IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Received 15 March 2024, accepted 9 April 2024, date of publication 12 April 2024, date of current version 25 April 2024.

Digital Object Identifier 10.1109/ACCESS.2024.3388290

RESEARCH ARTICLE

Value Identification and Its Creation Mechanism of Digital Transformation at Enterprises

SHUIFANG LI[1], AINI BINTI AMAN[1,2], DAHLIA FERNANDEZ[1], SOLIHA SANUSI[1], SHASHA DONG[1], YUQIONG FAN[1], AND ZHENWEI LIAO[1]

[1]Department of Financial and Accounting Management, National University of Malaysia, Bangi, Selangor 43000, Malaysia
[2]Faculty of Business, Sohar University, Sohar 311, Oman

Corresponding author: Aini Binti Aman (aini@ukm.edu.my)

This work was supported by the Faculty of Economics and Management, Universiti Kebangsaan Malaysia.

ABSTRACT The survey highlights that most enterprise digital transformation (DT) projects failed to reach the expected outcomes. This is often due to a limited understanding of DT's value and its creation mechanism (VM). The purpose of this article is to compile a list of variables that affect DT's VM and assess the VM factors according to causal links, thereby further understanding of the intricate connections among VM factors. This article adopts a mixed approach called "CS: GT-DEMATEL-ISM" which incorporates the concepts of case study (CS), grounded theory (GT), decision experimentation and evaluation laboratory (DEMATEL), and interpretative structural modeling (ISM). Through GT, 32 concepts related to the DT's VM system were extracted and summarized into 15 VM elements, which further converged into 7 categories: IT, data, process, organization, business, business mode, and values. Using DEMATEL and ISM, DT's VM system model is established, it shows digital technology enables the reconstruction and evolution of data, processes, organizations, and business, thereby establish, or optimize business models, ultimately improve enterprise capabilities and performance. Three main aspects make up research contributions. In terms of methodology, this study suggests that using a mixed approach known as "CS: GT-DEMATEL-ISM" to identify and examine the factors of complex systems. In terms of theoretical and practical contribution, this article is the first to systematically identify DT's values and build the framework of DT's VM system, which fills the gap in DT-related theory and would help enterprise management for DT planning and DT project implementation in DT practice.

INDEX TERMS Digital transformation, value of digital transformation, mechanism of digital transformation, value of digital transformation, case study, grounded theory, DEMATEL, ISM.

I. INTRODUCTION

According to the Global Digital Economy White Paper 2023 released by CAICT [1], the digital economy has become an important component of the global economy, growing rapidly, and industrial DT has become an important means of digital economic growth. Firstly, in 2022, in terms of scale, the US digital economy ranked first in the world, reaching $17.2 trillion, while China ranked second with a scale of $7.5 trillion. In terms of proportion, the digital economy in the UK, Germany, and the US all accounts for over 65% of GDP. Secondly, in terms of growth rate, Saudi Arabia, Norway, and Russia rank among the top three in the world in terms of digital economy growth rate, all of which are above 20%. Finally, the DT of industries has become the main engine for the growth of the three major industries. According to the 51 countries included in the calculation, the economic growth brought about by the DT of industries accounts for 85.3% of the proportion of digital economic growth. Among them, the digital economic growth of the first, second, and third industries accounts for 9.1%, 24.7%, and 45.7% of the industry's added value, respectively. The DT of the third industry is the most active, and the DT of the second industry continues to exert force.

To adapt to the trend of the times, enterprises are undergoing DT one after another. For at least a decade, DT has been a top priority on the corporate agenda, and there are no signs of slowing down. On the contrary, many commentators

The associate editor coordinating the review of this manuscript and approving it for publication was Vivek Kumar Sehgal.

emphasized that DT was accelerated in the COVID-19 era [2].

However, most DTs have failed. Various studies from scholars, consultants, and analysts have shown that the rate of DT failing to achieve its initial goals ranges from 70% to 95%, with an average of 87.5 % [2]. According to the "2021 China Enterprise DT Index Research" launched by Accenture and the Chinese National Industrial Information Security Development Research Center, only 16% of Chinese enterprises achieved significant DT results in 2021 [3]. In view of this, research on how to carry out enterprise DT is of great significance and urgent.

Over the past 20 years, scholars have seemed keen on examining the relationship between DT and its outcomes (such as corporate performance, corporate value, etc.), but there is still a lack of answers on how to carry out enterprise DT, like Zhu and Lin's [4] finding in her literature review about DT, there is a lack of sufficient discussion in the literature on DT's dynamic evolution mechanism, as well as the collaborative and operational mechanisms of its internal factors (such as digital technology, processes, organizations, models, etc.).

To bridge this gap, this study proposes a mixed method of "CS: GT-DEMATEL-ISM" by combining case study (CS), grounded theory (GT), decision-making trial and evaluation laboratory (DEMATEL), and interpretative structural modeling (ISM). The mixed method is performed to thoroughly gather factors related to DT's VM and evaluate relationships among factors. In particular, this paper takes insight into the whole process of DT's VM. The objective of this paper is to develop a theoretical framework of VM factors and evaluate the collected factors based on the cause–effect relations. The goal is to improve the understanding of how to implement DT projects successfully. The research outcome is expected to fill the relevant research gap of the existing body of knowledge and provide the framework for managers to make DT strategy and implementation of the DT project.

The framework of this study is assigned as follows. The next section depicts the literature review to present the relevant published articles and further identify the research gaps. Following this, the methodology applied in the research procedure is systematically delineated Section III. Then the results and discussions in Section IV.

II. LITERATURE REVIEW

This article provides a systematic literature review on the VM of DT. The finding including the DT's effects and cause factors.

A. DT's VALUE

The existing literature has answered whether DT can create value for enterprises. Most of the researchers agree that DT has significant effects on enterprises, such as enterprise performance [5], [6], productivity [7], [8], [9] or enterprise capability, like operation efficiency [10], [11], [12], [13].

B. CAUSE FACTORS OF DT's VALUE

Researchers also focus on cause factors that affect DT's value, including technologies, data, processes, organizations, etc.

1) TECHNOLOGIES

Technologies are classified by different ways, such as "general technology and advanced technology", "blockchain technology, big data, cloud computing, and other technologies", "traditional ICT technology and modern digital technology", etc. And scholars test the relationship between DT's results and different types of digital technologies, they found that different types of technologies have different results [5], [7], [8], and the diversity and combination of different digital technologies also produce different results [14], [15].

2) DATA/INFORMATION

Some articles discuss data or information as an effective factor. Xia et al. [16] claim that data are used by analysts to improve the focus and promote enterprise total factors productivity (TFP). Wu et al. [17] find that information transparency is a bridge to DT's results; DT can improve information transparency and increase the total factor productivity (TFP) of an enterprise.

3) PROCESS

Some studies find that process can be the intermediate variable between DT and its values. Llinás Sala and Abad Puente [18] reported that DT can optimize the business process and eventually improve total factors productivity (TFP), and DT can improve GTFP by promoting structural optimization of industrial and business processes and reducing pollution emissions, according to Wang et al.'s [19] test.

4) HUMAN OR ORGANIZATION

Many articles discuss humans or organizations as the bridge factor between DT and its values. First, researchers focus on the human structure changing through DT; they claim that DT can optimize the human asset, such as the rate of high-skilled and low-skilled talents, and it can create values for enterprise eventually [20], [21], [22]. Second, some studies discuss internal and external collaboration created by DT. Li et al. [23] and Opazo-Basáez et al. [24] point out DT can improve the technology/knowledge cooperation between enterprises, and Bettiol et al. [14] find that DT can integrate the departments internally and build the links among enterprises, to reach the result of labor productivity improving. While Zhang and Zhang [8] investigate DT's effect on suppliers and clients, they find that DT will improve the concentration ratio of suppliers which can improve total factors productivity (TFP), but the concentration ratio of clients raised by DT will weaken DT's effect to total factors productivity (TFP). Furthermore, some researchers focus on the use of manpower, Li and Tian [5] claim that DT can replace manpower, which becomes the bridge from DT to DT's values. Zhai and Liu [25] report DT can help enterprises improve their human resource utilization efficiency, then improve the productivity of enterprises. At the same time, Picazo Rodríguez et al. [26] find that DT will bring positive employees with technical pressure and work engagement, and eventually have a positive effect on enterprises. Besides, some articles point out that organizations' willingness will be changed by DT; Su et al. [27] report that DT enhances corporate social responsibility, willingness, and ability, while Hou et al. [28] find that DT can enhance enterprises' environmental responsibility, both of which will improve enterprise productivity ultimately.

C. CREATION MECHANISM OF DT's VALUE

Researchers discovered the mechanism factors of DT value creation, namely intermediary value factors, including new business/operational models' construction, innovation capabilities improvement, and costs and expenses reduction.

1) BUSINESS/OPERATION MODE CONSTRUCTION

Some articles find that new business/operation mode construction is the mediate value. Firstly, some researchers have found that DT can change the business operation mode and promote the scaling of production and management which eventually promotes enterprise productivity [5], [29]. Secondly, Llinás Sala and Abad Puente [18] found that DT affects business model innovation, which in turn brings huge economic opportunities. Meanwhile, in the study from Zhang et al. [30], it was found that DT can promote changes in the combination, matching, and structure of production factors such as data, labor, and capital in enterprises, thereby improving the green productivity. In addition, in the upgrading of agricultural industrial structure, Xu et al. [9] found that DT can promote changes in agricultural product cultivation, business models, etc., thereby promoting ACP agricultural carbon productivity.

2) INNOVATION CAPABILITY IMPROVEMENT

As an intermediate bridge between DT and DT's values, innovation capability is one of the most popular elements researchers mention. And their conclusion is consistent; they claim that DT can improve efficiency or quality of technology innovation, which will enhance enterprise productivity [7], [9], [14], [17], [19], [21], [22], [25], [27], [28], [30], [31], [32], [33], [34], [35].

3) COST AND EXPENSE REDUCTION

Some of the existing articles report cost and expense reduction as an intermediate effect between DT and DT's values and they claim consistently that DT can improve enterprise productivity through cost or expense reduction [5], [7], [14], [21], [25], [27], [33], [35].

4) SERVITIZATION

Some articles discuss servitization as a mediate factor between DT and DT's value. Li and Tian [5] argue that strengthening service-oriented manufacturing DT can enhance the total factor productivity of manufacturing enterprises. While Wen et al. [35] claim that the improvement of service efficiency and quality created by DT leads to a closer relationship between enterprises and consumers, enterprises can effectively establish and maintain interest relationships with customers, successfully meeting their personalized needs, so that it improves enterprise productivity eventually.

5) EFFICIENCY IMPROVEMENT

Efficiency improvement is mentioned in some articles, as another mediate factor between DT to its values. These studies mainly focus on the efficiency improved by DT in the following three areas, finance and cash efficiency, management and operating efficiency, and resource allocation efficiency. First, some research works discuss finance and cash efficiency as the mediate factor. For example, Cheng et al. [20] claim that DT can raise the operating capital turnover rate, and Wu et al. [17] argue that DT can keep the financial stability of enterprises, both of which help DT realize its values. Second, some other studies reveal that management and operating efficiency can be improved by DT, then raise the productivity of enterprises [7], [22], [33]. Third, one researcher mentioned that DT has the function of increasing resource allocation efficiency, so as to boost enterprise productivity. Besides, researchers discuss other types of efficiency improvement as the mediate factor between DT and its values, such as efficiency of investment [22], and energy utilization [28].

6) INTERNAL CONTROL IMPROVEMENT

Some articles mention internal control as another mediate factor of the mechanism of DT's value creation. Zhang and Dong [36] reveal that DT of enterprises can improve the quality of internal control through the advantages of automated processes, data integration and analysis, real-time monitoring and alerting, knowledge management and collaboration, innovation and business optimization, and ultimately contribute to the improvement of total factor productivity in enterprises.

Although scholars have studied the value of DT, the cause factors of DT value, and the mechanism or path of DT value, almost all studies have only verified the relationship between a few factors in the process of DT value creation and have not systematically studied the VM. Therefore, the current theory cannot answer the question of how to successfully implement DT projects. The viewpoint above is like Zhu and Lin's [4] study which have done a systematic review of DT and find that there is sufficient research on the results and causes of DT, but there is a lack of research on the dynamic mechanisms including that DT's operation internally, the process of value generation and the collaborative relationships among mechanism factors.

D. RESEARCH QUESTIONS

Based on the analysis above, we found that the existing literature has rich research on factors of DT's value and its

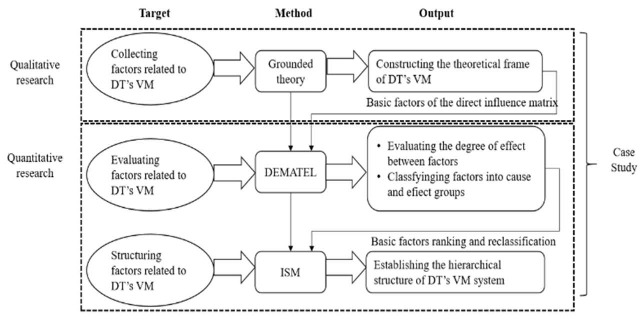


FIGURE 1. **The structure of the research's methodology.**

generation mechanism factors, but these studies have not systematically described the synergistic relationship among these factors, resulting in the inability to obtain a systematic architecture of DT's value and its generation mechanism. Therefore, the research objective of this article is to identify the value of enterprise DT and study the mechanism of value generation (VM) systematically. To achieve the research objectives above, the research questions of this study are:

RQ1: What value of DT can be created for enterprises (V)?

RQ2: How does DT create value at the enterprise, including the value formation mechanism and value delivery path (M)?

