of digital transformation on data-based ethical decision-making and environmental performance in Vietnamese manufacturing firms: The moderating role of organizational mindfulness, Cogent Business & Management, 9:1, 2101315, DOI: [10.1080/23311975.2022.2101315](https://doi.org/10.1080/23311975.2022.2101315)

To link to this article: <https://doi.org/10.1080/23311975.2022.2101315>



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Received: 28 January 2022
Accepted: 09 July 2022

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Reviewing editor:
David McMillan, University of Stirling, Stirling, UK

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ACCOUNTING, CORPORATE GOVERNANCE & BUSINESS ETHICS | RESEARCH ARTICLE

The impacts of digital transformation on data-based ethical decision-making and environmental performance in Vietnamese manufacturing firms: The moderating role of organizational mindfulness

Nguyen Phong Nguyen¹ and Tu Thanh Hoai^{1*}

Abstract: Using the contingency theory of decision-making and a natural-resources-based view (NRBV) of the firm, we developed and tested a moderated mediation model examining (1) the impact of digital transformation on environmental performance (EP) via the mediating mechanism of data-based ethical decision-making (DEDM) and (2) the moderating role of organizational mindfulness in the effect of digital transformation on DEDM. The results of an analysis of 466 Vietnamese manufacturing firms indicate that DEDM mediates the impact of digital transformation on environmental performance. Moreover, the positive relationship between digital transformation and DEDM grows stronger as an organization's mindfulness level increases. The findings contribute to a more nuanced understanding of how digital transformation and organizational mindfulness play a vital role in environmental management practices.

Subjects: Business, Management and Accounting; Corporate Social Responsibility & Business Ethics; Business Ethics

Keywords: Data-based ethical decision-making; digital transformation; environmental performance; organizational mindfulness; Vietnam

1. Introduction

Economic globalization has compelled firms worldwide to constantly create, innovate, and improve technology to leverage digital transformation in order to achieve their objectives and ensure performance. Digital transformation has become the new norm and is widely regarded as

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a significant influencer of business operations (Li et al., 2021). It has introduced technology into firms' basic operations while also assisting them in being prepared to revolutionize and adapt flexibly to environmental uncertainties. Therefore, digital transformation is a critical trend for manufacturing firms, particularly as digitalization of the value chain greatly influences their operations.

Previous studies indicated that digital transformation can aid firms in achieving market agility (Li et al., 2021), resulting in a shift in business model (Pagani & Pardo, 2017) that increases competitive advantage (Matarazzo et al., 2021; Singh et al., 2021) and thereby improves firm performance (Singh et al., 2021; Tihanyi et al., 2021). Indeed, digital transformation enables manufacturing firms to reduce costs, boost productivity, enhance product development, reduce time-to-market, and strengthen customer focus across various value-chain elements (Savastano et al., 2018). Digital transformation also results in rapid technological advancement (Hirsch-Kreinsen, 2016), which is applied to production data to predict waste-related issues before they occur (Albukhitan, 2020). In addition, digital transformation can improve the environmental performance of manufacturing firms (Wen et al., 2021), forcing them to confront the challenge of balancing income growth and environmental concerns (UNIDO, 2018). Therefore, manufacturing firms must rethink how they can leverage digital transformation to deal with environmental concerns (Kutzschenbach & Daub, 2021).

However, prior research has not examined the environmental performance implications of digital transformation in manufacturing firms in emerging markets. Therefore, our study adds to the interface of environmental management and digital transformation in an emerging-market context by investigating the effect of digital transformation on environmental performance via data-based ethical decision-making (DEDM) that concerns environmental issues. DEDM enables firms to effectively manage the growing information load associated with ethical reasoning processes in the turbulent business environment (S. R. Valentine et al., 2018). It can therefore be argued that, as well as actively contributing to the resolution of environmental concerns, digital transformation can be a driver of DEDM for manufacturing firms dealing with environmental issues.

Arguably, previous studies in the area of business ethics (e.g., Nguyen et al., 2020; S. Valentine et al., 2010) showed that firms can solve ethical problems pertaining to their environment by leveraging organizational mindfulness, which refers to the ability of an organization to gather information about emerging threats and develop the capability to respond swiftly to them (Vogus & Sutcliffe, 2012). The presence of organizational mindfulness increases an organization's likelihood of reaching effective digital transformation and deploying organizational resources to implement digital technologies more effectively (Li et al., 2021). Organizational mindfulness enables firms to leverage digital technologies (Singh et al., 2021) by providing alternatives for ethical decision-making and highlighting critical aspects of change adaptation (Weber & Johnson, 2009). However, the facilitating role of organizational mindfulness in promoting ethical behavior in the digital transformation process of manufacturing firms is still unspecified. While the critical role of organizational mindfulness in the digital transformation process is becoming more widely recognized (Li et al., 2021), how organizational mindfulness and digital transformation interact to facilitate ethical decisions has not yet been empirically examined. This demonstrates a potential synergy of digital transformation and organizational mindfulness that could help emerging-market manufacturing firms to cope with environmental concerns.

To address these critical research gaps, based on the contingency theory of decision-making (Beach & Mitchell, 1978; Mitchell & Beach, 1990; Tarter & Hoy, 1998) and the NRBV (Chan, 2005; Hart, 1995), we developed a moderated mediation model to demonstrate how organizational mindfulness can facilitate digital transformation to improve DEDM, which, in turn, improves environmental performance. Our study contributes to the body of knowledge by clearly defining the essential role of digital transformation in driving DEDM and the conversion of DEDM into

environmental performance. This study also demonstrates that digital transformation does not have to be a barrier for manufacturing firms, despite their struggles to cope (Rachinger et al., 2018; Verhoef et al., 2021); instead, when facilitated by organizational mindfulness, digital transformation can support DEDM. Our empirical evidence regarding the interaction between digital transformation and organizational mindfulness can guide manufacturing firms in emerging markets to improve environmental performance through promoting DEDM.

