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Digital Transformation Evaluation for Small- and Medium-Sized Manufacturing Enterprises Using the Fuzzy Synthetic Method DEMATEL-ANP

Qingmei Chen *, Wei Zhang *, Nanshun Jin, Xiaocheng Wang and Peiru Dai

School of Management, Guangdong University of Science and Technology, Dongguan 523000, China
* Correspondence: amaze1211@163.com (Q.C.); zw1010551@whu.edu.cn (W.Z.)

Abstract: In view of the characteristics of small- and medium-sized manufacturing enterprises and the status quo of digitalization, it is necessary to develop a more applicable digital transformation maturity model. The decision testing and evaluation laboratory method (DEMATEL) is used to provide the visual impact relationship between digital transformation criteria, and combined with the network analytic hierarchy process (ANP) to determine the mixed weight of indicators, and then fuzzy comprehensive evaluation is used to evaluate the digital maturity of small- and medium-sized manufacturing enterprises. The empirical analysis of small- and medium-sized manufacturing enterprises in Guangdong Province shows that digital strategy and information technology play a key role in the digital transformation of enterprises, and digital process and digital innovation are the main problems faced by small- and medium-sized enterprises. In addition, the digital maturity of enterprises is related to the industrial base, regional policies, industry types, etc. This study provides some guidance for the implementation path selection of small- and medium-sized enterprises' digital transformation and accelerates the digital transformation and sustainable development of small- and medium-sized manufacturing enterprises.

Keywords: digital transformation; decision-making test and evaluation laboratory methods; network analytic hierarchy process; fuzzy comprehensive evaluation; small- and medium enterprises

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1. Introduction

Since the beginning of the 21st century, the manufacturing industry has again become the field of competition among countries in the world in the fourth industrial revolution. Intelligent manufacturing, which integrates 5G, AI, IOT, big data, cloud computing and other new generation information technologies with industrial manufacturing, has set off a new wave of global industrial economic development, transformation and upgrading. However, the effect of enterprise digital transformation is not significant enough, and large enterprises have comparative advantages. The digitization level of most enterprises is still very low, especially the small- and medium-sized manufacturing enterprises, which need to face more challenges in the process of digital transformation due to their weak technical foundation, weak transformation awareness, and relative lack of funds and talents. These characteristics have implications for digital transformation, as they affect SMEs management investment, adoption implementation and usage of digital technologies [1]. Small- and medium-sized enterprises are a major component of China's economy. In recent years, the state has issued various policies to encourage small- and medium-sized enterprises to carry out digital transformation, but small- and medium-sized enterprises are at a loss.

Digitalization is defined as the use of digital technology to change the business model and provide new opportunities for income and value creation [2], which is a process toward digital commerce. Digital transformation is an organizational transformation to big data, cloud, mobile and social media platforms, and it has brought unique changes and impacts to the enterprises' organizational structure, daily business operations, business processes and value creation [3,4]. The framework of enterprise digital transformation needs to include two aspects: organization and operation, which can evaluate the effect of enterprise digital transformation [2]. In the digital transformation maturity evaluation, SMEs need to attach importance to the evaluation of technology and processes and use indicators such as strategy, roadmap, technology and personnel to comprehensively evaluate the enterprises [5,6].

In addition, scholars have tried different methods to evaluate digital maturity. In the evaluation of enterprise digital transformation, the 5-point Likert scale was used for integral calculation [5]. Experts score each evaluation index and then calculate the score of each dimension to evaluate the numerical level. In terms of methods, the decision expert (DEX) method can be used to evaluate the maturity of digital transformation of small- and medium-sized manufacturing enterprises [7], which is a qualitative multi-attribute modeling method. Multi-criteria decision-making methods (TOPSIS, MOORA, VIKOR) and entropy methods can also be used to describe the weight of determinants, conduct multi-criteria analysis and evaluate digital maturity [8]. In addition, some scholars use AHP to calculate the weight and fuzzy comprehensive evaluation to calculate the digital maturity level of enterprises in Turkey [9]. However, there is relatively little research on the evaluation of small- and medium-sized manufacturing enterprises; there are few studies on the causal relationship between evaluation indicators, and there is no appropriate method to determine the weight of evaluation figures.

Therefore, this study uses a hybrid approach to evaluate the maturity of digital transformation of small- and medium-sized manufacturing enterprises. First, based on the existing digital evaluation model and combined with the characteristics of small- and medium-sized manufacturing enterprises, the digital evaluation dimension is improved, and a six-dimension digital maturity evaluation system is constructed. Secondly, a hybrid method integrating DEMATEL, ANP and FCE (Fuzzy Comprehensive Evaluation) is used to evaluate the digital transformation level of small- and medium-sized manufacturing enterprises. Finally, through the real evaluation of small- and medium-sized manufacturing enterprises in Guangdong Province, we can understand their digital maturity status and provide effective suggestions for enterprises to accelerate the process of digital transformation. The content structure of the article is as follows. Section 2 collects and sorts out a wide range of literature reviews and theoretical backgrounds, including digital transformation, digital maturity, hybrid methods, etc. Section 3 details the application process of DEMATEL, ANP and FCE mixed methods used in this study. Section 4 conducts empirical research and result analysis. Section 5 discusses the theoretical and practical significance of this study. The last section analyzes the conclusions and limitations of the study.

2. Literature Review

2.1. Digital Transformation and Digital Maturity

2.1.1. Digital Transformation

Digitalization is defined as the use of digital technology to change the business model and provide new revenue and value creation opportunities, which is the process toward digital business [2]. These digital technologies can be described as big data, cloud computing, artificial intelligence, mobile Internet, blockchain, etc., to provide goods or services to improve customer experience, simplify operation processes, and enhance enterprise competitiveness [10,11]. Technologies such as automatic identification technology, additive manufacturing technology and cloud technology have been clearly applied in enterprises and can improve the transparency of information, production and operation efficiency and optimize resource allocation [12]. However, digital transformation is driven by strategy over technology [13], and a transformation strategy must be supported by the appropriate technology. Digital technologies and strategies, customer experience, and data driven business models that can shape the next generation of services have been identified as components of digital transformation implementation as well.

Although digitization has always been the responsibility of IT departments in most enterprises, digitization has had an impact on all fields of enterprises, including not only marketing, but also R&D (Research and Development), production, transportation and other links [14]. More scholars have proposed that digital transformation is not only a change in technology and strategy, but also a comprehensive effect of various changes brought by digital, such as organizational structure, personnel, concepts, processes, technologies, etc., which will affect the organizational form, ecological structure and industry rules of enterprises in the current field [15–17]. The organization and culture of enterprises [18], the digital skills of employees [13], and the digital leadership of enterprises [19] will all affect the digital transformation.

2.1.2. Digital Maturity

Digital maturity is gradually attached importance with the implementation of industry 4.0 strategy. The current situation, degree and gap of enterprise digitization are the issues that people pay attention to. "Maturity" refers to the state of being complete, perfect or ready [20], which is a result state after an enterprise implements a certain plan. Therefore, the term "digital maturity" reflects a state that the company has reached after implementing the digital transformation strategy [21]. It can be measured by the preparation made by enterprises in the face of digital environment and the achievements made in various aspects after the implementation of digital transformation. Generally speaking, digital maturity can be evaluated from technology and management. Therefore, if an enterprise has a perfect digital foundation and can make good use of the digital foundation to realize business value, its digital maturity will be relatively high [22]. The maturity model is composed of dimensions and standards. Dimensions refer to the major aspects concerned by the enterprise strategic level, and standards are the further expansion of dimensions. They measure the evolution path of maturity at different levels and provide guidance for enterprises on how to conduct digital transformation [23]. In the research on business models and digitalization of small and micro-enterprises, external drivers, human factors, income drivers and development trends can be used to evaluate [24]. In evaluating the digital transformation of small- and medium-sized retail enterprises, we can also evaluate from the aspects of strategy and leadership, corporate organization and culture, IT facilities construction, data maturity, business processes, products, etc. [25]. Other studies on the maturity evaluation dimensions of digital transformation mainly focus on information technology [5,7,10,25–27], strategy [5,7,10,25,26], organization [14,25,27], product [25,26], individual [5,7,25,28], process integration [5,26,28,29], data [9,27,29] and culture [9,28]. The dimensions faced by SMEs mainly include strategy, organization, technology, process, etc.

2.2. Small- and Medium Enterprises (SMEs)

Small- and medium-sized enterprises (SMEs) occupy an important position in China's economic development due to their large number and wide coverage. In the process of digital transformation, small- and medium-sized enterprises are different from large enterprises; their resources, costs and manpower are limited, and their digitization process is relatively slow [30]. Faced with the impact of the digital environment, the incentives of various national economic policies, and the pressure of successful transformation of large enterprises, small- and medium-sized enterprises are eager to carry out digital transformation. However, due to factors such as unclear transformation path, unclear transformation direction and uncertain transformation benefits, small- and medium-sized enterprises are at a loss.

In recent years, the digital transformation (DT) of SMEs has been a very realistic and interesting topic on the agenda of scholars and practitioners [3,31]. More and more enterprises will use advanced technologies to change production processes and innovate business models [32,33]. In addition, with the support of big data, cloud computing, artificial intelligence and other technologies, the digital transformation process has become more complex; Enterprises need continuous transformation. People have limited understanding of how to adapt, introduce and use these emerging technologies to transform enterprise business processes and realize product innovation. Moreover, these technologies may have more potential commercial value [34]. In addition, small- and medium-sized enterprises have some disadvantages in digital cognition and organizational resources due to their limited resources. Therefore, it is necessary to carry out digital transformation so that the entire organization and business processes can be digitized, so as to maintain their sustainable development in the trend of digital transformation [3,35]. Then, in view of how digital technology can trigger the change of business process of small- and medium-sized enterprises (SMEs) in the manufacturing industry, small- and medium-sized enterprises can participate in the adoption of digital technology through four levels of digital awareness, digital query, digital collaboration and digital transformation [36]. The attributes of SMEs' digital maturity include two main dimensions: organizational capability and digital capability [7]. Digital capabilities can be subdivided into the use of technology, the role of informatics, digital business models and strategies. Organizational competence can be described as human resources, organizational culture and management. However, most small- and medium-sized enterprises are unable to identify their own digital capabilities and the digital capabilities that need to be developed. Assessing their own digital status is an obstacle to implementing digital transformation [37].