III. METHODOLOGY

A. THE METHOD DESIGN FRAMEWORK

The research strategy adopted in this study is a mixed research method of "CS: GL-DEMATEL-ISM" (Figure1), which combines GT (Grounded Theory), DEMATEL (Decision Experimentation and Evaluation Laboratory), and ISM (Interpretative Structural Modeling) based on CS (Single Case Study).

1) SINGLE CASE STUDY

To achieve the research purpose of deeply identifying VM, this article adopts a case study strategy, which has the advantage of understanding the dynamic process of things in a certain environment [37].

Moreover, the key and difficult question that needs to be answered in this study is "How does DT value generate and transmit?" The answer to questions related to "how" is precisely the advantage of case studies [38]. Therefore, this study chose the strategy of the case study methodology.

In order to answer the research question correctly, the researchers considered which is wiser to conduct a single case study or multiple case studies. One of the benefits of a single case study is that it allows researchers to conduct in-depth examinations of specific events [39] making it most suitable for use when researchers want to have a deeper understanding of a specific environment. Moreover, single case studies can provide the most comprehensive data and generate specific branches or theories [40]. Therefore, this research strategy involves a comprehensive analysis and interpretation of individual cases [41].

Case studies usually select cases based on the research question and the theory to be developed, and the selected cases should be able to meet the needs of theoretical construction. Therefore, to follow the principle of "theoretical sampling" rather than random sampling [37], this study first sets preliminary selection criteria, and then screens Chinese enterprises based on these criteria.

This study selects cases based on the following three principles:

One is that the selected case should be able to answer research questions. Firstly, the case company needs to complete its DT. Secondly, the case must be a non-digital native enterprise, that is, an enterprise that has undergone DT from its original non-digital state. Thirdly, the DT of this case is recognized as a relatively successful enterprise.

The second principle is the availability of data. The selected case should be able to obtain reliable and substantial data, ensuring the robustness and completeness of the research conclusions. Therefore, the selected enterprise has already disclosed a wealth of documentary information. From this perspective, large companies with a certain level of popularity have relative advantages. On the one hand, these companies need to regularly disclose information to the outside world, and detailed information such as company introductions, press releases, and leader speeches can be retrieved on their official websites. On the other hand, these enterprises can attract widespread media attention, which helps to analyze the understanding of the case enterprises.

The third principle is related to theoretical university. The business coverage of the case needs to include comprehensive value chain links, including research and development, production and manufacturing, services, sales, etc., and pure trade enterprises cannot be selected. This provides comprehensive support for the formation process of DT value.

After careful consideration, this study chooses HW Company DT as a case.

2) GROUNDED THEORY

Glaser [42] from Columbia University proposed GT in medical practice for the first time. GT is a qualitative research method that analyzes and summarizes the collected data or materials, and then discovers new theories or deepens existing theories [43].

There is no theoretical assumption during the process of GT. Based on practical materials and data, researchers utilize their professional knowledge and theoretical sensitivity to sort, code, compare, and reanalyze, thus forming new theories [44]. The research process of GT mainly includes four stages [45]: research problem elaboration, data collection, data processing (opening coding, axial coding, and selective coding), theory construction.

The collection of VM factors play a fundamental role in the research field of DT's VM. However, most studies adopt quantitative methods to verify the relationship between a few factors such as DT and corporate performance, which is insufficient to present internal mechanism of DT's value. In order to ensure the completeness and coverage of factors related to the VM of DT, it is necessary to have a deep understanding of the entire stages and internal operation of DT's VM. Based on the above considerations, this article adopts the GT method to collect the factors of DT's VM.

3) DEMATEL

Scholars Gabus and Fontela from Battelle Laboratory in the USA established the Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach in 1971 [46]. It is mostly used to study extremely complex global issues [47]. The DEMATEL was developed to address problems involving complex and linked factors [48], [49] by reviewing causal relationships and illustrating the degree of effect between factors based on graph theory [50]. This technique was successfully used in numerous contexts, including business intelligence [51], global manager competency development [52], emergency management [50], risk analysis of the crude oil supply chain [53], and factors evaluation for supplier selection [54].

It might be important to provide a brief overview of the DEMATEL hierarchical analysis method before discussing the DEMATEL use in this study [55]. According to Uygun et al. [56], the original DEMATEL can be summed up in five steps: creating the direct influence matrix, figuring out the normalized direct influence matrix, figuring out the total influence matrix, figuring out the prominence and relationship of the elements, and creating the cause-effect diagram. When this method is put within the context of this study, DEMATEL can employ particular mathematical procedures to visualize the cause-and-effect links among complicated elements of VM, rank the VM elements in a cause-and-effect chain, and indicate the degree of relevance of each element in a particular mechanism. For the detail operation of DEMATEL, the readers could refer to a paper by Uygun et al. [56]

4) ISM

Warfield originally used Interpretative Structural Modeling (ISM) technology to make complex issues visible in 1976 [57]. ISM has been more closely involved with decision-making procedures across a range of domains since Warfield's approach, which combined graph theory and Boolean algebra to study the hierarchical structure of complex systems. According to Lin et al. [58], hierarchical structures with several tiers of effect paths can be used to describe complicated systems with multiple variable factors and hazy structures, thanks to ISM. Because of its characteristics, ISM is being used in many different fields, such as green supply chain management [59], total productive maintenance [60], and flexible manufacturing systems [61]. According to the researcher's interpretation based on the context of this study, ISM is a tool that uses a mathematical approach to provide a visual representation of how the DT's VM elements interact with one another across the system.

In summary, the ISM method is as follows: be given a set of variables (elements), compare those defined elements in an ordered relation, create a binary matrix based on the comparisons, and derive graphs that illustrate the hierarchical properties of the original elements set [62]. By applying particular mathematical techniques and contextualizing this process within the framework of this investigation, ISM can characterize the interactions among elements with basic graphs and ascertain the hierarchical link among them from cause to effect. The reader is advised to read a paper by Robert Waller [63] since a very succinct description of the technique's physics.

5) "CS: GT–DEMATEL–ISM"

As Figure 1 shows, this paper proposes a mixed data analysis method of "CS: GT–DEMATEL–ISM", that combines GT, DEMATEL, and ISM, to implement qualitative and quantitative study. The research procedure of this study is divided into three stages. The first stage is to implement qualitative investigation through the approach of GT. The objective of this stage is to explore the factors related to DT's VM. The investigation outcome will develop a theoretical framework of factors. Then, the quantitative study involves two stages. One is to analyze and evaluate the collected VM factors based on the cause–effect relations. Following the identification of the factors by GT, the DEMATEL is applied to analyze the relationships among VM factors by evaluating the effect degree of factors and classifying factors into cause-and-effect groups. Subsequently, following the calculation result by the DEMATEL, ISM is employed to graphically delineate the linkages between factors and visually construct a systemic multilevel hierarchical structure model.

With the integration of GT, DEMATEL, and ISM, the mixed method of GT–DEMATEL–ISM provides a thorough approach that addresses the systematic method of gathering, evaluating, and structuring data.

6) ADVANTAGES OF "CS: GT–DEMATEL–ISM"

When studying complex phenomena or mechanisms involving a large number of factors, the model of "CS: GT–DEMATEL–ISM" can make its unique advantages, they are as below:

First, combining GT into "CS: GT–DEMATEL–ISM" can get great advantages. The mixed approach first used GT to comprehensively gather factors based on practical data. GT is a type of methodical methodology with two benefits; it is appropriate and effective for qualitative research. First, because GT is applied by repeatedly extracting information based on experience and a wealth of materials, including literature, reports, documents, interview sources, network data, and so forth, it can, to a large extent, ensure the authenticity, integrity, and coverage of the research outcome [12], [64]. The other benefit is that, with the appropriate application of this technique, systematic knowledge can be concluded as a framework [65]. Combining GT into the mixed method in this study can compensate for the deficiencies in the comprehensiveness of elements and the depth of research in pure quantitative research.

Second, it can obtain benefits to apply Dematel and Ism into "CS: GT–DEMATEL–ISM". One thing is that the DEMATEL and ISM have in common is that they both investigate how the various factors interact with one another in the system [66]. Nonetheless, there are variations when putting the two methods into practice. While ISM assists in determining the pairwise relationships between factors and obtaining a clearly defined hierarchical model, DEMATEL concentrates on defining the priority and strength of the links among factors.

Fortunately, due to this difference, they were able to support each other, and the shortcomings of each method can be overcome by combining the two. First, DEMATEL can simultaneously measure the interrelationships among a large number of factors, supporting the purpose of ISM: to use visual charts to present the causal relationships of complex elements. According to Bai and Satir's [67] experience, the two methodologies' integration enables ISM to make use of the DEMATEL's calculation findings and the total influence matrix, thereby resolving the extra complexity in the face of new factors. Second, according to Mudgal et al. [68], one drawback of ISM is that it is unable to provide precise values for the quantification of the relationships among factors. In contrast, DEMATEL offers a practical and efficient method of measuring the relationships among the factors that influence the system. Third, DEMATEL is unable to offer a precise image of the interactions among all the different factors. To make up for DEMATEL's limitations, ISM can provide a hierarchical framework that graphically and concisely illustrates the relationships among every element in the system.

Consequently, by combining the two methods in a mixed way, it is possible to assess how the VM factors relate to one another and provide a comprehensive understanding of the VM framework.

B. VM FACTORS COLLECTION USING GROUNDED THEORY

The detailed research process of GT is drawn in Figure 2. The research scope by GT in this paper is defined to explore DT's VM related to enterprise. The exploration process mainly contains 2 steps: data collection, and coding analysis.

1) DATA COLLECTION

Based on scientific literature, survey reports, and other primary sources, GT carries out qualitative research. The reliability and persuasiveness of conclusions can be significantly improved by the richness and saturation of raw data. Glaser [42] claims that the conception of saturation shows that no new factors have emerged through continual comparison, and Manuj and Pohlen [69] pointed out that theoretical saturation simultaneously signaled the end of data collection and indicated the necessary sample size for the research.

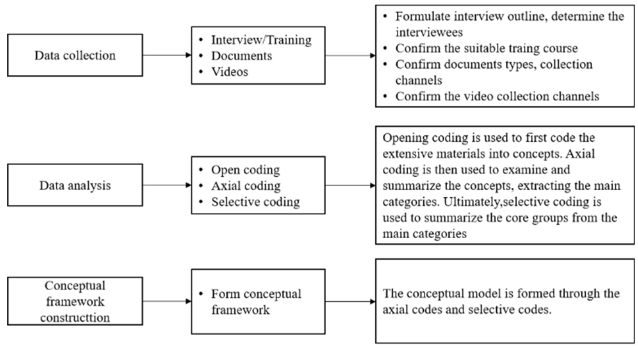


FIGURE 2. Research process of GT.

Nevertheless, the existing literature fails to provide definitive guidance for the necessary sample size for the assessment of saturation. Bowen [70] advised that the author detail the data processing procedure, including the concentration and interpretation steps. To guarantee the theoretical saturation of the original data as much as feasible, this article combines information from several data sources (Table 1), employees from various departments and positions (Table 2), and different projects (Table 3).

Firstly, the data includes three types: document, voice, and video. For document data, sources include leadership speeches shared by corporate executives and employees in the internal journals, meeting minutes, comment sharing (889 pages), company annual reports (2006-2022), internal training materials (4 books), and other documents in the official website (1443 pages), reports and comments shared by corporate executives in external media and meetings (394 pages), and external training materials for executives (3 books). For the audio materials, it includes semi-structured interviews (101 minutes) and external training audio materials (553 minutes). The video materials include videos about executive sharing published by external media (216 minutes) and videos about executive sharing published internally on the official website (288 minutes).

Secondly, from a human perspective, data come from the sharing of internal and external personnel. In addition to data published in the name of the company, internal personnel also include business department employees (n=17), finance and accounting department employees (6 people), IT department employees (n=10), consultants (n=1), and external experts (n=10). Positions include CEO, Rotating CEOs, CFO, CIOs, and Presidents in different departments, and other positions.

Finally, from the content perspective of the data, it involves internal DT projects (n=22) and external DT projects (9 areas). On one hand, regarding internal DT projects, the author classifies them based on the specific content of DT projects. In addition to the DT general description, it includes financial DT projects (n=2) and business DT projects (n=12) which cover 8 value chain links (strategy, research development, manufacturing, supply chain, marketing, finance, and digital office, asset management and expense reimbursement)

TABLE 1. Data types, quantities and sources.

NO	Types	Content	Description	Quantity	Link
1	Document	Internal Journal	Speech, Meeting Minutes, Sharing of HW's employee and management from the internal Journal" Community of Voice in Heart"	889 Pages	https://xinsheng.huawei.com/cn/index/guest.html
2		Annual Report	Annual Report	Y2006-Y2022	https://www.huawei.com/cn/annual-report
3		Internal Training	Internal material internally related to HW's DT and management	4 Books	Publication, refer to reference
4		Others from the Official Web	DT Sharing of HW's employees and management from the official website	1443 Pages	https://e.huawei.com/cn/
5		External Sharing	report, comments, sharing of meetings, external speeches related to HW's management	394 Pages	https://www.baidu.com/
6		External Training Material	Training material externally related to HW's DT	3 Books	Publication, refer to reference
7	Voice	Interview Voice Material	Interview with HW's management	101 Minutes	At scene
8		Training Voice Material	Training externally from HW's management	553 Minutes	At scene
9	Video	Internal Video	Video material related to DT and management from HW's management internally	216 Minutes	https://e.huawei.com/cn/
10		External Video	Video material related to meetings or speeches from HW's management externally	288 Minutes	https://www.baidu.com/

TABLE 2. Human book.

