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A managerial perspective on the determinants and outcome of digital transformation in multinational corporations in Malaysia

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A B S T R A C T

The primary objective of this study was to examine the antecedents of digital transformation (DT) within multinational corporations (MNCs) in Malaysia, from the perspectives of corporate managers. Amidst limited research on DT within the MNC context, this paper examines the key drivers of DT in Malaysian MNCs. A quantitative method using non-probability sampling was used to gather the required data via the distribution of questionnaires among the MNCs' managers. To evaluate the underlying theoretical model based on the collected data, we chose SmartPLS as the preferred method. Findings revealed that business value, digital leadership, inter-functional coordination and decision-making quality were significant drivers of DT, while DT exerted a positive influence on business performance. However, collaborative innovation did not have a significant relationship with digital transformation adoption in MNCs. The findings offer novel insights for both academics and international corporate managers, enhancing their understanding of the drivers behind DT adoption from the perspective of managers within MNCs in Malaysia.

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1. Introduction

In today's digital economy, technology is transforming human interactions, communication channels, business operations and business models through the utilization of electronic tools, disrupting the traditional economy. Manufacturing sector has seen a significant integration of digital technologies due to new production challenges from the market's growing demand for customized quality products (Frank *et al*., 2019). Digital technologies encompass advancements in mobile devices, internet services, blockchain, robotics systems, cyber security, virtualization, 3D printing, sensor technologies, automation, and other areas that are widely utilized in various aspects of social and economic life (Ulas, 2019). Fuelled by an arsenal of cutting-edge technologies, DT empowers businesses to achieve remarkable growth and performance (Warner & Wäger, 2019). The Fourth Industrial Revolution (IR4.0.0) has enhanced analytics and human-machine interaction (McKinsey & Company, 2015). The advent of IR4.0.0 technologies is accelerating DT within manufacturing industries. Digital manufacturing (DM) encompasses DT across various manufacturing industries to address the particular needs within the marketplace (Choi *et al*., 2015). It integrates various digital tools and technologies, including robotics, computer-aided manufacturing (CAM), IoT sensors, computer-aided design (CAD) and other online technologies to optimize all aspects of the manufacturing process (Riel *et al*., 2017). As stated by Zhu *et al*. (2021), prior studies on DT have evolved through three periods: early stage (2000-2012), growth stage (2013-2017) and thriving phase (2018-2020). Technology adoption research is dependent on two robust frameworks: Technology-Organization-Environment (TOE) and Diffusion of Innovation (DOI) theory framework with empirical evidence and alignment behind both theories (Oliveira & Martins,

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2011). Academics and business professionals have been interested in the research on DT since COVID-19 hastened the process of IR4.0 globally. Past studies' on DT have adopted various theories, such as resource-based view (Eller *et al*., 2020), UTAUT (Hujran *et al*., 2023), predictive antecedents of Behavioural Expectation (BE) and Behavioural Intention (BI) (Jayawardena *et al*., 2023), TOE (Omrani *et al*., 2022), diffusion of innovations theory (DOI) and TOE (Shahzad *et al*., 2023), DOI (Oh *et al*., 2022), theory of planned behavior (TPB) (Cetindamar, 2021), and sociotechnical system theory (STS) (Imran *et al*.,2021). Nguyen *et al*. (2023) and Venkates *et al*. (2003) also studied the drivers of DT of SMEs by employing the theory of reasoned action (TRA), Technology Acceptance Model (TAM), TPB, Taylor and Todd's C-TAM-TPB model. However, business model innovation (BMI) theory has not been exploited sufficiently in earlier research to explain how DT as a business strategy brings benefits to organisations. Therefore, this paper is planned to expand our understanding on the drivers of DT and the outcome of business performance with BMI.

In Malaysia, numerous studies were done before on DT of SMEs, but less attention was paid to multinational corporations (MNCs) (Shahzad *et al*., 2023; Ammeran *et al*., 2022; Wahid & Zulkifli, 2021; Tham & Atan, 2021; Ulas, 2019; Hamidi *et al*., 2018). In accordance with the published literature, it is evident that only scarce empirical studies have been done regarding the driving factors of DT adoption amongst MNCs in Malaysia, thus demonstrating a gap. According to Gurbaxani and Dunkle (2019), DT affects multiple functions of corporation, and therefore, developing DT strategy requires collaboration from various departments, including marketing, IT, product development, strategy and human resources. Each department must agree on prioritization of DT activities (Berghaus & Back, 2016; Chi *et al.,* 2018).

Although the importance of DT is increasing following the developments put forth by the Industry Revolution 4.0 agenda (IR4.0), there is limited past research regarding the antecedents of DT in the MNCs sector, especially in the context of Association of Southeast Asian Nations (ASEAN) countries. Some scholars relied on qualitative approaches to examine the antecedents of DT based on interviews with higher executives of successful MNCs in US, Spain, Germany and Japan (Weritz *et al.*, 2020). Also, some of the recent studies on DT were done in non-ASEAN countries such as India (Jayawardena *et al*., 2023), Greece (Kitsios *et al*., 2023), China (Zhao, 2023), Taiwan (Lo *et al*., 2023), Turkey (Ulas, 2019), Norway (Dasí *et al*., 2017). Consequently, this paper intends to bridge the geographical gap on DT by bringing new insights from Malaysia. ASEAN has become a major centre for leading MNCs to set up production and participate in global supply chains, particularly in the information and communication technology (ICT) sector, making it well-positioned for the future digital economy (ASEAN, 2017). Additionally, ASEAN's diverse cultural landscape, encompassing various religions and ethnicities necessitates the consideration of local perspectives alongside those from Western regions. The following section presents the literature review for the present study.

2. Literature review

2.1 Business Model Innovation in Digital Transformation

According to Foss and Saebi (2017), business model innovation (BMI) refers to any modifications on a company's existing business model, incorporating new elements or adapting them significantly to thrive in the digital age. Digital BMI has been described as the adoption of digital technology into a company's business model as outlined in transformation routes (Steininger 2019). Halme et al. (2007) regarded business models as a basis for understanding a company's efficiency. Digitalization creates opportunities for BMI, but these hinge on a corporation's value proposition and its role within the value network. However, future challenges lie in employees' skillsets and a company's capabilities (Rachinger *et al*. 2018). Bouwman *et al*. (2019) found that increased resource allocation for business model experimentation and stronger engagement in implementing strategies improve the performance of European SMEs. Bhatti *et al*. (2021) also stated that the elements which support the advancement of BMI in the IR4.0 industry should be examined regularly.

Similarly, Frank *et al*. (2019b) established a theoretical framework that links servitization and IR4.0 from BMI standpoint. Foss and Saebi, (2017) studied the performance implications of innovative business models, as primary motivations for BMI research, while Nwankpa and Roumani (2016) found that innovation is positively associated with business performance. BMI primarily drives financial success, leading to business growth and brand reputation (Böttcher & Weking, 2020). While BMI significantly boosts corporate performance, strong digital, operational and integration capabilities magnify the positive impact of BMI (Wang *et al*., 2023). Digital transformation involves the strategic integration of digital technologies to fundamentally change how businesses operate and deliver value to their stakeholders. This transformative process often requires innovative approaches to value proposition, customer engagement, and resource allocation—key elements highlighted in BMI research. Digital transformation enables firms to explore new and flexible business models (Ulas, 2019), expand their market reach, and improve operational efficiency to attain competitive advantage as substantiated by Sawhney *et al*., (2006) that BMI potentially alters the business environment to create firms' competitive advantage and can evolve as a response to external pressures (Rai & Tang, 2014). Hence, research on digital transformation aligns with BMI theory by exploring how businesses can leverage on the antecedents to innovate their business models via digital transformation to adapt to new economic realities while achieving better business performance.

2.2 Digital Transformation in Multinational Companies (MNCs)

MNCs operate across diverse environments to balance stakeholders' demands in a complex organizational structure. Thus, they are compelled to develop proper strategies to ensure smooth operations (Sun *et al*., 2021). However, recent crises i.e. pandemics and global warming are creating intense market, organizational, and geopolitical tensions that affect the operations and performance of MNCs (George & Schillebeeckx, 2022). Dasí *et al*. (2017) opined that mobile telecommunication MNCs face high challenges in today's market environment for responding to the imminent threat of digital technology disruption. Lo *et al*., (2023) also found that the internal resources of MNCs enhance their growth options and the pace of internationalization. Pereira *et al.* (2022) did research on Portuguese MNCs to inspect the challenges associated with introducing new technologies, the significance of using DT to integrate technological tools and effects of these corporate attributes. The authors found that the globalization of MNCs largely depended on the extent of their digitization efforts. Furthermore, the recent pandemic has triggered notable alterations to the worldwide business environment, particularly related to digital transformation. According to McKinsey (2020) Global online survey, most of the C-suite executives and senior managers reported that their businesses have sped up DT of their internal operations, collaboration with customers and the supply chain by 3 to 4 years.