The remainder of our paper is structured in the following manner: the next section discusses the development of a theoretical model based on the underlying theories, specifically the contingency theory of decision-making and the NRBV, focusing on the relationships between digital transformation, DEDM, and environmental performance and the moderating effect of organizational mindfulness; following that, the research methods and significant findings are described; the theoretical and practical implications are then discussed, along with the limitations and future research recommendations.

2. Theoretical background, model, and hypothesis development

2.1. Contingency theory of decision-making

According to the conventional view of classical decision theory, we argue that environmental information, such as environmental cost information, solid and hazardous waste (Nkundabanyanga et al., 2021), are critical for explaining environmental problems and environmental management concerning business operations, since they assist firms in making more accurate ethical business decisions. Nonetheless, according to the contingency theory of decision-making (Tarter & Hoy, 1998), there is no one-size-fits-all decision model. Therefore, environmental information cannot be used rigidly to make environmental decisions and analyze their consequences. Since mindfulness is critical for making business decisions, by cultivating mindfulness, managers can make more informed decisions about environmental issues (Patel & Holm, 2018). Additionally, when the reality of ethical decision-making is complicated and unstructured due to the need to resolve ethical dilemmas (Trevino & Brown, 2004), environmental information alone will not be sufficient to ensure that traditional decision-making models are rational. Thus, we argue that mindfulness can be viewed as a contingent factor of DEDM, demonstrating the relevance of the contingency theory of decision-making in our study.

2.2. Natural-resources-based view of the firm

According to the resource-based view of the firm, competitive advantage is determined by the organization's capacity to generate rent-earning resources and capabilities (Barney, 1991). Hart (1995) proposed the NRBV of the firm, recognizing the limited scope of resource-based view in explaining the competitive edge gained through interactions between organizations and the natural environment. Three proactive environmental strategies incorporated into the NRBV are pollution avoidance, stewardship of products, and ecological sustainability (Hart, 1995). This means that, according to the NRBV, proactive environmental strategies are seen as an important competitive advantage. Based on this theory, we argue that, with the support of digital transformation in mindful organization, DEDM can be a strategic resource that is valuable, rare, inimitable, and non-substitutable (Chan, 2005) and can assist manufacturing firms in effectively and proactively implementing their environmental strategies (i.e., pollution prevention, product stewardship, and sustainable development). Therefore, under the lens of the NRBV and supported by digital transformation and organizational mindfulness, DEDM can be a potential driver of environmental performance.

2.3. The mediating role of DEDM

The landscape of the 4.0 Revolution has resulted in a phenomenon known as digital transformation, which has captivated the business world (Borangiu et al., 2019). In this landscape, manufacturing firms are compelled to accelerate their digital transformation efforts to compete effectively in a dynamic and chaotic business environment. Digital transformation has been defined as the

process by which a firm uses digital technologies to create appropriate new digital business models (Verhoef et al., 2021). By aggregating information, computing, communication, and connectivity technologies, digital transformation can improve an organization's environmental performance by facilitating significant environmental initiatives (Vial, 2019). Therefore, digital transformation has become even more critical for manufacturing firms to achieve their environmental objectives.

Furthermore, digital transformation can improve firms' ability to collect, disseminate, store, analyze, and display data, all of which serve to strengthen their ultimate data-processing ability (Roberts & Grover, 2012; Verhoef et al., 2021). In keeping with this benefit, manufacturing firms are attempting to digitalize their operational processes to facilitate information exchange across their functions. They leverage technologies to collect, manage, and process data to make well-informed environmental decisions (Nisar et al., 2020; Thomas & Chopra, 2020). This means that, when faced with environmental concerns, firms must consider and utilize additional data from their digital transformation to make environmentally friendly decisions. Thus, we propose the following:

H1: Digital transformation has a positive effect on DEDM.

Information is required for all aspects of an organization, from daily to strategic operations (Li et al., 2021). Particularly in the digital era, technologies can facilitate the extraction of relevant information to aid DEDM (Singh et al., 2021). Relevant information can be used to make more informed decisions that conserve resources and adhere to ethical standards. Specifically, when firms have fully integrated relevant information, decisions are made based on data prioritization and careful analysis. The procedures used by decision-makers within the organization always include the use of information that addresses ethical concerns (S. R. Valentine et al., 2018), including carbon dioxide emissions, waste management, renewable energy, environmentally friendly products, and ensuring consumer health and safety. As a result, DEDM is a requirement for manufacturing firms that are confronting a slew of business challenges associated with digitalization (Singh et al., 2021) and are under pressure to make ethical decisions to address environmental issues.

While effective decision-making is critical for increasing an organization's competitiveness and achieving sustainable performance (Nisar et al., 2020; Zehir et al., 2020), DEDM would improve businesses' decision-making efficiency while improving environmental performance (Agarwal et al., 2010). We assert that manufacturing firms can enhance their competitiveness by being environmentally proactive, as the NRBV implies that it is critical to develop resources to address environmental challenges (Hart, 1995). While effective decision-making is a crucial indicator of sustainable environmental management (Nisar et al., 2020; Runhaar & Driessen, 2007), DEDM will significantly improve environmental performance.

We claim that manufacturing firms must exercise DEDM when confronted with environmental issues in ecological contexts with unexpected challenges. According to the NRBV, manufacturing firms can develop capabilities to mitigate negative environmental impacts due to their operations and boost their environmental performance (Hart, 1995). Thus, when DEDM is valuable, rare, inimitable, and non-substitutable (Chan, 2005), it becomes an extremely valuable resource, since it helps manufacturing firms to increase their competitive advantage via environmental performance. As a manufacturing firm increases its DEDM, the number of environmentally friendly decisions it makes can be increased, resulting in improved environmental performance. Thus, we posit the following:

H2: DEDM has a positive effect on environmental performance.