2.3. Proposed Method

2.3.1. DEMATEL-ANP

DEMATEL transforms complex interactions between elements into causality by establishing a system model [38]. The model shows the effectiveness of each standard by drawing the standard into a chart from the two dimensions of importance and reason, thus showing the relationship between elements [39]. The DEMATEL method was used to assess the impact factors of technology implementation in the Indian banking industry [40] and the key factors used to evaluate the digital transformation of energy enterprises [41]. However, the DEMATEL method cannot solve the problem of stratification and weight determination. Therefore, it needs to be mixed with ANP. ANP can calculate the weight of elements through expert comparison, scoring and evaluation, but it cannot solve the impact and feedback relationship between various standards [42]. In the literature, the combination of DEMATEL and ANP is often used to solve the problem of multi-criteria goal decision making and goal evaluation. This structure helps to determine the relationship between core attribute factors, thus supporting decision makers to make plans. For example, DEMATEL-ANP has been used to solve the problem of digital war readiness assessment in many countries [43], and DEMATEL-ANP has been used to solve the problem of assessment and selection of renewable resources in Turkey [44].

2.3.2. Fuzzy Comprehensive Evaluation (FCE)

The method of fuzzy comprehensive evaluation uses fuzzy statistics and fuzzy mathematics, applies the principle of fuzzy transformation and the principle of maximum membership, comprehensively considers various influencing factors, and scientifically evaluates the objectives. The fuzzy comprehensive evaluation method is based on the membership degree theory of fuzzy mathematics, which transforms qualitative evaluation into quantitative evaluation, and can better solve the fuzzy and difficult to quantify problems. For example, the fuzzy comprehensive evaluation method was used to evaluate the agency services of large products based on new technologies [45] and was used to evaluate the layout of strategic emerging industries [46]. This method can carry out the fuzzy evaluation of objectives, but it is unknown whether there is a causal relationship between evaluation indicators. Therefore, DEMATEL and ANP are used to calculate the causal relationship and weight between elements, and then, fuzzy evaluation is carried out. This cannot only make an objective evaluation of the objectives, but can also analyze the deep-seated causes of the objective evaluation results.

2.4. Proposed Attributes

For small- and medium-sized manufacturing enterprises, it is obviously unreasonable to adopt the same indicators for digital maturity evaluation as for large enterprises. Therefore, this paper constructs the index system by sorting out the literature and combining the expert opinions. Digital leadership (C1) plays an important role in the process of enterprise digital transformation and is an important indicator to measure the maturity of digital transformation [11,19]. Digital roadmap (C2) can effectively promote the digital transformation of enterprises, which can usually be evaluated from the perspective of consciousness and behavior [47]. Organizational adaptability (C3) can flexibly adjust the organization to adapt to digital changes as soon as possible and win competitive advantages; in addition, in the organizational structure, whether the information department (C4) is set separately is also a manifestation of whether the enterprise informatization construction is professional [31,37]. In addition, in the process of digital transformation, the supporting role of human resources is indispensable and plays a key role in implementing and achieving a higher level of digitization [24,26,27]. Therefore, the employee digital skills (C5) drive organizations' competitiveness and innovation capacity [48], and employees' digital cognition (C6) of employees affect the process of enterprise digitization to a certain extent and can promote or hinder enterprise digitization [49]. IT infrastructure (C7) is the most basic condition for an organization to carry out digital transformation, and it is an important indicator to measure whether digitalization is mature [12,18,20]. Enterprises should be equipped with infrastructure consistent with digital strategy to adapt to the future development environment. IT requirements of digital projects include: development, integration and maintenance of enterprise information system (C9), including hardware, software, data and business process layer; management of infrastructure such as internet of things equipment and servers; collect, store, analyze and distribute data, and manage data analysis [28]. Among them, the application of emerging technologies (C8) such as big data and artificial intelligence will greatly improve production efficiency and reduce operating costs [26].

The digitization of process management is the concrete embodiment of the digitization effect of enterprises, including digital R&D (C10), digital procurement (C11), digital production (C12) and digital marketing (C14) [33,50–52]. The favorable measures of digital governance (C13) can make the digital transformation more standardized [25,28]. Vertical integration (C15) is used to further strengthen the application of digitalization on the basis of informatization, making enterprise content information more transparent and production activities more timely [53]. Horizontal integration (C16) includes integration with suppliers and integration with customers. The digital chemical plant improves the efficiency of the whole supply chain system through external integration and sharing of resources, which makes the relationship between the enterprise and the upstream and downstream closer, and which enhances the competitive advantage of the enterprise [54]. R&D (C17) is an important indicator to measure enterprise innovation. A clear R&D roadmap is helpful to promote enterprises to achieve industrial 4.0 digital transformation [33]. In addition, the mobility of digital products and their development and commercialization determines how small start-ups carry out product innovation (C18) [55]. Product innovation is also a factor that enterprises pay more attention to in the process of digitalization, because it is the basis of business model innovation. The explanation of each criterion is shown in Table 1.

Table 1. Proposed attributes.

Aspects		Criteria		Explanation	References
A1	Strategy	C1	Digital leadership	Digital leadership is crucial for organizations to survive in the new digital era by adapting and transforming business strategies.	[11]
		C2	Digital roadmap	Determine the strategic milestones of the organization's implementation of digital transformation and clearly plan the path of digital transformation.	[47]
A2	Organization and people	C3	Organizational adaptability	The organization management system has certain flexibility and can better adapt to digital transformation.	[37]
		C4	Information management department	The more independent and professional the information management department is, the higher the digitization level of the enterprise will be.	[31]
		C5	Employee digital skills	To carry out an appropriate digital transformation process in particular, employees need to have or acquire adequate digital skills (DS).	[48]
		C6	Employees' digital cognition	Digital awareness is viewed as composed of three sequential phases: perception, comprehension, and projection.	[49]
A3	Information technology	C7	IT infrastructure	The importance of enterprise information technology (IT) infrastructure capability is considered to be the key to enterprise competitiveness, especially in the era of digital economy.	[18]
		C8	Emerging technology	The application of emerging technologies such as big data, Internet of things and artificial intelligence will promote the digital transformation of enterprises.	[26]
		C9	information system	The perfection and integration of various enterprise information systems are the manifestation of digitalization.	[28]
A4	Process and management	C10	Digital R&D	Digital R&D is a link in the digital operation process. It can effectively provide R&D efficiency and save R&D costs.	[33]
		C11	Digital procurement	The cost reduction effect brought by digital procurement process and technology application to enterprises. It is also a link in the digital business process.	[50]
		C12	Digital production	Digital production is the most important link in the digital transformation of small- and medium-sized manufacturing enterprises.	[51]
		C13	Digital governance	Digital governance can make continuous changes in organizational management to ensure that enterprises are moving in the right direction, thus promoting the implementation of the vision of enterprise digital transformation.	[25]
		C14	Digital marketing	Digital marketing is a practical activity that uses digital communication channels to promote products and services, which can enhance consumer insight and reflect consumer needs.	[51]
A5	Integration	C15	Vertical integration	Vertical integration means that in the intelligent factory system of the enterprise, each system of the enterprise communicates through the physical system, and the constituent elements include people, machines and resources.	[53]
		C16	Horizontal integration	Horizontal integration means that the intelligent factory cannot only reflect the internal production system of the enterprise in real time, but it also needs to connect with the systems between suppliers and customers.	[54]
A6	Innovation	C17	R&D investment	R&D activities will affect knowledge accumulation, which will lead to technological innovation and gradually increase productivity; thereby facilitating digital transformation.	[33]
		C18	Product innovation	Product innovation is affected by many factors, but in the digital platform, the effect is more obvious.	[55]

3. Methods

This paper uses the DEMATEL-ANP method and fuzzy comprehensive evaluation method. DEMATEL-ANP can clarify the causal relationship, can influence the relationship among various indicators of digital transformation maturity, and can calculate the weight of each indicator. The processed data were collected through expert interviews and questionnaires. When the internal indicators are dependent, DEMATEL can be used to show the internal dependency through pairwise comparison. By combining ANP and DEMATEL to calculate the weight, the assumption of equal weight in the ANP method can be avoided. The fuzzy comprehensive evaluation method can evaluate the maturity index by quantifying the qualitative language to obtain specific scores.

3.1. Use DEMATEL to Calculate the Factor Relationship between Criteria

Step 1: Construction of index system.

The target level, standard and substandard of the evaluation mode can be determined through literature surveys, expert interviews and enterprise visits.

Step 2: Establish direct impact matrix.

The direct relationship matrix is constructed by DEMATEL through the comparison of the impact degree between indicators. The influence degree a_{ij} can be divided into several levels, which are represented by 0~9. The number 0 means no impact, 1 means very weak impact, 3 means slight impact, 5 means general impact, 7 means obvious impact, 9 means very impact, and 2, 4, 6 and 8 are between the above assessment scales. The surveyed experts are required to compare and evaluate the standards in pairs, and an n-order matrix, i.e., direct relationship matrix A, can be obtained.

$$A = \begin{bmatrix} 0 & a_{12} & \cdots & a_{1n} \\ a_{21} & 0 & & a_{2n} \\ \vdots & & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 0 \end{bmatrix} \quad (1)$$

where n represents the number of criteria, a_{ij} represents the impact of criteria a_i on criteria a_j, and the diagonal element a_{ii} is set to 0, which indicates the impact of the indicator on itself.

Step 3: The normalized matrix M is obtained by normalizing the direct relationship matrix through the following Equations (2) and (3).

$$M = kA \quad (2)$$

$$k = \min\left(\frac{1}{max_{1\le i\le n}\sum_{j=1}^{n}|a_{ij}|}, \frac{1}{max_{1\le j\le n}\sum_{i=1}^{n}|a_{ij}|}\right) \quad (3)$$

Step 4: The comprehensive influence matrix t is calculated by Equation (4).

$$T = \left(t_{ij}\right)_{n\times n} = M + M^2 + M^3 + \ldots = \sum_{l=1}^{\infty} M^l = M(I-M)^{-1} \quad (4)$$

where t_{ij} reflects the comprehensive influence of a_i on a_j, and I is the unit matrix.

