Tourism digital transformation and future supply chain competition: an integrated perspective on real options theory and digital competencies

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Abstract

Purpose – This study analyzes how digital technologies collaboration, and technological capabilities affect tourism products' advantage and supply chain resilience via virtual integration and customer service capabilities.

Design/methodology/approach – To achieve the goals of this study, a digital transformation model was formulated based on the real option theory (ROT) and digital competencies perspective. Data were collected from travel agencies in Taiwan. This study uses the partial least square structural equation modeling (PLS-SEM) technique to analyze the research model, and 384 samples were collected from travel agencies for analysis.

Findings – The research results point out that digital technology collaboration and technical capabilities affect virtual integration and customer service capabilities; customer service capabilities should also be regarded as key influencing variables to improve tourism product advantages and supply chain flexibility.

Originality/value – This study shares a unique perspective on the digital transformation model, which includes antecedents, mediators and moderators, to construct the critical effects for analyzing the tourism products' advantage and supply chain resilience.

Keywords Digital transformation, Tourism products advantage, Tourism supply chain resilience, Real options theory, Digital competencies

Paper type Research paper

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1. Introduction

Digital transformation is one of the leading innovative approaches for tourism enterprises to solve operational issues and strategic opportunities (Sánchez and Oskam, 2022; Woolley and Lim, 2023); the digital transformation of tourism enterprises has solved operational issues and strategic opportunities and leveraged data analytics to gain insights into customer behavior, preferences, and market trends, enabling better decision-making.

This study aims to understand how using and collaborating with digital technologies affects the advantages of tourism products and the ability to address tourism supply chain challenges. The *gaps* between the study and prior research include prior research focused on the digital marketing of tourism enterprises (Dewantara *et al.*, 2022; Gutierriz *et al.*, 2023); that research needs more exploration into the impact of digital transformation on tourism supply chain competition. On the other hand, many studies have emphasized that digital transformation is an essential strategy for tourism enterprises facing the threats and challenges of the epidemic (Sánchez and Oskam, 2022; Tang and Huang, 2023). Furthermore, few studies have discussed the role of technology

interoperability in the advantages of tourism products and supply chain resilience; technology compromise will influence the digital transformation of tourism enterprises.

Continuing the research scope, the study will discuss the advantages of tourism products and the resilience of the tourism supply chain. Specifically, this study will explore and analyze the following issues:

RQ1. What factors related to enterprises' digital competence can affect travel agencies' tourism product advantage and tourism supply chain resilience?

RQ2. Does technology interoperability moderate travel agencies' tourism product advantage and tourism supply chain resilience?

Digital transformation is enterprises using new digital technologies to achieve significant business or process improvements (Kraus *et al.*, 2022). Previous studies stated that tourism enterprises use digital technologies to accelerate disruption at the industrial and social levels (Tsou and Chen, 2023); digital technologies play a nucleus role in digital transformation.

Digital transformation enables travel agencies to offer a more customer-centric and personalized experience (Ivanova *et al.*, 2022). Accordingly, real options theory (ROT) is based on a financial perspective; it analyzes managers' perspectives when evaluating investment decisions (Sharma *et al.*, 2022); the digital transformation of travel agencies requires substantial amounts of capital and mature collaboration in digital technologies (Tsou and Chen, 2023); travel agencies should evaluate their technological capabilities (Cheng *et al.*, 2023) in digital transformation.

Digital technologies transactions are significant for travel agencies that operate multi-channel services (Huang *et al.*, 2022; Ku, 2023b) within the tourism supply chain; the emergence of digital technologies enables suppliers to establish virtual integration (Jean *et al.*, 2020) and attach great importance to customer service capabilities (Abadie *et al.*, 2023) based on the perspective of virtual competence. Furthermore, technology interoperability and data processing capabilities are critical aspects that enterprises need to consider (Ali *et al.*, 2022b) when adopting digital transformation.

To achieve the goals of this study, a digital transformation model based on ROT and digital competencies was proposed. Data were collected from travel agencies in Taiwan. This study uses the partial least square structural equation modeling (PLS-SEM) technique to analyze the research model; research findings will help tourism businesses carefully consider digital transformation strategies.

2. Literature review

2.1 Theoretical background

2.1.1 Real options theory and digital transformation. ROT provides a powerful and persuasive theoretical perspective on technology investment (Singh *et al.*, 2017); the theory focuses on helping enterprises make correct decisions under uncertainty (Wu and Ku, 2024). Likewise, government policies, investment in technologies, and technological turbulence will affect the digital transformation of tourism enterprises.

ROT emphasizes identifying the ability to process multiple pieces of information to implement the selected option effectively (Irwin *et al.*, 2022; Salvoldi and Brock, 2023). Previous research has pointed out that digital transformation requires mature **digital technologies collaboration** (Tsou and Chen, 2023), and tourism enterprises should evaluate their **technological capabilities** and calculate the benefit-cost ratio (Cheng *et al.*, 2023) to formulate better digital transformation strategies.

