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Research article

Evaluating the optimal digital transformation strategy using hierarchical sensitivity decision model: A case study of tourism industry

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Abstract: In this study, we addressed the critical challenge of digital transformation (DT) strategy evaluation in the tourism industry. While the literature extensively discusses DT's importance, it lacks quantitative frameworks for systematic strategy prioritization under varying market conditions, leaving practitioners without actionable decision-support tools. Therefore, we presented a comprehensive hierarchical decision support system that integrates the Analytic Hierarchy Process (AHP) with robust sensitivity analysis. The analysis identified "Digitalized Customer Preferences" as the paramount success factor and "Business Model Transformation" (BMT) as the optimal strategy. Critically, sensitivity analysis revealed a 78.68% threshold for "Digital Consumer Demand", where strategic priorities shifted from BMT to product-service optimization. These findings advance DT theory through dynamic, threshold-based strategy frameworks while providing tourism managers with quantitative guidance for adaptive strategic decision-making based on market dynamics.

Keywords: digital transformation strategy; tourism industry; delphi method; Analytic Hierarchy Process; sensitivity analysis
Mathematics Subject Classification: 90B50,90C31

1. Introduction

Since the importance of digital transformation (DT) has increasingly been recognized by governments and businesses worldwide following the rise of numerous digital technologies, many scholars have consolidated the technologies influencing DT into the acronym SMACIT [1], which stands for Social [2,3], Mobile [4,5], Analytics [6,7], Cloud [8,9], and Internet of Things (IoT) [4,10]. These digital technologies have significantly impacted various industries, including the tourism industry [11]. The application of these technologies can establish new business models, processes, and systems, bringing more profit, greater competitive advantage, and higher business efficiency to organizations [5]. As an essential component of the digital economy, the tourism industry can leverage these digital technologies to streamline service processes and enhance customer experience [11]. While these digital technologies have laid the foundation for transformation across industries, the COVID-19 pandemic has emerged as a critical catalyst that fundamentally reshaped the urgency and trajectory of DT in the tourism sector.

During COVID-19, many businesses faced challenges such as economic recession and operational disruptions, necessitating a quicker adoption of digital technologies. This enabled companies to maintain operations through remote work, video conferencing, and other solutions, thereby accelerating their DT [12]. The tourism industry is experiencing profound transformation driven by the strategic adoption of digital technologies [6,11,13]. This DT transcends mere technological upgrades, encompassing fundamental restructuring of business processes, value creation mechanisms, and strategic frameworks within tourism enterprises [11]. Emergent technologies, including the IoT, Big Data analytics, Artificial Intelligence (AI), Augmented Reality (AR), and Virtual Reality (VR), are systematically reshaping the industry landscape, enhancing operational efficiency and tourist experiences [11,14]. The COVID-19 pandemic served as an unprecedented catalyst for this transformation, compelling tourism firms to accelerate digitalization efforts in pursuit of operational resilience and innovative customer engagement strategies amid global disruption [13,14]. In the context of the tourism industry, the impact of the pandemic has been significantly underestimated. Since the first quarter of 2020, the global tourism sector has been profoundly affected by the pandemic. In 2020, the number of international tourist arrivals was only 406 million, a dramatic decrease of 72.3% compared to 1,465 million in 2019 [15]. The global tourism numbers from 2019 to 2023 for various regions are shown in Figure 1.

From Figure 1, it can be observed that the number of international tourist arrivals in various regions experienced a significant decline from 2020 to 2023 compared to 2019. In the Americas, the decreases were 68.2%, 62.7%, 28.3%, and 8.7% for the years 2020 to 2023, respectively. In Europe, the declines were 67.7%, 59.5%, 17.9%, and 4.4% for the same period. In Africa, the reductions were 72.7%, 71.2%, 31.9%, and 3.9% from 2020 to 2023, respectively. In the Middle East, the declines were 72.8%, 57.7%, and 5.0% for 2020 to 2022, respectively, with an increase of 22.0% in 2023 compared to 2019. In Asia and the Pacific, the decreases were 83.7%, 92.7%, 74.3%, and 34.6% for 2020 to 2023, respectively. Only the Middle East saw a recovery to pre-pandemic tourism levels in 2023, while other regions have yet to return to the 2019 standards. In the case of accommodations, there was a significant double-digit decline in room revenues across all regions globally, with Asia and Europe being the most severely affected. Room revenues in Asia decreased by 66.7%, while in Europe, the decline was around

61.6%. In Taiwan, the occupancy rate of tourist hotels in April 2020 was only 15.13%, representing a 75% decrease compared to January of the same year [16]. In other words, the pandemic led to a drastic reduction in accommodation revenue and occupancy rates, particularly in Asia and Europe, highlighting the severe economic impact on the hospitality industry.

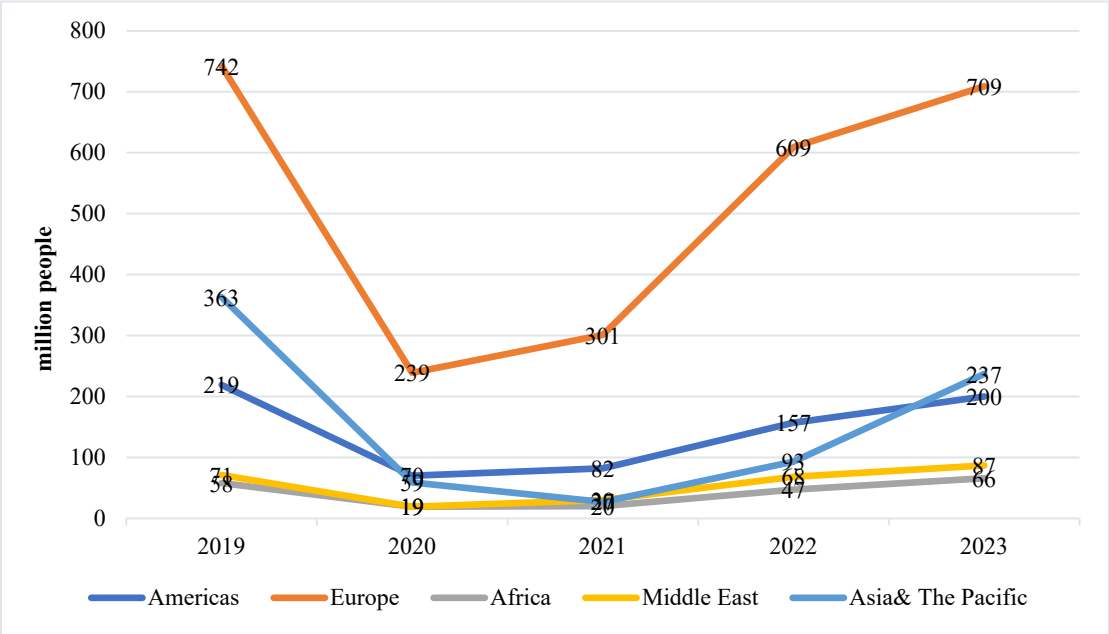

Figure 1. Global and regional tourism results (source from [15]).

The pandemic's devastating impact on the tourism industry has served as a wake-up call for the sector [17], revealing the critical need for digital resilience. Unlike other industries that could rapidly leverage technological advancements to address pandemic challenges, the tourism industry faced unique difficulties due to its reliance on physical travel and face-to-face interactions. Consequently, governments worldwide have recognized the need to support the tourism sector through digitalization initiatives, not only to mitigate unemployment but also to establish sustainable tourism policies through enhanced domestic and international cooperation [18]. This context underscores the urgent imperative for DT in tourism, where digitalization must evolve from an optional enhancement to a fundamental operational requirement for recovery and future growth. Liu et al. [14] indicated that the COVID-19 crisis illuminated the critical nexus between DT and tourism firm performance and resilience. The Empirical analysis of Chinese-listed tourism companies spanning 2013–2022 demonstrated that firms exhibiting higher digitalization levels sustained superior financial and non-financial performance throughout the pandemic disruption [14]. This positive correlation proved particularly pronounced for non-financial metrics, notably Environmental, Social, and Governance (ESG) performance, as the crisis catalyzed firms' integration of sustainable development principles into their operational frameworks [14]. Digital technologies are fundamentally reconceptualizing tourist-destination interactions and experiential paradigms. The emergent concept of smart tourism, underpinned by an integrated ecosystem of IoT, Big Data analytics, and AI, facilitates the provision of seamless, personalized service delivery [11].

Given the unprecedented challenges revealed by the pandemic and the persistent uncertainties in the global tourism landscape, undertaking DT has evolved from a competitive advantage to a survival imperative. Therefore, in times of challenges and instability, undertaking DT has become imperative to maintain competitiveness. DT can enable businesses to collect relevant information, such as customers' historical footprints or search records, and analyze them to provide a better travel experience for [19], thereby improving operational and management efficiency [20]. However, the process of DT often involves significant changes in business operations, affecting products, processes, organizational structures, and management principles. Therefore, businesses need to establish systems to manage the complex transformation process, and one crucial method is to develop transformation strategies [21]. In other words, to navigate the complexities of DT, businesses must implement strategic frameworks that guide and streamline the transformation process, ensuring that all aspects of the business are effectively aligned with new digital initiatives.

Westerman et al. [22] stated that "When DT is done right, it's like a caterpillar turning into a butterfly, but when done wrong, all you have is a really fast caterpillar." This metaphor underscores a critical reality: The selection of inappropriate transformation strategies can expose organizations to severe consequences rather than competitive advantages. Specifically, strategic missteps in DT may result in the following challenges:

1. Decreased Competitiveness: If an organization's DT fails, it may lose its competitive edge in the market. Competitors who have successfully implemented DT strategies may gain a dominant position, leaving the organization that failed to transform at a significant disadvantage [23].
2. Erosion of Market Position: When competitors have already introduced more advanced digital products or services in the market, customers tend to gravitate towards the more convenient and efficient offerings. Organizations that fail to successfully undergo DT may consequently see their existing market share diminish as customers shift to the superior digital solutions provided by their competitors [24].
3. Financial Burden: The process of DT typically requires significant investment, including the costs of updating technological infrastructure, employee training, system integration, and other related expenses. If the DT initiative fails, these investments may be considered sunk costs, and the organization may need to incur additional expenses to revert to its original operating methods, leading to a financial burden [25].

To mitigate these risks and maximize the likelihood of successful DT, a systematic approach to strategy selection is essential. Based on comprehensive literature review and expert consultation, we consolidate four major DT strategies that organizations can leverage: Business Model Transformation (BMT) [26], Optimization for Product-Service (OPS) [27,28], Enhancing Operational Efficiency [29], and Organizational Culture Change (OCC) [30]. By evaluating these four core DT strategies, the tourism industry can assess their resources and capabilities to select the most suitable approach to embark on their DT, achieving their profitability goals.