2.3 Hypotheses Development

2.3.1 Business Value

Ghobakhloo and Iranmanesh (2021) acknowledged that the success of a firm in current business environments hinges on choosing the right IR4.0 technologies with proper implementation, user satisfaction, and consistent use that is aligned with strategic goals. This can unlock benefits i.e. improved worker productivity, market awareness, cost reductions and better decision-making. Ferreira *et al*. (2019) further highlighted the drivers for DT, with companies seeking to increase market share, increase service quality and access new markets. The authors found that DT offers a powerful toolkit for manufacturers to enhance efficiency, innovation and overall performance. Additionally, Sousa and Rocha (2019) anticipated significant benefits from IR4.0, including reduced labour costs, increased flexibility, faster delivery times, higher productivity, improved product quality, digital manufacturing, big data analysis, and creation of novel products and services that eventually innovate the business model. Dubey *et al*. (2019) also confirmed that cost savings through lowering adjustment costs is another advantage that DT brings to businesses. Other scholars highlighted that DT in the business process lowers expenses while boosting productivity (Kraus *et al*., 2021). An organization's innovation can be fostered by DT via lowering transaction, operating, agency and marginal costs. DT can reduce the innovation's marginal costs due to the almost zero cost of information transmission and low costs of intermediary linkages and depreciation. Enterprises are encouraged to increase their R&D spending, expedite product upgrades and foster their innovation by lowering the operation costs (Ferreira *et al*., 2019). In relation to these arguments, the following hypothesis is put forth:
H_1: *Business value positively impacts digital transformation in MNCs.*

2.3.2 Digital Leadership

Hansen *et al*., (2011) stated that leadership is essential for involving business and information system executives in their companies' DT. In the digital age, leaders need to be proficient in both hard and soft skills in addition to understanding leadership principles (Kawiana *et al*., 2021). They also have to warrant that their teams adopt digital attitude and agility to react to DT challenges in the right way (Vial, 2019). According to El Sawy *et al*. (2020), digital leadership (DL) exists through taking appropriate actions to ensure the success of a company as well as digitization of its business ecosystem. Digital leaders with a mindset oriented toward DT are able to foster mutual cooperation among their staff members and build technological competencies (Bresciani *et al*., 2021). As illustrated by Alos-Simo *et al*. (2017), transformational leadership and adaptive culture which assist in comprehending the social reach of the digital economy are two crucial drivers of e-business adoption. Their findings showed that leadership is crucial to the internal revolution of the culture, which has consequences on the acceptance of e-business. Moreover, AlNuaimi *et al.* (2022) discovered that organizational agility and DL both positively impact DT, and that DL impacts organizational agility. To successfully seize the potential opportunities and deal with the encounters of DT in IR4.0, leaders must reinvent themselves as "Digital Leaders" while not only maintain and develop their skills, but also the digital talent of co-workers for spearheading the level of DT that the company needs (Venkatesh, 2020). Given the preceding discussions, the research posits that:
H_4: *Digital leadership positively impacts digital transformation in MNCs.*

2.3.3 Inter-functional Coordination

DT impacts both external and internal teamwork. Within the organization's intra-firm networks, DT addresses network configuration and coordination including changes in centralization and autonomy (Borangiu *et al*., 2019; Plekhanov *et al*., 2021). Academics and professionals agree that successful DT in a company depends on cross-functional internal collaboration (Earley, 2014; Maedche, 2016). Nevertheless, DT also affects how businesses collaborate and build relationships with upstream and downstream

partners as well as how businesses function in markets (Demeter *et al*., 2021; Pagani & Pardo, 2017). Giri *et al*. (2019) also anticipated that digital technologies can boost performance in the organizations as well as communication and coordination across different functions. In addition to lowering information processing needs (IPN) in an organization, DT may improve the capacity of the network to process information. Similarly, Wu *et al*. (2024) concluded that real-time synchronization of the inter-functional coordination is made possible by DT. Businesses can monitor the movement of all goods from digital platforms all over the function. Hence, the next hypothesis is formulated as below:

H_3: *Inter-functional coordination positively impacts digital transformation in MNCs.*

2.3.4 Collaborative Innovation

Businesses nowadays have highly interconnected networks among their stakeholders and leverage various technologies for developing goods and services within their digital business ecosystem. Digital breakthroughs enable enterprises to make new collaborations and easily interact with their clients and staff (Kiel *et al*., 2016). By fostering innovative software development through establishment of dispersed, integrated and ubiquitous networks of regional digital ecosystems, knowledge exchange and community building can sustain business competitiveness (Nachira *et al*., 2002). Companies should engage in cooperative efforts and establish strategic partnerships with various organizations through joint ventures, open innovation projects or industry consortia, with vendors, clients and even rival businesses in order to stimulate innovation and co-create value (Adner, 2017). According to Hamann-Lohmer *et al*. (2023), the transparency and digital tools automation potentials of DT led to better external supply chain and distributed manufacturing networks collaboration as well as improved existing collaborations. Previous research also showed that DT and IT adoption improve supply chain partner collaboration (Stank *et al*., 2019; Vial, 2019). Besides, Gu & Yang (2022) also showed that collaborative innovation (CI) with clients enable firms to digitize their work process through digital innovations and improve their performance. Similarly, Gu *et al*. (2023) revealed that the role of industrial digitalization can be strengthened by regional CI. Through enhanced absorptive capacity, CI capability can improve process performance and has the ability to guide the creation and execution of firm-level digital collaboration with partners (Mishra *et al*., 2013). Given the context, the study postulates the following hypothesis:

H_5: *Collaborative innovation positively impacts digital transformation in MNCs.*

2.3.5 Decision Making Quality

Digital transformation via business intelligence system (BIS) comprises a system for integrating data-driven decision making with data collection, storage and analysis which deliver valuable ideas (Ishaya & Folarin, 2012). It converts valuable data into meaningful results and outcomes thereby enhancing a firm's competitive advantage. To facilitate strategic decision making, it is imperative to provide correct, sensible, complete and relevant information to the right individuals when needed (Bucher *et al*., 2009). Hamrouni *et al*. (2018) stated that the intelligent decision-support system (IDSS) is acknowledged as a tool for decision-making as it facilitates real-time data changes that impact the precision of decision-making in all processes. Decision-making effectiveness in most enterprises has improved in recent years by up to 56% when an accurate prediction model is used. According to Tariq and Rafi (2012), the integration of area knowledge, analysis and modelling systems in IDSS enables users to receive intelligent assistance resulting in enhancement of decision-making quality. IDSS covers knowledge management components that store and manage a series of cutting-edge AI tools (e.g. machine learning) that allows users to draw conclusions from earlier data and choices while enabling IDSS to facilitate complicated, repeated decision-making in real time. Jarrahi (2018) mentioned that AI systems can assist managers in identifying anomalies and potentially take timely corrective action by offering real-time insight into the early warning signs of more serious problems. Even though human intuition is the greatest advantage when making decisions, humans still require the development of analytical skills. Accordingly, the subsequent hypothesis is planned as follows:

H_6: *Decision-making quality positively impacts digital transformation in MNCs.*

2.3.6 Business Performance

The significance of DT in enhancing business performance has gained large emphasis in the literature. Zhai *et al*. (2022) found that DT helps improve business performance (BP) at the organization level, including performance indicators. Shao and Lin (2002) research on exploitative DT also demonstrated that IT positively influences technical efficiency, resulting in increased productivity and improved financial performance. Likewise, Verhoef *et al*. (2021) reported that enterprises use DT to improve business processes by facilitating more effective harmonization between processes to generate customer value by improving service quality. According to Wu *et al*. (2013), technological innovation directly benefits business and can be further amplified by a company's market orientation and attitude to innovation. This focus on DT is echoed by Teng *et al*. (2022) who studied DT SMEs and highlighted three key resources for it: digital technologies, digital strategy, and employee digital skills that lead to positive financial performance. In China, a study was conducted about DT and found that it positively enhances a company's performance and reduces costs, improves operating efficiency and leads to successful innovations that result in improved performance (Zhai *et al*., 2022). Other research further revealed that DT can improve BP and enhance business creativity (Peng & Tao, 2022). Moreover,

Umar *et al*. (2024) indicated that a firm's competitive advantage and digitalization has a positive impact on its BP. Thus, the subsequent hypothesis is suggested as follows:

H_7: Digital transformation positively impacts business performance in MNCs' business.