Internal or External	Department	Name	Position
Huawei's Employee	Business Department	N1	CEO
		N2,N3,N4,N5	Rotating CEO
		N6	HR Presidents
		N7	Supply Chain President
		N8	Business President
		N9,N10,N11,N12,N13,N14,N15,N16	Others
	Company	N17-HW	Others
	Consultant	N18	Consultant
	Finance and Accounting Department	N19	Group CFO
		N20	Accounting Presidents
		N21, N22, N23, N24	Others
	IT Department	N25, N26, N27	CIO
		N28, N29, N30, N31, N32, N33, N34	Others
External Expert	/	N35, N36, N37, N38, N39, N40, N41, N42, N43	/

and internal operations DT projects (n=7). On the other hand, regarding external DT projects, which HW acts as a consultant, it covers 9 different industries: construction, education, energy, finance, government, manufacturing, retail, technology, and transportation.

2) CODING ANALYSIS

To develop a theory through encoding analysis, researchers must eliminate prior experiences, opinions, conjectures, and theories while maintain theoretical sensitivity and be grounded in the original data [71]. Coding analysis includes three stages: open coding, axial coding, and selective coding.

Analyzing raw data line by line is known as open coding [72]. The data is disorganized and subjected to multiple analyses for comparison. Sentences that are irrelevant to the goal of the study are eliminated throughout this stage, and relevant data is found and annotated. The conceptualization of the original information has been completed, supporting the axis coding in the following step.

In the step of axial coding, use logical relationships, condense, and further develop the ideas created via open

TABLE 3. Project book.

P(S)	P(A)	P(O)	Description
DT	General Description of DT	DT	General description from HW's management or employees about DT
Accounting DT	Accounting DT	4 Unification	"4 unification" started in 1998, is the project of accounting process standardization for the entire group globally, including regulation, process, codes, and reports.
		New 4 Unifications	"4 New Unifications" started in 2005, is the project of moving the accounting process online. "4 unification" started in 1998, is the project of accounting process standardization for the entire group globally, including process unification, accounting organization unification, IT system unification, and COA (chart of accounting) unification.
Business DT	Strategy	DSTE	DSTE (design strategy to execution), started in 2006, is the project of strategy process digitalization for the entire group globally, introduced IBM's BLM (Business Leadership Model).
	R&D	IPD	IPD (Integrated Product Development), started in 1999, is the project of product development process digitalization, using IBM as a consultant.
		IPD+	IPD+ (Integrated Product Development+), started in 2016, is a continuation of the IPD project. It focused on data integration and sharing between product development and other processes or systems, such as sales, manufacturing, accounting, etc.
	Manufacturing	Manufacturing DT	Manufacturing DT refers to the DT for the production line, production process, and production plant.
	Supply Chain	ISC	ISC(Integrated Supply Chain), started in 1999, is the project of supply chain process digitalization for the entire group globally, including ERP migration, warehousing, transportation network layout, etc.
		ISC+	ISC (Integrated Supply Chain+), started in 2016, is a continuation of the ISC project. It focused on automation of planning, decision-making, and operation.
		ISD	ISD (Integrated Service Delivery), started in 2011, is the project of project delivery process digitalization.
	Sales	LTC	LTC (lead to cash), started in 2007, is the project of sale process (from order leads to collection) digitalization for the entire group globally.
		LTC+	LTC (lead to cash+), started in 2016, is a continuation of the LTC project, it focused on marketing digitalization.
	Expense reimbursement	SSE	SSE (Sel-service expense), started in 2006, is a project for employee expense reimbursement process digitalization for the entire group globally, including regulation, sharing organization, and IT system.
	FA Management	RFID	FA (Radio Frequency Identification), started in 2016, is a project fixed asset management digitalization using IOT technology.
	Working Environment	Welink	Welink started in 2016, is a project of a fully connected collaborative office for the entire group globally.
Digital Operating	Digital Operating	5 one	5 one started in 2014, is a project of internal operation efficiency improvement using the digital method, the target was "1 day for contract/PO pre-processing, 1 day from order to shipment preparation of finished products/1 week for site equipment, 1 month from order confirmation to customer designated site, 1 minute for software preparation from customer order to download, and 1 month for site delivery acceptance".
		CBAR	CBAR (Consistency between accounts and reality) started in 2014, is a project to improve data quality using digital technology.
		FRCC	FRCC (Financial Reporting Internal Control) started in 2014, is a project to improve financial data quality using the method of setting KCP (key control points) in the business process.
		IFS	IFS(Integrated Financial Service) started in 2007, is a project of using data to improve business and accounting operations, including business and accounting process integration, organization building, IT system construction, etc.
		PB&F	PB&F (Plan budget &Forecast) started in 2011, is a sub-project of IFS, integrated accounting process and enterprise plan, budget, and forecast.
		PFM	PFM (Project Finance Management) started in 2012, is a sub-project of IFS, integrated accounting process and project management process.
		PTP	PTP (Procurement to Payment) started in 2007, is a sub-project of IFS, integrated accounting process and purchasing process.
External Projects	External Projects	Construction	DT projects of HW attendance as a consultant for construction enterprises
		Education	DT projects of HW attendance as a consultant for education institutes
		Energy	DT projects of HW attendance as a consultant for energy enterprises
		Finance	DT projects of HW attendance as a consultant for finance enterprises
		Government	DT projects of HW attendance as a consultant for governmental institutes
		Manufacturing DT	DT projects of HW attendance as a consultant for manufacturing enterprises
		Retail	DT projects of HW attendance as a consultant for retail enterprises
		Technology	DT projects of HW attendance as a consultant for technology enterprises
		Transportation	DT projects of HW attendance as a consultant for transportation enterprises

coding [73] and formed the main categories, namely the VM factors list, by analyzing the relationships between concepts and then resuming, refining, and maintaining internal consistency within the categories. Causal conditions, phenomenon backgrounds, action tactics, and action results are commonly included in axial coding models.

By summarizing core categories based on the concepts and main categories, selective encoding aims to create a "storyline" that may be used to constantly enhance and augment preexisting categories [74]. The core category serves as the main hub that connects and encompasses all other categories, like the trunk of a tree. Selective encoding involves assessing accuracy, coverage, and alignment with the research topic in addition to confirming the connection between the core category and other categories. Lastly, a fresh framework for theory will be developed.

C. THE SATURATION TEST

For the reliability of coding, the original data is encoded separately by two people, and then compared and discussed. The codes of both parties are merged, and the names of codes with the same meaning are unified to form the codes system required for the research.

It is determined that 30% of the original data will be used to conduct the saturation test because the original data is sufficiently large. The outcomes are contrasted with the theoretical model developed by coding analysis. The theoretical framework must be adjusted and rebuilt if new categories are created. If not, the theoretical framework is approved if no new categories are created.

D. EVALUATING FACTORS WITH THE DEMATEL

This study applied the DEMATEL to evaluate the VM factors, grouped the factors into cause-effect sets, and ranked the importance of the factors in VM systems. The application steps of DEMATEL are as follows:

1) IDENTIFY THE SYSTEM OF VM FACTORS

The system of factors related to DT's VM is constructed and expressed as VM = {VM1; VM2; VM3...VMn}, where n is the number of main categories, in line with the starting categories summarized by GT.

2) ESTABLISH THE DIRECT INFLUENCE MATRIX

To conduct a quantitative analysis of the relationships between VM factors of the system. The influence relationship between paired factors was determined by experts, and the values were assigned using a two-level scale (0–1), where 1 indicated direct influence and 0 indicated no direct influence. The discussion was conducted as a workshop, which was addressed to practitioners and researchers. The direct influence matrix D is established as below:

$$D = \begin{bmatrix} 0 & d_{12} & \dots & d_{1n} \\ d_{21} & 0 & \dots & d_{2n} \\ \vdots & \vdots & \ddots & d_{3n} \\ d_{n1} & d_{n2} & \cdots & 0 \end{bmatrix} \tag{1}$$

in which, when $i = j$ and $d_{ij} = 0$.

3) CALCULATE THE NORMALIZED DIRECT INFLUENCE MATRIX

The normalized direct influence matrix E is acquired based on Equation (2):

$$E = \frac{1}{\underset{1 \le i \le n}{max} \sum_j^n d_{ij}} \tag{2}$$

4) CALCULATE THE TOTAL INFLUENCE MATRIX

The total influence matrix F is formed by Equation (3):

$$F = \lim_{n \to \infty} (E + E^1 + E^2 + E^3 + \ldots + E^n) = E(I - E)^{-1} \tag{3}$$

where I indicates the identify matrix as below:

$$I = \begin{bmatrix} 1 & 0 & \dots & 0 \\ 0 & 1 & \dots & 0 \\ \vdots & \vdots & \ddots & 0 \\ 0 & 0 & \cdots & 1 \end{bmatrix}$$

5) CALCULATE THE INFLUENTIAL IMPACT DEGREE AND INFLUENCED IMPACT DEGREE

In the total influence matrix F, f_{ij} indicates the total influence degree of VM factor VM_i acting on VM_j. The influential impact degree, indicated by M, symbolizes the total influence of factor i acting on all other factors, while N named the influenced impact degree, measures the total influence from all other factors working on factor j. The M and N computation methods are represented respectively by Equations (4) and (5).

$$M = \sum_{j=1}^{n} f_{ij} (i = 1, 2, \ldots, n) \tag{4}$$

$$N = \sum_{j=1}^{n} f_{ij} (i = 1, 2, \ldots, n) \tag{5}$$

6) DEVELOP THE CAUSE-EFFECT DIAGRAM

The cause-effect figure is created using the Z and Y data set as a basis. Z namely "Prominence" is the total of M and N (see Equation 6), and it denotes the degree of importance that factor i in the whole system. Furthermore, Y namely "Relation" is determined by deducting N from M (refer to Equation 7). To divide the factors into groups of causes and effects, Y is used to calculate the net effect of factor i in the system. The factor is classified into the cause set when Y is positive. In contrast, the factor is divided into the effect group when Y has a negative value.

$$Z = M + N \tag{6}$$

$$Y = M - N \tag{7}$$

E. STRUCTURING FACTORS BY ISM

Based on the technique and applications of ISM provided by Waller [63], the steps below are settled with the basic results of DEMATEL in this study:

1) CREATE THE STRUCTURAL SELF-INTERACTION MATRIX (SSIM)

The SSIM is a matrix representing the pairwise association between factors. The SSIM, represented by C, is calculated using the total influence matrix F from DEMATEL, shown as Equation (8)

$$C = F + I = [c_{ij}]_{n' \times n'} \tag{8}$$

where n′ is the number of VM factors and I is the identify matrix.

2) CALCULATE THE REACHABILITY MATRIX

By converting the SSIM C into a binary matrix based on a threshold of 0, the reachability matrix R is obtained. Equations (9) and (10) carry out the transformation procedure.

$$R = [r_{ij}]_{n' \times n'} \tag{9}$$

$$r_{ij} = \begin{cases} 1, & c_{ij} > 0 \\ 0, & c_{ij} = 0 \end{cases} \tag{10}$$

3) CALCULATE REACHABILITY, ANTECEDENT, AND COMMON SETS

To assign a factor to a certain level and ultimately aid in the creation of the hierarchical structure diagram, the reachability set Q_i, antecedent set A_i, and common set S are computed [75]. The three types of sets are calculated using Equations (11) - (13) in that order.

$$Q_i = \left\{R_j | R_j \in R_i, r_{ij} = 1\right\} (i = 1, 2, \ldots, n'; j = 1, 2, \ldots, n') \tag{11}$$

$$A_i = \left\{R_j | R_j \in A_i, r_{ji} = 1\right\} (i = 1, 2, \ldots, n'; j = 1, 2, \ldots, n') \tag{12}$$

$$S = \{R_i | R_i \in S_i, R_i \cap A_i = R_i\} (i = 1, 2, \ldots, n') \tag{13}$$

4) CREATE THE LEVEL DIVISIONS AND SKETCH THE MODEL OF THE HIERARCHICAL STRUCTURE

The factors are categorized into the common set(S) when the intersection set of the antecedent set and the reachability set matches the reachability set ($Q_i \cap A_i = R_i$). The first layer contains the factors that were first collected in common set S. The first layer's factors are then taken out of reachability matrix R, and the remaining factors are taken into account for the subsequent iteration in order to determine the factors of the second layer. The process is repeated until all the factors are assigned. The factor set for each layer is created as a result of the level partitioning, and it is signed as $S(v)$ ($v = 1, 2, \ldots, h$), where h is the total number of level layers. Based on the layer, arrow lines are used to indicate the relationship among nodes, including layers (S_v) and factors (R_i).

IV. RESULTS AND DISCUSSIONS

A. RESULT OF GROUNDED THEORY STAGE

According to the framework of the methodology, GT was applied in the first stage focusing on the exploration of VM factors related to enterprises. Initially, data collection was accomplished through documents, audio, and video from descriptions of HW's internal or external DT projects. Subsequently, the authors implemented coding analysis in accordance with the three steps: open coding, axial coding, and selective coding.

Through open coding, 32 concepts were identified, as shown in Table 4. Owing to the paper's brief duration, the table only includes a portion of the original statements.

In the second step of axial coding, an additional study was carried out, focusing on the logical relationship. Meanwhile, the internally consistent notions were reworked and condensed. This process led to the formation of 15 main categories, as Table 5 illustrates.

In the third step of selective coding, the core category is abstracted through processing. All of the categories listed in the first two steps must be covered. As indicated in Table 5, it is characterized in this study using five core categories in accordance with the research topic "DT's VM".

Ultimately, a novel conceptual framework was constructed and showcased in Figure 3. The conceptual framework of VM factors comprises five main areas, as shown in Figure 3: IT, data, process, organization, and values. These categories are further divided into fifteen main groups. After conceptual framework is completed, the 15 main categories that were found and determined, and they will be used as VM factors for DEMATEL's further research.