Step 5: Calculate the degree of influence, the degree of influence, the degree of centrality and the degree of cause through Equations (5)–(8).

Solve the influence degree of system factors. In the comprehensive influence matrix T, the sum of the factors in each row is the influence degree d_i, and the affected degree r_i is obtained by adding the factors in each column. d_i represents the direct and indirect influences of a_i on other factors; r_i represents the sum of the direct and indirect influences of the factor a_i by other factors, which is called the affected degree of a_i .

Solve the centrality and cause degree of each factor. $d + r$ is the centrality, which indicates the position of this element in the evaluation index system and its role. The higher the centrality, the higher the importance of this element in the whole system. $d - r$

is the cause degree. If $d + r > 0$, then this element is a cause type and has an impact on other indicators. It has great flexibility in adjustment. If $d + r < 0$, then this element is biased toward the affected element, which is the result element, and there is great room for improvement.

$$d_i = \sum_{j=1}^{n} t_{ij} \ (j = 1, 2, 3, \ldots, n) \tag{5}$$

$$r_i = \sum_{j=1}^{n} t_{ji} \ (j = 1, 2, 3, \ldots, n) \tag{6}$$

$$d_i + r_i = \sum_{j=1}^{n} t_{ij} + \sum_{j=1}^{n} t_{ji} \tag{7}$$

$$d_i - r_j = \sum_{j=1}^{n} t_{ij} - \sum_{j=1}^{n} t_{ji} \tag{8}$$

where $i, j = 1, 2, 3, \ldots, n$.

Step 6: Set a threshold value and construct the impact diagraph map.

All the data of ($d + r$, $d - r$) are drawn on one graph, $d + r$ indicates the degree of influence, and $d - r$ indicates the degree of cause. Here, an impact level threshold must also be set to ensure that the obtained diagram is more appropriate, so that the key information can be better displayed. When the influence level in the matrix T is higher than the threshold, it can be converted into a graph.

3.2. Construct the Network Diagram and Use ANP to Determine the Index Weight

Step 1: According to the causality diagram obtained by DEMATEL, the network structure of indicators is established.

Step 2: Establish the super matrix and check the consistency of the matrix.

$$W_{ij} = \begin{bmatrix} W_{i1}^{(j_1)} & W_{i1}^{(j_2)} & \cdots & W_{i1}^{(j_n)} \\ W_{i2}^{(j_1)} & W_{i2}^{(j_1)} & \cdots & W_{i2}^{(j_n)} \\ \vdots & & \ddots & \vdots \\ W_{in}^{(j_1)} & W_{in}^{(j_2)} & \cdots & W_{in}^{(j_n)} \end{bmatrix} \tag{9}$$

where the column vector of W_{ij} is the importance value of e_{jn} in e_{in} versus C_j. If the two are not related, then $W_{ij} = 0$.

- The eigenvalues and eigenvectors of the matrix are calculated.

The comparison matrix is normalized using the row vector average method introduced by Saaty [42], and the approximate weight W_i is calculated by the following calculation Equation (10).

$$W_i = \frac{\sum_{j=1}^{n} \left(\frac{b_{ij}}{\sum_{i=1}^{n} b_{ij}} \right)}{n} \ (\forall\, i, j = 1, 2, 3, \ldots, n) \tag{10}$$

Then the approximate value of the maximum eigenvalue λ_{max} is calculated using the following formula.

$$BW = \lambda W \lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(AW_i)}{W_i} \tag{11}$$

Lastly, check consistency: the consistency index ($C.I$) and consistency ratio ($C.R$) are checked by the following two formulas, so that the consistency of the pairwise comparison matrix can be estimated.

$$C.I = \frac{\lambda_{max} - n}{n - 1} \tag{12}$$

$$C.R = \frac{C.I}{R.I} \tag{13}$$

If the $C.R$ is less than 0.1, the consistency of the matrix is acceptable. $R.I$ is the average index for randomly generated weights. When the number of levels in the hierarchy is $n = 2, \ldots, 8$, $R.I = 0.00, 0.52, 0.89, 1.12, 1.26, 1.36, 1.41$.

Step 3: A weighted hypermatrix is constructed. The above-mentioned super matrix is constructed without considering the influence of other levels. Only considering the influence between levels can the accurate ranking be achieved. Therefore, it is necessary to construct a weighted super matrix, which is random and has limits.

Step 4: Limit the hypermatrix. The limit of the above weighted super matrix can better reflect the correlation between the index elements. If the value of $W_{ij} \lim_{k \to \infty} W^k$ is convergent and unique, it is the obtained weight value.

Step 5: The mixing weight is calculated by Equation (14).

When determining the weight of the criteria system, there may be a criterion whose weight is not high, but its relevance in the whole indicator system is high. Therefore, attaching importance to such criteria will enhance the ability of digital transformation. The influence relationship of each criterion is calculated by DEMATEL, and then, the weight of each criterion is calculated by ANP. Combining the two, the mixed weight of the evaluation index can be obtained through Equation (14). The mixed weight data can reflect the importance and influence of each standard in the system.

$$Z = W + T * W = (I + T)W \tag{14}$$

where Z is the mixing weight; W is the weight of the indicator; T is the comprehensive impact matrix of indicators; I is the identity matrix.

3.3. Fuzzy Comprehensive Evaluation

- Constructing fuzzy comprehensive evaluation matrix

Step 1: Determine the factor set: $A = (A_1, A_2, A_3, \ldots A_n)$, the comment set: the comment level is 1–5 levels, where 1 represents the worst and 5 represents the best.

Step 2: Determine the degree of membership:

$$D_{ij} = \frac{V_{ij}}{k} \tag{15}$$

where V_{ij} is the number of times of selecting item j for index i, and k is the number of samples.

Step 3: Construct the fuzzy evaluation matrix R_n according to the membership degree.

$$R_n = \begin{bmatrix} D_{11} & D_{12} & \cdots & D_{1j} \\ D_{21} & D_{22} & & D_{2j} \\ \vdots & & \ddots & \vdots \\ D_{i1} & D_{i2} & \cdots & D_{ij} \end{bmatrix} \tag{16}$$

- Fuzzy comprehensive evaluation of indicators

Step 1: Multiply the weight obtained by the previous formula with the fuzzy evaluation matrix to obtain the fuzzy comprehensive evaluation result.

$$E_i = W_E * R_E = (W_{B1}, W_{B2}, \ldots W_{Bi}) * \begin{bmatrix} D_{11} & D_{12} & \cdots & D_{1j} \\ D_{21} & D_{22} & & D_{2j} \\ \vdots & & \ddots & \vdots \\ D_{i1} & D_{i2} & \cdots & D_{ij} \end{bmatrix} \tag{17}$$

Step 2: Multiply the fuzzy comprehensive evaluation result with the assignment of the answer to obtain the final score of each indicator.

$$G = E_i * V \tag{18}$$

4. Empirical Results

4.1. Case Information

As an important driving mode of economic development, digital transformation has always been an important way for countries to move toward industry 4.0. In particular, Guangdong and other coastal areas, occupying economic, geographical and resource advantages, have been at the forefront of digital transformation. For a long time, the economy of Guangdong Province has been developing at a high speed and high quality in China, and the contribution of small- and medium-sized enterprises cannot be ignored. Small- and medium-sized manufacturing enterprises in Guangdong Province account for 95% of the total number of manufacturing enterprises. Therefore, small- and medium-sized enterprises are not only the main body of digital transformation, but are also the focus and difficulty of transformation. In China's 14th five year plan, the development goal of the digital economy is to enter a comprehensive expansion period by 2025 and a prosperous and mature period by 2035, so that small- and medium-sized manufacturing enterprises can realize digital transformation under the new requirements of national economic development. For traditional manufacturing enterprises, they try to start with the pursuit of digital equipment and gradually realize intelligent manufacturing. For emerging technology enterprises with inherent advantages, they will choose to carry out digital reform in organizational reform and talent skills training.

However, due to the differences with large enterprises in various aspects, these small- and medium-sized manufacturing enterprises have encountered great difficulties in the process of digital transformation. Under the pressure of the industry digital transformation environment, most enterprises do not have a clear digital transformation goal and do not know their own preparations, let alone the methods and steps of digital implementation. In addition, the enterprise has limited resources and poor ability to resist risks. It either does not dare to implement digitization at will or blindly reforms. Wrong decisions waste resources. In addition, digital transformation is a system engineering involving all aspects of enterprises. Enterprises cannot assess the importance of all aspects, nor can they decide how to invest limited resources in digital construction, nor can they balance the relationship between these standards. In this study, DEMATEL-ANP simplifies the complex relationship between these standards by providing a digital maturity structure and determines the importance of each standard. Then, the fuzzy comprehensive evaluation method is used to evaluate and compare the typical industries, and the relationship between the digital maturity indicators is deeply analyzed, which provides effective guidance for the digital transformation of small- and medium-sized manufacturing enterprises.

4.2. Analytical Results

4.2.1. Influence Relationship between Primary Indicators

Step1: The establishment dimension of this indicator is based on six dimensions proposed when evaluating the digital readiness of Italian SMEs, namely strategy, personnel, technology, process and integration [5]. We consulted 10 information department managers or digital transformation leaders of different types of small- and medium-sized manufacturing enterprises in Guangdong Province, 5 university digital research experts and 5 Industry Association experts; these experts have worked in relevant fields for more than 10 years. Thus, the evaluation of small- and medium-sized manufacturing enterprises is determined, and the dimension of digital innovation is added. Then, 18 criteria were obtained by extending 6 dimensions: digital strategy (A1), including digital leadership and digital roadmap; organization and people (A2) includes organizational adaptability, information management department, employee digital skills and employee digital cognition; information technology (A3) includes IT infrastructure, emerging technologies and information systems; enterprise process and management (A4) includes digital R&D, digital procurement, digital production, digital governance and digital marketing; integration (A5) includes vertical integration and horizontal integration; and enterprise innovation (A6) includes R&D investment and product innovation. Experts evaluate the importance of the standard by scoring. The direct impact matrix A is obtained as shown in Table 2.

Table 2. The initial direct relation matrix for aspects.