Subsequently, the proposed theoretical framework is constructed as seen in Fig. 1 below.

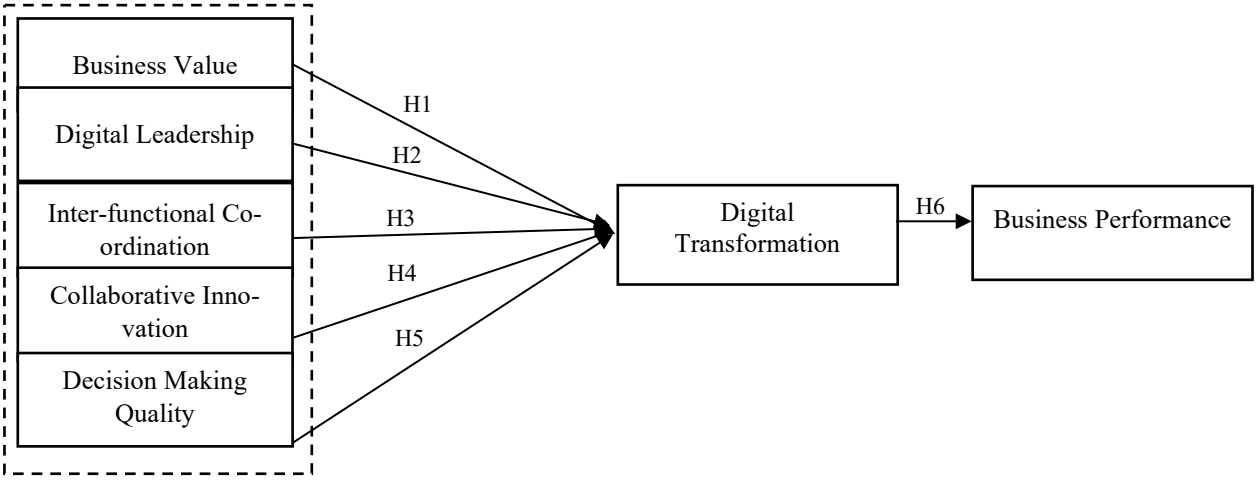

Fig. 1. Theoretical Framework

3. Methodology

3.1 Sample and Data collection

This research adopted the quantitative method for data collection. Thus, managers in MNCs were chosen to participate in answering a structured survey, particularly those involved in digitization efforts of MNC's in Malaysia's Northern region. Non- probability sampling approach specifically the purposive sampling method was utilized to gather the responses (Taherdoost, 2016). The contacts were obtained from Invest Penang MNC directory list. Three filtering questions were included at the start of the questionnaire to ensure that the respondents were i) managerial level respondents, ii) had a minimum of 2 years of work experience within the MNC and iii) they were part of the digital transformation efforts in their organization. The survey data was collected using Google Forms questionnaires' Uniform Resource Locator (URL) link which were distributed to the targeted respondents via email and social media networks. By setting the effect size f2 at 0.15, the α err prob at 0.05, the power (1-β err prob) at 0.95, and the number of predictors at 5 on G*Power, a minimum 138 respondents is deemed necessary to produce desired outcome. In general, a total of 298 usable responses were obtained from the participants and used for data analysis.

3.2 Instrument and Measurement

The questionnaire of this paper was developed by utilizing various measurement scales which were adapted from past studies. The survey form was administered to the participants along with a cover letter stating the research's goal and guaranteeing confidentiality of responses. The questionnaires consist of various sections including the cover letter, screening section of the respondents followed by demographic questions. Next, respondents were instructed to respond to the questions based on the measurement scales of all variables. The items were measured via a 5-point Likert scale (1 to 5), with 1 being "strongly disagree", 3 being "neutral" and 5 being "strongly agree" as advised by Podsakoff *et al*. (2003). Appendix A shows the measurement scales of variables and the original sources from which they were adapted.

3.3 Respondents Profile

Most of the participants were males, comprising 87% of the total responses, while only 13% were females. As for the age group, the highest percentage (45%) of participants were 40 to 49 years, followed by 34% of the participants aged from 31 to 39 years old, 18% aged younger than 30 years old, whereas 4% were aged more than 49 years old. Most of the participants were Chinese representing 85%, while Malay and Indian consisted of 12% and 3% respectively. Moving to the educational background of the respondents, 76% are undergraduates, while 20% and 4% are master's degree and Diploma/certificate holders respectively.

Regarding the business sector, 41% were from the electronics sector, 23% in medical services, and the rest (17%) work in the automotive sector. Majority of the respondents were from Penang (75%) and Kedah (20%) which are areas concentrated with MNC's in northern Malaysia.

4. Results

4.1 Measurement Model

The measurement model was initially estimated to verify the reliability as well as validity of measurement scales. Specifically, the average variance extracted (AVE) was utilized to examine if the convergent validity (CV) assumptions are fulfilled (Hair *et al*., 2022)). The values of AVE should be between 0.5 and 1. Furthermore, composite reliability (CR) and the Cronbach's Alpha values should be more than 0.7 to ensure an indicator's reliability. Also, reflective indicators could be eliminated from the model without altering its conceptual meaning if they are highly correlated and interchangeable (Hair *et al*., 2014). However, in this study, some items (see Fig. 2) were removed due to low loadings (0.5) (Hair *et al*., 2022). Table 1 and 2 provide a summary of the measurement model that illustrates first-order constructs, second-order constructs, indicator loadings, CR and AVE. Referring to the below Table, it is evident that both reliability as well as validity assumptions are fulfilled.

Table 1
Summary of the Measurement Model

First-order Construct	Second-order Construct	Items	Loadings	CR	AVE
	Business Value (BV)	TSV	0.745	-	-
		STV	0.888		
		TRV	0.956		
Digital Leadership (DL)		DL1	0.841	0.812	0.591
		DL2	0.750		
		DL4	0.710		
Interfunctional Coordination (IC)		IC1	0.746	0.846	0.528
		IC2	0.805		
		IC3	0.706		
		IC4	0.801		
		IC5	0.542		
Collaborative Innovation (CI)		CI1	0.891	0.911	0.72
		CI2	0.854		
		CI3	0.831		
		CI4	0.817		
Decision Making Quality (DMQ)		DMQ1	0.682	0.899	0.57
		DMQ2	0.881		
		DMQ3	0.879		
		DMQ4	0.819		
		DMQ5	0.893		
		DMQ6	0.512		
		DMQ7	0.499		
Digital Transformation (DT)		DT4	0.634	0.865	0.564
		DT5	0.784		
		DT6	0.829		
		DT7	0.777		
		DT8	0.716		
Business Performance (BP)		BP1	0.858	0.87	0.574
		BP2	0.689		
		BP3	0.799		
		BP4	0.726		
		BP5	0.704		

Table 2
Second-Order Construct Validity

HOC	LOCs	Outer Weight	T Statistics	P Values	Outer Loadings	VIF
BV	TSV	0.405	12.469	000	0.745	2.311
	STV	0.644	21.015	000	0.888	2.46
	TRV	0.033	30.906	000	0.956	2.144

4.2 Structural Model

This study adopted the variance-based PLS-SEM to analyse the variance of multiple variables as it is characterized by less statistical identification issues (Shiau *et al*., 2019). Structural equation modelling (SEM) is an increasingly popular multivariate method for assessing multivariate causal relationships in scientific research. As stated by Hair *et al*. (2014), collinearity statistics and the significance of the structural model relationships can be assessed through the variance inflation factor (VIF) of formative indicators. Table 3 displays the collinearity analysis of the inner model matrix. The analysis demonstrated that all values of the VIF are less than 3, thus indicating the absence of collinearity issues among the items (Hair *et al*., 2019). After ensuring the absence of Multicollinearity, the significance of each path relationship was determined by running the bootstraps analysis with the resampling technique using 5,000 subsamples as proposed by Hair *et al*. (2022). The findings of the hypotheses are then obtained and displayed in Table 5.