B. RESULT OF DEMATEL STAGE

1) CALCULATION RESULTS OF THE DEMATEL

A visual tool for calculating and evaluating the significance of each factor is provided by the DEMATEL. As per the DEMATEL's implementation stages, the data obtained from an expert workshop was utilized to build the direct influence matrix D. Following consultation with three experts, the direct impact channel is ascertained, yielding the direct influence matrix D, which is displayed in TABLE 6. Equation (2) was then used to calculate the normalized direct influence matrix, E, which is shown in TABLE 7. Equation (3) was used in considering the data above to determine the total influence matrix F, which is displayed in TABLE 8. According to steps (5) and (6) of DEMATEL procedure, relationship among VM factors are calculated, the results is shown in Table 9. Meanwhile, the scatter diagram of prominence and relation for VM factors is shown in Figure 4.

2) CAUSE-EFFECT SETS DIVISION AND IMPORTANCE RANK DETERMINATION

Based on the computation results above, this part aims to present the importance and cause-effect classification of VM factors through thorough examination with reference to

TABLE 4. Concepts indentied through open coding and axis coding.

Opening Coding		
Concepts(C)	Description of (C)	Typical Original Statement
C1 Digital Technologies	C1 refers to IT technologies, devices, or facilities used in DT, such as the internet, computer, server, block chain, big data, cloud computing, IoT, etc.	HW is rooted in three core technologies for continuous innovation, enabling DT in various industries: 5G communication technology, IOT, data computing power, and platform algorithms (N28, DT).
C2 IT Connectivity	C2 refers to the function or feature of digital technology that connects people, things, and people to things both inside and outside the enterprise.	Connecting helps enterprises break through the constraints of capabilities and resources. In the wave of digital economic transformation, traditional industries are undergoing digital reconstruction, and ICT is entering traditional industries (N1, DT).
C3 Digital Twin	C3 refers to the functional features of digital technology that transform enterprise business value chain objects, links, and methods into digital form and present them online.	Digital twins are digital mirrors of physical objects or processes used to optimize business performance (N7, ISC & ISC+).
C4 IT System Integration	C4 refers to IT systems that are interconnected and aggregated along the enterprise value chain to support the transmission, interaction, and querying of data and business.	Through the ISC transformation, we adhere to replacing dozens of scattered IT systems with a unified "ERP+APS",and establish an integrated global supply network including six supply centers, seven hubs, and national central warehouses. This has fundamentally improved the quality, cost, flexibility, and customer response speed of our supply, effectively supporting the global development of the business (N4, DT).
C5 IT Platform	C5 refers to the process of using digital technology in DT to provide system users with a standardized and simplified interface, making it a "one-stop", convenient, and fast way to find IT and business resources.	HW is committed to being a leader in the DT of the industry. Based on its grasp of industry development trends and deep understanding of customer needs, as well as its long-term high-intensity R&D investment in the ICT field, HW continuously surpasses itself and innovates to create an open, flexible, elastic, and secure digital platform (N4, DT).
C6 IT Sharing	C6 refers to the process of enabling IT systems and other IT resources to break through time and space limitations during the DT process,and achieve seamless sharing between internal and external users of the enterprise.	The Integrated Supply Chain (ISC) transformation extracts common parts of supply chain processes into shared platforms for centralized management to gain cost advantages, standardizes digital platforms, and extends integrated supply chain processes globally (N27, DT).
C7 IT Intelligentization	C7 refers to the process of using IT big data, cloud computing, and other IT technologies to replace the human brain in making judgments, making decisions according to set rules, and driving business progress.	Enterprise intelligence is the comprehensive intelligence of operations based on big data and artificial intelligence. It is an extension of the characteristics of "connection", "sharing", and "online" in enterprises, and is a high-level goal of enterprise DT With the support of new technologies such as cloud computing, the Internet of Things, big data, and artificial intelligence, how to make business more "intelligent" has become a new digital demand based on the digital foundation formed by enterprise "connection", "online", and "sharing" (N27, DT).
A8 Data Integration	C8 refers to the organic integration of data from different sources, formats, and characteristics, logically or physically, in order to provide comprehensive data computing and sharing for enterprises.	The experience and lessons of IPD tell us that sorting out information in business flows is a prerequisite for process definition, the foundation for IT application architecture definition, and also a prerequisite for IT system development. The integration of main processes is essentially the integration of data. Data management is at the core of processes and IT, so it is necessary to give sufficient attention to data (N4, IPD).
C9 Data Connection by Subject	C9 refers to the calculation of business-related data based on the management themes required by enterprise managers, which support the enterprise business management and operation.	HW establishes a data connection layer on the basis of the data lake, and based on different analysis scenarios, connecting cross-domain data, process data from "raw materials" into "semi-finished products" and "finished products" to meet the data consumption needs of different scenarios (N1, DT).
C10 Data Quality Improving	C10 refers to the process of governing business data in the DT process, ensuring that it reflects business status in a timely, reliable, and accurate manner, and maintains consistency with the business.	Data is information that runs through the process. The process is smooth, but because the things inside have no value, the process is also useless. Information is crucial, we must control the entry point to ensure the authenticity and quality of the source data (N4, IPD).
C11 Data Sharing	C11 refers to the process of breaking time and space limitations in the DT process, allowing data to be shared indiscriminately between internal and external users of the enterprise.	The data base is the key to on-demand data sharing. Before the start of data infrastructure construction, a common problem faced by businesses is the difficulty in obtaining data for data analysis and insight, and sometimes even knowing where the data is cannot be obtained (N1, DT).
C12 Process Standardization	C12 refers to the process of standardizing and unifying business processes across different business entities or departments within the group during DT.	Why do we need to do IFS first? So we cannot idealistically determine what our future outcomes are, but we can establish the rules of a process. With the rules of a process, we will not be confused, and the determination of rules will deal with the uncertainty of results. That is why we introduced IFS (N2, IFS).

TABLE 4. ***(Continued.)*** **Concepts indentied through open coding and axis coding.**

C13 Process Online	C13 refers to the process of using digital technology to bring business operations online during DT.	Enterprises achieve business process digitization and online process digitization. The process has shifted from manual mode to online automation mode, enabling synchronization and symbiosis between the business flow and data flow of the enterprise (N27, DT).
C14 Process Integration	C14 refers to the use of IT technology to bridge the operation between process links and between processes, making business operations smooth and aggregating processes, making it convenient and fast for users to find processes and operate business processes.	The process and IT need to grasp the main contradictions and their main aspects, and the current main contradiction is the full process integration of customer PO. The IT department cannot cover all aspects and should not strive for excellence in every aspect. IT needs to work hard to connect the entire customer PO process, which is the most important thing (N2, IFS).
C15 Process Sharing	C15 refers to the process of breaking time and space constraints during the DT process, enabling internal and external users of the enterprise to query and use processes.	The task of the data-driven DT stage is to build a shared service platform for the entire process, eliminate data silos, establish a data governance system, ensure high-quality, safe, shared, and orderly flow of data throughout the entire process, effectively manage and mine the value of data assets, and enhance the digital management ability of the business, thereby building strategic competitive advantages for enterprises (N27, DT).
C16 BP Organization Construction BP	C16 refers to the establishment of intermediate connectivity departments during DT to alleviate differences in expertise and capabilities among different departments, and promote collaboration between departments, such as establishing a financial BP to form collaboration between business and finance departments.	Frontline financial organizations need to accelerate construction, and finance needs to understand mainstream business operations. The construction of frontline CFO organizations needs to be accelerated. The financing, payment collection, and financial operations of the representative office are still a few superficial operations, without effectively integrating resources and providing comprehensive support. In the financial team, sand should be added; concrete is only strong with sand (N2, IFS).
C17 Sharing Organization Construction	C17 refers to the process of establishing a unified organization for processing the same business of different business entities (such as different subsidiaries) during DT.	We must not only promote shared centers in finance, but also in business (N2, IFS).
C18 Organization Online	C18 refers to the process of using digital technology to bring an organization online during DT, enabling people to communicate and operate online.	HW has implemented a collaborative office digitization project called "One HUAWET", which provides globally unified online organizational services effectively. Regardless of where HW people are located, they can always stay online with the organization, maintaining seamless connections between people and organizations, making organizational management flatter, internal collaboration smoother, and communication simpler and more efficient (N27, Welink).
C19 Organization Flattening	C19 refers to the process of reducing organizational hierarchy during DT.	The previous multi-level administrative transmission and management system will become more flattened, especially with the gradual construction of the IT system. With the disappearance of the middle layer, a large number of cadres will become surplus (N2, DT).
C20 Organization Synergy	C20 refers to the process of forming good communication, collaboration, and between individuals or departments in the DT process for the same business goal.	HW has created a cloud and mobile fully connected collaborative platform, Welink, which provides employees with a fully connected Living Service that connects people, knowledge, business, and devices. It integrates advanced collaborative services and technologies such as IM, email, video conferencing, video live streaming, business tasks, and intelligent equipment, greatly improving the overall efficiency of individual combat, team collaboration, and cross-regional collaboration (N1, Welink).
C21 Organization Authorization	C21 refers to the process in which management authority is delegated downwards or to the frontline of the business during DT.	We propose that the transformation should take three to five years to connect LTC, support the alignment of accounts and reality, and achieve the "five ones", in order to lay a solid foundation and support the strengthening of grassroots authorization. The board of directors of a subsidiary represents the supervisory system of the company, and when they have the ability to oversee operations, they can delegate power to the forward combat command center (N2, LTC).
C22 Business Online	C22 refers to the process of using digital technology to move business online for online operation and management.	Business online is the foundation of digital enterprises. Enterprises achieve business process digitization and online process digitization. The process has shifted from manual mode to online automation mode, enabling synchronization and symbiosis between the business flow and data flow of the enterprise thereby promoting customer-centric full business from offline to online, connecting offline and online through digitization, and innovating business models (N27, DT).
C23 Business Visuable	C23 refers to the process of presenting the status of the business (such as progress, profitability, etc.) to managers through data during DT.	Through the IFS transformation, we have built a global financial management system that integrates finance into our business. We have made fundamental progress in accelerating cash inflows, accurately recognizing revenue, visible project gains and losses, and controllable operational risks, supporting the company's sustainable and profitable growth (N4, IFS).

TABLE 4. ***(Continued.)*** **Concepts indentied through open coding and axis coding.**

C24 Business Sharing	C24 refers to the process of breaking time and space constraints during DT, enabling internal and external users of the enterprise to query, operate, and manage the business.	Fortunately, IBM consultants tirelessly and hand in hand led us into the world of shared services. We anxiously began the construction of seven major accounting sharing centers. Later on, I gradually gained my own understanding of "sharing": the accounting sharing center is like a sturdy dam, efficiently processing similar businesses in one place, which can play a supervisory and control role, save costs, and provide better services. From the perspective of institutional design, the shared center is directly managed by the headquarters, which can maintain independence and present relatively real data. The seven major shared centers utilize the advantage of time difference to continuously process accounting and support frontline timely acquisition of business data at the fastest speed (N20, New four unification).
C25 Digital Operation Mode Construction	C25 refers to the establishment of an operational model that uses data as raw material for business operations and decision-making during DT.	Digital operation has become a necessary path for various enterprises to undergo DT. If it is missing, it seems to mean that the DT of enterprises is incomplete (N1, DT).
C26 Business Mode Evolution	C26 refers to the process of forming new business models or optimizing existing business models during DT.	With the continuous deepening of business DT, information acquisition becomes more convenient and the amount of information is increasing. Enterprises can break through the limitations of distance and time on business execution in the past, driving three important changes in business operation modes: the transformation of operation mode from efficiency to innovation, the transformation of customer experience from function to scene, and the transformation of operation mode from pipeline to platform (N1, DT).
C27 DT Value Related to Business Operation Efficiency	C27 refers to the result of improving business operations and management efficiency during DT.	With the continuous deepening of business DT, information acquisition becomes more convenient and the amount of information is increasing. Enterprises can break through the limitations of distance and time on business execution in the past, driving three important changes in business operation modes: the transformation of operation mode from efficiency to innovation, the transformation of customer experience from function to scene, and the transformation of operation mode from pipeline to platform (N27, DT).
C28 Business Risk and Quality Management	C28 refers to the result of business risk control and business quality improvement.	In 2007, as a sub-project of IFS, internal control management opened the door to change from scratch. Ten years of sharpening, now our internal control awareness, mechanisms, and capabilities have been immersed in various business activities. Wherever the business is, internal control is there, forming a global internal control management system based on "process responsibility and organizational responsibility" (N19, IFS).
C29 Users' Experience Improvement	C29 refers to the result of users' experience improvement, including Real-time, On-demand, All-online, DIY, and Social.	Building an online platform for digital transactions to make business simple, efficient, and secure for customers Digital showrooms, customer online collaboration, smart retail, etc. for example, digitizing partnership management, aggregating enterprise ecology, building a digital collaborative platform for customer partners, achieving end-to-end connectivity of business flow data, and improving efficiency and customer experience (N1, DT).
C30 Profitability	C30 refers to the result of profitability-related improvements, such as expense and cost reduction, etc.	XXX's (CFO) speech at HW's 2013 performance forecast press conference also confirmed the viewpoint. When answering where HW's profit growth came from, she pointed out that after calculation, HW's main business profit in 2013 was 28.6 billion to 29.4 billion yuan, with a main business profit margin of 12.1%, an increase of 3 percentage points compared to the previous year (9.1%). Among these 3 percentage points, 2.8 percentage points come from management change, with IFS change contributing 0.5 percentage points (N19, IFS).
C31 Cash flow	C31 refers to the result of cash flow-related improvement, such as collection speed acceleration.	Through the IFS transformation, we have made fundamental progress in accelerating cash inflows, accurately recognizing revenue, visible project gains and losses, and controllable operational risks, supporting the company's sustainable and profitable growth (N1, IFS).
C32 Growth of Scale	C32 refers to the result of growth-scale-related improvement, such as customer increase.	Continuously promoting comprehensive changes in customer relationship management (CRM+). The LTC process supports the growth of the operator business scale and the improvement of transaction quality in global system hubs (N1, LTC).