2.1.2 Digital competencies of digital transformation. Digital competencies can be broadly defined as the ability of members of an organization to confidently and critically (Alam *et al.*, 2018); digital technologies interact with consumers and provide services by travel agencies (Calvaresi *et al.*, 2023;

Huang *et al.*, 2022; Ku, 2023a), inter-organizational systems (IOS) collaborative tourism industry conducts more information technology-based cross-organizational remote collaboration (Ku, 2023b) and responds to real-time market changes.

The emergence of digital technologies enables suppliers to establish **virtual integration** (Jean *et al.*, 2020), and digital transformation attaches significant importance to **customer service capabilities** (Abadie *et al.*, 2023) because it is of great significance to the multi-channel service operation management of travel agencies.

2.2 Hypotheses development

2.2.1 Digital technologies collaboration. Digital technology collaboration embodies information exchange and transactions across organizations, distributed ledgers, and shared infrastructure (Tsou and Chen, 2023). Verstegen *et al.* (2019) stated that enterprises' use of digital technologies is reflected in at least three aspects: enterprises use new digital technologies to achieve corporate goals and the processes of digitally innovative enterprises.

The impact of digitalization included internal and external collaboration in innovation activities; Moschko and Blazevic (2023) argued that internal partnership refers to the internal integration of digital technologies and will affect cooperation, representation, and contribution of the company's innovation activities, Eslami *et al.* (2023) stated that external collaboration creates value and innovation through the application of digital technologies in the context of digitalization.

2.2.2 Virtual integration. Virtual integration includes the concepts of user intention and virtual governance, and it has two aspects: coordination and cooperation (Jean *et al.*, 2020); virtual integration in the context of digital transformation refers to the seamless integration of various digital technologies, processes, and data across an organization (Jean *et al.*, 2020) to enhance collaboration, efficiency, and innovation.

Past research has pointed out that the relationship between travel agencies' digital technologies collaboration and their virtual integration is closely related to the evolving landscape of the tourism industry (Rashed and Mutis, 2023; Runck *et al.*, 2022) and digital technologies will reshape the future of tourism industry (Elia *et al.*, 2020; Hamann-Lohmer *et al.*, 2023).

Virtual integration will also moderate the impact of digital technologies on customer-supplier relationships in the tourism supply chain; by utilizing digital technologies, travel agencies can provide tourists with a more convenient and personalized service; the following hypothesis is proposed:

> *H1.* Digital technologies' collaboration with enterprises is positively associated with their virtual integration.

2.2.3 Customer service capabilities. Customer service capabilities can be seen as an enterprise's ability to meet customer needs through its existing service portfolio under digital competition (Sok *et al.*, 2018); they are also essential to service marketing to assess the service representatives they supervise (Ali *et al.*, 2022a; Bani-Melhem *et al.*, 2021).

Previous research has stated that enterprises can improve customer service capabilities and productivity by using digital technologies (Adhiatma *et al.*, 2023; Almunawar and Anshari, 2022); for example, Halpern *et al.* (2021) pointed out that using digital technologies at critical stages of the airport journey can enhance passengers' travel experience.

Digital technology collaboration using IOS will provide real-time updates, help tourists through chat or messaging apps, and continually gather feedback to improve travel services. We argued that digital technologies will enhance the customer service capabilities of travel agencies and are essential to assist such customer engagement and aggregate market knowledge effectively. This leads to hypothesis 2:

H2. Enterprises' digital technologies collaboration is positively associated with their customer service capabilities.

2.2.4 Technological capabilities. Technological capabilities refer to the skills, knowledge, expertise, and resources possessed by organizations or societies to effectively use and develop technology for various purposes (Ku, 2022b). This will help the enterprise collect consumer knowledge and share market transaction information through different cooperation channels (Abdelaziz *et al.*, 2023; Wu and Ku, 2024), which can increase enterprises' capabilities to integrate the collaborative relationship.

The relationship between travel agents' technological capabilities and their virtual integration is integral to transforming the tourism industry (Bhattacharya *et al.*, 2022; Chen *et al.*, 2023). Enterprises' technological capabilities are increasingly considered critical (Hadjielias *et al.*, 2022; Romero *et al.*, 2023), and their virtual integration is increasingly regarded as critical for maintaining a long-term joint competitive advantage.

Digital transformation of travel agencies are embracing and harnessing technologies to provide a seamless, customer-focused travel experience. Furthermore, travel agencies can leverage virtual collaboration tools to communicate with tourists through various digital channels by using data analytics to gain insights into customer behavior, market trends, and booking patterns. This leads to hypothesis 3:

H3. Technological capabilities of enterprises are positively associated with their virtual integration.

Collaborative technology and knowledge sharing between enterprises is fundamental, especially the core planning and control processes between cooperative enterprises; this will enable managers to cope with the technical complexities of tourism business operations (Hadjielias *et al.*, 2022; Romero *et al.*, 2023). Likewise, Hadjielias *et al.* (2022) found that tourism enterprises leverage digital technologies to generate and deliver customer value through customer service agility while coping with inherent tensions.