Table 3
VIF Values in the Inner Model Matrix

	BP	BV	CI	DL	DMQ	DT	IC
BP							
BV						1.743	
CI						2.069	
DL						1.388	
DMQ						1.92	
DT	1						
IC						1.946	

In this study, business value was considered a higher-order construct measured by three lower-order constructs: transactional business value (TSV), strategic business value (STV) and transformational business value (TRV). The construct validity for higher order measures was determined based on construct validity, outer loadings, the outer weights, and VIF. Outer weights can be considered significant when their values are recorded at less than 5 (Hair *et al*., 2022, Ramasamy et al., 2020). The analysis showed that all LOC's outer loadings were more than 0.7 and VIF were less than 3. Thus, HOC validity was established.

As portrayed in the findings, the values of the R square are recorded at 0.445 and 0.255, respectively. This reveals that BP explains 44.5% of the overall variance in DT, while the 5 latent variables (BV, DL, IC, CI and DMQ) explain 27.4% of total variance in DT. On the other hand, the Q^2 of BP and DT were 0.255 and 0.406, respectively. These values were higher than zero, indicating that the current model has a good predictive power at the variable level (Cohen, 2013).

4.3 Discriminant Validity

Discriminant validity (DV) was executed for verifying if the reflective constructs have strong correlations with their own indicators. To prove DV, measurement items of constructs should not have high correlations with each other. Fornell and Larcker (1981) stated that the square root of AVE for every latent variable should exceed the correlation amongst the other variables. Henseler *et al*. (2015) also revealed that the Heterotrait-Monotrait ratio of correlations (HTMT) is a more stringent method for evaluating DV. Thus, instead of using the Fornell-Larcker criterion, the HTMT criterion was employed to verify if the constructs are discriminant against one another. Furthermore, DV is considered dubious when HTMT score exceeds 0.85 (Kline, 2023). Table 4 displays that each construct in this study had an HTMT value below 0.85. Thus, the predetermined threshold for DV has been met and verified.

Table 4
Stage 1 HTMT Ratio for Measurement Model (n = 298)

	BP	CI	DL	DMQ	DT	IC
BP						
CI	0.548					
DL	0.232	0.503				
DMQ	0.567	0.641	0.165			
DT	0.591	0.422	0.403	0.467		
IC	0.599	0.726	0.402	0.686	0.567	

After ensuring adequate fit for the data, the structural model was finalized and then used for hypothesis testing. Referring to Table 5 based on the outcomes of structural model with hypotheses decisions, the analysis infer that there are significant influences of business value ($t = 6.173$, $p < .05$), digital leadership ($t = 2.785$, $p < .05$), inter-functional coordination ($t = 1.647$, $p < .05$) and decision-making quality ($t = 2.008$, $p < .05$) towards digital transformation. This is further confirmed through all the beta value within the confidence level of 95%. Thus, hypotheses H1, H2, H3 and H5 are accepted. Besides that, DT positively impacts

business performance (t > 1.645, p < .05); consequently, H6 is also supported. However, collaborative innovation (CI) showed an insignificant influence on DT (t < 1.645 and p > .05); thus, hypotheses H4 is not supported.

Table 5
Summary of the Structural Model with Hypotheses Decision

Hypothesis	Path	Beta	Sample mean (M)	Standard deviation (STDEV)	t-value	P values	5%	95 %	Support
H1	BV → DT	0.471	0.464	0.076	6.173	0.000	0.343	0.592	YES
H2	DL → DT	0.142	0.148	0.051	2.785	0.003	0.052	0.219	YES
H3	IC → DT	0.156	0.157	0.094	1.647	0.050	-0.004	0.308	YES
H4	CI → DT	-0.114	-0.10	0.08	1.425	0.077	-0.237	0.013	NO
H5	DMQ → DT	0.165	0.161	0.082	2.008	0.022	0.022	0.291	YES
H6	DT → BP	0.526	0.532	0.046	11.51	0.000	0.441	0.592	YES

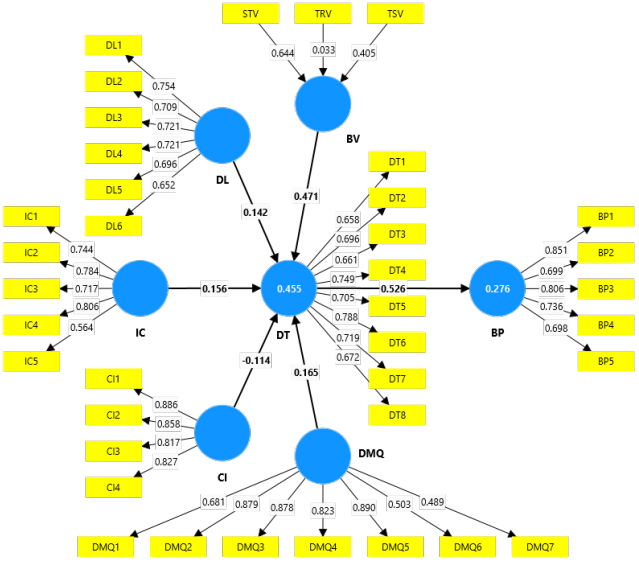

Fig. 2. Measurement Model

5. Discussion

The present study sought to investigate the antecedents of DT adoption in MNCs in Malaysia. The analysis revealed that business value (BV), digital leadership (DL), inter-functional coordination (IC) and decision-making quality (DMQ) all positively influence digital transformation of MNCs in Malaysia. Specifically, the outcomes verified the positive impact of BV on DT. According to Ji-fan Ren *et al*. (2017), the indicators for BV include transactional business value (TSV), strategic business value (STV) and transformational business value (TRV). While TRV provides insights into decision-making in real time, TSV concentrates on increasing productivity and reducing expenses, while STV is concerned with establishing a competitive edge. The study's finding is aligned with Ghobakhloo and Iranmanesh (2021) and Ferreira *et al*. (2019) who verified that business values, such as cost reduction, enhanced productivity, as well as improved product and services are the drivers of DT. Sousa and Rocha (2019) and Dubey *et al*. (2019) also both anticipated significant benefits from Industry 4.0, including reduced labour costs, increased flexibility, faster delivery times, higher productivity, improved product quality, digital manufacturing, and the development of new product and services that eventually innovate the business model. Moreover, Kraus *et al*., (2021) suggested that DT in the business process reduce expenses through lowering adjustment costs while boosting productivity.

Next, the findings supported the depiction that there exists a significant link among digital leadership and digital transformation. This is aligned with the previous research of AlNuaimi *et al.* (2022) who verified the importance of leadership in positively affecting digital transformation, and that DT positively impacts the agility of an organization. Brunner *et al*. (2021) also concluded that digital leadership competencies positively impact organization's capability to adopt new technology and undergo digital transformation. Kawiana *et al*. (2021), El Sawy *et al*. (2020), Hansen *et al*., (2011), Vial (2019) and Alos-Simo *et al*. (2017) highlighted

the significance of digital leadership in adoption of digital transformation in an organization. According to Kokot *et al*. (2021), top-level managers should be knowledgeable about digital technologies for the purpose of supporting the DT process in Industry 4.0. Schwarzmüller *et al*. (2018) further confirmed the importance of leaders in establishing a high relationship-oriented work environment to support staff members in tackling the obstacles of the DT in the organisation.

Regarding the impact of inter-functional coordination (IC) on DT, the results also supported the third hypothesis (H3). The finding is also aligned with Wu *et al*. (2024) who reported that a real-time synchronization of the IC can be made possible by DT and product flow across various functional departments in organizations. Another research conducted by Giri *et al*. (2019) in the textile and apparel context about IC and DT also suggested that digital technologies can boost communication and coordination across different functional departments as well as improve performance in the organizations. According to Rapp *et al*. (2012), to ensure adequate customer orientation and IC, the right technology infrastructure needs to be in place to support an external sales team. Utilizing proper electronic tools and technologies, for instance: blockchain, digital platforms and 3D design toolkits, can all enhance the inter-functional coordination between various functional departments in an organization and enhance both data sharing and analysis (Bellemare, 2018).