Despite the proliferation of DT literature in recent years, three critical knowledge gaps persist that this study addresses. First, research predominantly offers conceptual frameworks and case-based insights without providing systematic, quantitative methodologies for DT strategy evaluation and prioritization. While qualitative studies contribute valuable contextual understanding, tourism practitioners require actionable decision-support tools that can systematically assess multiple strategic

alternatives against complex, multi-dimensional criteria. Second, researchers treat DT strategies as static choices without examining how optimal strategies shift under varying market conditions; a critical oversight given the dynamic nature of digital markets and customer expectations. Third, tourism-specific DT research remains fragmented, lacking integrated frameworks that simultaneously consider technological, organizational, operational, customer, and financial dimensions holistically. To address these gaps, this research is guided by the following overarching questions:

(1) What are the critical factors and their relative importance in determining DT success in the tourism industry?

(2) Which DT strategy among BMT, product-service optimization, operational efficiency enhancement, and OCC is optimal alternative for the tourism industry context?

(3) Under what conditions do optimal strategy rankings shift, and what are the critical threshold points that trigger strategic reorientation?

Given the critical importance of strategy selection in DT success and the identified research gaps in quantitative evaluation frameworks, we aim to achieve the following objectives:

(1) Identify the key factors influencing DT in the tourism industry.

(2) Ranking four strategies to assess the optimal alternative for the travel industry's DT strategy

(3) Sensitivity analysis of criteria and sub-criteria to the changing of all alternatives.

To address these research objectives systematically, we employ a rigorous multi-method analytical approach. The Analytic Hierarchy Process (AHP) is selected as the primary analytical framework due to its proven effectiveness in handling complex decision-making problems with multiple objectives and evaluation criteria, such as energy planning issues, including the identification of optimal solutions for electricity supply in remote rural areas [31]. It has also been applied to assess the impact of various qualitative criteria on alternative transportation choices [32]. The strength of AHP lies in its ability to handle decision-making problems with multiple objectives and evaluation criteria, allowing the evaluation of the most appropriate strategy from among multiple alternative options. However, the ultimate rankings of these alternative solutions are greatly influenced by the weights given to the main criteria. Even minor adjustments in the relative weights can cause substantial shifts in the final rankings. Since these weights are usually derived from subjective assessments, it is important to assess the stability of the rankings when the criteria weights are varied. For this purpose, sensitivity analysis can be performed based on assumptions that reflect different future development scenarios. Therefore, this research proposes to utilize the AHP to identify the influential factors and determine the optimal DT strategy for the tourism industry. Additionally, the study will incorporate the concept of sensitivity analysis to assess the stability of the selected strategy under different weighting scenarios.

The remainder of this paper is organized as follows: In Section 2, we present the integrated modified Delphi method (MDM)-AHP and Sensitivity methodology, evaluation criteria development, and analytical procedures. In Section 3, we discuss the sensitivity analysis results and their strategic implications for tourism DT. In Section 4, we articulate both theoretical contributions to DT literature and practical implications for industry practitioners. In Section 5, we conclude by synthesizing key findings and proposing future research directions.

2. Research methodology

We employ an integrated MDM-AHP with sensitivity analysis framework to systematically evaluate DT strategies for Taiwan's tourism industry. The research design comprises three interconnected phases: (1) Criteria identification and hierarchy construction through the Delphi method and literature review, (2) strategy prioritization using AHP with expert pairwise comparisons, and (3) strategic robustness assessment through comprehensive sensitivity analysis. Figure 2 illustrates the complete hierarchical evaluation framework developed for this study. The procedures are as below.

Step 1: Define the strategies, evaluative criteria, and develop a hierarchical framework.

In this study, evaluation criteria are determined through a systematic literature review and expert interviews with industry professionals, subsequently validated through the MDM to confirm both evaluative criteria and alternatives. The MDM constitutes a structured, iterative process designed to systematically gather and synthesize expert perspectives through anonymous panel consultation. This methodological approach proves particularly valuable when addressing complex, multifaceted issues requiring diverse professional viewpoints and consensus-building. The Delphi method leverages collective expertise through carefully orchestrated rounds of consultation, facilitating consensus development on the examined phenomenon [33]. This technique has gained widespread adoption for eliciting expert insights and supporting informed decision-making across sectors, including business management, engineering, and public policy formulation.

According to Wu et al. [34], the conventional Delphi method encompasses five fundamental stages:

1. Expert panel selection and anonymization
2. First-round survey administration
3. Second-round questionnaire distribution
4. Third-round questionnaire implementation
5. Opinion integration and consensus achievement

Stages 3 and 4 undergo iterative repetition until satisfactory consensus emerges [33]. The modified Delphi technique streamlines this process by incorporating preliminary expert interviews to identify shared perspectives, thereby replacing the traditional open-ended initial survey [33]. We employ the modified Delphi technique in conjunction with anonymous expert interviews to establish evaluation criteria and define operational thresholds for the research domain. The resulting criteria framework encompasses qualitative and quantitative assessment dimensions. Established methodological guidelines recommend maintaining expert panel sizes between five and nine participants to optimize both diversity of perspectives and manageable consensus-building [33,35]. Through the process of MDM, the researchers were able to develop a hierarchical structure consisting of five major evaluation criteria, twenty-one sub-criteria, and four alternative DT strategies for the tourism industry (as shown in Figure 2 and Table 1).

The framework encompasses five primary evaluation criteria (C_1–C_5), twenty-one sub-criteria (SC_1–SC_{21}), and four alternative DT strategies, forming a three-level decision hierarchy. This structure enables systematic decomposition of the complex strategy selection problem into manageable components while maintaining logical relationships between evaluation dimensions.

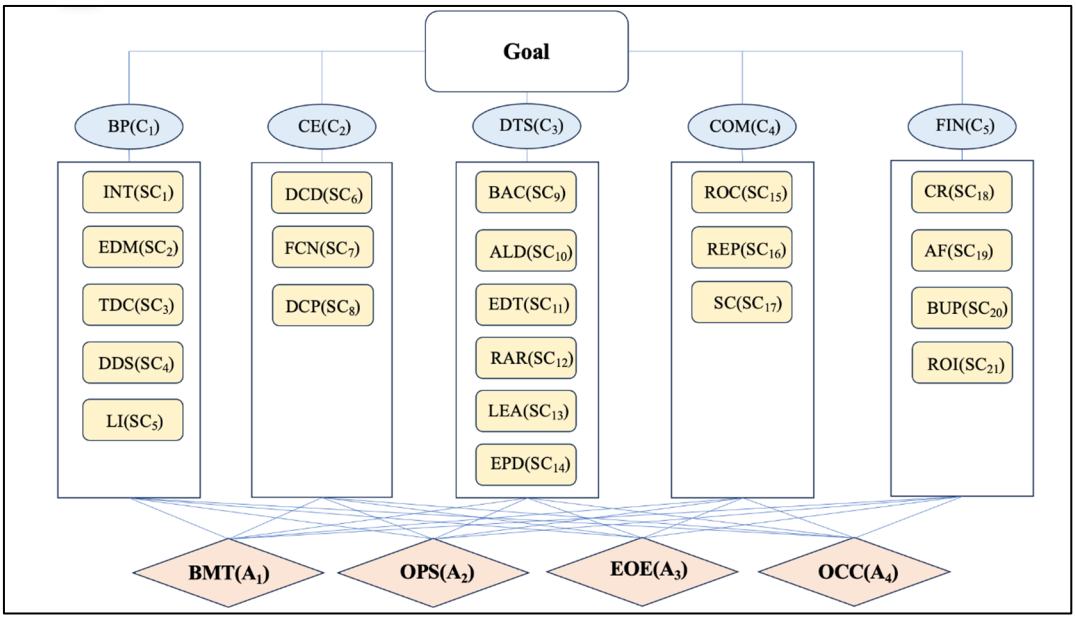

Figure 2. Hierarchical structure to evaluate the optimal DT strategies.

Table 1. Definition of influencing factors.

Criteria	Factors	Definitions	Reference
Business Process (C_1)	Integration (SC_1)	Integrating various digital technologies, systems, and processes to achieve more efficient business operations and enhance overall organizational effectiveness aims to seamlessly incorporate digital technologies into all levels of the organization, driving comprehensive DT.	[36]
	Establish digital mindset (SC_2)	Help organizations build a proactive, innovative, and adaptable digital mindset.	[37]
	The digital capabilities (SC_3)	Organizations with strong digital business capabilities are better equipped to face challenges in the digital environment and achieve business objectives.	[38]
	Developing a digital strategy (SC_4)	It is developed according to processes such as determining business goals, conducting organizational assessments, establishing digital culture, and setting milestones.	[39]
	The legal of a country business infrastructural (SC_5)	Impacting the way businesses and individuals engage in the digital environment, such as regulatory frameworks and interventions.	[38]
Customer Experience (C_2)	Digital consumer demand (SC_6)	Consumers are increasingly reliant on digital technology in their daily lives and personal interactions, expecting ubiquitous access to virtual resources.	[40,41]
	Forecasting customer needs (SC_7)	Integrating digital technology helps businesses more comprehensively and accurately predict customer needs, thereby better meeting market demands and providing personalized products and services.	[42]
	Digitalized customer preferences (SC_8)	Based on customer preferences, businesses can achieve customized and even personalized production.	[43]

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Criteria	Factors	Definitions	Reference
Digital Technology Skills (C_3)	Big data analytics capabilities (SC_9)	An increasing number of sources generate large volumes of data. Companies realize that the data they possess and how they utilize it can provide them with a competitive advantage.	[44]
	The accessibility of large volumes of data (SC_{10})	The ease with which individuals within an organization can access, understand, and use data to make informed business decisions.	[38]
	Emerging digital technology (SC_{11})	The utilization of emerging digital technologies across various industries and sectors has profound social and economic impacts, including artificial intelligence, the Internet of Things, blockchain technology, augmented reality, and cloud computing.	[38]
Digital Technology Skills (C_3)	Resilient against risk (SC_{12})	Strong risk management and defense capabilities, such as data security and privacy protection.	[45]
	Leadership (SC_{13})	The success of DT depends on how leaders leverage digital technology to drive organizational development.	[42,46]
	The extent to which its core products can be digitized (SC_{14})	How businesses apply digital technology and information systems to improve, optimize, or innovate their core products or services.	[21]
Competitiveness (C_4)	Recognizing opportunities to difference from competitors (SC_{15})	Trying to find ways to differentiate yourself from your competitors.	[42]
	Reputation (SC_{16})	Some improvements in organizational performance, including reputation, are also related to a company's competitive advantage.	[47]
	Staying competitive (SC_{17})	Through DT, enterprises can continue to remain competitive and avoid being eliminated.	[42]
Finance (C_5)	Cost reductions (SC_{18})	Improving company performance and creating new forms of value.	[48]
	Ability to finance a digital transformation (SC_{19})	Companies already facing financial pressure may lack external avenues to fund their transformation.	[21]
	Budget planning (SC_{20})	Develop a clear digital transformation budget, including capital expenditures and operating expenses. Ensure the budget can support necessary technology investments and related training.	[49]
	Return on investment (SC_{21})	Implementing cutting-edge technologies, no matter how promising, will not lead to transformation if there is no understanding of how they will deliver a return on investment (ROI) for the organization and its customers.	[50]

Four distinct DT strategies constitute the decision alternatives in this study, each representing fundamentally different approaches to organizational transformation:

(1) Business Model Transformation

Business models are defined as the way firms operate, rather than something that physically exists; they represent the causal relationships between customers, organizations, and money [51]. Business models are also seen as ideal types or role models that companies aim to emulate, serving as inspiration

for business model innovation [52]. Therefore, the change in business models is essentially a transformation from traditional models to new organizational forms. The transformed organizational structure is better suited to operate in today's digital economy, altering relationships with partners and continuously increasing digital assets through the use of digitalization [53].