prominence, relation, influenced impact degree, and influential impact degree (Table 9). It represents that the 15 VM factors are divided into 7 cause factors and 8 effect factors. The value of prominence indicates that the VM factor importance ranks in the entire DT's VM system. As shown in Figure 4, the importance order of VM factors according to the rank of prominence are VM9>VM8>VM6>VM12>VM11>VM5 >VM10 >VM7 >VM14 >M1 >VM4>VM2>VM3>VM13>VM15. Furthermore, as shown by line-relation in Figure 4, VM1(Digital Technologies), VM2 (IT Construction), VM3 (IT Sharing), VM4 (IT Intelligentization), VM5 (Data Construction), VM6 (Data Sharing), VM7 (Process

TABLE 5. **The axis coding and selective coding.**

Selective Coding		Axis Coding	
Main Category(S)	Description of S	Initial Category (VM Factors)	Description of VM
S1 IT - IT	S1 refers to IT, including its content, construction, and how it works.	VM1 Digital Technologies	VM1 refers to the content of digital technology.
		VM2 IT Construction & evolution	VM2 refers to how IT constructs or evolves in DT.
		VM3 IT Sharing	VM3 refers to sharing of IT, including IT technologies, systems, platforms, etc.
		VM4 IT Intelligentization	VM4 refers to intelligentization.
S2 Data	S2 refers to data including its construction & evolution and how it works.	VM5 Data Construction & evolution	VM5 refers to how data construct or evolve in DT.
		VM6 Data Sharing	VM6 refers to the sharing of data.
S3 Process	S3 refers to the process, including its construction & evolution in DT.	VM7 Process Form Construction & Evolution	VM7 refers to how the process constructs or evolves in DT.
		VM8 Process Sharing	VM8 refers to sharing of the process.
S4 Organization	S4 refers to the organization, including its construction & evolution in DT.	VM9 Organization Construction	VM9 refers to how an organization constructs in DT.
		VM10 Organization Form Evolution	VM10 refers to how an organization forms or evolves in DT.
S5 Business	S5 refers to the effect on business from DT, including construction & evolution of business.	VM11 Business Construction & Evolution	VM11 refers to how business constructs or evolves in DT.
		VM12 Business Sharing	VM12 refers to the sharing of business.
S6 Business Mode	S5 refers to the business mode construction and evolution.	VM13 Business Mode Construction & Evolution	VM13 refers to how business mode constructs or evolves in DT, including digital operation mode construction and business mode evolution.
S7 Value	S7 Value refers to the effect on the enterprise level including enterprise capability and enterprise performance improvement.	VM14 Enterprise Capability Improvement	VM14 refers to capability improvement from DT, including efficiency, risk control, quality, and experience.
		VM15 Enterprise Performance Improvement	VM15 refers to performance improvement from DT, related to profit, cash flow, and Growth.

TABLE 6. **The direct influence matrix D of the dematel.**

D	VM1	VM2	VM3	VM4	VM5	VM6	VM7	VM8	VM9	VM10	VM11	VM12	VM13	VM14	VM15
VM1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0
VM2	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0
VM3	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0
VM4	0	0	0	0	1	1	1	1	1	1	1	1	0	1	0
VM5	0	0	0	1	0	1	1	1	1	1	1	1	1	1	0
VM6	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0
VM7	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0
VM8	0	0	0	0	1	1	0	0	1	1	1	1	1	1	0
VM9	0	0	0	0	1	1	1	1	0	1	1	1	1	1	0
VM10	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0
VM11	0	0	0	0	0	0	1	1	1	1	0	1	1	1	0
VM12	0	0	0	0	0	1	0	1	1	1	1	0	1	1	1
VM13	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
VM14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
VM15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note."1" indicate VM_i can affect VM_j directly.

Form Evolution) are classified as the cause group in DT's VM system, and VM8 (Process Sharing), VM9 (Organization Construction), VM10 (Organization Form Evolution), VM11 (Business Form Evolution), VM12 (Business Sharing), VM13 (New Business Mode Construction), VM14 (Enterprise Capability Improvement), VM15 (Enterprise Performance Improvement) are classified as the effect group.

For the cause set, VM5 (Data Construction), VM6 (Data Sharing), and VM7 (Process Form Evolution) are the top three important factors in the system, which means that data construction, data sharing, and process form evolution are the main causing factors in DT's VM. In other words, during implementing the DT in the enterprise, we should focus on process construction of data and process, but also the data sharing.

For the effect set, VM13 (New Business Mode Construction), and VM14 (Enterprise Capability Improvement) are the top two important factors in the system, which means that new business mode construction and enterprise capability improvement are the main results in the DT system. Also,

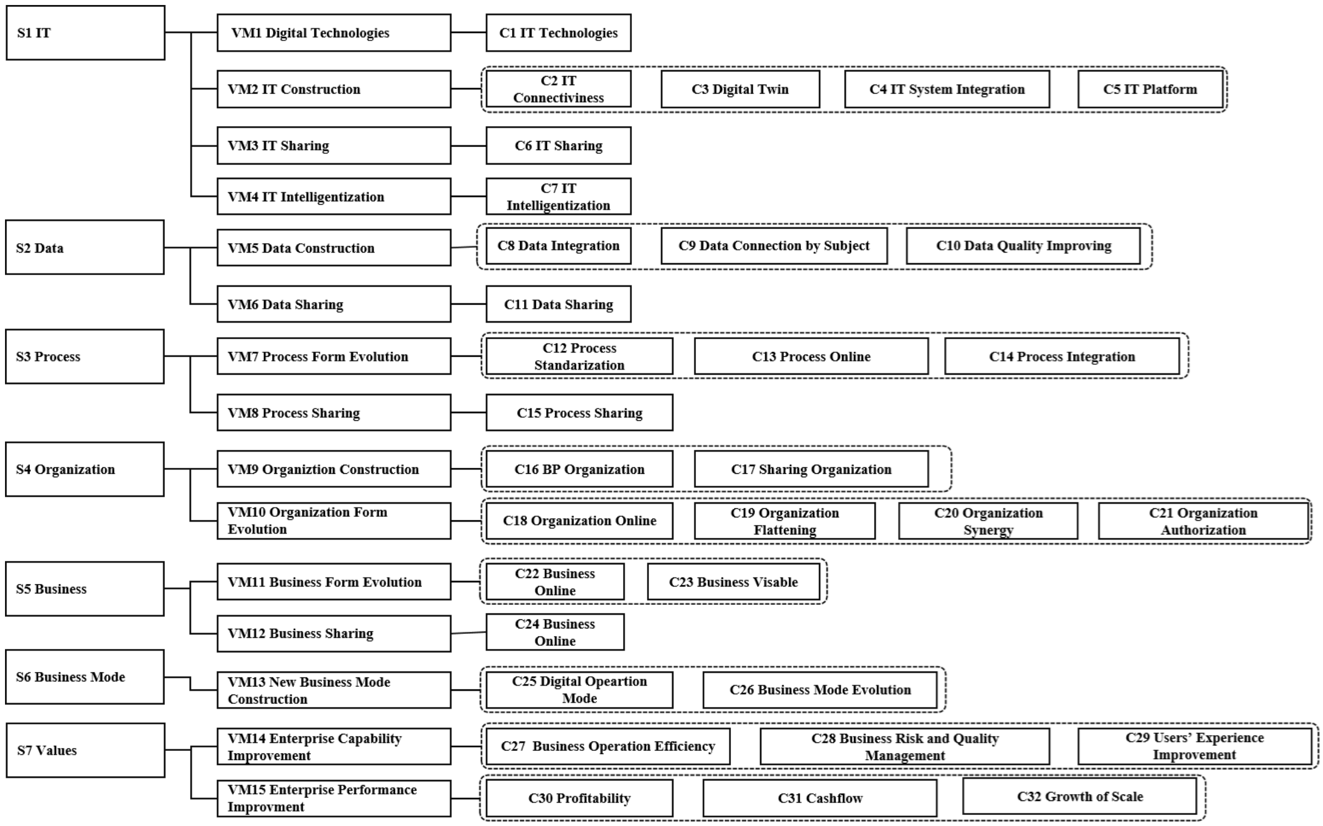


FIGURE 3. Factors structure of DT's value and its creation mechanism.

TABLE 7. The normalized direct influence matrix E of the dematel.

E	VM1	VM2	VM3	VM4	VM5	VM6	VM7	VM8	VM9	VM10	VM11	VM12	VM13	VM14	VM15
VM1	0.0000	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0000	0.0000	0.0000
VM2	0.0000	0.0000	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0000	0.0000	0.0000
VM3	0.0000	0.0000	0.0000	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0000
VM4	0.0000	0.0000	0.0000	0.0000	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0000	0.0909	0.0000
VM5	0.0000	0.0000	0.0000	0.0909	0.0000	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0000
VM6	0.0000	0.0000	0.0000	0.0909	0.0909	0.0000	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0000
VM7	0.0000	0.0000	0.0000	0.0000	0.0909	0.0909	0.0000	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0000
VM8	0.0000	0.0000	0.0000	0.0000	0.0909	0.0909	0.0000	0.0000	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0000
VM9	0.0000	0.0000	0.0000	0.0000	0.0909	0.0909	0.0909	0.0909	0.0000	0.0909	0.0909	0.0909	0.0909	0.0909	0.0000
VM10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0909	0.0909	0.0000	0.0909	0.0909	0.0909	0.0909	0.0000
VM11	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0909	0.0909	0.0909	0.0909	0.0000	0.0909	0.0909	0.0909	0.0000
VM12	0.0000	0.0000	0.0000	0.0000	0.0000	0.0909	0.0000	0.0909	0.0909	0.0909	0.0909	0.0000	0.0909	0.0909	0.0909
VM13	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0909	0.0909
VM14	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0909
VM15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

business mode and enterprise capability are the most important mediating links of DT's value delivery.

To sum up, 15 VM factors are included in the frameworks of DT's VM, containing 7 cause factors: VM1, VM2, VM3, VM4, VM5, VM6, VM7, and effect factors: VM8, VM9, VM10, VM11, VM12, VM13, VM14, and VM15. These VM factors provide the factors for ISM investigation in the next section.

C. RESULT OF ISM STAGE

Building the multilevel hierarchical model and graphically representing the pairwise relations between VM factors are the goals of the ISM implementation. Based on DEMATEL analysis, it considers the 15 VM factors to be the fundamental factors in ISM procedure. And ISM utilize the results of the DEMATEL's computation (the total influence matrix F) as the basis data. Firstly, SSIM was calculated using Equation (8),

TABLE 8. The total influence matrix F of the dematel.

F	VM1	VM2	VM3	VM4	VM5	VM6	VM7	VM8	VM9	VM10	VM11	VM12	VM13	VM14	VM15
VM1	0.0000	0.0909	0.0992	0.1495	0.2153	0.2392	0.2153	0.2870	0.2870	0.2870	0.2870	0.2870	0.2003	0.2321	0.0654
VM2	0.0000	0.0000	0.0909	0.1370	0.1973	0.2192	0.1973	0.2631	0.2631	0.2631	0.2631	0.2631	0.1836	0.2128	0.0599
VM3	0.0000	0.0000	0.0000	0.1256	0.1809	0.2010	0.1809	0.2412	0.2412	0.2412	0.2412	0.2412	0.2517	0.2860	0.0708
VM4	0.0000	0.0000	0.0000	0.0318	0.1658	0.1842	0.1658	0.2211	0.2211	0.2211	0.2211	0.2211	0.1474	0.2546	0.0566
VM5	0.0000	0.0000	0.0000	0.1152	0.0825	0.1842	0.1658	0.2211	0.2211	0.2211	0.2211	0.2211	0.2307	0.2621	0.0649
VM6	0.0000	0.0000	0.0000	0.1152	0.1658	0.1009	0.1658	0.2211	0.2211	0.2211	0.2211	0.2211	0.2307	0.2621	0.0649
VM7	0.0000	0.0000	0.0000	0.0292	0.1520	0.1689	0.0687	0.2027	0.2027	0.2027	0.2027	0.2027	0.2184	0.2409	0.0602
VM8	0.0000	0.0000	0.0000	0.0267	0.1393	0.1548	0.0629	0.1024	0.1858	0.1858	0.1858	0.1858	0.2002	0.2209	0.0552
VM9	0.0000	0.0000	0.0000	0.0292	0.1520	0.1689	0.1520	0.2027	0.1193	0.2027	0.2027	0.2027	0.2184	0.2409	0.0602
VM10	0.0000	0.0000	0.0000	0.0075	0.0353	0.0477	0.0353	0.1489	0.1489	0.0656	0.1489	0.1489	0.1618	0.1772	0.0443
VM11	0.0000	0.0000	0.0000	0.0100	0.0480	0.0618	0.1244	0.1658	0.1658	0.1658	0.0825	0.1658	0.1800	0.1972	0.0494
VM12	0.0000	0.0000	0.0000	0.0171	0.0491	0.1395	0.0491	0.1673	0.1673	0.1673	0.1673	0.0840	0.1810	0.1990	0.1331
VM13	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0909	0.0992
VM14	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0909
VM15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

TABLE 9. The calculation results of the dematel.