Furthermore, the fourth hypothesis (H4) was not supported as the results displayed that collaborative innovation (CI) does not affect digital transformation in MNCs. The finding contrasts with those of past studies (Kiel *et al*., 2016; Adner, 2017; Stank *et al*., 2019; Vial, 2019; Nachira *et al*., 2002; Hamann-Lohmer *et al*., 2023) which tested the linkages among CT and DT. According to Nachira *et al*. (2002), an organization can establish a dispersed, integrated and ubiquitous network of regional digital ecosystems, knowledge exchange and community building to promote innovative software development in order to sustain its competitiveness. Nylén & Holmström (2015) also highlighted that the majority of digital product designs are still partially developed due to the fact that many companies are devoting much of their time to developing innovative malleable intangibles that can be rapidly reconfigured. However, a possible explanation for the inconsistency with research results refers to the high level of uncertainty about the benefits of CI which make it impossible to create any meaningful system to oversee the interorganizational collaborative innovation process. Moreover, Dattée *et al*. (2018) suggested that organizations must dynamically govern their systematic processes driven by coupled feedback loops that are increasingly necessary for the creation and management of an innovative ecosystem. Additionally, partnerships among organizations should address any disagreements among partners regarding responsibility discrepancies and conflicts between the users' and partnership organizations' in the value systems (Mele, 2011). Another possible reason for the significant link among CI and DT could be because most of the respondents are from the electronic business sector where there is less partnership and collaboration among them.

Moving on to decision making quality, the result supported the fifth hypothesis (H5). Eerier studied also testified that DMQ is positively related to digital transformation that takes place through business intelligence system (BIS), intelligent decision support system (IDM-IDSS) and artificial intelligence (AI) (Hamrouni *et al*., 2018; Jarrahi, 2018; Tariq & Rafi, 2012). Moreover, data analytics is an important organizational capability which is vital for attaining competitiveness in the market. Through digital transformation, firms can rely on latest technologies for getting, accumulating, and analysing data to produce novel insights (Rialti *et al*., 2019). Li *et al*. (2022) also concluded that utilizing big data for diverse analysis improves organizational efficiency as well as decision-making. Another research done by Ralea *et al*., (2019) about digital transformation of quality management also identified the advantages of implementing a Digital Quality Management System and indicated that it improves decision-making quality as well.

Lastly, H6 was supported in this study and it aligns with earlier studies (Umar *et al*., 2024; Benavides-Espinosa *et al*., 2024; Masoud & Basahel, 2023; Teng, Wu, & Yang, 2022, Shao & Lin, 2002; Verhoef *et al*., 2021; Wu *et al*., 2013) which concluded that DT positively impacts business performances especially the financial outcomes, such as increased revenue. Gillani *et al*. (2020) measured operational performance through delivery performance, product/service quality, design and adaptability. The process of digitization leads to consumer-focused results such as increased profitability, organizational efficiency, transparency, quality, flexibility, and personalization (Chkoniya & Mateus, 2019). Similarly, Eller *et al*. (2020) verified the influence of digitalization on financial outcomes and concluded that information technology, staff competencies and digital strategy can improve business performance.

6. Implications

The present paper expands the existing literature on BMI framework for explaining digital transformation in MNCs as earlier researches of this nature are limited. Moreover, most of the past studies on digital transformation are mostly based on the TPB (Cetindamar, 2021), RBV theory (Eller *et al*., 2020), UTAUT (Hujran *et al*., 2023), predictive antecedents of Behavioural Intention (BI) and Behavioural Expectation (BE) (Jayawardena *et al*., 2023), DOI, and TOE framework (Shahzad *et al*., 2023). Till date, the use of BMI theory in explaining the role of DT as a corporate strategy for bringing the desired benefits to organisations has not been fully explored in earlier research. Therefore, this paper was conducted with the intention of covering existing gaps in the

literature on digital transformation by examining its antecedents from managers' perspectives in MNCs. DT can be viewed as a key aspect of business transformation which alters the way a business model is developed in either small medium-sized or large-scale enterprises which lead to performance improvement of both individuals and the enterprises. Hence, in an era of digital transformation, a company's continuous reconfiguration of its business model is essential.

From a managerial perspective, this paper enhances our comprehension of the factors affecting the adoption of DT processes in international business and the implications of digitalization on business performance. In spite of the significant developments in this field of research, top-level executives still find it difficult to decide whether to employ DT or not. There are still significant gaps in the empirical literature regarding the drivers of DT adoption (Omrani *et al*., 2022), particularly in MNCs. Therefore, this study aimed to improve our comprehension about the drivers of business digital transformation in international business in the region of Malaysia as an ASEAN country. The findings of this paper showed that businesses become more competitive and can enhance their performance when they embrace digital transformation. Therefore, this study can be used as a reference by researchers and international corporate decision makers for understanding the factors that drive DT in MNCs. It also suggests that managers in these corporations should be able to determine their readiness prior to making any investments in digital transformation. According to the findings, it is also suggested that MNCs which aim to improve their DT should develop clear DT's strategies that fits the preferred business value which lead to innovative business models. Leaders who are digitally proficient are vital for DT, as they are the key persons to evaluate the existing technology and then create a detailed strategic technological plan that includes expenditures in staff upskilling and skill improvements. Decision support systems can also act as powerful tools to analyse big data and transform them into usable insights to improve efficiency and agility in decision making. In short, creating a completely integrated strategic approach is essential for implementing DT in MNCs.

7. Limitation and Future Research

This research has certain limitations which should be considered in future research. First, the results may not be generalizable due to geographical boundaries in carrying out this research in MNCs located in the Northen region of Malaysia, and most of the participants were from the state of Penang. Thus, future research can be carried out in other geographical areas, including east Malaysia with a larger sample size. Second, this study examined five independent variables as antecedent of DT study, and therefore, future researches can explore other predictors and include moderating variables. Third, most of the respondents were from marketing, production/operations and information technology departments the surveyed organizations. Thus, future research can target other departments to get better insights about the drivers of DT. Lastly, using different statistical tools for data analysis other than structural equation modelling could be considered in future studies. Future researchers can also approach DT research from the dynamic capability angle of the RBV angle (i.e. Ashaari et al., 2021) in order to understand the resource and capability requirements that are associated with DT adoption while uncovering challenges and benefits associated with DT.

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References

Adner, R. (2017). Ecosystem as structure: An actionable construct for strategy. *Journal of Management*, *43*(1), 39-58.

AlNuaimi, B., Singh, S., Ren, S., Budhwar, P., & Dmitriy , V. (2022). Mastering digital transformation: The nexus between leadership, agility, and digital strategy. *Journal of Business Research, 145*, Journal of Business Research.

Ammeran, M. Y., Noor, S., & Yusof, M. (2022). Digital Transformation of Malaysian Small and Medium-Sized Enterprises: A Review and Research Direction. *Innovation of Businesses, and Digitalization during Covid-19 Pandemic: ICBT 2021 (Lecture Notes in Networks and Systems; Vol. 488*), 255-278. Springer.

Alos-Simo, L., Verdu-Jover, A. J., & Gomez-Gras, J. M. (2017). How transformational leadership facilitates e-business adoption. *Industrial Management & Data Systems*, 117(2), 382-397.

ASEAN (2017). A Historic Milestone for FDI and MNEs in ASEAN. https://asean.org/wp-content/uploads/2020/12/ASEAN-at-50-A-Historic-Milestone-for-FDI-and-MNEs-in-ASEAN.pdf

Ashaari, M. A., Singh, K. S. D., Abbasi, G. A., Amran, A., & Liebana-Cabanillas, F. J. (2021). Big data analytics capability for improved performance of higher education institutions in the Era of IR 4.0: A multi-analytical SEM & ANN perspective. Technological Forecasting and Social Change, 173, 121119.

Benavides-Espinosa, M. D. M., Ribeiro-Soriano, D., & Gieure, C. (2024). How can agrifood businesses improve their performance? The role of digital transformation. *British Food Journal*, *126*(4), 1682-1697.

Berghaus, S., & Back, A. (2016). Stages in digital business transformation: Results of an empirical maturity study. *Mediterranean Conference on Information Systems (MCIS)*, 1-17.

Bellemare, J. (2018). Fashion Apparel Industry 4.0 and Smart Mass Customization Approach for Clothing Product Design (pp. 619-633). *Springer Proceedings in Business and Economics, in: Stephan Hankammer & Kjeld Nielsen & Frank T. Piller & Günther Schuh & Ning Wang (ed.), Customization 4.0*, 619-633, Springer.

Bhatti, S. H., Santoro, G., Khan, J., & Rizzato, F. (2021). Antecedents and consequences of business model innovation in the IT industry. *Journal of Business Research*, 123, 389-400.