(2) Optimization for Product-Service

The process of optimizing product services aligns with the rise of digitalization trends. Coupled with smart digital systems, product services can now operate independently of manual processes and interact with digital machinery. The integration of advanced product service optimization processes with smart machines has become an inevitable outcome [54]. With the emergence of digital technologies, companies are leveraging smart digital systems to transition towards providing customized, service-oriented solutions [55]. These services encompass everything from conventional product-focused offerings, like routine maintenance and repairs, to customer-centric services [56]. By linking physical products through personalized delivery of intangible services, businesses can better cater to deeply individualized customer requirements [57]. These personalized product-service combinations increase the value provided to customers, thereby improving organizational competitiveness [58].

(3) Enhancing Operational Efficiency

Due to DT, organizations have widely embraced and adopted new digital innovation technologies, focusing extensively on agile digitalization. Integrating digital technologies into organizational activity chains aims to provide added value to customers and stakeholders, thereby enhancing organizational performance. The application of new technologies leads to the development of new value, including innovations in products, value propositions, value chains, and new product delivery channels, which can improve operational efficiency and effectiveness [29].

(4) Organizational Culture Change

Successful DT is often considered to be contingent upon organizational culture [59,60]. Therefore, when undertaking significant digital changes, organizations should consider both organizational culture and its impact on information technology (IT) [61]. Organizational culture refers to the shared values among individuals within an organization [62]. Research suggests that organizational culture has a reciprocal relationship with absorptive capacity and IT success and implementation. Organizational culture is also discussed as a catalyst for new knowledge and innovation but can simultaneously become a barrier when adopting new digital services [63].

These four strategies represent distinct strategic emphases rather than mutually exclusive paths; organizations may pursue hybrid approaches combining elements from multiple strategies. However, resource constraints and organizational capabilities necessitate strategic prioritization, making the identification of optimal primary strategies critically important for tourism industry decision-makers.

Step 2: Establish each factor of the pairwise comparison matrix.

Mu [64] indicated that AHP/ANP methodologies were created to address decisions in many different domains. Therefore, this step implements the AHP methodology to develop the pairwise comparison matrix. Previous research has implemented the AHP and BOCR (Benefits, Opportunities, Costs, and Risks) methodology to address diverse decision-making challenges across various domains [65–68]. The BOCR framework provides a systematic, comprehensive approach for establishing non-redundant evaluation

criteria, rendering it particularly appropriates for complex strategic decisions characterized by multiple positive and negative dimensions [66]. Conversely, the exclusion of the BOCR framework proves equally defensible when problem-specific criteria are sufficiently clear, parsimonious, and efficient for the decision context, as exemplified in supplier selection applications utilizing standalone AHP methodologies [67]. The selection of evaluation criteria whether structured through BOCR or alternative frameworks must be methodologically justified relative to the specific decision objectives and contextual requirements. Accordingly, we employ an integrated MDM-AHP framework augmented with sensitivity analysis to identify and evaluate optimal DT strategies within the tourism industry context.

Elements within a specific level are compared in pairs relative to a particular element in the immediate upper level. *A* judgment matrix, *A*, is constructed and utilized to calculate the priority weights of the corresponding elements. First, each criterion is compared in pairs concerning the goal. A judgment matrix, represented by *A*, will be created based on these pairwise comparisons. Each entry a_{ij} of the judgment matrix is formed by comparing the row element ai with the column element a_j.

$$A = [a_{ij}],\ i,\ j = 1,\ 2,\ \ldots,\ n. \tag{1}$$

The comparison between any two criteria, C_i and C_j, in relation to the goal involves determining which of the two is more important and to what extent. Saaty [69] suggests using a 9-point scale to translate qualitative judgments into numerical values, which are represented as a_{ij}. Figure 3 illustrates the 9-point scale, where a higher value in pairwise comparisons indicates a more significant difference between the criteria levels. The entries a_{ij} are determined by the following rules:

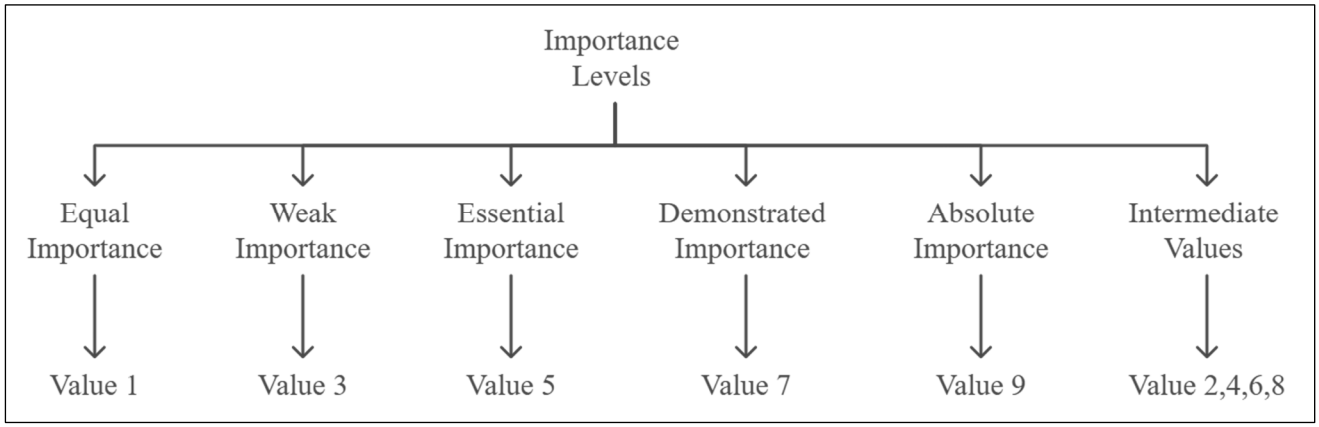


Figure 3. The pair- wise comparison scale (Saaty, [69])

$$a_{ij} > 0,\ a_{ji} = \frac{1}{a_{ij}},\ a_{ii} = 1 \quad \text{for all } i \tag{2}$$

This scale is versatile and applicable to both criteria that can be quantitatively defined and those that cannot. It presents a relative importance scale where decision-makers express their judgments regarding the relative importance of each criterion's contribution to achieving the overarching goal.

To gather expert opinions through pairwise comparisons, an AHP questionnaire was developed. Consequently, purposive sampling was employed to select six respondents. Six respondents were purposively selected based on stringent qualification criteria designed to capture comprehensive domain expertise in both DT and tourism industry management. Respondent panel members were required to possess a minimum of ten years' professional experience in tourism management or DT implementation, hold at least a master's degree in relevant disciplines, and occupy senior management positions with direct strategic decision-making responsibilities. Additionally, experts must demonstrate substantive involvement in DT initiatives and possess comprehensive knowledge of Taiwan's tourism industry landscape and its distinctive challenges.

The final weighted values assigned by experts are utilized, and the geometric mean value is calculated to determine the decision-making community scores of all experts. This process is undertaken to formulate the optimal DT strategy for the tourism industry and ascertain the weight values of key influencing factors. Table 3 presents the main criteria as the sample.

Table 2. Aggregate pair-wise comparison matrix for criteria of level 2.

	C_1	C_2	C_3	C_4	C_5
C_1	1	0.240	5.657	1.225	2.374
C_2	4.167	1	8.485	5.292	4.973
C_3	0.177	0.118	1	1.023	0.362
C_4	0.816	0.189	0.978	1	0.473
C_5	0.421	0.201	2.762	2.114	1
λ_{max} = 5.289; *C.I.* = 0.072; *R.I.* = 1.12; *CR* = 0.064					

Step 3: Calculate the eigenvalues and their corresponding eigenvectors.

Using the numerical judgments a_{ij} recorded in the matrix A, the goal is to calculate the numerical weights ($W_1, W_2, \ldots, W_n$) for the alternatives represented in the matrix. To achieve this, we can consider the following equation.

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} = \begin{bmatrix} W_1/W_1 & W_1/W_2 & \cdots & W_1/W_n \\ W_2/W_1 & W_2/W_2 & \cdots & W_2/W_n \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ W_n/W_1 & W_n/W_2 & \cdots & W_n/W_n \end{bmatrix}, \tag{3}$$

Furthermore, if we multiply both matrices in Equation (3) on the right-hand side by the weight vector W= ($W_1, W_2, \ldots, W_n$), where W is a column vector, the result of this multiplication between the pairwise ratio matrix and W will be nW, thus leading to the following conclusion:

$$AW = nW \tag{4}$$

This forms a system of homogeneous linear equations, which has a non-trivial solution only if the determinant of $A-nI$ equals zero. This condition indicates that n is an eigenvalue of A, where I is an identity matrix. Using Saaty's method, the weights vector W is determined as the principal right eigenvector of the matrix A; that is,

$$AW = \lambda_{max} W \tag{5}$$

The matrix A principal eigenvalue of the is represented as n. If matrix $A$is positive reciprocal, then n is the largest eigenvalue [69]. If A is a consistency matrix, the eigenvector X can be determined using the following equation

$$(A - \lambda_{max} I)X = 0 \tag{6}$$

In this context, a comparison matrix, like the one presented in Table 3, is utilized to calculate eigenvectors using Equations (5) and (6). Table 4 provides a summary of these eigenvectors for criteria, sub-criteria, and the selection of four decision-making strategies. Additionally, Table 4 presents the outcomes of the analysis, showcasing the importance or weight assigned to different criteria, sub-criteria, and decision-making strategies within the framework of the study.

Table 3. Eigenvectors (weights) for Level 2 to Level 4.

Criteria	Weights for level 2	Sub-criteria	Weights for level 3	Weights for level 4			
				BMT	EOE	OPS	OCC
C_1	0.193	SC_1	0.537	0.326	0.328	0.078	0.268
		SC_2	0.058	0.187	0.562	0.160	0.091
		SC_3	0.129	0.383	0.210	0.211	0.196
		SC_4	0.126	0.458	0.293	0.186	0.063
		SC_5	0.151	0.360	0.358	0.195	0.088
C_2	0.539	SC_6	0.139	0.214	0.464	0.211	0.111
		SC_7	0.335	0.600	0.233	0.062	0.104
		SC_8	0.526	0.315	0.297	0.263	0.125
C_3	0.057	SC_9	0.250	0.218	0.383	0.213	0.186
		SC_{10}	0.205	0.180	0.570	0.129	0.121
		SC_{11}	0.099	0.580	0.261	0.070	0.088
		SC_{12}	0.167	0.331	0.307	0.301	0.061
		SC_{13}	0.062	0.588	0.261	0.090	0.061
		SC_{14}	0.217	0.638	0.177	0.127	0.057
C_4	0.086	SC_{15}	0.302	0.550	0.235	0.169	0.047
		SC_{16}	0.311	0.383	0.329	0.172	0.116
		SC_{17}	0.387	0.577	0.175	0.170	0.078
C_5	0.127	SC_{18}	0.296	0.635	0.190	0.103	0.072
		SC_{19}	0.156	0.563	0.215	0.172	0.049
		SC_{20}	0.130	0.602	0.192	0.122	0.085
		SC_{21}	0.419	0.635	0.179	0.119	0.068

Step 4: Conduct the consistency test.