Result of Dematel	The influential impact degree M	Rank	The influential impact degree N	Rank	Prominence Z	Rank	Relation Y	Rank	Category
VM1	2.9421	1st	0.0000	15st	2.9421	10st	2.9421	1st	Cause Factor
VM2	2.6137	2st	0.0909	14st	2.7046	12st	2.5227	2st	Cause Factor
VM3	2.5026	3st	0.1901	13st	2.6927	13st	2.3125	3st	Cause Factor
VM4	2.1116	6st	0.7940	12st	2.9056	11st	1.3176	4st	Cause Factor
VM5	2.2108	4st	1.5833	9st	3.7940	6st	0.6275	5st	Cause Factor
VM6	2.2108	5st	1.8703	8st	4.0811	3st	0.3405	7st	Cause Factor
VM7	1.9515	7st	1.5833	10st	3.5348	8st	0.3682	6st	Cause Factor
VM8	1.7055	9st	2.4443	2st	4.1498	2st	-0.7388	9st	Effect Factor
VM9	1.9515	8st	2.4443	3st	4.3958	1st	-0.4928	8st	Effect Factor
VM10	1.1705	12st	2.4443	6st	3.6147	7st	-1.2738	13st	Effect Factor
VM11	1.4164	11st	2.4443	5st	3.8607	5st	-1.0279	12st	Effect Factor
VM12	1.5213	10st	2.4443	4st	3.9656	4st	-0.9230	10st	Effect Factor
VM13	0.1901	13st	2.4042	7st	2.5943	14st	-2.2141	14st	Effect Factor
VM14	0.0909	14st	2.8767	1st	2.9677	9st	-2.7858	15st	Effect Factor
VM15	0.0000	15st	0.9749	11st	0.9749	15st	-0.9749	11st	Effect Factor

as seen in Table 10. The reachability matrix R (Table 11) is then obtained by applying Equations (9) and (10). The sets of reachability set (R_i), antecedent set (Q_i), and common set (S), were then developed using the methods outlined in Step (3) in ISM procedure. These sets were then utilized to produce level partitions and the relevant factor sets in Step (4) of ISM procedure, the calculation process is shown in Table 12 and Table 13 and the result is shown in Table 14. Ultimately, the multilevel hierarchical model was developed and presented in Figure 5 based on the aforementioned analysis.

V. DISCUSSIONS

A. Grounded Theory, DEMATEL, ISM

The data analysis consists of three stages GT, DEMATEL and ISM.

In the first stage, the investigation of GT concludes with a conceptual framework of VM factors related to DT's VM. The framework contains 15 VM factors; they are classified into 5 categories: IT, data, process, organization, and values. The conceptual framework enables readers to better understand the structure and the areas DT VM system, and it also drive the managers to attention on what factors should be considered when doing DT implementation in practice. Meanwhile, participants can focus on specific factors according to their position and the real-time progress of the DT project. Additionally, this framework is relatively comprehensive. It covers both the operational level (cause factors and process factors) and the management (effect factors). In a word, this study has developed a conceptual framework to list VM factors related to DT's VM with more comprehensive information and systematic structure.

In the second stage, following the qualitative research results investigated by GT, the DEMATEL offers an efficient tool to evaluate the collected risk factors. The investigation of the DEMATEL undertakes quantitative analysis comprehensively considering various indexes including the influential impact degree, the influenced impact degree, prominence, and relation. Therefore, the values of relation classify the

TABLE 10. The structural self-interactrion matrix of ISM.

C	VM1	VM2	VM3	VM4	VM5	VM6	VM7	VM8	VM9	VM10	VM11	VM12	VM13	VM14	VM15
VM1	1.0000	0.0909	0.0992	0.1495	0.2153	0.2392	0.2153	0.2870	0.2870	0.2870	0.2870	0.2870	0.2003	0.2321	0.0654
VM2	0.0000	1.0000	0.0909	0.1370	0.1973	0.2192	0.1973	0.2631	0.2631	0.2631	0.2631	0.2631	0.1836	0.2128	0.0599
VM3	0.0000	0.0000	1.0000	0.1256	0.1809	0.2010	0.1809	0.2412	0.2412	0.2412	0.2412	0.2412	0.2517	0.2860	0.0708
VM4	0.0000	0.0000	0.0000	1.0318	0.1658	0.1842	0.1658	0.2211	0.2211	0.2211	0.2211	0.2211	0.1474	0.2546	0.0566
VM5	0.0000	0.0000	0.0000	0.1152	1.0825	0.1842	0.1658	0.2211	0.2211	0.2211	0.2211	0.2211	0.2307	0.2621	0.0649
VM6	0.0000	0.0000	0.0000	0.1152	0.1658	1.1009	0.1658	0.2211	0.2211	0.2211	0.2211	0.2211	0.2307	0.2621	0.0649
VM7	0.0000	0.0000	0.0000	0.0292	0.1520	0.1689	1.0687	0.2027	0.2027	0.2027	0.2027	0.2027	0.2184	0.2409	0.0602
VM8	0.0000	0.0000	0.0000	0.0267	0.1393	0.1548	0.0629	1.1024	0.1858	0.1858	0.1858	0.1858	0.2002	0.2209	0.0552
VM9	0.0000	0.0000	0.0000	0.0292	0.1520	0.1689	0.1520	0.2027	1.1193	0.2027	0.2027	0.2027	0.2184	0.2409	0.0602
VM10	0.0000	0.0000	0.0000	0.0075	0.0353	0.0477	0.0353	0.1489	0.1489	1.0656	0.1489	0.1489	0.1618	0.1772	0.0443
VM11	0.0000	0.0000	0.0000	0.0100	0.0480	0.0618	0.1244	0.1658	0.1658	0.1658	1.0825	0.1658	0.1800	0.1972	0.0494
VM12	0.0000	0.0000	0.0000	0.0171	0.0491	0.1395	0.0491	0.1673	0.1673	0.1673	0.1673	1.0840	0.1810	0.1990	0.1331
VM13	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0909	0.0992
VM14	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0909
VM15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000

TABLE 11. The reachability R of ISM.

R	VM1	VM2	VM3	VM4	VM5	VM6	VM7	VM8	VM9	VM10	VM11	VM12	VM13	VM14	VM15
VM1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VM2	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
VM3	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
VM4	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
VM5	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
VM6	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
VM7	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
VM8	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
VM9	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
VM10	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
VM11	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
VM12	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
VM13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
VM14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
VM15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

factors into two groups, namely, the effect factor and the cause factor, while the value of prominence for each factor indicates its impact strength in the entire system. By comprehensively considering the four kinds of index, the importance of the 15 VM factors is presented in the conceptual framework. Meanwhile, the evaluation results reveal that VM5 (Data Construction), VM6 (Data Sharing), VM7 (Process Form Evolution) VM13 (New Business Mode Construction), and VM14 (Enterprise Capability Improvement) are the most crucial issues at the level of main category. In other words, data, process, business mode, and enterprise capability improvement (efficiency improving, internal control improving, experience improving, etc.) are highly associated with DT implementation. Therefore, to ensure the success of the DT project, it is suggested that data, process, business mode, and enterprise capability should be paid more attention in the DT implementation plan, but also should be clear about the mediate values and the path of DT's value realization (relationship between VM factors) before the project starts. The findings above are similar with some existing studies: (a)Various of factors will affect the results of DT, stating that technology [5], [8], [7], [14], [15], [76], process [18], [19], organization [5], [8], [14], [20], [21], [22], [24], [25], [26], [27], [28] are important factors of enterprise performance improvement or productivity improvement from DT; (b)The ultimate target or purpose of DT is to improve the enterprise performance for DT project, but the mediate values of DT like business mode building [18], [29], [30], [31] and efficiency improvement [7], [20], [21], [22], [28], [33], [34], internal control improvement [36] should be focused

TABLE 12. The first level calculation result of VM factors by ISM.

R_i	Q_i	$Q_i=\{R_j \mid R_j \in R_i, r_{ij}=1\}(i=1,2,...,n;j=1,2,...,n)$	A_i	$A_i=\{R_j \mid R_j \in A_i, r_{ji}=1\}(i=1,2,...,n;j=1,2,...,n)$	$Q_i \cap A_i$	Whether "$Q_i \cap A_i=R_i$"?
VM1	Q1	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12,VM13,VM14,VM15	A1	VM1	VM1	Y
VM2	Q2	VM2,VM3,VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12,VM13,VM14, VM15	A2	VM1,VM2	VM2	Y
VM3	Q3	VM3,VM4,VM5,VM6,VM7,VM8,VM9, VM10,VM11,VM12,VM13,VM14,VM15	A3	VM1,VM2,VM3	VM3	Y
VM4	Q4	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A4	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM5	Q5	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A5	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM6	Q6	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A6	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM7	Q7	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A7	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM8	Q8	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A8	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM9	Q9	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A9	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM10	Q10	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A10	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM11	Q11	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A11	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM12	Q12	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A12	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM13	Q13	VM13,VM14,VM15	A13	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12,VM13	VM13	Y
VM14	Q14	VM14,VM15	A14	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12,VM13, VM14	VM14	Y
VM15	Q15	VM15	A15	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12,VM13, VM14,VM15	VM15	Y

Note. VM1, VM2, VM3, VM13, VM14, VM15 can be assigned to set S, means that these factors are classified to surface or bottom layer, and taken out of reachability matrix R, the remain factors VM4~VM12 will be conducted the same procedure.

on, because they play an important role in the path of DT's values creation. However, it is worth noting that, despite the previous publications have studied DT's VM using quantitative methods, the limitation in common was that they verified the relationship among a few VM factors individually but did not take all the VM into the whole DT system. This study does not only consider all the important VM factors, but also evaluates important degree and the relationship in the whole DT system.

In the final stage, ISM graphically construct the multi-level hierarchical model and analyze the pairwise relations between critical factors. As can be seen from Figure 5, the multilevel hierarchical model of DT's VM contains 3 layers, including the fundamental factors, surface factors, and middle factors. Traditionally, the factors located in the lower layer plays a more significant role in the whole system, since it affects other factors in the upper layer. Therefore, value transmission chains are revealed along with the arrow lines from the bottom layer pointing to the upper layers. For instance, VM1 (Digital Technologies), VM2 (IT Construction), and VM3(IT Sharing) are at the bottom level and belong to the fundamental factors, indicating that Digital Technologies, IT construction, and IT sharing are the most fundamental issues supporting DT's value creation. Therefore, adopting appropriate digital technology and conducting appropriate IT construction and IT sharing is of great significance to ensure the success of the DT project. Otherwise, these fundamental factors can seriously impede progress and even cause a series of failure risks in DT projects. Secondly, VM5-VM12 (related to data, process, organization, and business) lies in the layer of the middle factors in Figure 5, which reveals the process of DT's VM. It can be described that the relevant factors of data, process, organization, and business interact one another to form the value of DT based on IT construction. Thirdly, the model reveals that VM13 (New Business Mode Construction), VM14 (Enterprise Capability Improvement),

TABLE 13. The second level calculation result of VM factors by ISM.

R	Q_i	$Q_i=\{R_j\|R_j\epsilon R_i,r_{ij}=1\}(i=1,2,...,n;j=1,2,...,n)$	A_i	$A_i=\{R_j\|R_j\epsilon A_i,r_{ji}=1\}(i=1,2,...,n;j=1,2,...,n)$	$Q_i\cap A_i$	Whether "$Q_i\cap A_i=R_i$"?
VM4	Q4	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A4	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM5	Q5	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A5	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM6	Q6	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A6	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM7	Q7	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A7	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM8	Q8	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A8	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM9	Q9	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A9	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM10	Q10	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A10	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM11	Q11	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A11	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N
VM12	Q12	VM4,VM5,VM6,VM7,VM8,VM9,VM10, VM11,VM12,VM13,VM14,VM15	A12	VM1,VM2,VM3,VM4,VM5,VM6,VM7, VM8,VM9,VM10,VM11,VM12	VM4,VM5,VM6,VM7,VM8, VM9,VM10,VM11,VM12	N

Note. For VM4~VM12, no factor can be assigned to set S, means the remain factors VM4~VM12 should all be classified on the same layer.

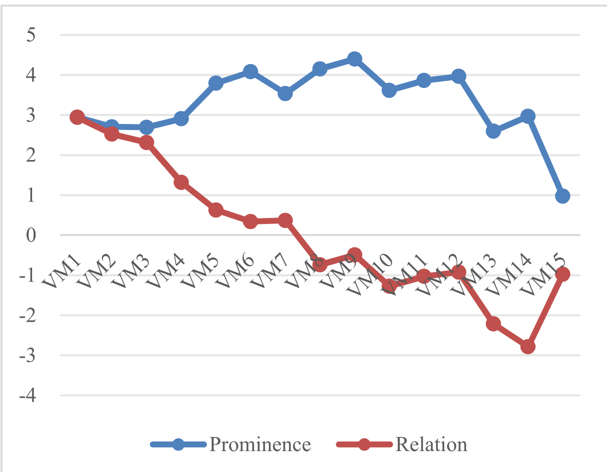


FIGURE 4. The scatter diagram of prominence and relation for VM factors. Note. Prominence indicates the importance degree of VM factor in VM system. Relation indicates the nodes the VM factor stay in cause-effect chain.

TABLE 14. Level partitions of critical VM factrs by ISM.

LEVEL v	Factor set S	Level Description
1	VM13, VM14, VM15	Surface factor
2	VM4, VM5, VM6, VM7, VM8, VM8, VM10, VM11, VM12	Middle factor
3	VM1, VM2, VM3	Fundamental factor

and VM15 (Enterprise Performance Improvement) are the key factors on surface layer; it indicates that DT can obtain the results that include changing or establishing business models and improving enterprise capabilities and enterprise performance.

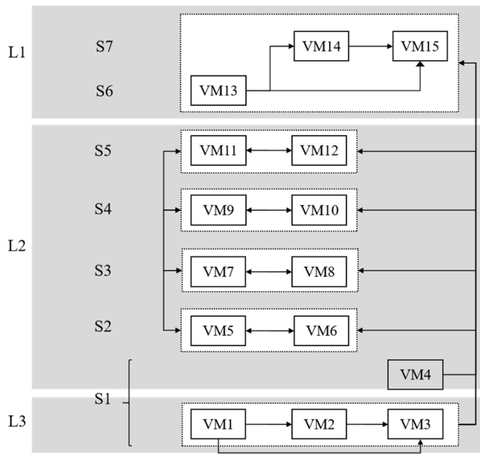


FIGURE 5. The multilevel hierarchical model of ISM.