Borangiu, T., Trentesaux, D., Thomas, A., Leitão, P., & Barata, J. (2019). Digital transformation of manufacturing through cloud services and resource virtualization. *Computers in Industry*, *108*, 150-162.

Böttcher, T. P., & Weking, J. (2020). Identifying Antecedents and Outcomes of Digital Business Model Innovation. *ECIS 2020 Research-in-Progress Papers*. 24. https://aisel.aisnet.org/ecis2020_rip/24

Bouwman, H., Nikou, S., & de Reuver, M. (2019). Digitalization, business models, and SMEs: How do business model innovation practices improve performance of digitalizing SMEs?. Telecommunications Policy, 43(9), 101828.

Bresciani, S., Huarng, K. H., Malhotra, A., & Ferraris, A. (2021). Digital transformation as a springboard for product, process and business model innovation. *Journal of Business Research*, 128, 204-210.

Brunner, M., Gonzalez-Castañé, G., & Ravesteijn, P. (2021). How Digital Leadership competences and IT Capabilities affect an organization's ability to digitally transform and adopt new technologies. *Journal of International Technology and Information Management*, 30(4), 139-156.

Bucher, T., Gericke, A., & Sigg, S. (2009). Process-centric business intelligence. *Business Process Management Journal*, 15(3), 408-429.

Cetindamar, D., Abedin, B., & Shirahada, K. (2021). The role of employees in digital transformation: a preliminary study on how employees' digital literacy impacts use of digital technologies. *IEEE Transactions on Engineering Management*.

Chi, M., Wang, W., Lu, X., & George, J. F. (2018). Antecedents and outcomes of collaborative innovation capabilities on the platform collaboration environment. *International Journal of Information Management*, 43, 273-283.

Chkoniya, V., & Mateus, A. (2019). Digital category management: How technology can enable the supplier-retailer relationship. In *Smart Marketing With the Internet of Things*(pp. 139-163). IGI Global.

Choi, S., Jun, C., Zhao, W.B. and Noh, S.D. (2015). Digital manufacturing in smart manufacturing systems: contribution, barriers, and future directions. *IFIP International Conference on Advances in Production Management Systems, Springer, Cham*, 21-29.

Cohen, J. (2013). Statistical power analysis for the behavioral sciences. New York: Academic Press.

Dasí, À., Elter, F., Gooderham, P. N., & Pedersen, T. (2017). New Business Models In-The-Making in Extant MNCs: Digital Transformation in a Telco. *Advances in International Management*, 29-53.

Dattée, B., Alexy, O., & Autio, E. (2018). Maneuvering in poor visibility: How firms play the ecosystem game when uncertainty is high. *Academy of Management Journal*, 61(2), 466-498.

Demeter, K., Losonci, D., & Nagy, J. (2021). Road to digital manufacturing - a longitudinal case-based analysis. *Journal of Manufacturing Technology Management*, 32(3), 820-839.

Dubey, R., Gunasekaran, A., Childe, S. J., Blome, C., & Papadopoulos, T. (2019). Big Data and Predictive Analytics and Manufacturing Performance: Integrating Institutional Theory, Resource Based View and Big Data Culture. *British Journal of Management*, 30(2), 341–361.

Earley, S. (2014). The digital transformation: Staying competitive. *It Professional*, 16(2), 58-60.

El Sawy, O. A., Kræmmergaard, P., Amsinck, H., & Vinther, A. L. (2020). How LEGO built the foundations and enterprise capabilities for digital leadership. *In Strategic information management*, 174-201. Routledge.

Eller, R., Alford, P., Kallmünzer, A., & Peters, M. (2020). Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization. *Journal of Business Research*, *112*, 119-127.

Ferreira, J. J. M., Fernandes, C. I., & Ferreira, F. A. F. (2019). To be or not to be digital, that is the question: Firm innovation and performance. *Journal of Business Research*, *101*, 583-590.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39-50.

Foss, N. J. & T. Saebi (2017). Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go?. *Journal of Management,* 43 (1), 200-227.

Frank, A.G., Dalenogare, L.S. & Ayala, N.F. (2019). Industry 4.0 technologies: implementation patterns in manufacturing companies. *International Journal of Production Economics*, 210, 15-26.

Frank, A. G., Mendes, G. H., Ayala, N. F., & Ghezzi, A. (2019b). Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective. *Technological Forecasting and Social Change*, 141, 341-351.

George, G., & Schillebeeckx, S. J. (2022). Digital transformation, sustainability, and purpose in the multinational enterprise. *Journal of World Business*, 57(3), 101326.

Gu, J., & Yang, M. (2022). Platform Enterprises Help Traditional Enterprises in Digital Transformation: Collaborative Innovation in the Process. *WHICEB 2022 Proceedings*, 71.

Gu, R., Li, C., Yang, Y., & Zhang, J. (2023). The impact of industrial digital transformation on green development efficiency considering the threshold effect of regional collaborative innovation: Evidence from the Beijing-Tianjin-Hebei urban agglomeration in China. *Journal of Cleaner Production*, 420, 138345.

Ghobakhloo, M., & Iranmanesh, M. (2021). Digital transformation success under Industry 4.0: A strategic guideline for manufacturing SMEs. *Journal of Manufacturing Technology Management*, 32(8), 1533-1556.

Gillani, F., Chatha, K. A., Jajja, M. S. S., & Farooq, S. (2020). Implementation of digital manufacturing technologies: Antecedents and consequences. *International Journal of Production Economics*, 229, 107748.

Gurbaxani, V., & Dunkle, D. (2019). Gearing up for successful digital transformation. *MIS Quarterly Executive, 18*(3), 209 -220.

Hair, J., Hult, G. T., Ringle, C. M., & Sarstedt, M. (2022). A Primer on Partial Least Squares

Structural Equation Modeling (PLS-SEM) (3rd ed.). *SAGE Publications*, Inc.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European business review*, 31(1), 2-24.

Hair, J., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. (2014). Partial least squares structural

equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review*, 26(2), 106-121.

Halme, M., Anttonen, M., Kuisma, M., Kontoniemi, N., & Heino, E. (2007). Business models for material efficiency services: Conceptualization and application. *Ecological Economics*, *63*(1), 126-137.

Hamann-Lohmer, J., Bendig, M., & Lasch, R. (2023). Investigating the impact of digital transformation on relationship and collaboration dynamics in supply chains and manufacturing networks-A multi-case study. *International Journal of Production Economics*, 262, 108932.

Hamidi, S. R., Aziz, A. A., Shuhidan, S. M., Aziz, A. A., & Mokhsin, M. (2018). SMEs Maturity Model Assessment of IR4.0.0 Digital Transformation. *Proceedings of the 7th International Conference on Kansei Engineering and Emotion Research 2018*, 721-732.

Hamrouni, B., Korichi, A., & Bourouis, A. (2018). IDSS-BM: Intelligent decision support system for business models. *In Proceedings of the 7th international conference on software engineering and new technologies,* 3, 1-5.

Hansen, A. M., Kræmmergaard, P., & Mathiassen, L. (2011). Rapid Adaptation in Digital Transformation: A Participatory Process for Engaging IS and Business Leaders. *MIS Quarterly Executive*, 10(4), 175-185.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modelling. *Journal of the academy of marketing science*, 43, 115-135.

Hujran, O., Al-Debei, M. M., Al-Adwan, A. S., Alarabiat, A., & Altarawneh, N. (2023). Examining the antecedents and outcomes of smart government usage: An integrated model. *Government Information Quarterly*, 40(1), 101783.

Imran, F., Shahzad, K., Butt, A., & Kantola, J. (2021). Digital transformation of industrial organizations: Toward an integrated framework. *Journal of Change Management*, 21(4), 451-479.

Ishaya, T., & Folarin, M. (2012). A service oriented approach to Business Intelligence in Telecoms industry. *Telematics and Informatics*, 29(3), 273-285.

Jarrahi, M. H. (2018). Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. *Business horizons*, 61(4), 577-586.

Jayawardena, C., Ahmad, A., Valeri, M., & Jaharadak, A. A. (2023). Technology acceptance antecedents in digital transformation in hospitality industry. *International Journal of Hospitality Management*, *108*, 103350.

Ji-fan Ren, S., Fosso Wamba, S., Akter, S., Dubey, R., & Childe, S. J. (2017). Modelling quality dynamics, business value and firm performance in a big data analytics environment. *International Journal of Production Research*, 55(17), 5011-5026.