	A1	**A2**	**A3**	**A4**	**A5**	**A6**
A1	0	7	6.4	7	6	7
A2	4.8	0	6.2	5.4	4.2	6.4
A3	5.8	5.2	0	5.2	6.8	7.4
A4	5.4	5.2	5	0	5.4	5.6
A5	4.4	4.4	5.6	5.6	0	6.4
A6	6.2	4.8	6.4	5.6	6	0

Step 2: The normalization matrix M and the comprehensive influence matrix T can be calculated according to Equations (2)–(4). T is shown in Table 3.

Table 3. The total relation matrix T for aspects.

	A1	**A2**	**A3**	**A4**	**A5**	**A6**
A1	0.977	1.142	1.227	1.212	1.184	1.335
A2	0.944	0.809	1.048	1.007	0.977	1.133
A3	1.051	1.029	0.986	1.095	1.125	1.257
A4	0.944	0.933	1.009	0.857	0.990	1.101
A5	0.916	0.907	1.015	0.992	0.845	1.111
A6	1.027	0.989	1.110	1.069	1.073	1.036

Step 3: Establish a causal relationship diagram.

With reference to the suggestions of experts, the lower value in the comprehensive matrix T, that is, the value without significant correlation, is removed to simplify the relationship network between indicators. In this paper, the threshold value is set to 0.940, and all values lower than the threshold value are deleted to obtain the adjusted comprehensive impact matrix (shown in Table 4). Next, calculate the values of d, r, d + r and d − r according to Equations (5) to (8) (as shown in Table 5), and then draw the causality diagram (as shown in Figure 1) with d + r as the abscissa and d − r as the ordinate.

Table 4. Comprehensive impact matrix of adjusted evaluation indexes.

	A1	**A2**	**A3**	**A4**	**A5**	**A6**	**d**	**d + r**	**d − r**
A1	0.977	1.142	1.227	1.212	1.184	1.335	7.077	12.02	2.134
A2	0.944	0	1.048	1.007	0.977	1.133	5.109	8.269	1.949
A3	1.051	1.029	0.986	1.095	1.125	1.257	6.543	12.938	0.148
A4	0.944	0	1.009	0	0.99	1.101	4.044	9.419	−1.331
A5	0	0	1.015	0.992	0	1.111	3.118	8.467	−2.231
A6	1.027	0.989	1.11	1.069	1.073	1.036	6.304	13.277	−0.669
r	4.943	3.16	6.395	5.375	5.349	6.973			

Table 5. Weights of aspects and criteria.

Aspects	Weights	Criteria	Weights	Final Weights
A1	0.183	C1 C2	0.456 0.544	0.084 0.100
A2	0.160	C3 C4 C5 C6	0.251 0.247 0.252 0.249	0.040 0.039 0.040 0.040
A3	0.171	C7 C8 C9	0.320 0.337 0.343	0.055 0.058 0.059
A4	0.164	C10 C11 C12 C13 C14	0.202 0.173 0.193 0.226 0.206	0.033 0.028 0.032 0.037 0.034
A5	0.157	C15 C16	0.499 0.501	0.078 0.079
A6	0.165	C17 C18	0.505 0.495	0.083 0.082

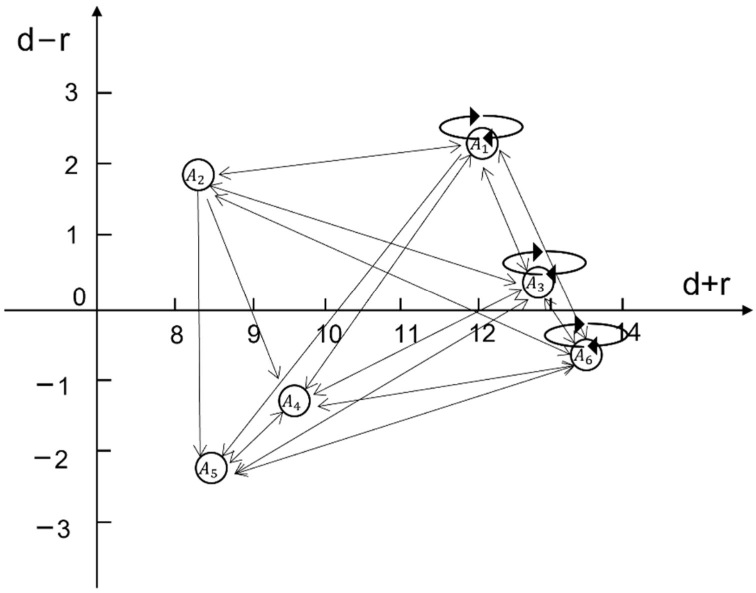

Figure 1. Causality of aspects of digital transformation.

It can be seen from the Figure 1 that the d − r value of the three indicators of digital strategy (A1), digital organization and people (A2) and information technology (A3) is greater than 0, which is the cause indicator. The d − r value of the three indicators of digital process and management (A4), integration (A5) and enterprise innovation (A6) is less than 0, which is the result indicator. This indicates that A1, A2 and A3 indicators will affect A4, A5 and A6 indicators. A1, A2 and A3 are the driving indicators of enterprise digital transformation, and A4, A5 and A6 are the effect indicators of enterprise digital transformation and also the most vulnerable key factors. d + r value indicates the importance of indicators in the digital transformation system. Therefore, among the six indicators, A6, A3 and A1 are more important. Among them, A1 and A3 will also affect other indicators, and they are the indicators that need to be focused on in the digital transformation process. In addition, A1, A3, A6 also have internal dependence.

4.2.2. Calculate the Weight of Indicators at All Levels Based on ANP

On the basis of the causality diagram obtained by DEMATEL, this paper uses SD (super decisions) to build the network structure diagram and to calculate the weights of criteria at all levels. The specific calculation steps are as follows:

Step 1: Build ANP network structure chart, as shown in Figure 2.

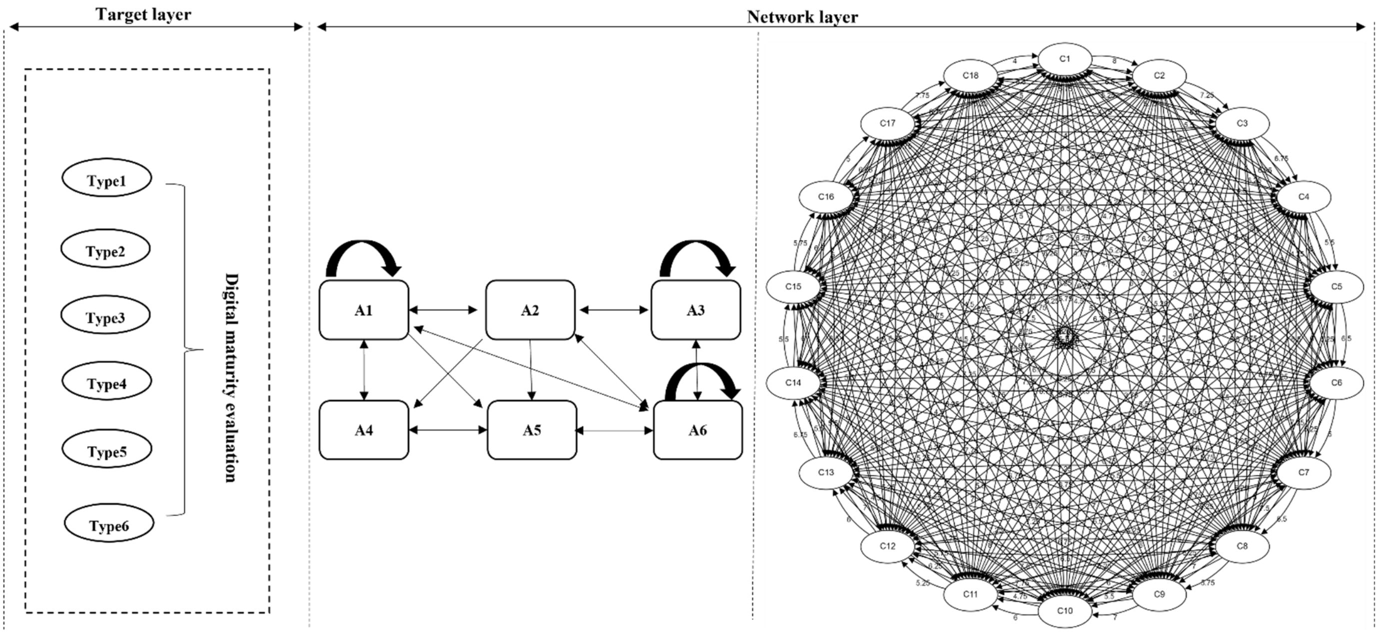

Figure 2. ANP network structure diagram for digital maturity evaluation.

The ANP structure is established by setting the target layer and the network layer, wherein the indexes in the network layer have mutual relations; the target layer is used to conduct digital evaluation on six types of small- and medium-sized manufacturing enterprises, including electronic information, intelligent manufacturing, electrical machinery, textile and clothing, food, chemicals and plastics. The network structure diagram constructed by using SD is shown in Figure 3.

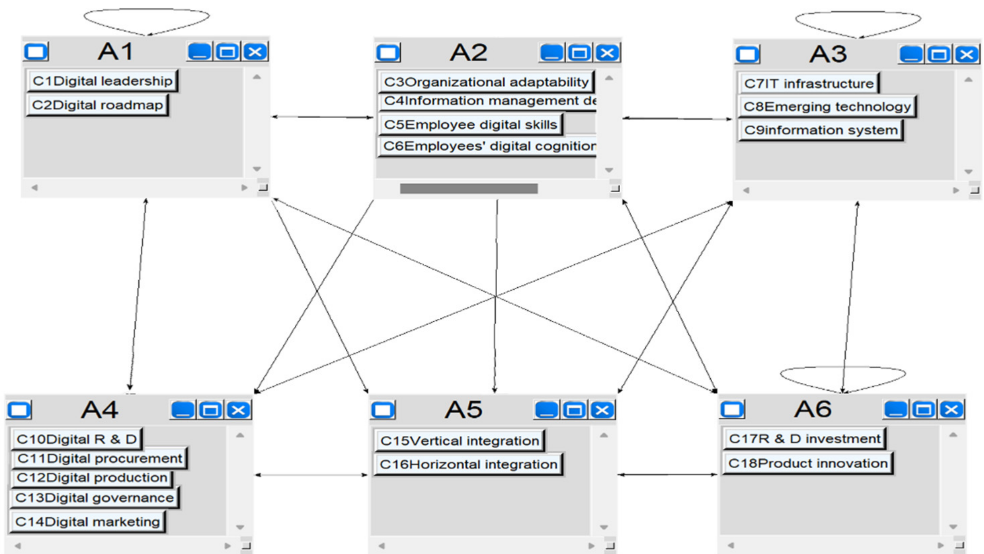

Figure 3. Network diagram of criteria in SD.