Under digital transformation, manufacturing firms can implement cloud computing for higher business processes such as supply chain management, digital marketing, and enterprise resource planning (Martínez-Caro et al., 2020). Although environmental sustainability is a well-established concept in the business lexicon, the role of digital transformation in fostering environmental sustainability is still debated (Dubey et al., 2019), and the existing literature has discussed the challenges and barriers associated with digital transformation (Favoretto et al., 2021). We claim that DEDM can translate the potentials of digital transformation into high levels of environmental performance. While it is challenging for manufacturing firms to keep up with growing environmental issues, if they fully understand how to leverage the beneficial information generated by digital transformation, they will achieve good results in DEDM.

In addition, digital technology is transforming the global economy in unprecedented ways (Kutzschenbach & Daub, 2021), and digitally transformed firms can outperform their competitors (Singh et al., 2021); digital transformation can support and facilitate engagement with sustainability challenges (Kutzschenbach & Daub, 2021). The success of a firm is contingent upon its ability to leverage the knowledge and skill capabilities necessary to cope with environmental challenges (Shahzad et al., 2020). Thus, manufacturing firms will make every effort to fully leverage the benefits of digital transformation to promote DEDM and thereby ensure improved, sustainable environmental performance. The preceding arguments imply that DEDM is a potential mediator in the impact of digital transformation on environmental performance; therefore, we posit the following:

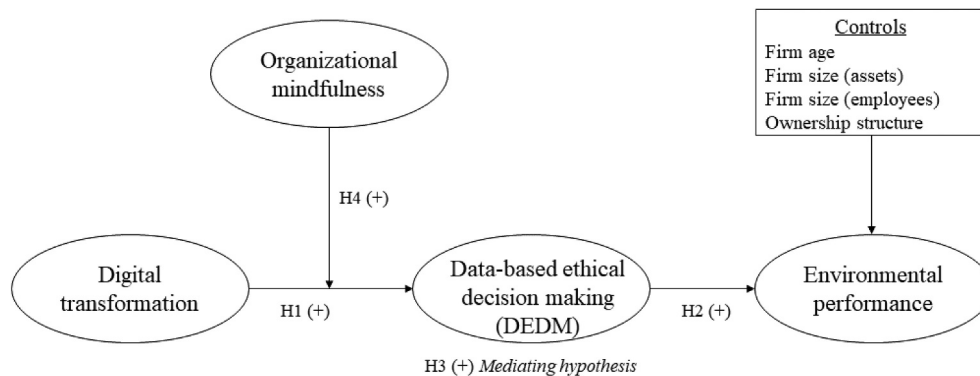
H3: Digital transformation positively affects environmental performance via the mediating role of DEDM.

2.4. The moderating roles of organizational mindfulness

While digital transformation is gaining increasing amounts of research attention, many firms struggle to fully realize transformational potentials (Hess et al., 2020). In the digital transformation process, organizational mindfulness enables proactive management of digital technologies, reduces the possibility of digital-technology-induced rigidity, and empowers firms to leverage data-based decision-making (Li et al., 2021; Singh et al., 2021). Singh et al. (2021) also emphasized the relationship between digital transformation and organizational mindfulness, stating that organizational mindfulness proactively uses market data and intelligence to stay informed about changing versions of digital technology, thereby facilitating decision-making. Thus, the critical role of organizational mindfulness will become increasingly recognized, as the presence of organizational mindfulness can increase the effectiveness of DEDM.

Organizational mindfulness enables manufacturing firms to scan their environments and expand their knowledge of implied social contexts, improving the perceived utility of digital transformation. Combining digital transformation and organizational mindfulness enables these firms to proactively and ethically align their business processes with market conditions. The vast quantities of data that have been integrated as a result of digital transformation will have an even greater chance of being useful once organizational mindfulness has been established, allowing manufacturing firms to make ethical decisions and engage in environmentally friendly activities. Additionally, because digital transformation is customer-centric (Fernández-Rovira et al., 2021), firms increasingly focus on customers' needs in conjunction with environmental and ethical concerns. Consequently, with the support of digital transformation, organizational mindfulness can easily assist firms in developing practical solutions to meet customers' needs to make ethical decisions. Specifically, digital transformation will make it easier for functional departments and employees to share relevant information (Li et al., 2021). As a result, relevant information about operating procedures for environmental protection is also shared—the greater the organizational

Figure 1. Proposed model and hypotheses.



mindfulness, the greater the likelihood of sharing such information and the larger the effect of digital transformation on DEDM.

Based on the contingency theory of decision-making, we argue that mindful organizations could promote proactive use of recorded environmental information to respond quickly to the rapid changes occurring in the context of digital transformation. Then, with a high level of organizational mindfulness, manufacturing firms will have a strong sense of leveraging digital transformation to make more informed ethical decisions. The theory holds that the effectiveness of a decision procedure is contingent on various situational factors (e.g., the amount of relevant information possessed; the decision’s quality and the extent to which it is accepted; Beach & Mitchell, 1978; Mitchell & Beach, 1990). This being the case, manufacturers seek to leverage the massive amounts of data collected through digital transformation, including relevant information directly related to environmental issues. Under stakeholder pressures, manufacturing firms can increase their awareness of DEDM to perform well in environmentally beneficial activities, thereby improving their environmental performance. Based on the preceding discussion, we suggest the following:

H4: Organizational mindfulness positively moderates the effect of digital transformation on DEDM.

The proposed model and hypotheses are shown in [Figure 1](#).

3. Methods

3.1. Research setting

Our research setting is in Vietnam, a transition economy. Vietnam is an ideal location to investigate the interface between digital transformation and environmental performance for the following reasons. First, digital transformation has recently emerged in Vietnam and is one of the most intriguing trends there today. Although the transformation process has not been implemented synchronously and effectively, government programs have significantly impacted firm digitization, while most Vietnamese firms (64%) benefit from the supporting initiatives of the Vietnamese government (Cisco, 2019). As a result, it is critical to investigate digital transformation in Vietnamese firms, particularly manufacturing firms, because stakeholders pressure them to perform well in environmental activities (Nishitani et al., 2021).