The eigenvector approach provides an inherent way to assess consistency. Saaty (1990) introduced the concept of the consistency index (CI), defined as follows

$$CI = (\lambda_{max} - n)/(n - 1) \tag{7}$$

where λ_{max} represents the largest eigenvalue of the matrix, and n is the total number of criteria in the judgment matrix. Accordingly, Saaty [69] defined the consistency ratio (CR) as

$$CR = CI/RI\ , \tag{8}$$

for each size of matrix n, random matrices are created, and their mean Consistency Index (CI) values are computed, referred to as the Random Index (RI). The RI signifies the average consistency index across randomly generated matrices of the same order as the reciprocal matrices under consideration. Figure 4, developed by Saaty [69], provides reference values for the RI. The CR indicates the extent to which the consistency of a given matrix deviates from that of a completely random matrix, based on their respective consistency indices. A lower CR value indicates a closer resemblance to a random matrix, implying higher consistency in judgments. Conversely, larger CR values suggest a departure from randomness, indicating the need for decision-makers to reassess their judgments for improved consistency.

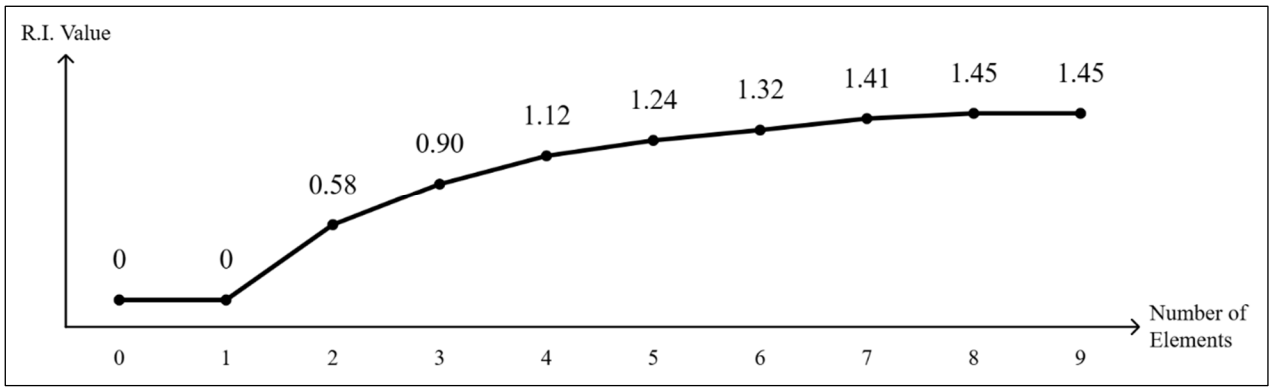


Figure 4. The Random Index (Saaty, [69]).

According to Equations (7) and (8), the consistency of the criteria comparison matrix for each criterion is computed, as demonstrated in Figure 3. The outcomes of the consistency test for each criterion, as well as the CR, are consistently measured at 0.1 across all experts, indicating a high level of consistency in their assessments. Moreover, the CR of the aggregate matrix, representing the combined judgments of all experts, also stands at 0.1, reaffirming the overall consistency of the decision-making process. The results consistently show a high level of agreement among the experts, both individually and when their judgments are combined.

Step 5: Calculate the overall level hierarchy weight to select the optimal DT strategy in tourism industry

The overall priorities are obtained by combining the weights across the hierarchy. These aggregated priorities are presented in Table 4. Based on Table 4, the "BMT" strategy is identified as the most favorable transformation strategy.

Table 4. The evaluation outcomes and evaluate the optimal DT strategy in tourism industry.

Criteria	Weights	BMT	EOE	OPS	OCC
		Synthesis Value	Synthesis Value	Synthesis Value	Synthesis Value
C_1	0.192	0.331	0.338	0.160	0.136
C_2	0.539	0.609	0.536	0.289	0.183
C_3	0.056	0.144	0.112	0.053	0.033
C_4	0.086	0.130	0.064	0.044	0.021
C_5	0.127	0.309	0.099	0.066	0.035
Result	Aggregate score	0.444	0.296	0.158	0.102
	Rank	***1***	***2***	***3***	***4***

Step 6: Sensitivity analysis

The final ranking of alternatives is greatly influenced by how much importance is assigned to the main criteria. Even small adjustments in these relative weights can have a significant impact on the ultimate order. Since these weightings are often based on subjective judgments, it is crucial to assess how stable the ranking is when these weights vary. Sensitivity analysis enables this examination, using different scenarios to explore how changes in criteria importance affect the priorities and ranking of alternatives. By adjusting the weightings of individual criteria, we can observe how the rankings change accordingly. This analysis provides an understanding of how stable the ranking is. If the ranking is highly sensitive to minor changes in the weights, it is advisable to carefully reassess these weights. Additionally, if a highly sensitive ranking suggests that the current criteria set lacks the ability to effectively discriminate between alternatives, it may be necessary to introduce additional decision criteria. To conduct this analysis, the weights of the key criteria are adjusted separately, spanning 0% to 100%. Importantly, when altering the weight of one criterion, the weights of the others change proportionately, ensuring that the total always equals 100%. The local priority weights of the selected subjective factors are adjusted using the Super Decisions software. Sensitivity analyses are necessary because changing the importance of criteria requires various levels of "Business Processes", "Customer Experience", "Digital Technology Skills", "Competitiveness", and "Finance" to ensure evaluating the optimal DT strategy in tourism industry.

3. Discussions of AHP-sensitivity analysis

The final priority rankings are calculated by aggregating weights across the hierarchical models. As shown in Table 4, this comprehensive analysis reveals that among all transformation strategies evaluated, the "BMT" approach emerges as the optimal strategy. Figures 5 shows the sensitivity performance of the criteria for "Business Processes (C_1)", "Customer Experience (C_2)", "Digital Technology Skills (C_3)", "Competitiveness (C_4)", and "Finance (C_5)".

Figures 6 to 8 show the sensitivity performance of the sub- criteria for "Integration (SC_1)", "Establish digital mindsets (SC_2)", "The digital capabilities (SC_3)", "Developing a digital business strategy (SC_4)", "The legal of a country business infrastructural (SC_5)", "Digital consumer demand (SC_6)", "Anticipation of customer needs (SC_7)", "Digitalized customer preferences (SC_8)", "Big data

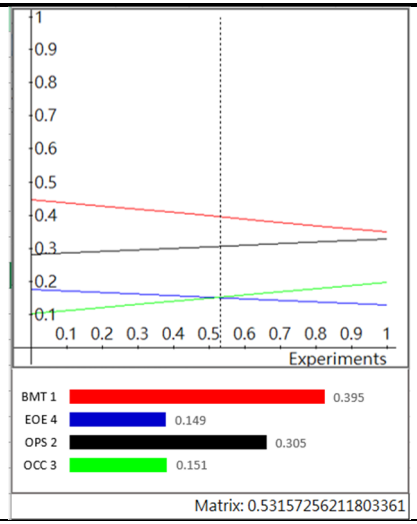
analysis capabilities (SC_9)", "The accessibility of large volumes of data (SC_{10})", "Emerging digital technology (SC_{11})", "Resilient against risk (SC_{12})", "Leadership (SC_{13})", "The extent to which its core products can be digitized (SC_{14})", "Recognizing opportunities to difference from competitors (SC_{15})", "Reputation (SC_{16})", "Staying competitive (SC_{17})", "Cost reductions (SC_{18})", "Ability to finance a DT (SC_{19})", "Budget planning (SC_{20})", and "Return on investment (SC_{21})".

According to Figure 5, when the sensitivity of Business Processes (C_1) is increased by 53.16%, a minor reordering occurs between two strategic alternatives. The EOE shifts downward from third to fourth position, while OCC moves upward from fourth to third position. However, this sensitivity adjustment has minimal strategic implications, as the rankings of all other criteria remain stable and the overall decision-making hierarchy is largely unaffected. The sensitivity analysis revealed two notable ranking shifts, as illustrated in Figure 6. First, when Digital consumer demand (SC_6) sensitivity is increased by 78.68%, a reversal occurs at the top positions: BMT moves from first to second position, while OPS advances from second to first position. Second, in the Anticipation of customer needs (SC_7) dimension, an 83.68% increase in sensitivity causes a reordering between EOE and OCC, with EOE declining from third to fourth position and OCC improving from fourth to third position. Importantly, all other sub-criteria maintain their original rankings following these sensitivity adjustments.

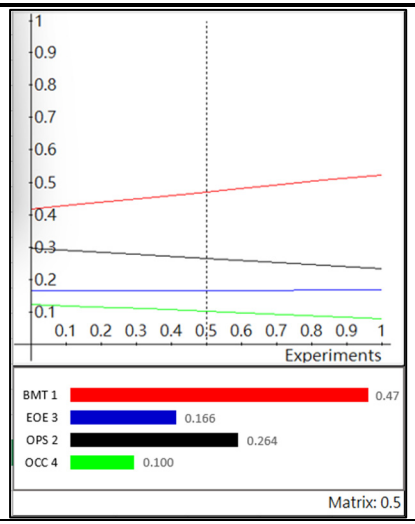
Based on the AHP sensitivity analysis method, this study demonstrates that in evaluating DT strategies, the "Business Processes" aspect influences the ranking of "OCC" and "OPS" within the transformation strategy. "OCC" shifts from its original ranking of 4 to 3. This shift is due to the fact that business processes are pivotal to organizational operations, and the purpose of DT is to enhance revenue and reduce costs to achieve profitability goals. Enhancing business processes can improve organizational efficiency and flexibility, increase productivity, reduce human errors and waste, and thus enable quicker adaptation to market changes and customer demands. Regarding sub-criteria, increasing the sensitivity analysis percentage of "Digital consumer demand" will affect the ranking order of the BMT and OPS transformation strategies. This result holds considerable significance for the study, as the original ranking 1 transformation strategy shifts from "BMT" to "OPS" due to the impact of "Customer Demand". Therefore, from this result, we can infer that with the advent of the digital age, the expectations of customers regarding products and services are continuously evolving. If digital customer demands become increasingly significant, tourism operators should adjust their transformation strategies to enhance the quality of products and services, thereby meeting the digitalized demands of travelers.