Kargas, A., Gialeris, E., Komisopoulos, F., Lymperiou, A., & Salmon, I. (2023). Digital Maturity and Digital Transformation Strategy among Greek Small and Medium Enterprises. *Administrative Sciences*, *13*(11), 236.

Kawiana, I., Dewi, L. K. C., Hartati, P. S., Setini, M., & Asih, D. (2021). Effects of leadership and psychological climate on organizational commitment in the digitization era. *Journal of Asian Finance, Economics and Business*, 8(1), 1051-1062.

Kiel, D., Arnold, C., Collisi, M., & Voigt, K. I. (2016). The impact of the industrial internet of things on established business models. *In Proceedings of the 25th international association for management of technology (IAMOT) conference* (673-695).

Kitsios, F., Kamariotou, M., & Mavromatis, A. (2023). Drivers and Outcomes of Digital Transformation: The Case of Public Sector Services. *Information 2023*, 14(1), 43.

Kline, R. B. (2023). *Principles and practice of structural equation modeling*. Guilford publications.

Kokot, K., Kokotec, I. Đ., & Čalopa, M. K. (2021). Impact of leadership on digital transformation. In *2021 IEEE Technology & Engineering Management Conference-Europe (TEMSCON-EUR), Dubrovnik, Croatia*, 1-6. IEEE.

Kraus, S., Jones, P., Kailer, N., Weinmann, A., Chaparro-Banegas, N., & Roig-Tierno, N. (2021). Digital transformation: An overview of the current state of the art of research. *Sage Open*, *11*(3), 1-15.

Li, L., Lin, J., Ouyang, Y., & Luo, X. R. (2022). Evaluating the impact of big data analytics usage on the decision-making quality of organizations. *Technological Forecasting and Social Change*, 175, 121355.

Li, W., Liu, K., Belitski, M., Ghobadian, A., & O'Regan, N. (2016). e-Leadership through strategic alignment: An empirical study of small-and medium-sized enterprises in the digital age. *Journal of Information Technology*, *31*, 185-206.

Lohmer, J., Kossmann, F., & Lasch, R. (2021). Manufacturing strategy in multi-plant networks- a multi-case study on decision making authority, network capabilities and competitive advantages. *International Journal of Production Research*, 60(16), 5108-5129.

Lo, F. Y., Bui, Q. T., & Huarng, K. H. (2023). The pace of international expansion for digital multinational enterprises. *Technological Forecasting and Social Change*, 193, 122629.

Maedche, A. (2016). Interview with Michael Nilles on "What Makes Leaders Successful in the Age of the Digital Transformation?". *Business & Information Systems Engineering*, *58*(4), 287-289.

Masoud, R., & Basahel, S. (2023). The effects of digital transformation on firm performance: The role of customer experience and IT innovation. *Digital*, *3*(2), 109-126.

McKinsey & Company (2015). Industry 4.0 How to navigate digitization of the manufacturing sector. *McKinsey & Company*. Retrieved from https://www.mckinsey.com/business-functions/operations/our-insights/industry-four-point-o-how-to-navigae-the-digitization-of-the-manufacturing-sector (8 December 2023)

McKinsey (2020). How COVID-19 Has Pushed Companies over the Technology Tipping Point-And Transformed Business Forever. *McKinsey Global Publishing*. https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformedbusiness-forever.

Mele, C. (2011). Conflicts and value co-creation in project networks. *Industrial Marketing Management*, 40(8), 1377-1385.

Mishra, A. N., Devaraj, S., & Vaidyanathan, G. (2013). Capability hierarchy in electronic procurement and procurement process performance: An empirical analysis. *Journal of Operations Management*, 31(6), 376-390.

Nachira, F., Chiozza, E., Ihonen, H., Manzoni, M., & Cunningham, F. (2002). Towards a network of digital business ecosystems fostering the local development. *Directorate General Information Society and Media, European Commission*, Tech.

Nwankpa, J. K., & Roumani, Y. (2016). IT capability and digital transformation: A firm performance perspective.

Nguyen, V., Hoang, T., Mai, T., Lam, T., & Pham, H. (2023). The factors affecting digital transformation in small and medium enterprises in Hanoi city. *Uncertain Supply Chain Management*, 11(4), 1705-1718.

Nylén, D., & Holmström, J. (2015). Digital innovation strategy: A framework for diagnosing and improving digital product and service innovation. *Business horizons*, 58(1), 57-67.

Oh, K., Kho, H., Choi, Y., & Lee, S. (2022). Determinants for successful digital transformation. *Sustainability*, 14(3), 1215.

Oliveira, T., & Martins, M. F. (2011). Literature review of information technology adoption models at firm level. *Electronic journal of information systems evaluation*, 14(1), 110-121.

Pagani, M., & Pardo, C. (2017). The impact of digital technology on relationships in a business network. *Industrial Marketing Management*, 67, 185-192.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of applied psychology*, 88(5), 879-903.

Omrani, N., Rejeb, N., Maalaoui, A., Dabić, M., & Kraus, S. (2022). Drivers of digital transformation in SMEs. *IEEE Transactions on Engineering Management*.

Peng, Y., & Tao, C. (2022). Can digital transformation promote enterprise performance? From the perspective of public policy and innovation. *Journal of Innovation & Knowledge, 7*(100198).

Pereira, C., Durão, N., Moreira, F., & Veloso, B. (2022). The Importance of Digital Transformation in International Business. *Sustainability, 14*(2), 834.

Rachinger, M., Rauter, R., Müller, C., Vorraber, W., & Schirgi, E. (2018). Digitalization and its influence on business model innovation. *Journal of manufacturing technology management*, 30(8), 1143-1160.

Ralea, C., Dobrin, O. C., Barbu, C., & Tanase, C. (2019). Looking to the future: Digital transformation of quality management. *In Proceedings of the International Management Conference*, 13(1), 121-132.

Rai, A., & Tang, X. (2014). Research commentary- information technology-enabled business models: A conceptual framework and a coevolution perspective for future research. *Information Systems Research*, *25*(1), 1-14.

Ramasamy, S., Dara Singh, K. S., Amran, A., & Nejati, M. (2020). Linking human values to consumer CSR perception: The moderating role of consumer skepticism. *Corporate Social Responsibility and Environmental Management*, *27*(4), 1958-1971.

Rapp, A., Beitelspacher, L. S., Schillewaert, N., & Baker, T. L. (2012). The differing effects of technology on inside vs. outside sales forces to facilitate enhanced customer orientation and interfunctional coordination. *Journal of Business Research*, 65(7), 929-936.

Riel, A., Kreiner, C., Macher, G., & Messnarz, R. (2017). Integrated design for tackling safety and security challenges of smart products and digital manufacturing. *CIRP annals*, 66(1), 177-180.

Rialti, R., Zollo, L., Ferraris, A., & Alon, I. (2019). Big data analytics capabilities and performance: Evidence from a moderated multi-mediation model. *Technological Forecasting and Social Change*, 149, 119781.

Ruiz-Alba, J. L., Guesalaga, R., Ayestarán, R., & Mediano, J. M. (2019). Interfunctional coordination: the role of digitalization. *Journal of Business & Industrial Marketing*, 35(3), 404-419.

Santos-Jaén, J. M., Gimeno-Arias, F., León-Gómez, A., & Palacios-Manzano, M. (2023). The business digitalization process in SMEs from the implementation of e-Commerce: An empirical analysis. *Journal of theoretical and applied electronic commerce research*, 18(4), 1700-1720.

Sawhney, M., Wolcott, R. C., & Arroniz, I. (2006). The 12 different ways for companies to innovate. *MIT Sloan Management Review* 47.

Schwarzmüller, T., Brosi, P., Duman, D., & Welpe, I. M. (2018). How does the digital transformation affect organizations? Key themes of change in work design and leadership. *Management Revue*, 29(2), 114-138.

Shahzad, A., bin Zakaria, M. S. A., Kotzab, H., Makki, M. A. M., Hussain, A., & Fischer, J. (2023). Adoption of fourth industrial revolution 4.0 among Malaysian small and medium enterprises (SMEs). *Humanities and Social Sciences Communications*, 10(1), 1-14.

Shao, B.B.M., Lin, W.T., 2002. Technical efficiency analysis of information technology investments: A two-stage empirical investigation. *Information & Management*, 39(5), 391-401.

Shiau, W.-L., Sarstedt, M. and Hair, J.F. (2019). Internet research using partial least squares structural equation modeling (PLS-SEM). *Internet Research*, 29(3), 398-406.