Step 2: Establish a judgment matrix. This paper involves 6 first-class indicators and 18 second-class indicators. Due to the large number of pairwise judgment matrices among the indicators, the amount of calculation is large. In order to reduce the repeated workload of experts, this paper uses the total relation matrix for transformation. Among them, the total relation matrix of criteria is calculated by Equation (4) from the normalized matrix, as shown in Appendix A, Table A2. The normalized matrix is obtained by calculating the direct influence matrix through Equations (2) and (3), as shown in Appendix A, Table A1. After removing the value of the comprehensive influence matrix less than the threshold, the initial judgment matrix is obtained, and the consistency within the matrix is checked.

The maximum eigenvalue is obtained by the calculation of Equations (10)–(13). $\lambda_{max} = 6.2421,\ n = 6, R.I = 1.26,$ and $C.R = 0.038.$ If $C.R < 0.1$, the degree of consistency is acceptable.

Step 3: Based on the judgment matrix, use SD (super decisions) software to establish the weighted super matrix (as shown in Appendix A, Table A3) and construct the limit super matrix (as shown in Appendix A, Table A4). Then, the preliminary weights of each index can be calculated, as shown in Table 5 below.

Step 4: Calculate the mixing weight according to Equation (14).

$$Z = (2.176, 1.858, 2.089, 1.683, 1.519, 2.051)$$

The mixing weight is obtained. $A_1 = 2.176, A_2 = 1.858, A_3 = 2.089, A_4 = 1.683,$ $A_5 = 1.519$, $A_6 = 2.051$, from large to small: $A_1 > A_3 > A_6 > A_2 > A_4 > A_5$. In terms of importance, it is preliminarily judged that the result is similar to the importance result of DEMATEL and the result of ANP calculation. Digital strategy (A1), information technology (A3) and enterprise innovation (A6) are of great importance.

4.2.3. Digital Maturity Evaluation of Small- and Medium-Sized Manufacturing Enterprises

According to the development plan of Guangdong Hong Kong Macao Bay area and the "ten strategic pillar industries" and "ten strategic emerging industries" proposed in the "14th five year plan" for the high-quality development of Guangdong's manufacturing industry, this paper selects six typical industries, including electronic information, electromechanical equipment, textile and clothing, food, intelligent manufacturing and textile and clothing, and takes chemical industry and plastics as the object. According to 18 criteria, 35 questions were designed to complete the survey. The answers are mainly designed by the Likert scale with a score of 1–5. The interviewees are the heads of enterprise information departments or technical management personnel. Changsha Ranxing Information Technology Co., Ltd. (Changsha, China) was entrusted to conduct this survey using its online survey platform, Questionnaire Star. Through the data collection platform established by the company, 233 questionnaires were distributed to small- and medium-sized manufacturing enterprises in Guangdong Province. After collecting the questionnaires, 106 valid questionnaires were obtained through screening, excluding incomplete questionnaires and possibly randomly filled questionnaires. The following results are obtained through the fuzzy comprehensive evaluation calculation of Equations (15)–(18). See Table 6 for the evaluation scores of various small- and medium-sized manufacturing enterprises.

Table 6. Evaluation value of digital transformation maturity of various manufacturing enterprises.

Industry	Electronic Information	Intelligent Manufacturing	Electrical Machinery	Textile and Clothing	Food	Chemicals and Plastics
Evaluation score	3.652	3.678	3.609	3.599	3.641	3.567

The evaluation results of various dimensions and standards of various types of small- and medium-sized manufacturing enterprises are shown in Figures 4 and 5. It can be seen from the results that in the digital maturity evaluation, intelligent manufacturing equipment scored the highest, 3.678 points; the second is electronic information, 3.652 points; the chemical and plastic categories scored the lowest, 3.567 points; and the digital maturity of electrical machinery, food, textiles and clothing is at an average level. From the specific dimension of digital maturity, digital strategy (A1) scores high, information technology (A3) scores relatively low, and integration (A5) and enterprise innovation (A6) scores are scattered. Specifically, all types of enterprises' digital strategy (A1) scores are very high, but the scores of digital the roadmap (C2) vary greatly. In terms of scores (A2) of digital organizations and people, intelligent manufacturing enterprises perform better, and their scores in the information sector (C4) and employee digital skills (C5) are both high, at 3.879. The score of information technology (A3) index is basically low. Among them, chemical and plastic enterprises scored the lowest, especially the score of emerging technology application (C8), which was only 2.975. Among the scores of digital management and process (A4), chemical and plastic enterprises scored 3.471 at the lowest and 3.716 at the highest; this is mainly due to the low scores of digital production (C12), digital management (C13) and digital marketing (C14). Chemical and plastic enterprises scored the lowest in the integration (A5) index, and their vertical integration (C15) and horizontal integration (C16) scores were relatively poor. The enterprises with high scores in enterprise innovation (A6) are electronic information, textile clothing and food, especially in product innovation (C18).

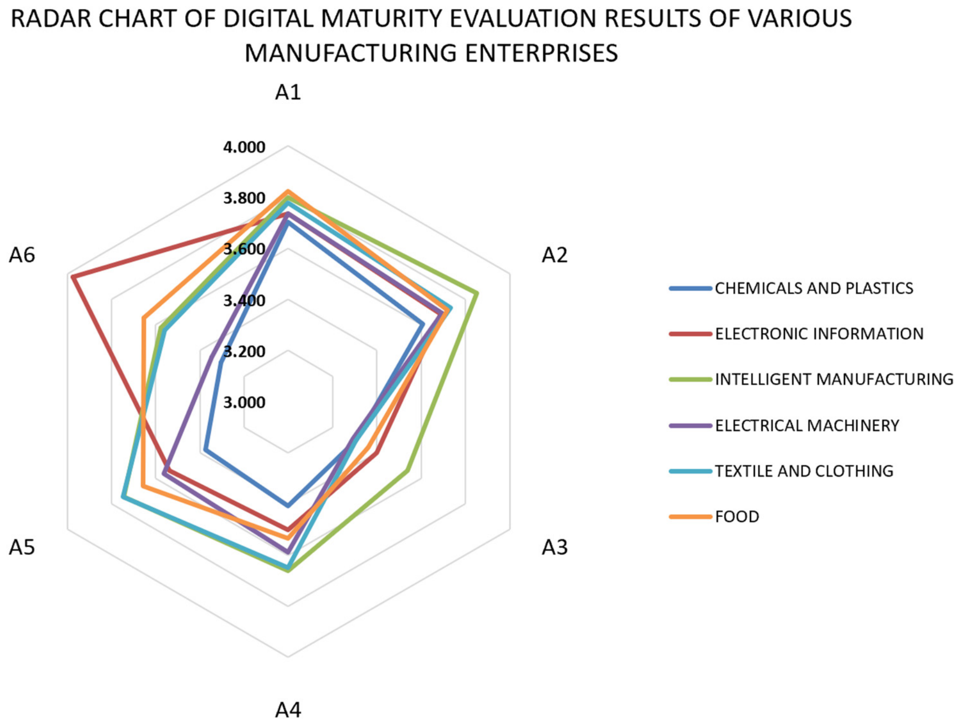

Figure 4. Radar chart of digital maturity evaluation results of various enterprises.

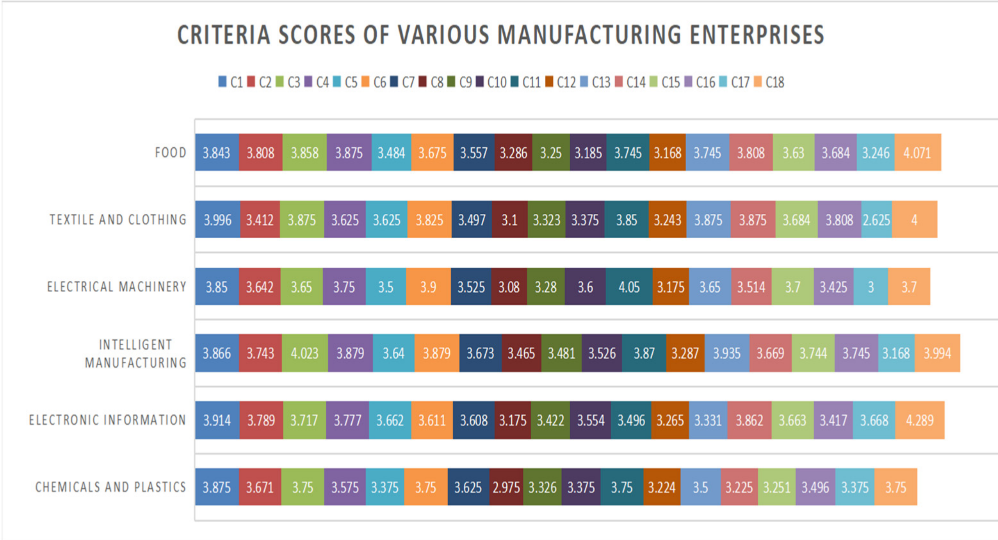

Figure 5. Evaluation value of digital transformation maturity of criteria.