B. DT's VALUE AND ITS CREATION MECHANISM THEORY FRAMEWORK

Based on the findings in GT, DEMATEL, ISM, DT's VM system model is constructed (Figure 6). This model consists of three main parts: technology, mechanism, and value, corresponding to the level 1, level 2 and level 3 calculated by the ISM. The relationship between the three parts is indicated by the blue arrow on the framework. Firstly, technology can directly affect mechanisms and value, and it is the foundation for the generation of DT value. Secondly, the mechanism is an intermediate variable that generates value, including the four core elements of data, process, organization, and business. At the same time, according to the reachability matrix R of ISM (Table 11), these four core elements work together and influence each other, forming the value of DT. Finally,

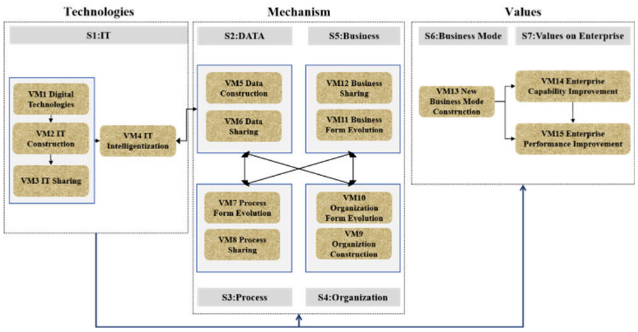


FIGURE 6. Value and its creation mechanism of digital transformation at enterprises. Note: Level 1, level 2, and level 3 correspond to technologies, mechanisms, and values respectively. Although VM4 IT intelligence belongs to the second level according to ISM calculations, VM4 is placed at level 1. The main reason for this consideration is that VM4 and W7-W12 are not directly interdependent, VM4 only has an interdependent relationship with VM5 and VM6, while the eight main axis elements of VM5-VM12 are directly interdependent. Therefore, this study ultimately decided to display VM5-VM12 as a mechanism in the architecture and VM4 IT intelligence as a technology.

value includes three aspects: the construction of business models, the enhancement of enterprise capabilities, and the enhancement of enterprise performance. According to the reachability matrix R of ISM (Table 11), the construction of business models can enhance enterprise capabilities and directly improve enterprise performance. The enhancement of enterprise capabilities can promote the improvement of enterprise performance [77], which constitutes the transmission path of DT value.

REFERENCES

[1] CAICT. (Jan. 11, 2023). *Global Digital Economy White Paper (2023)*. [Online]. Available: https://www.sohu.com/a/750958630_121757514

[2] D. Bonnet. (2022). *3 Stages of a Successful Digital Transformation*. [Online]. Available: https://hbr.org/2022/09/3-stages-of-a-successful-digital-transformation

[3] Accenture, and CICII. (Oct. 14, 2021). *2021 China Enterprise Digital Transformation Index Research Report*. [Online]. Available: https://www.sohu.com/a/495012436_601778

[4] X. M. Zhu and X. G. Lin, "Digital transformation of enterprises: Research context combing and integration framework construction," *RD Manag.*, vol. 4, pp. 141–155, Apr. 2022, doi: 10.13581/j.cnki.rdm.20211174.

[5] S. Li and Y. Tian, "How does digital transformation affect total factor productivity: Firm-level evidence from China," *Sustainability*, vol. 15, no. 12, p. 9575, Jun. 2023, doi: 10.3390/su15129575.

[6] Y. Peng and C. Tao, "Can digital transformation promote enterprise performance?—From the perspective of public policy and innovation," *J. Innov. Knowl.*, vol. 7, no. 3, Jul. 2022, Art. no. 100198, doi: 10.1016/j.jik.2022.100198.

[7] J. Han, R. Sun, M. Zeeshan, A. Rehman, and I. Ullah, "The impact of digital transformation on green total factor productivity of heavily polluting enterprises," *Frontiers Psychol.*, vol. 14, Nov. 2023, Art. no. 1265391, doi: 10.3389/fpsyg.2023.1265391.

[8] H. Zhang and Q. Zhang, "How does digital transformation facilitate enterprise total factor productivity? The multiple mediators of supplier concentration and customer concentration," *Sustainability*, vol. 15, no. 3, p. 1896, Jan. 2023, doi: 10.3390/su15031896.

[9] C. Zhuo and J. Chen, "Can digital transformation overcome the enterprise innovation dilemma: Effect, mechanism and effective boundary," *Technol. Forecasting Social Change*, vol. 190, May 2023, Art. no. 122378, doi: 10.1016/j.techfore.2023.122378.

[10] R. Adner, P. Puranam, and F. Zhu, "What is different about digital strategy? From quantitative to qualitative change," *Strategy Sci.*, vol. 4, no. 4, pp. 253–261, Dec. 2019, doi: 10.1287/stsc.2019.0099.

[11] K. Dey and S. Saha, "Influence of procurement decisions in two-period green supply chain," *J. Cleaner Prod.*, vol. 190, pp. 388–402, Jul. 2018, doi: 10.1016/j.jclepro.2018.04.114.

[12] R. Xu, F. Luo, G. Chen, F. Zhou, and E. W. Abdulahi, "Application of HFACS and grounded theory for identifying risk factors of air traffic controllers' unsafe acts," *Int. J. Ind. Ergonom.*, vol. 86, Nov. 2021, Art. no. 103228, doi: 10.1016/j.ergon.2021.103228.

[13] H. Zhai, M. Yang, and K. C. Chan, "Does digital transformation enhance a firm's performance? Evidence from China," *Technol. Soc.*, vol. 68, Feb. 2022, Art. no. 101841, doi: 10.1016/j.techsoc.2021.101841.

[14] Z. Mohd Noor, H. K. Kasimin, A. Aman and N. Sahari, "An adoption model of electronic government services in Malaysia: Electronic labor exchange (ELX)," *Jurnal Pengurusan*, vol. 33, pp. 87–97, 2011.

[15] F. Nucci, C. Puccioni, and O. Ricchi, "Digital technologies and productivity: A firm-level investigation," *Econ. Model.*, vol. 128, Nov. 2023, Art. no. 106524, doi: 10.1016/j.econmod.2023.106524.

[16] G. Xia, Z. Yu, and X. Peng, "How does enterprise digital transformation affect total factor productivity? Based on the information intermediary role of analysts' attention," *Sustainability*, vol. 15, no. 11, p. 8601, May 2023, doi: 10.3390/su15118601.

[17] Y. Wu, H. Li, R. Luo, and Y. Yu, "How digital transformation helps enterprises achieve high-quality development? Empirical evidence from Chinese listed companies," *Eur. J. Innov. Manag.*, vol. 26, Apr. 2023, doi: 10.1108/ejim-11-2022-0610.

[18] D. Llinas and J. Abad, "The role of high-performance people management practices in Industry 4.0: The case of medium-sized Spanish firms," *Intangible Capital*, vol. 15, no. 3, pp. 190–207, Jan. 2020, doi: 10.3926/ic.1485.

[19] J. Wang, Y. Liu, W. Wang, and H. Wu, "How does digital transformation drive green total factor productivity? Evidence from Chinese listed enterprises," *J. Cleaner Prod.*, vol. 406, Jun. 2023, Art. no. 136954, doi: 10.1016/j.jclepro.2023.136954.

[20] Y. Cheng, X. Zhou, and Y. Li, "The effect of digital transformation on real economy enterprises' total factor productivity," *Int. Rev. Econ. Finance*, vol. 85, pp. 488–501, May 2023, doi: 10.1016/j.iref.2023.02.007.

[21] Z. Lei and D. Wang, "Digital transformation and total factor productivity: Empirical evidence from China," *PLoS One*, vol. 18, no. 10, Oct. 2023, Art. no. e0292972, doi: 10.1371/journal.pone.0292972.

[22] X. Du and K. Jiang, "Promoting enterprise productivity: The role of digital transformation," *Borsa Istanbul Rev.*, vol. 22, no. 6, pp. 1165–1181, Nov. 2022, doi: 10.1016/j.bir.2022.08.005.

[23] N. Li, X. Wang, Z. Wang, and X. Luan, "The impact of digital transformation on corporate total factor productivity," *Frontiers Psychol.*, vol. 13, Dec. 2022, Art. no. 1071986, doi: 10.3389/fpsyg.2022.1071986.

[24] M. Opazo-Basáez, F. Vendrell-Herrero, O. F. Bustinza, and J. Marić, "Global value chain breadth and firm productivity: The enhancing effect of Industry 4.0," *J. Manuf. Technol. Manag.*, vol. 33, no. 4, pp. 785–804, May 2022, doi: 10.1108/jmtm-12-2020-0498.

[25] S. Zhai and Z. Liu, "Artificial intelligence technology innovation and firm productivity: Evidence from China," *Finance Res. Lett.*, vol. 58, Dec. 2023, Art. no. 104437, doi: 10.1016/j.frl.2023.104437.

[26] B. P. Rodríguez, A. J. Verdú-Jover, M. Estrada-Cruz, and J. M. Gomez-Gras, "Does digital transformation increase firms' productivity perception? The role of technostress and work engagement," *Eur. J. Manag. Bus. Econ.*, vol. 33, no. 2, pp. 137–156, Apr. 2023, doi: 10.1108/ejmbe-06-2022-0177.

[27] J. Su, Y. Wei, S. Wang, and Q. Liu, "The impact of digital transformation on the total factor productivity of heavily polluting enterprises," *Sci. Rep.*, vol. 13, no. 1, p. 6386, Apr. 2023, doi: 10.1038/s41598-023-33553-w.

[28] S. Hou, L. Song, and J. He, "Greening the digital revolution: Assessing the impact of digital transformation on green total factor productivity in Chinese enterprises," *Environ. Sci. Pollut. Res.*, vol. 30, no. 45, pp. 101585–101598, Aug. 2023, doi: 10.1007/s11356-023-29552-z.

[29] N. Xu, D. Zhao, W. Zhang, M. Liu, and H. Zhang, "Does digital transformation promote agricultural carbon productivity in China?" *Land*, vol. 11, no. 11, p. 1966, Nov. 2022, doi: 10.3390/land11111966.

[30] W. Zhang, N. Xu, C. Li, X. Cui, H. Zhang, and W. Chen, "Impact of digital input on enterprise green productivity: Micro evidence from the Chinese manufacturing industry," *J. Cleaner Prod.*, vol. 414, Aug. 2023, Art. no. 137272, doi: 10.1016/j.jclepro.2023.137272.

[31] Y. Wang and P. Han, "Digital transformation, service-oriented manufacturing, and total factor productivity: Evidence from A-share listed companies in China," *Sustainability*, vol. 15, no. 13, p. 9974, Jun. 2023, doi: 10.3390/su15139974.