Second, both the domestic and international communities are paying close attention to environmental issues in Vietnam. Vietnam is now prepared to focus on specific strategies related to pollution prevention and control, environmental valuation actions, and the efficient management of forest and water resources, thanks to the Poverty Reduction Support Credit Programs supported

by the World Bank (Shahbaz et al., 2019). As can be seen, manufacturing firms in Vietnam play a critical role in environment-related activities. However, environmental issues associated with manufacturing activities are serious in Vietnam. Over the last three decades, emissions of carbon dioxide have doubled (from 14 million tons in 1980 to 80 million tons in 2005; World Bank, 2015), and environmental pollution is increasing daily (Nishitani et al., 2021). Moreover, both marine and river ecosystems are gravely threatened by industrial activity (T. T. H. Nguyen et al., 2016). For example, the Thi Vai River was tarnished by Vedan (Van & Ly, 2021), Formosa Ha Tinh Steel Corporation must pay at least \$500 million to compensate for polluting the sea in Ha Tinh (Tiezzi, 2016), and Vietnam Graphite Company caused severe environmental pollution in Yen Bai (Hoang et al., 2019). These consequences have served as a wake-up call for manufacturing firms seeking to leverage production-enhancing technology in order to provide environmentally friendly products and address issues related to emissions and waste.

Finally, Vietnam provides a unique context for examining the impact of mindfulness on environmental issues, since Buddhism is deeply ingrained in Vietnam's political, economic, and educational systems, providing moral codes and ethical guidance and connecting all facets of society. This further motivates these firms to exercise caution and make sound judgments in ethical situations. Under the catalysis of mindfulness, firms can pay increased attention to data about environmental harms.

3.2. Sample and data collection

The study recruited relevant participants through a purposive convenience sampling strategy that screened for their work positions and experience. The targeted participants met the following criteria: (a) senior or middle management positions in Vietnamese manufacturing firms; (b) at least two years of experience in the representative firm responding to the survey. These conditions were put in place to ensure that participants had the necessary experience and knowledge to complete the survey questionnaires. The survey's email list was compiled using data extracted from LinkedIn, a professional social networking site. LinkedIn is a well-developed professional social network (Mintz & Currim, 2013) that has been used to extract the email addresses of potential participants in several prior studies, including Mintz and Currim (2013) and Ouakouak and Ouedraogo (2017). We noted that sending survey questionnaires via LinkedIn emails enables us to solicit feedback from managers in various regions throughout Vietnam, whereas sending questionnaires to participants via physical mail or in person is difficult to implement, especially in light of the COVID-19 pandemic. This method of data collection ensures the safety of both researchers and participants.

To avoid common method bias, we collected data in two stages (Podsakoff et al., 2003). To prevent a high drop-out rate and memory bias, we used a two-month interval between two stages, as Einarsen et al. (2009) recommended. We distributed the survey form to 4,695 potential informants and received 689 completed responses during Stage 1. Participants provided their email addresses and demographic data in exchange for assessing digital transformation and organizational mindfulness. Stage 2 collected data on the mediating and dependent variables (i.e., DEDM and environmental performance) by sending the second part of the survey form to Stage 1 participants. The two stages of data collection were linked via a unique identifier assigned to each participant. The final sample included 466 Vietnamese business organizations and had a response rate of 9.92%. Given the low percentage of target informants in our LinkedIn networks and the lack of familiarity with email questionnaire surveys in Vietnam, this response rate is reasonable and comparable to that of previous studies using a similar data collection approach (e.g., Nguyen & Adomako, 2022; Nguyen et al., 2018). We then conducted independent t-tests for potential non-response bias following Armstrong and Overton (1977)'s recommendation and found no differences in demographic and key variables between the first and fourth quartiles. This result implies that our study was not biased by non-response.

Because the study was conducted at the organizational level, we carefully scanned the sample for possible duplicate responses from the same organization. This procedure included verifying firm information (e.g., firm name, business email address, and domain name) to ensure that each firm in the sample provided a single response. To ascertain the participants' informant competency, we followed Morgan et al. (2004) to rate their level of knowledge about the questions, the accuracy of the information provided, and their confidence in providing responses. The data were collected using a seven-point Likert scale (1 being "very low" and 7 being "very high"). As a result, the mean score for participants' level of knowledge was 6.34 (SD = 0.89); their response accuracy was 6.42 (SD = 0.82); and their confidence in answering the questions was 6.13 (SD = 0.91). These results indicated that the participants were capable of responding appropriately to the survey questions.

3.3. Measure of constructs

The main constructs in our study were measured using well-established scales from the literature. Specifically, we measured digital transformation using a five-item scale proposed by Nasiri et al. (2020). DEDM was measured with four items, following S. R. Valentine et al. (2018). The moderating variable, i.e., organizational mindfulness, was rated using an eight-item scale suggested by S. Valentine et al. (2010). Items were scored on a three-point scale, with 1 indicating no mindfulness, 2 indicating some, and 3 indicating a great deal. To assess environmental performance (the dependent variable), we used a four-item scale proposed by Judge and Douglas (1998) and subsequently used by recent studies, e.g., Chen et al. (2015). All items, except those of organizational mindfulness, were rated on a seven-point scale ranging from 1 ("strongly agree") to 7 ("strongly disagree"); the coding direction was set to indicate higher variable values. All of the scales for the primary constructs were reflective rather than formative, as their items were intercorrelated and unidimensional. Finally, following previous studies (e.g., Adomako & Nguyen, 2020; Dardati & Saygili, 2020), we used firm size (in terms of assets and full-time equivalent employees), firm age, and foreign ownership (1 being "without foreign capital" and 2 being "with foreign capital") as control variables for environmental performance, as they could affect firms' environmental strategies.