5. Discussion

Previous studies have attempted to assess the digital maturity of enterprises from different dimensions. Mittal et al. [24] evaluated the industrial 4.0 maturity of SMEs from the dimensions of finance, personnel, strategy, process and product. Schumacher et al. [26] evaluated the digital maturity of manufacturing enterprises from the dimensions of strategy and organization, intelligent factories, intelligent products, data driven services, intelligent operations and employees. It is common for small- and medium-sized manufacturing enterprises to evaluate their digital level from such dimensions as strategy, personnel, technology, process and integration [5]. However, few studies evaluate the digital transformation of small- and medium-sized manufacturing enterprises, and less discuss the interaction between evaluation dimensions, but this will affect the weight of each evaluation index, and then affect the evaluation results. In order to reflect the current situation of digital transformation of small- and medium-sized manufacturing enterprises, this study solved this research gap and provided guidance for small- and medium-sized enterprises to accelerate digital transformation. The evaluation dimensions and criteria of this study add a dimension to the existing scholars' research on different countries and industries. This dimension is the digital innovation criterion highlighted in the planning outline of Guangdong Hong Kong Macao Greater Bay Area. Innovation can measure the effect of enterprises using technology to change their current situation. The research results show that digital strategy (A1) and information technology (A3) are the driving factors of small- and medium-sized manufacturing enterprises' digital transformation, digital organization and people (A2) is the supporting factor, integration (A5) is the independent factor, and digital process and management (A4) and enterprise innovation (A6) are the core factors of digital transformation. The specific analysis is as follows:

First, the weight of the digital strategy (A1) is 0.183, and the comprehensive weight of the digital roadmap (C2) is 0.100, both of which are the highest values of the same level indicators. This shows that digital strategy has a very significant impact on the overall digital transformation of enterprises and other evaluation indicators. Figure 4 shows that all types of enterprises attach great importance to digital strategy, and the difference is caused by the digital roadmap. Digital strategy will affect all other aspects of enterprise change, especially enterprise innovation (A6) and information technology (A3). The criteria value of intelligent manufacturing, electronic information and food enterprises is relatively superior to that of other industries, indicating that these types of enterprises have good digital leadership, and have a clear digital roadmap and implementation plan to guide the digital transformation of enterprises.

Second, the weight of information technology (A3) is 0.171, second only to digital strategic indicator (A1). This shows that information technology has a great impact on the overall digital transformation of enterprises and other aspects. For example, information technology has a significant impact on enterprise innovation (A6), and the degree of impact is different in different types of enterprises. Figure 4 shows that the evaluation index of information technology of intelligent manufacturing enterprises is the best, followed by electronic information enterprises. Chemical and plastic enterprises, electrical machinery enterprises and textile and clothing enterprises are relatively poor. Because the industry of intelligent manufacturing enterprises and electronic information enterprises has its own digital "gene", the progressiveness and intelligence of the product technology produced by enterprises require a high level of digitalization in product R&D, production and management. Most chemical and plastic manufacturing enterprises have more than 10 years of experience. Their production mode is more traditional, their production equipment is highly specialized, and their value is relatively high. Therefore, there are great risks and uncertainties in implementing digital transformation.

Third, the weight of enterprise innovation (A6) is 0.165, and the weight of digital process and management (A4) is 0.164. These two indicators are the core issues of the digital transformation of small- and medium-sized manufacturing enterprises. It can be seen from Figure 4 that the index value of intelligent manufacturing enterprises and electronic information enterprises is optimal. This is the driving result of information technology (A3), which provides the basis and conditions for enterprise digital innovation; furthermore, intelligent manufacturing enterprises and electronic information enterprises attach great importance to R&D business, and their R&D expenditure is much higher than that of other enterprises. In addition, it can be seen from Figure 4 that the enterprise innovation index of food and clothing enterprises performs well. The main reason is that product innovation (C18) scores higher, as well as the promotion of digital strategy (A1) and information technology (A3). These types of enterprises are currently focusing on using emerging technologies to develop e-commerce, such as short video, live broadcast and other emerging models, to narrow the distance between enterprises and consumers, better understand consumer needs, predict development trends, and develop new products to meet consumer personalized needs.

Finally, as an auxiliary factor in the process of digital transformation, the organization and people (A2) of the enterprise have low weight. This shows that the organization and personnel of the enterprise have little influence on the digital transformation of the enterprise, but it will affect other evaluation indicators of digital transformation maturity. As shown in Figure 4, the enterprise organization and people indicator of intelligent manufacturing enterprises perform best, which also shows that such enterprises have strong technical teams and organizational adaptability, which can better improve the possibility of implementing digitalization.

From the evaluation results of digital transformation of 106 small- and medium-sized manufacturing enterprises in Guangdong Province, it can be seen that the overall digital level of enterprises is at a medium level. The enterprise has problems such as insufficient application of information technology, insufficient digital integration, and insufficient digital innovation capability. However, these problems are mainly result factors. It is necessary to improve the digital implementation path, staff skills, IT technology and other driving factors, promote the digitalization of enterprise management and production processes, information sharing between enterprises and suppliers or customers, and enterprise product innovation, and finally accelerate the process of enterprise digital transformation.

6. Conclusions

This paper establishes the DEMATEL-ANP model to evaluate the digital transformation maturity of small- and medium-sized manufacturing enterprises. First, the DEMATEL method is used to clarify the complex causal relationship between aspects, then the ANP method is used to determine the weight of indicators at all levels, and then the composite weight is obtained by combining the two methods. Finally, the fuzzy comprehensive evaluation method is used to evaluate the digital transformation of small- and medium-sized enterprises in Guangdong Province. The main contributions of this study are as follows.

First, this study brings digital innovation into the measurement dimension of the digital transformation maturity of small- and medium-sized manufacturing enterprises and constructs a new and more applicable digital transformation maturity evaluation index system and evaluation model. Compared with the previous evaluation indicators, this indicator system can be better applied to small- and medium-sized manufacturing enterprises in Guangdong Province, because it focuses on the digital innovation capability of enterprises, and the research results also show that digital innovation is the core problem that enterprises need to solve.

Second, the DEMATEL-ANP method proposed in this paper is applied to the digital research of small- and medium-sized manufacturing enterprises, which is an exploration of the maturity evaluation method of small- and medium-sized enterprises' digital transformation. This clarifies the complex relationship of various evaluation indicators in the digital transformation system of small- and medium-sized manufacturing enterprises, finds out the cause indicators and result indicators, calculates the mixed weight, and completes the evaluation of the digital maturity of small- and medium-sized manufacturing enterprises. The research results show that digital strategy and information technology are in a key position in the process of digital transformation, among which digital roadmap, application of emerging technologies and improvement of information systems are the priorities of enterprises. This provides theoretical support for enterprises to implement digital transformation, complements the research theory of digital transformation to a certain extent, and enriches the research perspective of enterprise digital transformation.

Third, this study provides some reference for the digital transformation of small- and medium-sized manufacturing enterprises in Guangdong Province. In recent years, the overall planning of the Guangdong Hong Kong Macao Bay Area requires the development of high-end intelligent manufacturing and advanced manufacturing, which requires enterprises to have a sound digital foundation to support. The main problems existing in the digital transformation of small- and medium-sized manufacturing enterprises in Guangdong Province are insufficient digital innovation and inadequate digital processes and management, which need to be driven by the continuous improvement of the importance of digital strategy and the use of information technology. First, the enterprise needs to plan a clear digital transformation roadmap, which determines the purpose, direction and stage of the enterprise's implementation of digital transformation, but it needs to consider the policy environment, industry attributes, enterprise characteristics, digital foundation, enterprise planning and other factors. Second, enterprises try to use emerging technologies to improve information systems. For small- and medium-sized manufacturing enterprises with limited resources, in the process of digital transformation, they can give priority to using emerging technologies to promote the implementation of digital production, which is the center of their business activities. This activity, to a certain extent, determines the transformation of digital procurement, digital marketing, digital management and other processes, and also puts forward certain requirements for employees' digital skills. Therefore, it can drive the whole enterprise to realize digital transformation, thus promoting sustainable development of the enterprise.

This study is based on the selection criteria in the existing research literature. Although considering the similarity between the background and the assessment object, it may not be comprehensive. Guangdong Province is the regional scope of this study. Only six types of small- and medium-sized manufacturing enterprises are selected, and the results may not be universal. Therefore, the next research plan can compare the digital level of different types of manufacturing industries in different regions, provinces or countries. In addition, the evaluation of the importance of the standard is completed by experts, depending on their knowledge and experience, and the results are relatively subjective. In order to overcome this problem, we can consider analyzing the quantitative data of the company in the future to avoid the subjectivity of the evaluation.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. The normalization matrix of criteria.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18
C1	0.000	0.068	0.051	0.053	0.043	0.061	0.057	0.053	0.058	0.057	0.050	0.054	0.058	0.052	0.058	0.058	0.060	0.052
C2	0.061	0.000	0.062	0.064	0.054	0.059	0.059	0.061	0.061	0.059	0.057	0.060	0.061	0.059	0.055	0.055	0.060	0.051
C3	0.053	0.052	0.000	0.057	0.054	0.046	0.045	0.055	0.054	0.053	0.049	0.051	0.054	0.052	0.045	0.038	0.037	0.040
C4	0.051	0.057	0.051	0.000	0.049	0.047	0.049	0.052	0.053	0.046	0.046	0.049	0.053	0.045	0.050	0.050	0.034	0.040
C5	0.043	0.049	0.059	0.044	0.000	0.059	0.044	0.057	0.046	0.053	0.049	0.053	0.052	0.052	0.050	0.044	0.043	0.047
C6	0.052	0.061	0.054	0.044	0.058	0.000	0.044	0.051	0.044	0.045	0.044	0.047	0.051	0.049	0.050	0.042	0.044	0.050
C7	0.043	0.049	0.051	0.054	0.051	0.046	0.000	0.058	0.057	0.057	0.053	0.055	0.057	0.052	0.058	0.057	0.051	0.053
C8	0.050	0.051	0.055	0.057	0.055	0.054	0.065	0.000	0.053	0.060	0.053	0.055	0.060	0.054	0.057	0.060	0.054	0.057
C9	0.054	0.049	0.062	0.051	0.057	0.050	0.062	0.061	0.000	0.060	0.059	0.061	0.064	0.055	0.062	0.059	0.051	0.051
C10	0.052	0.053	0.060	0.051	0.057	0.054	0.055	0.060	0.054	0.000	0.050	0.053	0.051	0.049	0.050	0.047	0.065	0.064
C11	0.043	0.045	0.049	0.039	0.053	0.051	0.044	0.047	0.057	0.045	0.000	0.050	0.047	0.043	0.044	0.050	0.037	0.042
C12	0.045	0.055	0.057	0.052	0.059	0.055	0.057	0.054	0.061	0.047	0.053	0.000	0.052	0.046	0.047	0.047	0.039	0.051
C13	0.051	0.059	0.058	0.054	0.059	0.057	0.058	0.057	0.060	0.057	0.054	0.057	0.000	0.053	0.057	0.052	0.043	0.052
C14	0.044	0.054	0.050	0.045	0.055	0.053	0.050	0.051	0.052	0.043	0.046	0.049	0.050	0.000	0.047	0.050	0.043	0.053
C15	0.052	0.054	0.054	0.055	0.054	0.054	0.059	0.059	0.059	0.054	0.046	0.051	0.058	0.049	0.000	0.052	0.046	0.053
C16	0.050	0.057	0.052	0.052	0.054	0.052	0.054	0.059	0.053	0.054	0.053	0.057	0.055	0.055	0.054	0.000	0.049	0.054
C17	0.047	0.052	0.047	0.042	0.049	0.047	0.047	0.050	0.047	0.060	0.050	0.051	0.051	0.050	0.050	0.054	0.000	0.067
C18	0.045	0.057	0.049	0.040	0.049	0.046	0.050	0.052	0.046	0.054	0.047	0.057	0.052	0.050	0.042	0.051	0.057	0.000