The sensitivity analysis elucidates critical strategic inflection points with significant implications for tourism industry strategic management. When digital consumer demand (SC6) sensitivity escalates by 78.68%, precipitating a positional shift wherein BMT descends from first to second rank while OPS ascends to primacy, this threshold delineates a fundamental strategic decision boundary requiring managerial cognizance. These findings underscore the imperative for tourism organizations to implement adaptive strategic frameworks characterized by contextual responsiveness to market dynamics. Under current market conditions where digital consumer demand maintains moderate strategic significance, BMT emerges as the optimal strategic pathway, necessitating comprehensive business model innovation, revenue stream diversification, and systematic organizational restructuring. Conversely, in scenarios characterized by critically elevated digital consumer demand, as demonstrated through sensitivity analysis, organizations must demonstrate strategic agility by transitioning toward

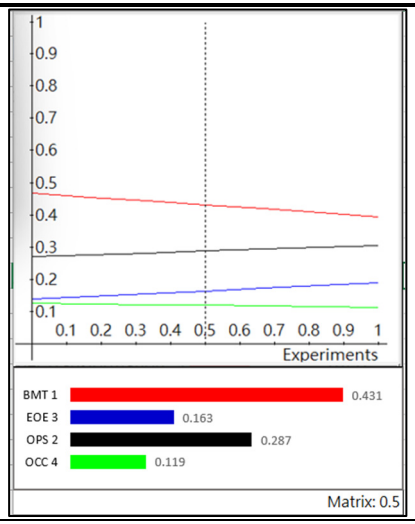
OPS strategies. This alternative strategic orientation prioritizes service quality enhancement, advanced personalization capabilities, and systematic customer experience optimization, reflecting the heightened importance of consumer-centric digital touchpoints in value creation processes. Several strategic imperatives emerge from this sensitivity analysis for tourism industry practitioners. First, tourism enterprises should cultivate hybrid organizational capabilities that facilitate rapid strategic pivoting between operational modes. This strategic flexibility requires developing dual competencies: business model innovation capabilities for moderate digital demand environments, and product-service optimization expertise for high-intensity digital demand scenarios. Organizations maintaining strategic agility across both dimensions will demonstrate superior responsiveness to volatile market conditions and shifting consumer behaviors. Second, the identified 83.68% sensitivity threshold for "Forecasting customer needs" (SC7) establishes a practical benchmark for strategic resource allocation decisions. When customer need prediction capabilities assume heightened strategic importance, organizations should systematically reallocate resources from operational efficiency enhancement (EOE) initiatives toward OCC programs. This reallocation prioritizes the development of predictive analytics capabilities and customer-centric organizational mindsets, thereby enhancing the organization's capacity for anticipatory service delivery and proactive market positioning.



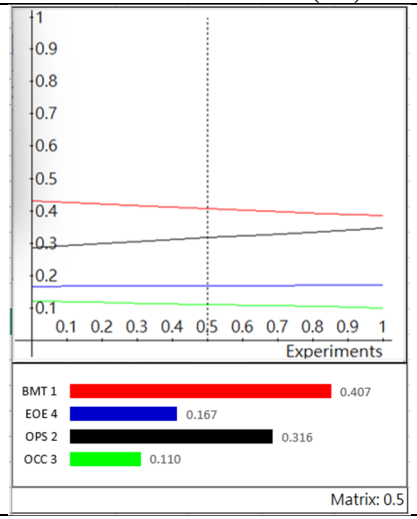
Business Processes (C_1)



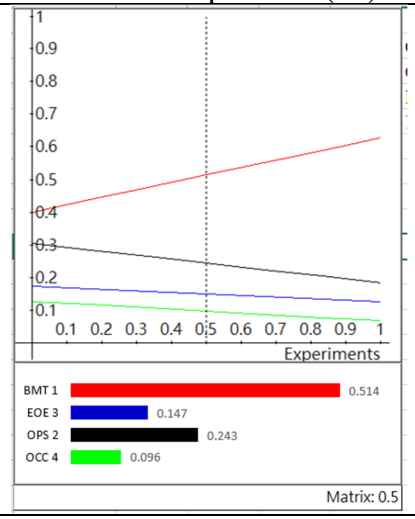
Customer Experience (C_2)



Digital Technology Skills (C_3)

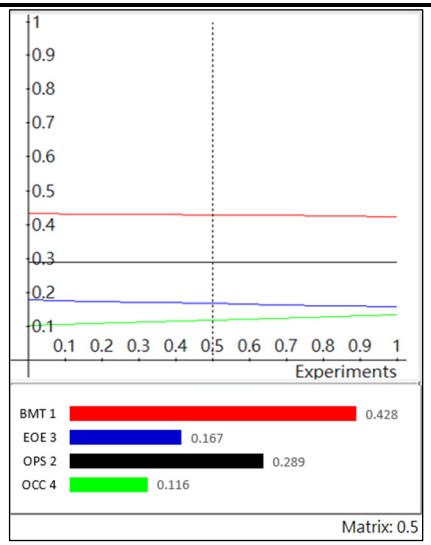


Competitiveness (C_4)

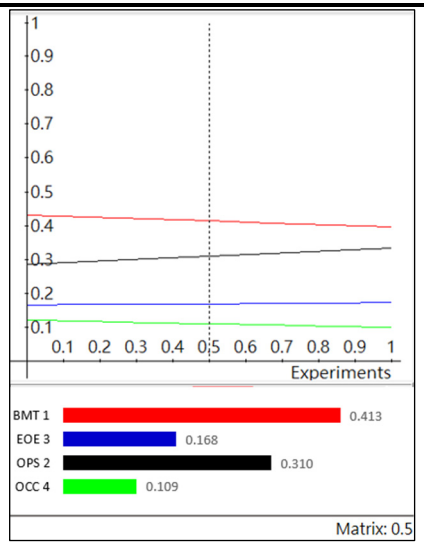


Finance (C_5)

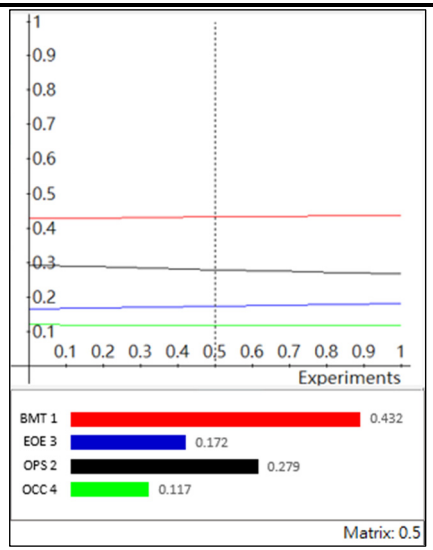
Figure 5. The sensitivity of criteria.



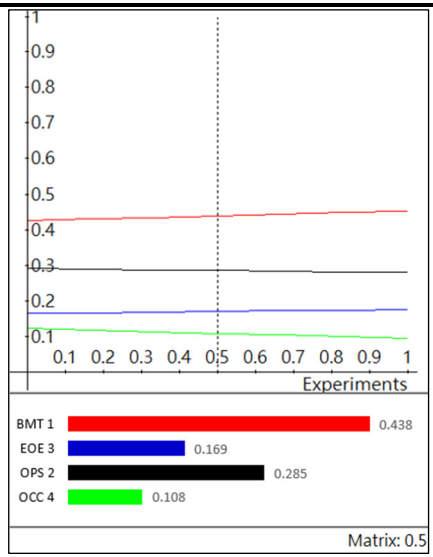
Integration (SC_1)



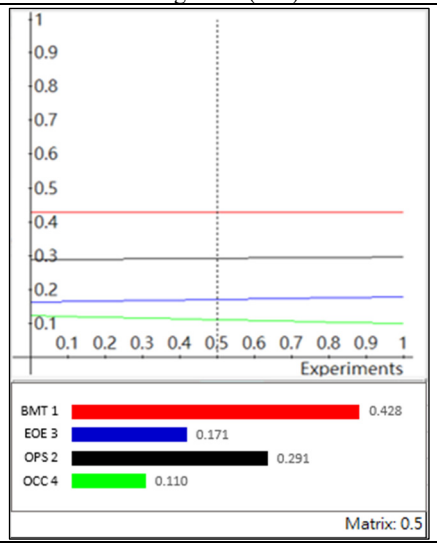
Establish digital mindsets (SC_2)



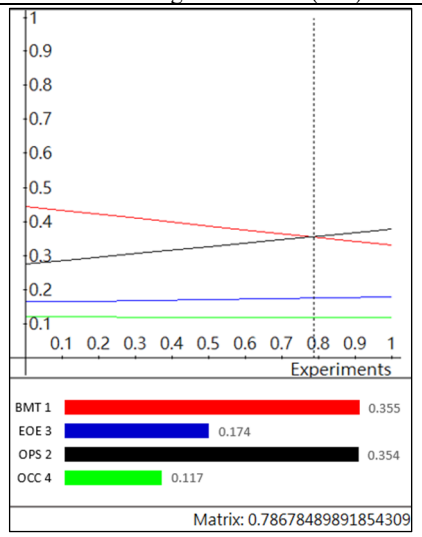
The digital capabilities (SC_3)



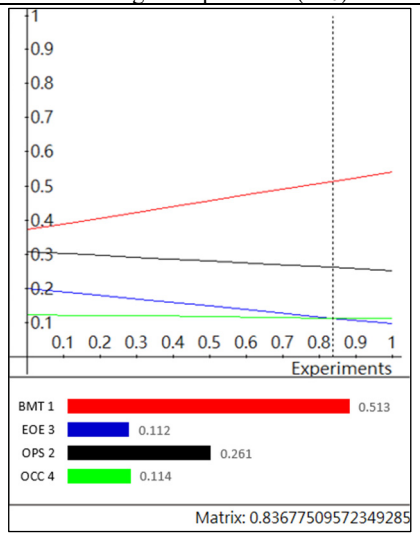
Developing a digital business strategy (SC_4)



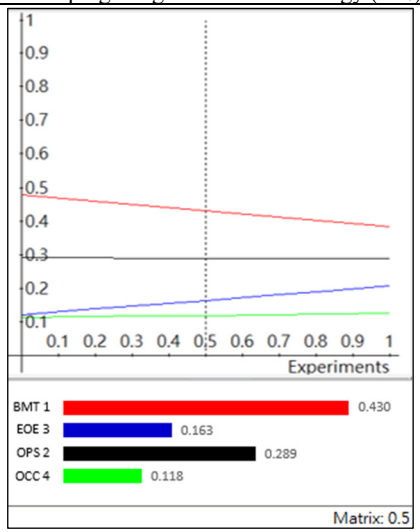
The legal of a country business infrastructural (SC_5)



Digital consumer demand (SC_6)

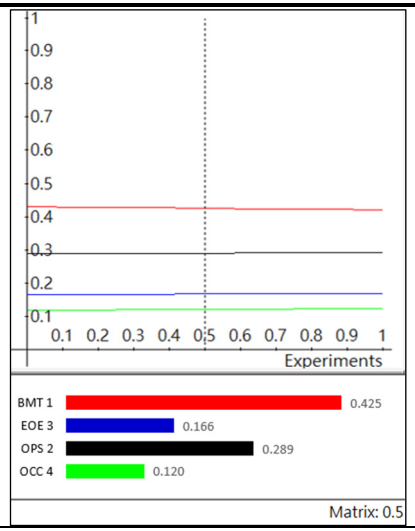


Forecasting customer needs (SC_7)

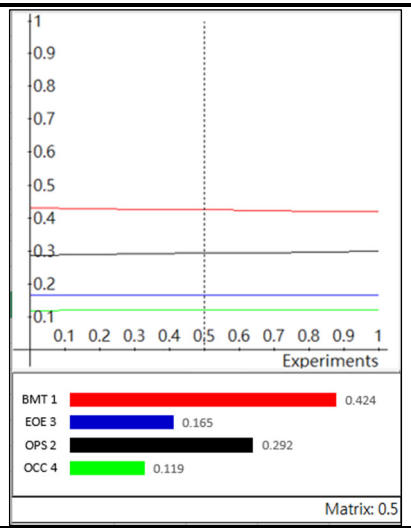


Digitalized customer preferences (SC_8)

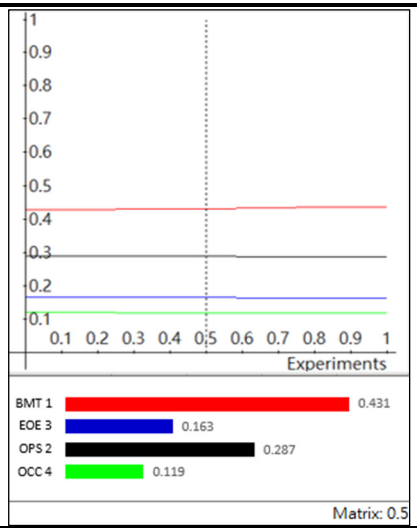
Figure 6. The sensitivity of sub-criteria (SC_1–SC_8).