Sousa, M. J., & Rocha, Á. (2019). Digital learning: Developing skills for digital transformation of organizations. *Future Generation Computer Systems*, *91*, 327-334.

Stank, T., Esper, T., Goldsby, T. J., Zinn, W., & Autry, C. (2019). Toward a digitally dominant paradigm for twenty-first century supply chain scholarship. *International Journal of Physical Distribution & Logistics Management*, 49(10), 956-971.

Steininger, D. M. (2019). Linking information systems and entrepreneurship: A review and agenda for IT-associated and digital entrepreneurship research. *Information Systems Journal*, 29 (2), 363-407.

Sun, P., Doh, J. P., Rajwani, T., & Siegel, D. (2021). Navigating cross-border institutional complexity: A review and assessment of multinational nonmarket strategy research. *Journal of International Business Studies*, 52(9), 1818-1853.

Taherdoost, H. (2016). Sampling methods in research methodology; how to choose a sampling technique for research. *How to choose a sampling technique for research (April 10, 2016)*.

Tariq, A., & Rafi, K. (2012). Intelligent decision support systems-A framework. *Information and Knowledge Management*, 2(6), 12-20.

Teng, X., Wu, Z., & Yang, F. (2022). Research on the Relationship between Digital Transformation and Performance of SMEs. *Sustainability*, 14(10), 6012.

Tham, K. W., & Atan, S. A. (2021). SME readiness towards digitalization in Malaysia. Research in Management of Technology and Business, 2(1), 361-375. Retrieved from https://publisher.uthm.edu.my/periodicals/index.php/rmtb/article/view/1858

Ulas, D. (2019). Digital Transformation Process and SMEs. *Procedia Computer Science*. 158. 662-671.

Umar, F., Septian, M. R. A., & Pertiwi, D. A. A. (2024). The Effect of Digitalization on Business Performance in the MSME Industry Context. *Journal of Information System Exploration and Research*, 2(1).

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Venkatesh, D. A. N. (2020). Leadership 4.0: Leadership strategies for industry 4.0. *Solid State Technology*, 63(6).

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of business research*, 122, 889-901.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *Journal of Strategic Information Systems*, 28(2), 118-144.

Wahid, R. A., & Zulkifli, N. A. (2021). Factors Affecting the Adoption of Digital Transformation among SME's in Malaysia. *Journal of Information Technology Management*, 13(3), 126-140.

Warner, K. S., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, 52(3), 326–349.

Weritz, P., Braojos, J., & Matute, J. (2020). Exploring the Antecedents of Digital Transformation: Dynamic Capabilities and Digital Culture Aspects to Achieve Digital Maturity. *Americas Conference on Information Systems (AMCIS) 2020 Proceedings*, 22. https://aisel.aisnet.org/amcis2020/org_transformation_is/org_transformation_is/22

Wu, J., Kopot, C. & Zhao, L., (2024). Improving Inter-functional Coordination in Apparel Companies through Digital Transformation - An Exploratory Case Study in China. *International Textile and Apparel Association Annual Conference Proceedings*, 80(1).

Wu, Y., Liang, Q. Z., and Wei, Z. L. (2013). A study on the impact of dual technological innovation and market orientation on firm performance, A disruptive innovation perspective. *Science, Technology, and Management*. 34, 140-151.

Zhai, H., Yang, M., & Chan, K. C. (2022). Does digital transformation enhance a firm's performance? Evidence from China. *Technology in Society*, 68, 101841.

Zhao, C. (2023). Research on antecedent configuration of digital transformation in manufacturing enterprises: a fuzzy-set QCA approach. In *2023 International Conference on Management Innovation and Economy Development (MIED 2023)*, 250-255. Atlantis Press.

Zhu, X., Ge, S., & Wang, N. (2021). Digital transformation: A systematic literature review. *Computers & Industrial Engineering*, 162, 107774.

Appendix: Adapted Indicators and Source of the Adaptation

Business Value (BV)

	Items	Descriptions	Source
Transactional Value (TSV)	TSV1	Digital transformation helps savings in supply chain management	Adapted from: Ji-fan Ren *et al*. (2017)
	TSV2	Digital transformation reduces operating costs	
	TSV3	Digital transformation reduces communication costs	
	TSV4	Digital transformation avoids additional workforce	
	TSV5	Digital transformation increasing return on financial assets	
	TSV6	Digital transformation enhances employees' productivity.	
Strategic Value (STV)	STV1	Digital transformation creating competitive advantage	
	STV2	Digital transformation aligning analytics with business strategy	
	STV3	Digital transformation establishing useful links with other organisations	
	STV4	Digital transformation enabling quicker response to change	
	STV5	Digital transformation improves customer relations	
	STV6	Digital transformation helps in providing better products or services to customers	
Transformational Value (TRV)	TRV1	Digital transformation enhances skill level of employees	
	TRV2	Digital transformation enhances development of new business plans	
	TRV3	Digital transformation promotes organisational capabilities expansion	
	TRV4	Digital transformation improves business models	
	TRV5	Digital transformation improves organisational structure and processes	

Digital Leadership (DL)

Items	Descriptions	Source
DL1	Leaders inspire all members with the digital transformation plans for our organization.	Adapted from: AlNuaimi *et al*. (2022)
DL2	Leaders provide a clear digital transformation vision for the organization's members to follow.	
DL3	Leaders motivate team members to work together for the same digital transformation goals.	
DL4	Leaders in encourage all members to achieve digital transformation goals for our organization.	
DL5	Leaders act by considering the digital transformation beliefs of all members.	
DL6	Leaders stimulate all members to think about digital transformation ideas.	

Inter-functional Coordination (IC)

Items	Descriptions	Source
IC1	With digitalisation, information about customers can be easily shared throughout the organisation. (Information about your customers is communicated freely throughout the company)	Adapted from: Rapp *et al*. (2012)
IC2	With digitalisation, different company functions work in an integrated fashion to fulfil the needs of company's objectives (Different company functions work in an integrated fashion to fulfil the needs of our objectives)	
IC3	With digitalisation, managers understand how employees from all functions can contribute to deliver customer value	
IC4	With digitalisation, we share "resources" between different business units	
IC5	With digitalisation, managers from different company functions visit customers regular	

Collaborative Innovation (CI)

Items	Descriptions	Source
CI1	With digitalization, our firm will gain competence to create new marketing strategy (e.g., social network marketing) with our distributors	Adapted from: Chi *et al*. (2018)
CI2	With digitalization, our firm will gain competence to creates new service to improve customer loyalty with our distributors	
CI3	With digitalization, our firm will gain competence to creates new products to satisfy customer demand with our distributors	
CI4	With digitalization, our firm will gain competence to creates new business mode (e.g., e-ordering, customization) with our distributors	

Decision Making Quality (DMQ)

Items	Descriptions	Source
DMQ1	With digitalization, decision outcomes are often flawless.	Adapted from: Li *et al*. (2022)
DMQ2	With digitalization, decision outcomes are often reliable.	
DMQ3	With digitalization, decision outcomes are often precise.	
DMQ4	With digitalization, decision outcomes are often error-free.	
DMQ5	With digitalization, decision outcomes are often accurate.	
DMQ 6	With digitalization, the time to arrive at decisions is fast.	
DMQ 7	With digitalization, the speed of arriving at decisions is high.	

Digital Transformation

Items	Descriptions	Source
DT 1	We are well aware of the possibilities and advantages of digitalization	Adapted from: Santos-Jaén *et al*. (2023)
DT 2	We allocate significant resources to digitize the business	
DT 3	The business model is evaluated and updated in terms of digitalization	
DT 4	Our employees are prepared for the digital development of the company	
DT 5	Our managers are well trained in digitalization	
DT 6	The degree of process automation is high in my company	
DT 7	We use digitalization in the organizational management of the company	
DT 8	Our company regularly organizes training for digital transformation	

Business Performance (BP)

Items	Descriptions	Source
BP 1	I am expecting my company to achieve increase in revenue from adoption of digital transformation.	Adapted from: Kargas *et al*. (2023)
BP 2	I am expecting my company to achieve increase in market share from adoption of digital transformation.	
BP 3	I am expecting increase in business speed and agility from adoption of digital transformation.	
BP 4	I am expecting improvement in customer satisfaction from adoption of digital transformation	
BP 5	I am expecting reduction of development time for new product/services from adoption of digital transformation	

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