Table A2. The total relation matrix of criteria.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18
C1	0.397	0.499	0.485	0.457	0.472	0.481	0.479	0.494	0.488	0.482	0.455	0.482	0.493	0.460	0.470	0.465	0.443	0.465
C2	0.477	0.459	0.519	0.488	0.506	0.502	0.505	0.525	0.515	0.508	0.484	0.511	0.520	0.489	0.490	0.485	0.464	0.487
C3	0.405	0.437	0.389	0.416	0.436	0.422	0.423	0.448	0.438	0.433	0.410	0.433	0.442	0.415	0.413	0.403	0.380	0.409
C4	0.397	0.435	0.431	0.357	0.424	0.417	0.420	0.438	0.431	0.420	0.402	0.424	0.435	0.403	0.412	0.407	0.371	0.403
C5	0.397	0.436	0.447	0.406	0.386	0.435	0.423	0.451	0.433	0.434	0.411	0.436	0.442	0.417	0.419	0.409	0.387	0.417
C6	0.401	0.442	0.437	0.401	0.435	0.374	0.418	0.440	0.425	0.422	0.402	0.426	0.435	0.409	0.414	0.402	0.383	0.414
C7	0.421	0.462	0.465	0.440	0.460	0.448	0.407	0.478	0.468	0.463	0.440	0.464	0.472	0.442	0.451	0.446	0.417	0.447
C8	0.447	0.486	0.491	0.462	0.486	0.477	0.489	0.446	0.487	0.488	0.461	0.486	0.497	0.464	0.471	0.469	0.440	0.471
C9	0.458	0.492	0.506	0.464	0.495	0.481	0.495	0.512	0.444	0.495	0.473	0.499	0.508	0.473	0.484	0.476	0.444	0.474
C10	0.438	0.476	0.484	0.446	0.475	0.466	0.469	0.491	0.476	0.420	0.446	0.472	0.477	0.448	0.453	0.447	0.439	0.467
C11	0.374	0.408	0.412	0.379	0.412	0.403	0.399	0.417	0.417	0.402	0.342	0.409	0.413	0.385	0.390	0.391	0.359	0.388
C12	0.414	0.459	0.461	0.429	0.458	0.448	0.451	0.466	0.463	0.446	0.432	0.402	0.459	0.428	0.433	0.429	0.398	0.436
C13	0.443	0.487	0.488	0.455	0.483	0.473	0.477	0.493	0.487	0.479	0.456	0.481	0.434	0.458	0.465	0.456	0.424	0.461
C14	0.395	0.438	0.435	0.404	0.436	0.427	0.426	0.442	0.435	0.422	0.407	0.429	0.437	0.365	0.414	0.412	0.384	0.419
C15	0.434	0.472	0.474	0.446	0.468	0.461	0.468	0.485	0.475	0.466	0.439	0.465	0.478	0.443	0.402	0.446	0.418	0.452
C16	0.433	0.476	0.473	0.444	0.470	0.460	0.465	0.486	0.472	0.467	0.446	0.472	0.478	0.451	0.454	0.398	0.421	0.455
C17	0.409	0.448	0.445	0.412	0.441	0.433	0.435	0.453	0.442	0.449	0.421	0.443	0.449	0.423	0.427	0.427	0.354	0.444
C18	0.400	0.444	0.438	0.404	0.433	0.424	0.430	0.447	0.434	0.436	0.411	0.440	0.443	0.416	0.413	0.417	0.400	0.373

Table A3. The weighted super matrix of criteria.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18
C1	0.076	0.087	0.091	0.091	0.091	0.092	0.091	0.090	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.020
C2	0.092	0.081	0.098	0.098	0.098	0.096	0.096	0.096	0.096	0.096	0.097	0.096	0.096	0.097	0.095	0.095	0.095	0.166
C3	0.041	0.041	0.033	0.038	0.038	0.037	0.041	0.041	0.042	0.041	0.041	0.041	0.041	0.041	0.040	0.040	0.040	0.040
C4	0.041	0.041	0.037	0.033	0.037	0.037	0.041	0.040	0.041	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
C5	0.041	0.041	0.038	0.037	0.033	0.038	0.041	0.042	0.041	0.041	0.041	0.041	0.041	0.041	0.040	0.040	0.041	0.041
C6	0.041	0.041	0.037	0.037	0.038	0.033	0.041	0.040	0.040	0.040	0.040	0.040	0.040	0.041	0.040	0.040	0.041	0.041
C7	0.055	0.056	0.055	0.055	0.055	0.055	0.046	0.052	0.052	0.055	0.055	0.055	0.055	0.055	0.057	0.057	0.056	0.056
C8	0.058	0.059	0.058	0.058	0.058	0.059	0.055	0.048	0.054	0.058	0.058	0.058	0.058	0.058	0.059	0.060	0.059	0.059
C9	0.060	0.059	0.060	0.059	0.059	0.059	0.055	0.055	0.049	0.059	0.059	0.059	0.059	0.059	0.061	0.060	0.059	0.059
C10	0.017	0.035	0.036	0.035	0.035	0.035	0.035	0.035	0.035	0.029	0.032	0.032	0.032	0.032	0.035	0.035	0.036	0.036
C11	0.015	0.030	0.030	0.030	0.031	0.031	0.030	0.030	0.030	0.028	0.025	0.028	0.028	0.028	0.030	0.031	0.030	0.030
C12	0.016	0.034	0.034	0.034	0.034	0.034	0.034	0.033	0.034	0.031	0.031	0.027	0.031	0.031	0.034	0.034	0.033	0.033
C13	0.060	0.036	0.036	0.036	0.036	0.036	0.036	0.035	0.035	0.033	0.033	0.033	0.029	0.033	0.036	0.036	0.035	0.035
C14	0.060	0.033	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.029	0.029	0.029	0.029	0.026	0.032	0.032	0.032	0.032
C15	0.080	0.079	0.079	0.079	0.079	0.079	0.081	0.080	0.081	0.080	0.080	0.080	0.080	0.080	0.067	0.076	0.079	0.080
C16	0.080	0.080	0.079	0.079	0.079	0.079	0.080	0.081	0.080	0.081	0.081	0.081	0.080	0.081	0.076	0.068	0.080	0.080
C17	0.085	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.085	0.085	0.085	0.084	0.084	0.084	0.085	0.085	0.072	0.083
C18	0.083	0.084	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.082	0.083	0.083	0.083	0.083	0.082	0.083	0.081	0.070

Table A4. The limit super matrix of criteria.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18
C1	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084
C2	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
C3	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
C4	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
C5	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
C6	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
C7	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
C8	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
C9	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
C10	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033
C11	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
C12	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
C13	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
C14	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
C15	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078
C16	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079
C17	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
C18	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082

References

1. Jeansson, J.; Bredmar, K. Digital transformation of SMEs: Capturing complexity. In Proceedings of the 32nd Bled eConference: Humanizing Technology for a Sustainable Society, Bled, Slovenia, 16–19 June 2019; University of Maribor Press: Maribor, Slovenia, 2019; pp. 523–541.
2. Gimpel, H.; Hosseini, S.; Huber, R.; Probst, L.; Röglinger, M.; Faisst, U. Structuring digital transformation: A framework of action fields and its application at ZEISS. *J. Inf. Technol. Theory Appl. (JITTA)* **2018**, *19*, 3.
3. Li, L.; Su, F.; Zhang, W.; Mao, J.Y. Digital transformation by SME entrepreneurs: A capability perspective. *Inf. Syst. J.* **2017**, *28*, 1129–1157. [CrossRef]
4. Nwankpa, J.K.; Datta, P. Balancing exploration and exploitation of IT resources: The influence of Digital Business Intensity on perceived organizational performance. *Eur. J. Inf. Syst.* **2017**, *26*, 469–488. [CrossRef]
5. Pirola, F.; Cimini, C.; Pinto, R. Digital readiness assessment of Italian SMEs: A case-study research. *J. Manuf. Technol. Manag.* **2019**, *31*, 1045–1083. [CrossRef]
6. Caputo, F.; Fiano, F.; Riso, T.; Romano, M.; Maalaoui, A. Digital platforms and international performance of Italian SEMs: An exploitation-based overview. *Int. Mark. Rev.* **2022**, *39*, 568–585. [CrossRef]
7. Kljajić Borštnar, M.; Pucihar, A. Multi-attribute assessment of digital maturity of SMEs. *Electronics* **2021**, *10*, 885. [CrossRef]
8. Brodny, J.; Tutak, M. Assessing the level of digital maturity of enterprises in the Central and Eastern European countries using the MCDM and Shannon's entropy methods. *PLoS ONE* **2021**, *16*, e0253965.
9. Ünal, C.; Sungur, C.; Yildirim, H. Application of the Maturity Model in Industrial Corporations. *Sustainability* **2022**, *14*, 9478. [CrossRef]
10. Warner, K.S.R.; Wäger, M. Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Plan.* **2019**, *52*, 326–349. [CrossRef]
11. De Araujo, L.M.; Priadana, S.; Paramarta, V.; Sunarsi, D. Digital leadership in business organizations. *Int. J. Educ. Adm. Manag. Leadersh.* **2021**, *2*, 45–56. [CrossRef]
12. Junge, A.L. Digital transformation technologies as an enabler for sustainable logistics and supply chain processes—An exploratory framework. *Braz. J. Oper. Prod. Manag.* **2019**, *16*, 462–472. [CrossRef]
13. Tabrizi, B.; Lam, E.; Girard, K.; Irvin, V. Digital transformation is not about technology. *Harv. Bus. Rev.* **2019**, *13*, 1–6.
14. Hajoary, P.K.; Akhilesh, K.B. Conceptual framework to assess the maturity and readiness towards Industry 4.0. In *Industry 4.0 and Advanced Manufacturing*; Springer: Singapore, 2021; pp. 13–23.
15. Westerman, G.; Bonnet, D.; McAfee, A. The nine elements of digital transformation. *MIT Sloan Manag. Rev.* **2014**, *55*, 1–6.
16. Scuotto, V.; Arrigo, E.; Candelo, E.; Nicotra, M. Ambidextrous innovation orientation effected by the digital transformation: A quantitative research on fashion SMEs. *Bus. Process Manag. J.* **2020**, *26*, 1121–1140. [CrossRef]
17. Kitsios, F.; Kamariotou, M. Artificial intelligence and business strategy towards digital transformation: A research agenda. *Sustainability* **2021**, *13*, 2025. [CrossRef]
18. Martínez-Caro, E.; Cegarra-Navarro, J.G.; Alfonso-Ruiz, F.J. Digital technologies and firm performance: The role of digital organizational culture. *Technol. Forecast. Soc. Chang.* **2020**, *154*, 119962. [CrossRef]
19. Jackson, N.C.; Dunn-Jensen, L.M. Leadership succession planning for today's digital transformation economy: Key factors to build for competency and innovation. *Bus. Horiz.* **2021**, *64*, 273–284. [CrossRef]