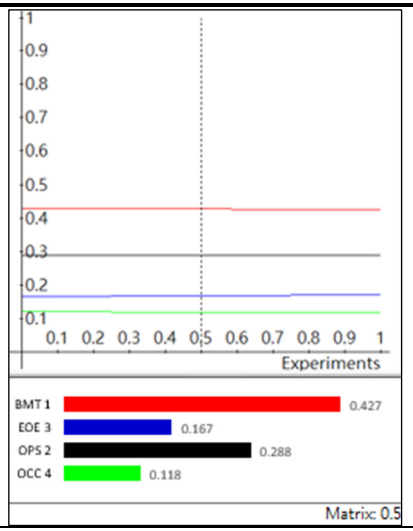
Big data analysis capabilities (SC_9)



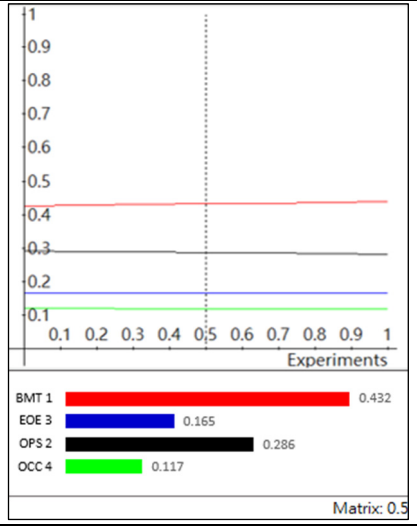
The accessibility of large volumes of data (SC_{10})



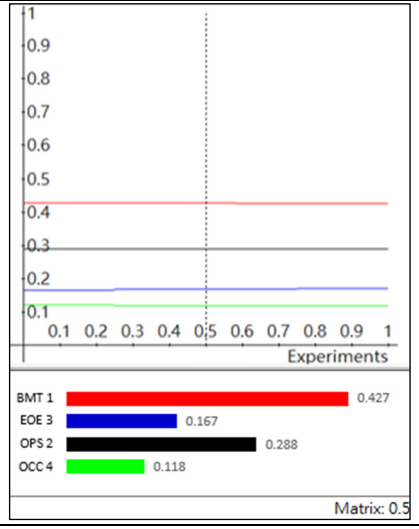
Emerging digital technology (SC_{11})



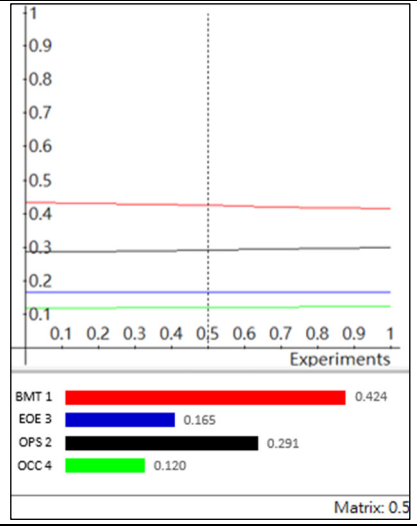
Resilient against risk (SC_{12})



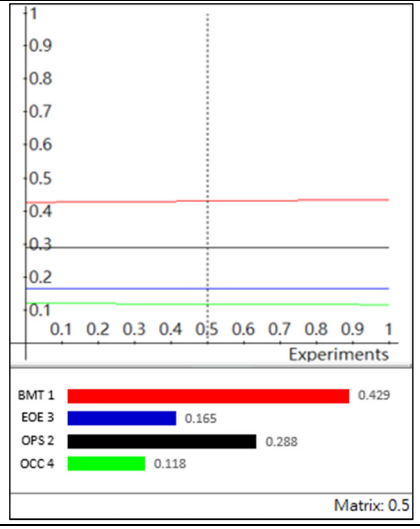
Leadership (SC_{13})



The extent to which its core products can be digitized (SC_{14})

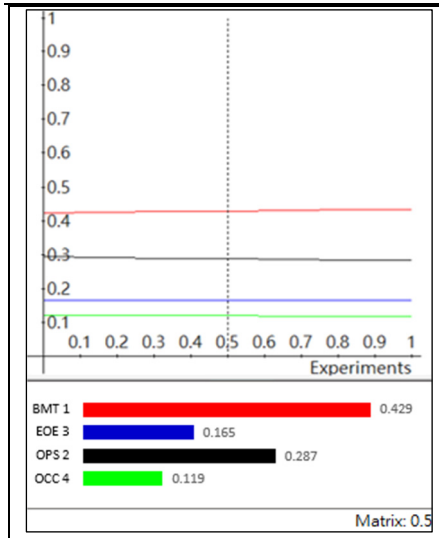


Recognizing opportunities to difference from competitors (SC_{15})

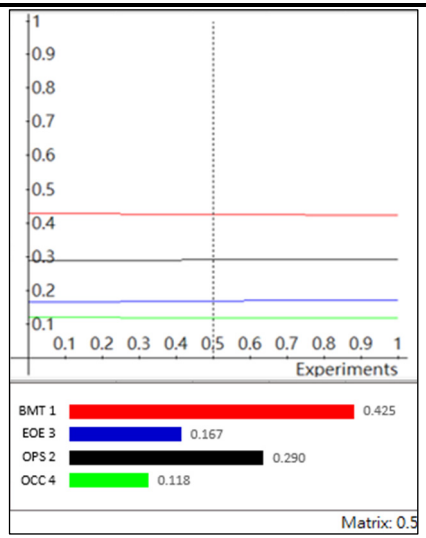


Reputation (SC_{16})

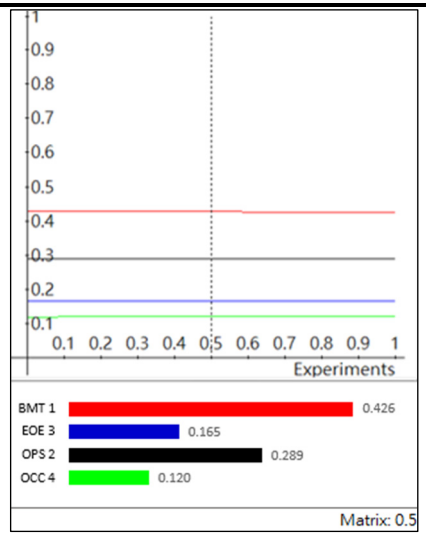
Figure 7. The sensitivity of sub-criteria (SC_9–SC_{16}).



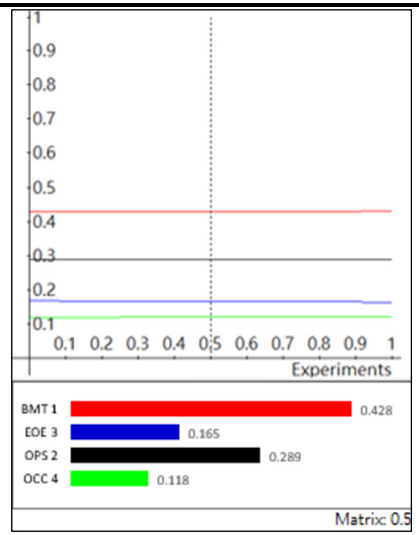
Staying competitive (SC_{17})



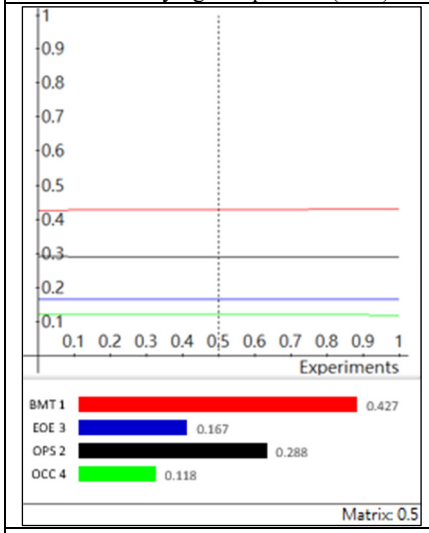
Cost reductions (SC_{18})



Ability to finance a DT (SC_{19})



Budget planning (SC_{20})



Return on investment (SC_{21})

Figure 8. The sensitivity of sub-criteria (SC_{17}–SC_{21})

4. Implications

4.1. Theoretical implications

This research makes several significant contributions to DT theory in the tourism context. The integrated Delphi-AHP-Sensitivity framework advances our theoretical understanding of strategy selection mechanisms by demonstrating how multiple evaluation methodologies can be synthesized to create a more robust decision-making model. The identification of "BMT" as the optimal strategy extends existing DT theory by empirically validating the primacy of business model innovation in the tourism sector's digital evolution.

Furthermore, our sensitivity analysis results regarding the influence of "Business Processes" and "Digital Consumer Demand" contribute to transformation theory by revealing the dynamic interplay between operational and market-facing aspects of DT. This theoretical insight challenges the traditional static view of transformation strategy selection and suggests a more fluid, context-dependent approach to strategic decision-making. The research also extends theoretical frameworks by demonstrating how the relative importance of different transformation factors can shift under varying conditions, providing a more sophisticated theoretical model for understanding strategic flexibility in DT initiatives.

4.2. Practical implications

Our findings from this study offer practical value for tourism industry stakeholders and decision-makers. Our research provides a systematic framework for evaluating and selecting DT strategies, which organizations can directly apply to their strategic planning processes. The emergence of BMT as the optimal strategy offers clear direction for tourism organizations, suggesting that they should prioritize fundamental business model innovation over isolated technological implementations or incremental operational improvements.