[32] L. Wang, "Digital transformation and total factor productivity," *Finance Res. Lett.*, vol. 58, Dec. 2023, Art. no. 104338, doi: 10.1016/j.frl.2023.104338.
[33] Y. Ren, X. Zhang, and H. Chen, "The impact of new energy enterprises' digital transformation on their total factor productivity: Empirical evidence from China," *Sustainability*, vol. 14, no. 21, p. 13928, Oct. 2022, doi: 10.3390/su142113928.
[34] Y. Wu, F. Shi, and Y. Wang, "Driving impact of digital transformation on total factor productivity of corporations: The mediating effect of green technology innovation," *Emerg. Markets Finance Trade*, vol. 60, no. 5, pp. 950–966, May 2023, doi: 10.1080/1540496x.2023.2200882.
[35] H. Wen, C. Wen, and C.-C. Lee, "Impact of digitalization and environmental regulation on total factor productivity," *Inf. Econ. Policy*, vol. 61, Dec. 2022, Art. no. 101007, doi: 10.1016/j.infoecopol.2022.101007.
[36] H. Zhang and S. Dong, "Digital transformation and firms' total factor productivity: The role of internal control quality," *Finance Res. Lett.*, vol. 57, Nov. 2023, Art. no. 104231, doi: 10.1016/j.frl.2023.104231.
[37] K. M. Eisenhardt, "Building theories from case study research," *Acad. Manag. Rev.*, vol. 14, no. 4, pp. 532–550, Oct. 1989, doi: 10.5465/amr.1989.4308385.
[38] R. K. Yin, *Case Study Research: Design and Methods*. Thousand Oaks, CA, USA: Sage, 2009.
[39] C. Daymon and I. Holloway, *Qualitative Research Methods in Public Relations and Marketing Communications*. Abingdon, U.K.: Routledge, 2010.
[40] K. M. Eisenhardt and M. E. Graebner, "Theory building from cases: Opportunities and challenges," *Acad. Manag. J.*, vol. 50, no. 1, pp. 25–32, Feb. 2007, doi: 10.5465/amj.2007.24160888.
[41] R. K. Yin, "Designing case studies," *Qual. Res. Methods*, vol. 5, no. 14, pp. 359–386, Feb. 2003.
[42] B. G. Glaser, *The Grounded Theory Perspective: Conceptualization Contrasted With Description*. Mill Valley, CA, USA: Sociology Press, 2001.
[43] Z. Wang and H. Hu, "Improved precast production–scheduling model considering the whole supply chain," *J. Comput. Civil Eng.*, vol. 31, no. 4, Jul. 2017, Art. no. 04017013, doi: 10.1061/(asce)cp.1943-5487.0000667.
[44] B. G. Glaser and J. Holton, "Staying open: The use of theoretical codes in grounded theory," *Grounded Theory Rev.*, vol. 5, no. 1, pp. 1–20, 2005.
[45] X. Qin, Z. Li, and Y. Mo, "A risk and vulnerability ontology for green building projects based on in-depth interview and grounded theory," *China Civ. Eng. J.*, vol. 49, pp. 120–132, Aug. 2016, doi: 10.15951/j.tmgcxb.2016.08.014.
[46] E. Fontela and A. Gabus, "DEMATEL: Progress achieved," *Futures*, vol. 6, no. 4, pp. 361–363, Aug. 1974, doi: 10.1016/0016-3287(74)90086-x.
[47] A. Alinezhad and J. Khalili, *New Methods and Applications in Multiple Attribute Decision Making (MADM)*. Berlin, Germany: Springer, 2019.
[48] C. W. Li, "A structure evaluation model for technology policies and programs," Ph.D. dissertation, Inst. Manag. Technol., Nat. Chiao Tung Univ., Taiwan, 2009.
[49] C.-L. Lin and G.-H. Tzeng, "A value-created system of science (technology) park by using DEMATEL," *Exp. Syst. Appl.*, vol. 36, no. 6, pp. 9683–9697, Aug. 2009, doi: 10.1016/j.eswa.2008.11.040.
[50] Q. Zhou, W. Huang, and Y. Zhang, "Identifying critical success factors in emergency management using a fuzzy DEMATEL method," *Saf. Sci.*, vol. 49, no. 2, pp. 243–252, Feb. 2011, doi: 10.1016/j.ssci.2010.08.005.
[51] R. Kiani Mavi and C. Standing, "Cause and effect analysis of business intelligence (BI) benefits with fuzzy DEMATEL," *Knowl. Manag. Res. Pract.*, vol. 16, no. 2, pp. 245–257, Mar. 2018, doi: 10.1080/14778238.2018.1451234.
[52] W.-W. Wu and Y.-T. Lee, "Developing global managers' competencies using the fuzzy DEMATEL method," *Exp. Syst. Appl.*, vol. 32, no. 2, pp. 499–507, Feb. 2007, doi: 10.1016/j.eswa.2005.12.005.
[53] S. Fazli, R. Kiani Mavi, and M. Vosooghidizaji, "Crude oil supply chain risk management with DEMATEL–ANP," *Oper. Res.*, vol. 15, no. 3, pp. 453–480, May 2015, doi: 10.1007/s12351-015-0182-0.
[54] R. K. Mavi and H. Shahabi, "Using fuzzy DEMATEL for evaluating supplier selection criteria in manufacturing industries," *Int. J. Logistics Syst. Manag.*, vol. 22, no. 1, pp. 15–42, Aug. 2015, doi: 10.1504/ijlsm.2015.070889.
[55] Y.-W. Du and X.-X. Li, "Hierarchical DEMATEL method for complex systems," *Exp. Syst. Appl.*, vol. 167, Apr. 2021, Art. no. 113871, doi: 10.1016/j.eswa.2020.113871.
[56] Ö. Uygun, H. Kaçamak, and Ü. A. Kahraman, "An integrated DEMATEL and fuzzy ANP techniques for evaluation and selection of outsourcing provider for a telecommunication company," *Comput. Ind. Eng.*, vol. 86, pp. 137–146, Aug. 2015, doi: 10.1016/j.cie.2014.09.014.
[57] J. N. Warfield, "Toward interpretation of complex structural models," *IEEE Trans. Syst., Man, Cybern.*, vol. SMC-4, no. 5, pp. 405–417, Sep. 1974, doi: 10.1109/TSMC.1974.4309336.
[58] F. Lin, P. Wu, and Y. Xu, "Investigation of factors influencing the construction safety of high-speed railway stations based on DEMATEL and ISM," *Adv. Civil Eng.*, vol. 2021, pp. 1–12, Jun. 2021, doi: 10.1155/2021/9954018.
[59] K. Mathiyazhagan, K. Govindan, A. NoorulHaq, and Y. Geng, "An ISM approach for the barrier analysis in implementing green supply chain management," *J. Cleaner Prod.*, vol. 47, pp. 283–297, May 2013, doi: 10.1016/j.jclepro.2012.10.042.
[60] P. S. Poduval, V. R. Pramod, and V. P. R. Jagathy, "Interpretive structural modeling (ISM) and its application in analyzing factors inhibiting implementation of total productive maintenance (TPM)," *Int. J. Quality Rel. Manag.*, vol. 32, no. 3, pp. 308–331, Mar. 2015, doi: 10.1108/ijqrm-06-2013-0090.
[61] T. Raj, R. Shankar, and M. Suhaib, "An ISM approach for modelling the enablers of flexible manufacturing system: The case for India," *Int. J. Prod. Res.*, vol. 46, no. 24, pp. 6883–6912, Dec. 2008, doi: 10.1080/00207540701429926.
[62] A. Jedlicka and R. Meyer, "Interpretive structural modeling: Cross cultural uses," *IEEE Trans. Syst., Man, Cybern.*, vol. SMC-10, no. 1, pp. 49–51, Jan. 1980, doi: 10.1109/TSMC.1980.4308352.
[63] R. J. Waller, "The synthesis of hierarchical structures: Technique and applications," *Decis. Sci.*, vol. 7, no. 4, pp. 659–674, Oct. 1976, doi: 10.1111/j.1540-5915.1976.tb00709.x.
[64] Y. Chun Tie, M. Birks, and K. Francis, "Grounded theory research: A design framework for novice researchers," *SAGE Open Med.*, vol. 7, Jan. 2019, Art. no. 205031211882292, doi: 10.1177/2050312118822927.
[65] K. Coskun, "A new explanation for the conflict between constructivist and objectivist grounded theory," *Int. J. Qualitative Methods*, vol. 19, Jul. 2020, Art. no. 160940692093828, doi: 10.1177/1609406920938280.
[66] A. Trivedi, S. K. Jakhar, and D. Sinha, "Analyzing barriers to inland waterways as a sustainable transportation mode in india: A dematel-ISM based approach," *J. Cleaner Prod.*, vol. 295, May 2021, Art. no. 126301, doi: 10.1016/j.jclepro.2021.126301.
[67] C. Bai and A. Satir, "Barriers for green supplier development programs in manufacturing industry," *Resour., Conservation Recycling*, vol. 158, Jul. 2020, Art. no. 104756, doi: 10.1016/j.resconrec.2020.104756.
[68] R. K. Mudgal, R. Shankar, P. Talib, and T. Raj, "Modelling the barriers of green supply chain practices: An Indian perspective," *Int. J. Logistics Syst. Manag.*, vol. 7, no. 1, pp. 81–107, Jul. 2010, doi: 10.1504/ijlsm.2010.033891.
[69] I. Manuj and T. L. Pohlen, "A reviewer's guide to the grounded theory methodology in logistics and supply chain management research," *Int. J. Phys. Distribution Logistics Manag.*, vol. 42, no. 8, pp. 784–803, Aug. 2012, doi: 10.1108/09600031211269758.
[70] G. A. Bowen, "Naturalistic inquiry and the saturation concept: A research note," *Qualitative Res.*, vol. 8, no. 1, pp. 137–152, Feb. 2008, doi: 10.1177/1468794107085301.
[71] R. A. Swendiman, D. I. Hoffman, A. N. Bruce, T. A. Blinman, M. L. Nance, and C. M. Chou, "Qualities and methods of highly effective surgical educators: A grounded theory model," *J. Surgical Educ.*, vol. 76, no. 5, pp. 1293–1302, Sep. 2019, doi: 10.1016/j.jsurg.2019.02.011.
[72] A. L. Strauss and J. M. Corbin, "Basics of qualitative research: Techniques and procedures for developing grounded theory," *Thousand Oaks CA Sage Tashakkori A Teddlie C*, vol. 36, no. 100, p. 129, Sep. 2014.
[73] Y. Fu, G. Ye, X. Tang, and Q. Liu, "Theoretical framework for informal groups of construction workers: A grounded theory study," *Sustainability*, vol. 11, no. 23, p. 6769, Nov. 2019, doi: 10.3390/su11236769.
[74] Z. Li, R. Mao, Q. F. Meng, X. Hu, and H. X. Li, "Exploring precursors of construction accidents in China: A grounded theory approach," *Int. J. Environ. Res. Public Health*, vol. 18, no. 2, p. 410, Jan. 2021, doi: 10.3390/ijerph18020410.
[75] F. Li, W. Wang, S. Dubljevic, F. Khan, J. Xu, and J. Yi, "Analysis on accident-causing factors of urban buried gas pipeline network by combining DEMATEL, ISM and BN methods," *J. Loss Prevention Process Industries*, vol. 61, pp. 49–57, Sep. 2019, doi: 10.1016/j.jlp.2019.06.001.

[76] A. P. M. Pérez, M. E. Martínez-Sánchez, and R. Nicolas-Sans, ''The Spanish tourism sector: Digital transformation and total factor productivity,'' *Cuadernos de Economía*, vol. 45, no. 127, pp. 140–155, May 2022, doi: 10.32826/cude.v1i127.612.

[77] H. Kasimin, A. Aman, and Z. M. Noor, ''Using evaluation to support organizational learning in e-government system: A case of Malaysia government,'' *Int. J. Electron. Government Res.*, vol. 9, no. 1, pp. 45–64, 2003, doi: 10.4018/jegr.2013010103.

SHUIFANG LI received the bachelor's degree in economics and accounting from Zhongnan University of Economics and Law, Wuhan, China, in 2006, the master's degree in accounting from Zhongnan University of Economics and Law, Wuhan, in 2008, and the Ph.D. degree in accounting from the National University of Malaysia (UKM), Bangi, Selangor, Malaysia, in 2024.

His previous work experiences include the Financial Director in listed company with the Financial Department and internal group company and the Financial Manager of the Financial Shared Service Center. His research interests include accounting information system and global business services and digital transformation in enterprise.

AINI BINTI AMAN received the bachelor's degree in accounting from Purdue University, West Lafayette, in 1991, the master's degree in accounting from Manchester Business School, Manchester, U.K., in 1995, and the Ph.D. degree in accounting and finance from The University of Manchester, U.K., in 2005.

She is currently a Professor in accounting information system and the Dean of the Faculty of Economics and Management, National University of Malaysia (UKM). She is the author of more than 240 articles. Her research interests include accounting information systems and global business services.

Prof. Aman's awards and honors include the Johan faithful Crown Size Level (J.S.M.), in 2023, and the UKM Grants Service Grant 20 Years/Service Grant 20 Years, in 2015.

DAHLIA FERNANDEZ received the bachelor's degree in accounting from the University of Development, Malaysia, in 2013, the master's degree in accounting from Universiti Islam Antarabangsa Malaysia (UIA), Malaysia, in 2017, and the Ph.D. degree in accounting and finance from the National University of Malaysia (UKM), Bangi, Selangor, Malaysia, in 2021.

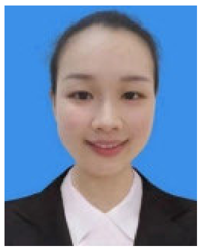
Her previous work experiences include an Internal Auditor with CIMB Bank Berhad and an Account Specialist with Sime Darby Global Services Centre Sdn. Bhd. She is currently a Lecturer with the Faculty of Economics and Management, National University of Malaysia (UKM). She is the author of more than 15 articles in WOS, Scopus-indexed journals, conference proceedings, and newspapers. Her research interests include accounting information systems (AIS), robotic process automation (RPA), digital accounting, enterprise resource planning (ERP), and global business services (GBS).

SOLIHA SANUSI received the Ph.D. degree from Universiti Teknologi MARA, Malaysia, in 2019.

She is currently a Senior Lecturer with the Faculty of Economics and Management, Centre of Global Business and Digital Economy Studies, National University of Malaysia (UKM). She has published and presented her research work in various conferences and journals. Her research interests include direct tax, indirect tax, financial criminology, small-medium enterprises, mixed-method, and public sector accounting. She was a SLAB/SLAI Scholarship Recipient for the M.B.A. and Ph.D. studies. She is also a Reviewer of *Management and Accounting Review* and *Asian Academy of Management Journal of Accounting and Finance*.

SHASHA DONG received the bachelor's degree in accounting from Qilu Normal University, Jinan, China, in 2006, and the master's degree in accounting from the National University of Malaysia (UKM), Bangi, Selangor, Malaysia, in 2024.

Her previous work experiences include accountant in listed company with the Financial Department. Her research interests include accounting information system and global business services and digital transformation in enterprise.



YUQIONG FAN received the bachelor's degree in accounting from Hunan Agricultural University, China, in 2014, and the master's degree in accounting from Changsha University of Science & Technology, China, in 2017. She is currently pursuing the Ph.D. degree in accounting with the National University of Malaysia (UKM).

She is also a Lecturer in accounting with the Business School, Hunan Institute of Technology. Her research interests include corporate governance, corporate green transformation, and digital transformation.

ZHENWEI LIAO received the Bachelor of Education degree from Jiangxi Normal University, Jiangxi, China, in 2012, the Master of Education degree from Ningbo University, Zhejiang, China, in 2015, and the Master of Science degree from The Hong Kong Polytechnic University, Hong Kong, SAR, in 2023. He is currently pursuing the Ph.D. degree in management with the National University of Malaysia (UKM), with a research emphasis that bridges the gap between supply chain finance and the economics of the tourism industry.

His entrepreneurial venture, which he founded, has given him practical experience and insights into the complexities of business operations, which complement his academic research. His research interests include the intricacies of supply chain financing to the economic levers driving the tourism sector, with a keen focus on how financial strategies can optimize tourism development and performance. His blend of educational background, practical business experience, and current research make him a distinctive voice in the fields of management, supply chain finance, and tourism economics, poised to contribute significantly to both academic discourse and industry practice.