4. Results

4.1. Common method bias and multicollinearity issues

Given that the measures for the various constructs were developed through a self-reported and single-informant approach, the possibility of method bias had to be addressed (Podsakoff et al., 2003). The Harman single-factor test was used to determine whether any single factor accounted for most of the variance (the first factor accounted for 45.06% of the 70.26% explained variance). We also used the marker-variable technique (Lindell & Whitney, 2001) because the Harman test is extremely conservative in detecting common method bias (Malhotra et al., 2006). The single item "Do you want to go to the beach this summer holiday?" was included in the questionnaire on purpose to test for common method bias, as single-item measures can be just as valid as multiple-item measures (Bergkvist, 2015). When the effects of rM were partially accounted for, the mean change in the correlations between the critical constructs ($r_U - r_A$) was 0.03. Additionally, we used the common latent factor test to account for method-specific bias (Podsakoff et al., 2003). There was no statistically significant difference in the standardized regression weights of all items between models with and without the common latent factor. All of the tests indicated that the study did not suffer from common method bias. To check for possible multicollinearity issues, we examined the independent variable's variance inflation factor (VIF) values (O'Brien, 2007). The results indicated that no serious multicollinearity problems existed because the inner VIF values ranged between 1.09 and 2.18, well below the criterion of 10.

4.2. Reliability and validity analyses

The measurement and structural models were estimated using partial least squares structural equation modeling (PLS-SEM) and the SmartPLS v.3.3.3 software. The reliability and validity of the major constructs are evaluated in Table 1 using Cronbach's alpha (CA), composite reliability (CR),

Table 1. Scale items and evaluation

Items	Weight/ loading	t-value
Digital transformation (Nasiri et al., 2020) (CA = 0.94; CR = 0.95; AVE = 0.81)		
• We aim to digitalize everything that can be digitized	0.93	100.87
• We collect massive volumes of data from different sources	0.94	144.86
• We aim to create stronger networking between the different business processes with digital technologies	0.94	159.02
• We aim to enhance an inefficient customer interface with digitality	0.87	48.90
• We aim at achieving information exchange with digitality	0.82	35.86
Organizational mindfulness (Valentine et al., 2010) (CA = 0.88; CR = 0.90; AVE = 0.54)		
• In our company, there is an organization-wide sense of susceptibility to the unexpected	0.80	26.66
• Everyone in our company feels accountable for the reliability	0.68	21.33
• Our leaders pay as much attention to managing unexpected issues as they do to achieving formal organizational goals	0.73	27.61
• People at all levels of our organization value the quality of their works	0.70	25.81
• We spend time identifying how our activities potentially harm our organization, employees, our customer, other interested parties, and the environment at large	0.76	33.83
• We pay attention to when and why our employees, or customers, or other interested parties might feel peeved or disenfranchised from our organization	0.74	32.04
• There is widespread agreement among the members on what we don't want to go wrong	0.73	27.11
• There is widespread agreement among the members about how things could go wrong	0.72	27.27
Data-based ethical decision-making (Valentine et al., 2018) (CA = 0.91; CR = 0.94; AVE = 0.79)		
• When decisions are made in this organization, they are based primarily on data and careful analysis of the 'numbers'	0.90	99.60
• In this organization, decision makers are strongly encouraged to gather data about all the decision issues and to carefully analyze the data before making a decision	0.89	92.32
• Data about important ethical issues is gathered and used when people in this organization make decisions	0.90	107.08
• The procedures that decision-makers use in this firm always include the use of data that reflects ethical considerations	0.88	83.91
Environmental performance (Judge and Douglas, 1998; Chen et al., 2015) (CA = 0.91; CR = 0.93; AVE = 0.78)		

(Continued)

Table 1. (Continued)

Items	Weight/ loading	t-value
• Complying with environmental regulations	0.88	86.14
• Preventing and mitigating environmental crises	0.88	86.45
• Limiting environmental impact beyond regulatory compliance	0.89	97.96
• Educating employees and the public about the environment	0.89	105.16

Notes: CR: Composite reliability, AVE: Average variance extracted

average variance extracted (AVE), and the outer loadings of the scale items, as well as their corresponding t-values. The outer loadings for all items ranged between 0.68 and 0.94, exceeding the 0.70 cut-off value (Hulland, 1999). Their corresponding t-values ranged between 21.33 and 159.02, well above the 1.96 threshold. Moreover, these constructs had AVE values ranging from 0.54 to 0.81, exceeding the 0.50 threshold. These results suggested that the measurement model had an adequate level of convergent validity. Furthermore, the CA values for the constructs ranged between 0.88 and 0.94, while the corresponding CR values were from 0.90 to 0.95, indicating high degrees of reliability for the measurement scales (Kline, 2016).

The discriminant validity was then assessed using the procedure recommended by Fornell and Larcker (1981). As shown in Table 2, the values of the square root of the AVE for the main constructs, including control variables (ranging between 0.73 and 1.00), were significantly greater than all absolute values of the bootstrapped correlation coefficients (between 0.03 and 0.70). Moreover, no individual correlation coefficient between latent constructs exceeded their respective composite reliabilities (ranging from 0.90 to 0.95), whereas the majority of correlation coefficients were consistently not higher than the 0.70 cut-off value. These findings indicated that the measurement scales possessed a high degree of discrimination validity. In addition to the approach proposed by Fornell and Larcker (1981), we used a more rigorous Heterotrait-Montrait (HTMT) test (Henseler et al., 2015). The bootstrapped HTMT values ranged between 0.02 and 0.70, significantly less than 0.85 (Henseler et al., 2015). These results provided further evidence for discriminant validity.