20. Valdez-de-Leon, O. A digital maturity model for telecommunications service providers. *Technol. Innov. Manag. Rev.* **2016**, *6*, 19–32. [CrossRef]
21. Chanias, S.; Hess, T. How digital are we? Maturity models for the assessment of a company's status in the digital transformation. *Manag. Rep./Inst. Wirtsch. Neue Medien.* **2016**, *2*, 1–14.
22. Carolis, A.D.; Macchi, M.; Negri, E.; Terzi, S. A maturity model for assessing the digital readiness of manufacturing companies. In *IFIP International Conference on Advances in Production Management Systems*; Springer: Cham, Switzerland, 2017; pp. 13–20.
23. Berghaus, S.; Back, A. Stages in Digital Business Transformation: Results of an Empirical Maturity Study. In Proceedings of the MCIS, Paphos, Cyprus, 6 September 2016; p. 22. Available online: https://aisel.aisnet.org/mcis2016/22/?utm_source=aisel.aisnet.org%2Fmcis2016%2F22&utm_medium=PDF&utm_campaign=PDFCoverPages (accessed on 29 August 2022).
24. Mittal, S.; Khan, M.A.; Romero, D.; Wuest, T. A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and mediumsized enterprises (SMEs). *J. Manuf. Syst.* **2018**, *49*, 194–214.
25. Andreas, S.; Selim, E.; Wilfried, S. A Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises. *Procedia Cirp* **2018**, *52*, 161–166.
26. Schumacher, A.; Nemeth, T.; Sihn, W. Roadmapping towards industrial digitalization based on an Industry 4.0 maturity model for manufacturing enterprises. *Procedia Cirp* **2019**, *79*, 409–414. [CrossRef]
27. Kıyıklık, A.; Kuşakcı, A.O.; Mbowe, B. A digital transformation maturity model for the airline industry with a self-assessment tool. *Decis. Anal. J.* **2022**, *26*, 100055. [CrossRef]
28. Vial, G. Understanding digital transformation: A review and a research agenda. *Manag. Digit. Transform.* **2021**, *26*, 13–66. [CrossRef]
29. Gökalp, E.; Martinez, V. Digital transformation capability maturity model enabling the assessment of industrial manufacturers. *Comput. Ind.* **2021**, *132*, 103–120. [CrossRef]
30. North, K.; Varvakis, G. Competitive strategies for small and medium enterprises. In *Increasing Crisis Resilience, Agility and Innovation in Turbulent Times*; Springer: Cham, Switzerland, 2016.
31. Cha, K.J.; Hwang, T.; Gregor, S. An integrative model of IT-enabled organizational transformation: A multiple case study. *Manag. Decis.* **2015**, *53*, 1755–1770. [CrossRef]
32. Alcácer, J.; Cantwell, J.; Piscitello, L. Internationalization in the information age: A new era for places, firms, and international business networks? *J. Int. Bus. Stud.* **2016**, *47*, 499–512. [CrossRef]
33. Lim, J.; Lee, B.; Won, D. R&D Transitions in Response to Digital Transformation in Korea. *J. Inf. Sci. Theory Pract.* **2022**, *10*, 96–111.
34. Mikalef, P.; Framnes, V.A.; Danielsen, F.; Krogstie, J.; Olsen, D. Big data analytics capability: Antecedents and business value. In Proceedings of the 21th Pacific Asia Conference on Information Systems, Langkawi Island, Malaysia, 16–20 July 2017.
35. Lu, Y. Industry 4.0: A survey on technologies, applications and open research issues. *J. Ind. Inf. Integr.* **2017**, *6*, 1–10. [CrossRef]
36. Garzoni, A.; De Turi, I.; Secundo, G.; Del Vecchio, P. Fostering digital transformation of SMEs: A four levels approach. *Manag. Decis.* **2020**, *58*, 1543–1562. [CrossRef]
37. González Varona, J.M.; ló PEZParedes, A.; Poza, D.; Acebes, F. Building and development of an organizational competence for digital transformation in SMEs. *J. Ind. Eng. Manag.* **2021**, *14*, 15–24. [CrossRef]
38. Lin, M.H.; Hu, J.; Tseng, M.L.; Chiu, A.S.; Lin, C. Sustainable development in technological and vocational higher education: Balanced scorecard measures with uncertainty. *J. Clean. Prod.* **2016**, *120*, 1–12. [CrossRef]
39. Govindan, K. Application of multi-criteria decision making/operations research techniques for sustainable management in mining and minerals. *Resour. Policy* **2015**, *46*, 1–5. [CrossRef]
40. Singhal, A.; Dube, P.; Jain, V.K. Evaluating Factors for Successful Technological Implementation in the Indian Banking Industry Using DEMATEL. *Int. J. Inf. Syst. Serv. Sect. (IJISSS)* **2022**, *14*, 1–23. [CrossRef]
41. You, Y.; Yi, L. A Corpus-based empirical study on energy enterprises digital transformation. *Energy Rep.* **2021**, *7*, 198–209. [CrossRef]
42. Saaty, T.L. *Decision Making with Dependence and Feedback: The Analytic Network Process*, 1st ed.; RWS Publications: Pittsburgh, PA, USA, 1996.
43. Sadeghi-Niaraki, A. Industry 4.0 development multi-criteria assessment: An integrated fuzzy DEMATEL, ANP and VIKOR methodology. *IEEE Access* **2020**, *8*, 23689–23704. [CrossRef]
44. Büyüközkan, G.; Güleryüz, S. An integrated DEMATEL-ANP approach for renewable energy resources selection in Turkey. *Int. J. Prod. Econ.* **2016**, *182*, 435–448. [CrossRef]
45. Kong, J.; Zhang, F.; Zhou, Z. Fuzzy Comprehensive Evaluation of Service Agent Based on Large-Scale Products of New Technology. *Mod. Econ.* **2015**, *6*, 498. [CrossRef]
46. He, K.; Zhu, N. Strategic emerging industry layout based on analytic hierarchy process and fuzzy comprehensive evaluation: A case study of Sichuan province. *PLoS ONE* **2022**, *17*, e0264578. [CrossRef]
47. Zaoui, F.; Souissi, N. Roadmap for digital transformation: A literature review. *Procedia Comput. Sci.* **2020**, *175*, 621–628. [CrossRef]
48. Van Laar, E.; Van Deursen, A.J.; Van Dijk, J.A.; De Haan, J. The relation between 21st-century skills and digital skills: A systematic literature review. *Comput. Hum. Behav.* **2017**, *72*, 577–588. [CrossRef]
49. Prezioso, G.; Ceci, F.; Za, S. Employee skills and digital transformation: Preliminary insights from a case study. *ImpresaProgetto-Electron J.* **2020**. [CrossRef]

50. Klünder, T.; Dörseln, J.N.; Steven, M. Procurement 4.0: How the digital disruption supports cost-reduction in Procurement. *Production* **2019**, *29*. [CrossRef]
51. Meissner, A.; Müller, M.; Hermann, A.; Metternich, J. Digitalization as a catalyst for lean production: A learning factory approach for digital shop floor management. *Procedia Manuf.* **2018**, *23*, 81–86. [CrossRef]
52. Desai, V. Digital marketing: A review. *Int. J. Trend Sci. Res. Dev.* **2019**, *5*, 196–200. [CrossRef]
53. Monostori, L.; Kádár, B.; Bauernhansl, T.; Kondoh, S.; Kumara, S.; Reinhart, G.; Sauer, O.; Schuh, G.; Sihn, W.; Ueda, K. Cyber-physical systems in manufacturing. *Cirp Ann.* **2016**, *65*, 621–641. [CrossRef]
54. Nick, G.; Szaller, Á.; Bergmann, J.; Várgedő, T. Industry 4.0 readiness in Hungary: Model, and the first results in connection to data application. *IFAC-PapersOnLine* **2019**, *52*, 289–294. [CrossRef]
55. Bunduchi, R.; Crișan-Mitra, C.; Salanță, I.I.; Crișan, E.L. Digital product innovation approaches in entrepreneurial firms–the role of entrepreneurs' cognitive frames. *Technol. Forecast. Soc. Chang.* **2022**, *175*, 121343. [CrossRef]