The sensitivity analysis results offer practical guidance for strategy adaptation, indicating that organizations should maintain flexibility in their transformation approaches based on changing market conditions and customer demands. Tourism industry practitioners can use our findings to develop more resilient transformation strategies that can adapt to shifts in consumer preferences and technological capabilities. The research also provides practical insights for resource allocation, suggesting that organizations should maintain balanced investment across different transformation dimensions while being prepared to adjust their focus based on market dynamics. The sensitivity analysis yields actionable insights for dynamic strategic management within tourism organizations. Tourism enterprises must acknowledge that optimal strategic configurations are inherently dynamic, contingent upon the evolving relative significance of market determinants rather than fixed strategic prescriptions. When digital consumer demand intensifies beyond critical thresholds, strategic priorities necessitate systematic reorientation from fundamental BMT toward immediate product-service optimization initiatives. This strategic adaptability requires organizations to cultivate organizational ambidexterity and implement sophisticated early warning systems capable of detecting market inflection points prior

to competitive recognition and response. Moreover, the threshold effects revealed through sensitivity analysis specifically 78.68% for digital consumer demand and 83.68% for forecasting customer needs establish empirically-derived benchmarks for evidence-based strategic decision-making. Organizations can operationalize these thresholds as strategic trigger mechanisms, establishing predetermined decision points that facilitate proactive strategic recalibration rather than reactive market responses. This threshold-based approach enables systematic strategic management processes that enhance organizational responsiveness while maintaining strategic coherence across dynamic market conditions.

Moreover, our findings offer practical guidance for implementation sequencing, indicating that organizations should begin with business model conceptualization before moving to technological integration and operational optimization. This sequential approach can help organizations avoid the common pitfall of technology-first transformation initiatives that fail to deliver sustainable value. The research also provides practical metrics for monitoring transformation progress, enabling organizations to assess and adjust their strategies based on measurable outcomes and changing market conditions.

5. Conclusion

Determining the most appropriate DT strategy is highly significant for the tourism industry's DT process. This research addresses this critical need by developing a comprehensive hierarchical decision support system that integrates the AHP with robust sensitivity analysis. The study reveals "BMT" as the optimal DT strategy while revealing the dynamic nature of strategic decision-making in DT contexts.

This research makes several significant theoretical contributions to the DT literature. First, we introduce a novel integrated Delphi-AHP-Sensitivity analytical framework that advances quantitative methodology for strategy evaluation in DT contexts. This methodological contribution fills a notable gap in the literature where systematic, quantitative approaches to DT strategy selection have been limited. Second, our empirical findings contribute to DT theory by demonstrating the hierarchical importance of transformation factors, with "Digitalized Customer Preferences" emerging as the paramount driver of DT success. This finding extends theoretical frameworks by providing empirical evidence for customer-centricity in DT prioritization. Finally, the sensitivity analysis results contribute to dynamic strategy theory by revealing how shifts in market conditions (specifically digital consumer demand intensity) can fundamentally alter optimal strategic choices. The identification of specific threshold points (78.68% for digital consumer demand) provides new theoretical insights into the conditional nature of strategic optimality in digital contexts.

In practical contributions, the developed decision support framework offers a systematic, replicable methodology that tourism organizations can directly implement for strategic planning and resource allocation decisions. Unlike previous conceptual frameworks, our model provides quantitative weightings and clear hierarchical priorities that enable practical application. The identification of BMT as the optimal strategy provides clear directional guidance for tourism executives, suggesting prioritization of fundamental business model innovation over incremental technological implementations. This finding helps organizations avoid the common pitfall of technology-first approaches that fail to deliver sustainable competitive advantage. The sensitivity

analysis delivers practical strategic intelligence by identifying critical decision thresholds. Tourism organizations can use the 78.68% threshold for digital consumer demand as an early warning indicator for strategic pivot points, enabling proactive strategy adjustment rather than reactive responses to market changes.

This research model serves as a decision support tool that can assist not only the tourism industry in undergoing DT but can also be adapted and applied to other industries requiring DT evaluation. The framework's emphasis on sensitivity analysis and dynamic strategy adjustment represents a significant advancement over static strategic planning approaches, highlighting the importance of adaptive strategic management in rapidly evolving digital environments.

While this study contributes valuable insights into DT strategies within the tourism sector, several methodological and contextual limitations need to be acknowledged: Our scope encompasses primarily the tourism industry within Taiwan's distinctive socio-economic context, potentially constraining the generalizability of findings across diverse geographical regions and cultural milieus. Taiwan's advanced digital infrastructure maturity and unique tourism market characteristics may not adequately represent the strategic challenges confronting tourism organizations operating within different regulatory environments, technological readiness levels, or market development stages. Additionally, while the integrated Delphi-AHP-Sensitivity framework demonstrates robust analytical capabilities for hierarchical strategy evaluation, it predominantly emphasizes hierarchical factor relationships while potentially underrepresenting complex interdependencies and network effects among transformation determinants. This methodological constraint may limit the framework's capacity to capture the full complexity of factor interactions inherent in DT ecosystems. These acknowledged limitations illuminate several compelling avenues for future scholarly investigation. First, comparative cross-national studies could empirically validate the framework's applicability across heterogeneous cultural, economic, and technological contexts. Such research endeavors could elucidate how regional variations in digital maturity indices, regulatory frameworks, and tourism industry structural configurations influence optimal transformation strategy selection and implementation outcomes. Second, methodological advancement could involve expanding the analytical framework to incorporate network analysis capabilities, thereby capturing complex factor interdependencies and synergistic effects that hierarchical models may obscure. Third, longitudinal studies could examine the temporal stability of identified strategic priorities and threshold effects across market cycles and technological evolution phases.

Author contributions

Dr. Chen: Conceptualization, Investigation Supervision, Review & Editing.
Dr. Lin: Conceptualization, Methodology, Software, Review & Editing.
Dr. Peng: Data Curation, Formal analysis, Writing-Review.

Use of Generative-AI tools declaration

The authors used ChatGPT for language polishing during manuscript preparation. All AI-assisted content was critically reviewed and revised by the authors, who take full responsibility for the final version.

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Conflict of interest

Ethical Approval: Not Applicable.
Availability of supporting data: Not Applicable.
Competing interests: Not Applicable.
Funding: Not Applicable.
Acknowledgments: Not Applicable.

Reference

1. M. Sebastian, J. W. Ross, C. Beath, M. Mocker, K. G. Moloney, N. O. Fonstad, How big old companies navigate digital transformation, *Strategic information management*, Routledge, 133–150, 2020. https://doi.org/10.4324/9780429286797-6
2. G. Oestreicher-Singer, L. Zalmanson, Content or community? A digital business strategy for content providers in the social age, *MIS Quarterly*, **37** (2013), 591–616. https://doi.org/10.25300/MISQ/2013/37.2.12
3. N. V. Olsen, K. Christensen, Social media, new digital technologies and their potential application in sensory and consumer research, *Curr. Opin. Food Sci.*, **3** (2015), 23–26. https://doi.org/10.1016/j.cofs.2014.11.006
4. Haleem, M. Javaid, M. A. Qadri, R. Suman, Understanding the role of digital technologies in education: A review, *Sustainable Oper. Comput.*, **3** (2022), 275–285. https://doi.org/10.1016/j.susoc.2022.05.004
5. K. Schwertner, Digital transformation of business, *Trakia J. Sci.*, **15** (2017), 388–393. https://doi.org/10.15547/tjs.2017.s.01.065
6. S. Khalil, A. Kallmuenzer, S. Kraus, Visiting museums via augmented reality: an experience fast-tracking the digital transformation of the tourism industry, *Eur. J. Innovation Manage.*, **27** (2024), 2084–2100. https://doi.org/10.1108/EJIM-09-2022-0479
7. L. Seres, V. Pavlicevic, P. Tumbas, *Digital transformation of higher education: Competing on analytics*, In: INTED2018 Proceedings, 2018, 9491–9497. https://doi.org/10.21125/inted.2018.2348
8. T. Borangiu, D. Trentesaux, A. Thomas, P. Leitão, J. Barata, Digital transformation of manufacturing through cloud services and resource virtualization, *Comput. Ind.*, **108** (2019), 150–162. https://doi.org/10.1016/j.compind.2019.01.006
9. T. Clohessy, T. Acton, L. Morgan, The impact of cloud-based digital transformation on IT service providers: evidence from focus groups, *Int. J. Cloud Appl. Comput.*, **7** (2017), 1–19. https://doi.org/10.18690/978-961-286-043-1.9

10. A. Zimmermann, R. Schmidt, K. Sandkuhl, M. Wißotzki, D. Jugel, M. Möhring, *Digital enterprise architecture-transformation for the internet of things*, In: 2015 IEEE 19th International Enterprise Distributed Object Computing Workshop, 2015, 130–138. https://doi.org/10.1109/EDOCW.2015.16
11. H. Bekele, S. Raj, Digitalization and digital transformation in the tourism industry: a bibliometric review and research agenda, *Tourism Rev.*, **80** (2024), 894–913. https://doi.org/10.1108/TR-07-2023-0509
12. P. Soto-Acosta, COVID-19 pandemic: Shifting digital transformation to a high-speed gear, *Inf. Syst. Manage.*, **37** (2020), 260–266. https://doi.org/10.1080/10580530.2020.1814461
13. N. Hernández Sánchez, J. Oskam, A "new tourism cycle" on the Canary Islands: scenarios for digital transformation and resilience of small and medium tourism enterprises, *J. Tourism Futures*, **11** (2025), 6–22. https://doi.org/10.1108/JTF-04-2022-0132
14. N. Liu, Q. Xu, M. Gao, Digital transformation and tourism listed firm performance in COVID-19 shock, *Finance Res. Lett.*, **63** (2024), 105398. https://doi.org/10.1016/j.frl.2024.105398
15. World Tourism Organization. European Union Tourism Trends. 2024. Available from: https://ec.europa.eu/growth/tools-databases/vto/content/2018-eu-tourism-trends-report
16. Tourism Victoria Association. Overall overview of global tourism in 2020 Q1. 2024. Available from: https://www.tva.org.tw/Trends_detail/57da9049b8294bf2beed0dca49e4890e
17. J. Pesonen, Management and leadership for digital transformation in tourism, *Handbook of e-Tourism*, Springer, 1–34, 2020. https://doi.org/10.1007/978-3-030-05324-6_68-1
18. S. Barykin, I. Kapustina, S. Sergeev, O. Kalinina, V. Vilken, E. De la Poza, et al., Developing the physical distribution digital twin model within the trade network, *Acad Strategic Manage. J.*, **20** (2021), 1–24.
19. M. Fitzgerald, N. Kruschwitz, D. Bonnet, M. Welch, Embracing digital technology: A new strategic imperative, *MIT Sloan Manage. Rev.*, **55** (2014), 1.
20. H. Zhang, C. Wu, Z. Zhang, Y. Zhu, H. Lin, Z. Zhang, et al., *Resnest: Split-attention networks*, In: Proceedings of the IEEE/CVF conference on computer vision and pattern recognition, 2022, 2736–2746. https://doi.org/10.1109/CVPRW56347.2022.00309
21. C. Matt, T. Hess, A. Benlian, Digital transformation strategies, *Bus. Inf. Syst. Eng.*, **57** (2015), 339–343. https://doi.org/10.1007/s12599-015-0401-5
22. G. Westerman, D. Bonnet, A. McAfee, *Leading digital: Turning technology into business transformation*, Harvard Business Press, 2014.
23. Y. Guseva, A conceptual framework for digital-asset securities: Tokens and coins as debt and equity, *Md. L. Rev.*, **80** (2020), 166.
24. S. Reddy, W. Reinartz, Digital transformation and value creation: Sea change ahead. *NIM Mark. Intell. Rev.*, **9** (2017), 10. https://doi.org/10.1515/gfkmir-2017-0002
25. J. Marinko, A. Ivanovska, M. Marzidovšek, M. Ramsden, M. Debeljak, Incentives and barriers to adoption of decision support systems in integrated pest management among farmers and farm advisors in Europe. *Int. J. Pest Manage.*, **71** (2025), 449–468. https://doi.org/10.1080/09670874.2023.2244912