4.3. Hypothesis testing

We analyzed the proposed model and hypotheses using the PLS-SEM approach. PLS-SEM is appropriate because it tends to achieve greater statistical power under comparable conditions than the conventional covariance-based structural equation model (CB-SEM; Reinartz et al., 2009). In addition, PLS-SEM permits researchers to evaluate the measurement model and structural model simultaneously, including both moderating and mediating effects (Lee et al., 2011). The sample size of 466 was excellent because it exceeds tenfold the number of possible paths leading to any construct (Hair Jr et al., 2017). Additionally, the standardized root mean square residual value was 0.04, which is less than the 0.08 threshold (Henseler et al., 2016), indicating that the proposed model adequately fits the data.

We established three hierarchical models in PLS-SEM to test the hypotheses. Model 1 established a direct link between digital transformation and environmental performance. Model 2 was an augmentation of Model 1, with DEDM added as the mediator of the effect of digital transformation on environmental performance. Model 3 was the final model, with DEDM as the mediating variable and organizational mindfulness as the moderating variable. The indices used to assess the predictive power of the individual routes (β coefficients, t-values) and the adjusted R^2 values for the mediating variable (i.e., DEDM) and the dependent variables (i.e., environmental performance) are shown in Table 3. These indices were calculated with 5,000 bootstrap sampling times. All three models had adjusted R^2 values greater than 0.10 (ranging from 0.19 to 0.42), which is the recommended level to indicate that the variance of variables is sufficient (Falk & Miller, 1992).

Table 2. Discriminant validity analysis

	1. _____	2. _____	3. _____	4. _____	5. _____	6. _____	7. _____	8. _____
1. DT	0.90							
2. OM	0.70**	0.73						
	0.77							
3. DEDM	0.62**	0.50**	0.89					
	0.67	0.55						
4. EP	0.36**	0.30**	0.56**	0.88				
	0.39	0.33	0.61					
5. Firm age	(0.06)	(0.08)	0.03	0.18**	1.00			
	0.06	0.08	0.03	0.19				
6. Foreign ownership	0.10*	0.08	0.09	(0.01)	(0.13)**	1.00		
	0.10	0.11	0.10	0.02	0.13			
7. Assets	(0.02)	(0.06)	(0.05)	0.20**	0.29**	(0.26)**	1.00	
	0.05	0.07	0.06	0.21	0.29	0.26		
8. Employees	(0.03)	(0.09)	(0.06)	0.20**	0.40**	(0.24)**	0.70**	1.00
	0.05	0.10	0.06	0.21	0.40	0.24	0.70	

Notes: DT: digital transformation; OM: organizational mindfulness; DEDM: data-based ethical decision making; EP: environmental performance; 1st value (off diagonal) = Correlation between constructs; 2nd value (italic) = HTMT ratio; Square root of average variance extracted (bold diagonal); *, **, ***: Correlations significant at the 5% and 1%, levels respectively

Table 3. Hypothesis testing results

Dependent variable	Model 1		Model 2 (with DEDM as the mediating variable)		Model 3 (with DEDM as the mediating variable and OM as the moderating variable)	
		EP	DEDM	EP	DEDM	EP
<i>Independent variable</i>						
H1	DT	0.37(9.73) ^c	0.62(23.21) ^c	0.04(0.81)	0.55(12.03) ^c	0.04(0.80)
	OM				0.17(3.66) ^c	
H2	DEDM			0.54 (13.36) ^c		0.54(13.37) ^c
H4	OM×DT					0.19(5.18) ^c
<i>Control variable</i>						
	Firm age	0.13(3.15) ^c		0.08(2.28) ^b		0.08(2.28) ^b
	Foreign ownership	0.02(0.47)		0.01(0.21)		0.01(0.22)
	Assets	0.12(2.09) ^b		0.13(2.50) ^b		0.13(2.50) ^b
	Employees	0.08(1.26) ^b		0.11(2.04) ^b		0.11(2.11) ^b
Adjusted R ²		0.19	0.38	0.37	0.42	0.37
Indirect effect				Estimate	LLCI	ULCI
H3	DT→DEDM→EP			0.30(8.94) ^c	0.24	0.38

Notes: DT: digital transformation; OM: Organizational mindfulness; DEDM: digital-based ethical decision-making; EP: environmental performance; OM×DT: interaction between OM and DT, numbers in brackets: *t*-values; ^{a, b, c} denotes significance at 10%, 5%, and 1% levels respectively (two-tailed *t*-test).

Moreover, the effect size (f^2) values of the digital transformation—DEDM path and the DEDM—environmental performance path were 0.27 and 0.29 respectively, well above the cut-off value of 0.15 to justify the strengths of the exogenous variables in explaining endogenous variables in the structural model were satisfactory at the medium level (Cohen, 1988).

H1 proposes that digital transformation has a beneficial effect on DEDM, which is supported by the data (Model 2: $\beta = 0.37$; t -value = 9.73). Our analysis also revealed a positive effect of DEDM on environmental performance (Model 2: $\beta = 0.54$; t -value = 13.36. Model 3: $\beta = 0.54$; t -value = 13.37), which corroborates H2. Moreover, the indirect effect of digital transformation on environmental performance via DEDM was significant ($\beta = 0.30$; t -value = 8.94; 95% confidence interval = [0.24; 0.38]), confirming H3 regarding the mediating effect of DEDM on the relationship between digital transformation and environmental performance. In addition to this, when DEDM was included as a mediator in the relationship between digital transformation and environmental performance, the path between digital transformation and environmental performance became insignificant (Model 2: $\beta = 0.04$; t -value = 0.81), implying that the DEDM played a fully mediating role in the effect of digital transformation on environmental performance. We also computed the Variance Accounted For (VAF) value to assess the intensity of the indirect effect of digital transformation on environmental performance via DEDM. The VAF value was 0.91, above the threshold of 0.80, which can justify the full mediating effect of DEDM in the relationship between digital transformation and environmental performance (Hair et al., 2013), further confirming H3.

To test H4 regarding the positive moderating effect of organizational mindfulness on the relationship between digital transformation and DEDM, we developed the interaction term $OM \times DT$, which was created by mean-centering the independent variable (i.e., digital transformation) and the moderating variable (i.e., organizational mindfulness) on avoiding multicollinearity (Aiken et al., 1991). The interaction term had a positive and significant effect on DEDM, supporting H4 (Model 3: $\beta = 0.19$; t -value = 5.18).

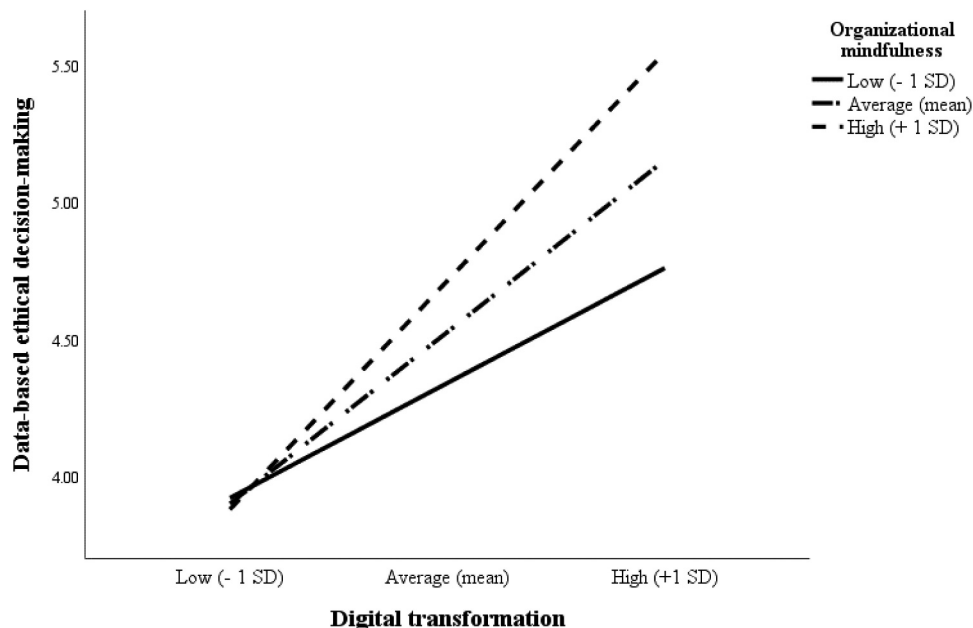
To better understand the nature of the significant interaction, this study followed Aiken et al. (1991) in plotting the effects of digital transformation on DEDM at high (+1 SD), average (mean), and low (−1 SD) organizational mindfulness levels. The interaction graph (Figure 2) demonstrates that, when organizational mindfulness is high, the effect of digital transformation on DEDM is high but average (low) when organizational mindfulness is average (low). This result lends additional support to H4.

5. Discussions, implications, limitations, and future research directions

5.1. Discussions

The digital era is characterized by rapid growth, innovation, and disruption (Albukhitan, 2020). This context forces manufacturing firms to constantly adapt to new digital transformation contexts caused by technology changes. As a result, firms anticipate significant efficiency and productivity gains resulting from digital transformation (Schwab, 2017). Under pressure from DEDM to protect the environment while meeting stakeholders' requirements, manufacturing firms have been forced to make significant efforts toward reaping the benefits of digital transformation in order to operate effectively. However, firms must develop organizational mindfulness to avoid digital disruption and foster informed decision-making (Albukhitan, 2020). Thus, as manufacturing firms integrate organizational mindfulness into the digital transformation-DEDM-environmental performance chain, they will have a stronger cognitive foundation for making environmentally beneficial decisions based on the diversity and accuracy of operational data, which influence decision quality and performance (Nisar et al., 2020). At the same time, the digital transformation process requires manufacturing firms to place a higher premium on collecting, classifying, and evaluating data quality, particularly data about ethical and environmental concerns. In today's competitive and technological landscape,

Figure 2. Interaction effect of digital transformation with organizational mindfulness on DEDM.



organizations cannot gain an advantage solely through the possession of high-quality data sets (Nisar et al., 2020): they must also excel at DEDM (S. R. Valentine et al., 2018) and organizational mindfulness to achieve environmental performance.

Digital transformation has emerged as a critical research topic for businesses (Albukhitan, 2020) and has also drawn the attention of academics (Galati & Bigliardi, 2019; Verhoef et al., 2021). Our research contributes to the body of knowledge about digital transformation by examining the mediation and moderation processes that link digital transformation to DEDM and environmental performance in manufacturing firms in a transition market. Based on the contingency theory of decision-making (Beach & Mitchell, 1978; Mitchell & Beach, 1990; Tarter & Hoy, 1998) and the NRBV (Chan, 2005; Hart, 1995), our study makes a significant contribution because it is one of the first to demonstrate that environmental performance is determined not only by practices or management of a firm's environmental activities but also by organizational mindfulness. The more conscientious an organization, the better equipped it is to convert digital transformation into environmental performance via DEDM. These findings have several theoretical and practical implications, which we will discuss sequentially.

5.2. Theoretical contributions

The findings from our study contribute to the existing literature in the following ways. First, the research results expand our understanding of the role played by digital transformation in improving environmental performance. The digital transformation literature has traditionally been focused on using technology to boost productivity (e.g., Savastano et al., 2018) or applied to production data to predict waste-related issues (Albukhitan, 2020) and has argued that digital transformation facilitates the performance of firms (Singh et al., 2021; Tihanyi et al., 2021). In contrast, our study shows that digital transformation is critical for environmental performance. Thus, our study provides a more nuanced understanding of digital transformation in the environmental management literature.