26. S. Vaska, M. Massaro, E. M. Bagarotto, F. Dal Mas, The Digital Transformation of Business Model Innovation: A Structured Literature Review. *Front. Psychol.*, **11** (2020), 539363. https://doi.org/10.3389/fpsyg.2020.539363
27. J. Almaazmi, M. Alshurideh, B. Al Kurdi, S. A. Salloum, The effect of digital transformation on product innovation: A critical review, *International conference on advanced intelligent systems and informatics*, Springer, 731–741, 2020. https://doi.org/10.1007/978-3-030-58669-0_65
28. G. Frank, G. H. Mendes, N. F. Ayala, A. Ghezzi, Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective, *Technol. Forecast. Social Change*, **141** (2019), 341–351. https://doi.org/10.1016/j.techfore.2019.01.014
29. Mavlutova, A. Spilbergs, A. Verdenhofs, A. Natrins, I. Arefjevs, T. Volkova, Digital transformation as a driver of the financial sector sustainable development: An impact on financial inclusion and operational efficiency, *Sustainability*, **15** (2022), 207. https://doi.org/10.3390/su15010207
30. K. Vey, T. Fandel-Meyer, J. S. Zipp, C. Schneider, Learning & development in times of digital transformation: Facilitating a culture of change and innovation, *Int. J. Adv. Corp. Learn.*, **10** (2017), 22–32. https://doi.org/10.3991/ijac.v10i1.6334
31. C. Rojas-Zerpa, J. M. Yusta, Application of multicriteria decision methods for electric supply planning in rural and remote areas, *Renewable Sustainable Energy Rev.*, **52** (2015), 557–571. https://doi.org/10.1016/j.rser.2015.07.139
32. S. Yedla, R. M. Shrestha, Multi-criteria approach for the selection of alternative options for environmentally sustainable transport system in Delhi, *Transp. Res. Part A: Policy Pract.*, **37** (2003), 717–729. https://doi.org/10.1016/S0965-8564(03)00027-2
33. W. Sung, Application of Delphi method, a qualitative and quantitative analysis, to the healthcare management, *J. Healthcare Manage.*, **2** (2001), 11–19.
34. C. R. Wu, C. T. Lin, H. C. Chen, Evaluating competitive advantage of the location for Taiwanese hospitals, *J. Inf. Optim. Sci.*, **28** (2007), 841–868. https://doi.org/10.1080/02522667.2007.10699777
35. F. Hasson, S. Keeney, Enhancing rigour in the Delphi technique research, *Technol. Forecast. Social Change*, **78** (2011), 1695–1704. https://doi.org/10.1016/j.techfore.2011.04.005
36. S. Ranganathan, Alloyed pleasures: Multimetallic cocktails, 2003.
37. M. Hansen, P. Kraemmergaard, L. Mathiassen, Rapid adaptation in digital transformation: a participatory process for engaging IS and business leaders, *MIS Q. Exec.*, **10** (2011).
38. A. Hanelt, R. Bohnsack, D. Marz, C. Antunes, Marante A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change, *J. Manage. Stud.*, **58** (2021), 1159–1197. https://doi.org/10.1111/joms.12639
39. S. K. Sia, C. Soh, P. Weill, How DBS bank pursued a digital business strategy, *MIS Q. Exec.*, **15** (2016), 105.
40. E. Brynjolfsson, Y. J. Hu, M. S. Rahman, Competing in the age of omnichannel retailing, *MIT Sloan Manage. Rev.*, **54** (2013).

41. A. Benlian, W. J. Kettinger, A. Sunyaev, T. J. Winkler, G. Editors, The transformative value of cloud computing: a decoupling, platformization, and recombination theoretical framework, *J. Manage. Inf. Syst.*, **35** (2018), 719–739. https://doi.org/10.1080/07421222.2018.1481634
42. S. Kraus, P. Jones, N. Kailer, A. Weinmann, N. Chaparro-Banegas, N. Roig-Tierno, Digital transformation: An overview of the current state of the art of research, *Sage Open*, **11** (2021), 21582440211047576. https://doi.org/10.1177/21582440211047576
43. G. Rekettye, G. Rekettye Jr, The effects of digitalization on customer experience, *ENTRENOVA-ENTerprise REsearch InNOVAtion*, **5** (2019), 340–346. https://doi.org/10.2139/ssrn.3491767
44. Hausladen, T. Zipf, Competitive differentiation versus commoditisation: The role of big data in the European payments industry, *J. Payments Strategy Syst.*, **12** (2018), 266–282. https://doi.org/10.69554/NNRV3506
45. G. Tian, B. Li, Y. Cheng, Does digital transformation matter for corporate risk-taking? *Finance Res. Lett.*, **49** (2022), 103107. https://doi.org/10.1016/j.frl.2022.103107
46. G. Sainger, Leadership in digital age: A study on the role of leader in this era of digital transformation, *Int. J. Leadership*, **6** (2018), 1.
47. L. Wessel, A. Baiyere, R. Ologeanu-Taddei, J. Cha, T. Blegind-Jensen, Unpacking the difference between digital transformation and IT-enabled organizational transformation, *J. Assoc. Inf. Syst.*, **22** (2021), 102–129. https://doi.org/10.17705/1jais.00655
48. R. Agarwal, G. Gao, C. DesRoches, A. K. Jha, Research Commentary—The Digital Transformation of Healthcare: Current Status and the Road Ahead, *Inf. Syst. Res.*, **21** (2010), 796–809. https://doi.org/10.1287/isre.1100.0327
49. N. Ivanova, G. Morunova, V. Fedosov, S. Kuzmina, M. Kankulova, Long-Term Budget Planning Based on Simulation Models in the Context of Digital Transformation of Global Markets, *Econ. Issues Probl. Perspect.*, 25, 2022.
50. C. Ebert, C. H. C. Duarte, Digital transformation, *IEEE Softw*, **35** (2018), 16–21. https://doi.org/10.1109/MS.2018.2801537
51. C. Baden-Fuller, V. Mangematin, Business models: A challenging agenda, *Strategic Organ.*, **11** (2013), 418–427. https://doi.org/10.1177/1476127013510112
52. V. Sabatier, V. Mangematin, T. Rousselle, From recipe to dinner: business model portfolios in the European biopharmaceutical industry, *Long Range Plann.*, **43** (2010), 431–447. https://doi.org/10.1016/j.lrp.2010.02.001
53. M. Kotarba, Digital transformation of business models, *Found. Manage.*, **10** (2018), 123–142. https://doi.org/10.2478/fman-2018-0011
54. M. Münster, T. Meiren, Internet-basierte Services im Maschinen-und Anlagenbau, 2011.
55. L. Baines, H. Lightfoot, O. Benedettini, J. M. Kay, The servitization of manufacturing: a review of literature and reflection on future challenges, *J. Manuf. Technol. Manage.*, **20** (2009), 547–567. https://doi.org/10.1108/17410380910960984
56. G. Lay, Servitization in industry: Springer, 2014. https://doi.org/10.1007/978-3-319-06935-7
57. A. Tukker, U. Tischner, Product-services as a research field: past, present and future. Reflections from a decade of research, *J. Cleaner Prod.*, **14** (2006), 1552–1556. https://doi.org/10.1016/j.jclepro.2006.01.022

58. T. Boyt, M. Harvey, Classification of industrial services: A model with strategic implications, *Ind. Mark. Manage.*, **26** (1997), 291–300. https://doi.org/10.1016/S0019-8501(96)00111-3
59. D. Tilson, K. Lyytinen, C. Sørensen, Research commentary—Digital infrastructures: The missing IS research agenda, *Inf. Syst. Res.*, **21** (2010), 748–759. https://doi.org/10.1287/isre.1100.0318
60. Y. Yoo, O. Henfridsson, K. Lyytinen, Research commentary—the new organizing logic of digital innovation: an agenda for information systems research, *Inf. Syst. Res.*, **21** (2010), 724–735. https://doi.org/10.1287/isre.1100.0322
61. C. Boynton, R. W. Zmud, Information technology planning in the 1990's: Directions for practice and research, *MIS Q.*, **11** (1987), 59–71. https://doi.org/10.2307/248826
62. J. Punnett, D. A. Ricks, International business, 1997.
63. H. Hallikainen, B. Paesbrugghe, T. Laukkanen, D. Rangarajan, M. Gabrielsson, *How Individual Technology Propensities and Organizational Culture Influence B2B (Business to Business) Customer's Behavioral Intention to Use Digital Services at Work*, In: Proceedings of the 50th Hawaii International Conference on System Sciences, 2017, https://doi.org/10.24251/HICSS.2017.552
64. E. Mu, What Constitutes a Novel AHP/ANP Study? *Int. J. Analytic Hierarchy Process*, **9** (2017). https://doi.org/10.13033/ijahp.v9i1.483
65. E. Altan, Z. Işık, Digital twins in lean construction: a neutrosophic AHP–BOCR analysis approach. *Eng. Constr. Archit. Manage.*, **31** (2024), 5029–5056. https://doi.org/10.1108/ECAM-11-2022-1115
66. A. Petrillo, V. A. P. Salomon, C. L. Tramarico, State-of-the-art review on the analytic hierarchy process with benefits, opportunities, costs, and risks, *J. Risk Financial Manag.*, **16** (2023), 372. https://doi.org/10.3390/jrfm16080372
67. V. A. P. Salomon, L. F. A. M. Gomes, Consistency improvement in the analytic hierarchy process, *Mathematics*, **12** (2024), 828. https://doi.org/10.3390/math12060828
68. I. Tukenmez, Z. Kamisli Ozturk, Enhancing wildfire response through drone selection: a BOCR-based multi-criteria approach. *Int. J. Environ. Sci. Technol.*, **22** (2025), 1–12. https://doi.org/10.1007/s13762-025-06682-0
69. T. L. Saaty, How to make a decision: The analytic hierarchy process, *Eur. J. Oper. Res.*, **48** (1990), 9–26. https://doi.org/10.1016/0377-2217(90)90057-i

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