Second, our finding is that DEDM acts as a mediating mechanism between digital transformation and environmental performance. This is an important extension of the environmental management literature because previous studies (e.g., Adomako & Nguyen, 2020; Albukhitan, 2020; Favoretto et al., 2021) have not explicitly clarified this mechanism. Unlike previous studies that examine the antecedents (e.g., Li et al., 2021; Singh et al., 2021) and outcomes of digital transformation (e.g., Singh et al., 2021), we explain the indirect effect of digital transformation on environmental performance

via DEDM. Therefore, our study adds to the burgeoning interface between digital transformation literature (e.g., Singh et al., 2021; Tihanyi et al., 2021) and the environmental management literature (e.g., Adomako & Nguyen, 2020; Albukhitan, 2020; Favoretto et al., 2021).

Third, by confirming the positive impact of DEDM on environmental performance, our study contributes to the literature on the significance of DEDM in manufacturing firms in a transition market while simultaneously highlighting the significance of NRBV. Specifically, DEDM is a competitively valuable resource for manufacturing firms (Chan, 2005). Under the NRBV framework, DEDM would assist manufacturing firms in proactively implementing environmental strategies, thereby enhancing product management efficiency, minimizing environmental damage (Hart, 1995), and enhancing environmental performance.

Fourth, our study expands our understanding of the boundary conditions of the effects of DEDM. Although the role of DEDM has been investigated (S. R. Valentine et al., 2018), there has not been much extensive research on this topic yet. To the best of our knowledge, our study is among the first to empirically examine the moderating role of mindfulness on the relationship between digital transformation and DEDM. This is also consistent with the contingency theory of decision-making (Tarter & Hoy, 1998), which asserts that there is no single optimal model for decision-making and that the efficacy of a decision procedure depends on a number of contingent factors (Beach & Mitchell, 1978; Mitchell & Beach, 1990). Additionally, mindfulness enables manufacturing firms to utilize technology to collect, aggregate, and analyze environmental data in a flexible manner (Li et al., 2021; Singh et al., 2021). Therefore, mindfulness will assist these firms in leveraging digital transformation in order to DEDM and excel in environmentally friendly activities.

Finally, since digital transformation has been conventionally investigated in the context of new ventures or developed economies, and there is limited extant knowledge of the role of developed economies in environmental management performed by manufacturing firms from emerging markets, our study contributes to the digital transformation literature by showing that digital transformation is critical to manufacturing firms in an emerging-market context.

5.3. Managerial implications

Our research has three managerial implications. First, the positive impact of digital transformation on environmental performance via the mediating mechanism of DEDM informs manufacturing firms of the critical nature of environmental concerns in their operations. Therefore, manufacturing firms should promote and place a premium on DEDM to improve environmental performance: they need to manipulate digital transformation in their operations to assist them in DEDM regarding environmental concerns. In addition, the positive impact of DEDM on environmental performance underpinned by NRBV has signaled to manufacturing firms the competitive advantage that DEDM can provide. Hence, to improve environmental performance, manufacturing firms should promote the implementation of environmental strategies associated with NRBV (Hart, 1995).

Second, as there is no one-size-fits-all decision-making model from the standpoint of the contingency theory of decision-making (Tarter & Hoy, 1998), managers of manufacturing firms should consider the moderating effect of organizational mindfulness on their DEDM processes. To operate DEDM effectively, manufacturing firms should capitalize on the benefits of digital transformation (Wen et al., 2021) and increase their attention on environmental-related activities. The beneficial moderating effect of organizational mindfulness demonstrates the importance of attention to and awareness of potential environmental concerns. Therefore, managers in manufacturing firms should consider cultivating organizational mindfulness in tandem with digital transformation to promote DEDM.

Finally, manufacturing firms should consider developing customized digital transformation strategies to maximize internal resource utilization. By doing so, these firms can develop new skills and competencies and connect the digital world effectively, adapting to the context of digital

transformation while also reducing environmental pressures (Ardito et al., 2021; Shahbaz et al., 2019); this will enable them to excel at environmental activities and contribute to sustainable development.

5.4. Limitations and future research directions

Despite its significant contributions, the current study has a few noteworthy limitations. First, despite the two waves of data collection, it was impossible to infer causal relationships between various variables; a longitudinal study will help to confirm such associations. Second, this study examined the digital transformation, mindfulness, and environmental practices of Vietnamese manufacturing firms during the ongoing COVID-19 pandemic. Therefore, it is critical to assess any potential changes in the findings by exposing this study model to real-world conditions. Third, because objective data on environmental performance from manufacturing firms in Vietnam are difficult to obtain due to privacy concerns, this study relied on self-reported data from managers. Future research should focus on gathering objective data to evaluate environmental performance. Fourth, another constraint may have arisen due to the study's geographical setting. Since this research involved Vietnamese manufacturing firms, it may have some limitations in terms of cross-national application. Additional research should be conducted from an institutional theory perspective in other countries with a range of digitalization policies and support systems, cultural values, and environmental regulations. Fourth, organizations are constantly refining their strategies and organizational structures to improve their ability to collect complete data and improve performance (Kohli & Grover, 2008). It is therefore necessary to examine the impact of digital transformation and factors such as organizational structure and environmental strategy on environmental performance. Fifth, we examined the environmental performance of manufacturing firms using only four control variables: firm age, asset size, employee size, and ownership structure. Subsequent research could incorporate additional control variables (e.g., resource availability, competitive intensity, and geographic location) that may affect environmental performance.

Acknowledgements

This research was supported by the University of Economics Ho Chi Minh City under Grant No. 2022-01-01-0751 and funded by the Ministry of Education and Training of Vietnam under Grant No. No. B2020-KSA-01

Funding

This work was supported by the University of Economics Ho Chi Minh City [2022-01-01-0751]; Ministry of Education and Training of Vietnam [No. B2020-KSA-01].

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Citation information

Cite this article as: The impacts of digital transformation on data-based ethical decision-making and environmental performance in Vietnamese manufacturing firms: The moderating role of organizational mindfulness, Nguyen Phong Nguyen & Tu Thanh Hoai, *Cogent Business & Management* (2022), 9: 2101315.

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