The more advanced their technological capabilities, the more effectively travel agencies can bridge the digital and physical aspects of travel, creating a cohesive and convenient virtual journey for their tourists; likewise, technological capabilities allow travel agents to access vast information about travel options, destinations, and customer preferences, and travel agencies need technological capabilities to share and connect with other partner companies in the market to achieve inter-organizational interactions. This leads to hypothesis 4:

H4. The technological capabilities of enterprises are positively associated with their customer service capabilities.

2.2.5 The tourism products advantage. Advantages in tourism products refer to the superiority and uniqueness of the product in terms of quality and efficiency compared with other products in the tourism market (Cui and Wu, 2017); highly innovative tourism products will have more advantages when tourists feel they are more suitable and meet their needs.

Virtual integration represents the integration of suppliers through digital technologies to achieve closer supply chain collaboration and replace ownership with partnership (Asamoah *et al.*, 2021; Tang and Zhang, 2022); prior studies have pointed out that virtual integration is significantly related to tourism product selection (Zhang *et al.*, 2023). Virtual customer integration also provides customers with the experience of participating in the new product development process (Kulkov *et al.*, 2023), which is conducive to innovative product advantages.

Virtual integration in the tourism industry will enhance the customer experience, offering a broader range of services, personalizing offerings, providing real-time information, reducing costs, and

improving adaptability. In a highly competitive tourism market, travel agencies that leverage virtual integration are more likely to succeed and outperform their rivals. This leads us to our hypothesis 5.

H5. Virtual integration of enterprises is positively associated with their tourism product advantage.

2.2.6 Tourism supply chain resilience. Tourism supply chain resilience is defined as the operational capabilities of enterprises within the supply chain system to return to their original state or shift to a new, more ideal state after being disrupted (Ghaderi *et al.*, 2023; Mandal and Dubey, 2020); eliminating any waste and reducing costs for tourism enterprises will bring greater flexibility and resilience to the tourism supply chain in a complex environment and comply with the lean supply chain paradigm.

The benefits of virtual integration drive enterprises to construct rational choices in the supply chain, further ensuring the maintenance of willingness to share knowledge and enhancing the supply chain's resilience (Chen and Huang, 2023); Sheng and Saide (2021) stated that enterprises' big data analysis through virtual integration had become a key strategy to achieve the viability of the tourism supply chain.

Virtual integration allows tourism enterprises to have real-time visibility into their supply chains. Virtual integration equips tourism enterprises with the tools and capabilities to respond proactively and effectively to disruptions while enhancing their overall supply chain resilience; by leveraging digital technologies and integrated systems, businesses in the tourism sector can better prepare for, withstand, and recover from unforeseen events and challenges. Therefore, this leads to hypothesis 6:

H6. Virtual integration of enterprises is positively associated with tourism supply chain resilience.

Prior research argued that exceptional customer service can differentiate tourism products from others in the market (Ko *et al.*, 2023), high-quality customer service creates a positive and memorable experience for tourists (Moliner-Tena *et al.*, 2023; Zhou *et al.*, 2023), and indicated customer service capabilities of enterprises and their competitive advantage in the tourism industry is highly significant (Lee *et al.*, 2022).

Travel agencies' customer service capabilities offer tourists personalized recommendations, itineraries, and services; a knowledgeable and well-trained customer service travel agency can provide valuable information and guidance to tourists. This leads to hypothesis 7:

H7. Customer service capabilities of enterprises are positively associated with their tourism product advantage.

Customer service capabilities often involve collecting and analyzing data about customer preferences and behaviors. These analytical competencies can be applied to supply chain data (Buhalis *et al.*, 2019; Zhang *et al.*, 2019); customer service capabilities will significantly contribute to the resilience of the tourism supply chain (Liu *et al.*, 2022), aiding in making data-driven decisions that enhance resilience.

The adaptability of customer service capabilities extends to the tourism supply chain, where the flexibility to adjust to disruptions or changing market conditions can enhance resilience. Travel agencies with solid customer service capabilities are better positioned to navigate and recover from supply chain disruptions, contributing to their overall resilience. Thus, hypothesis 8 is proposed as follows:

H8. Customer service capabilities of enterprises are positively associated with tourism supply chain resilience.

Competitive tourism products are often designed to operate efficiently and adapt quickly to changing market conditions (Kim *et al.*, 2016); these attributes can translate into more agile and adaptable supply chain practices (Vives and Ostrovskaya, 2023), helping tourism businesses respond to disruptions more effectively.

A competitive advantage may allow tourism businesses to work with a broader range of suppliers, and competitive tourism products are technologically advanced. These technologies can improve supply chain management and communication, leading us to our hypothesis 9.

> *H9.* The advantage of tourism products is positively associated with resilience in the supply chain.

2.2.7 The moderating effects of technology interoperability. Technology interoperability refers to the ability of different information communication systems (Hsu *et al.*, 2019) and electronic data applications to communicate, exchange data, and use existing information exchange capabilities; Hsu *et al.* (2019) stated that digital technology interoperability refers to the degree to which new digital technologies will be integrated with existing internal and external knowledge components of the enterprise. High interoperability means that enterprises can achieve many service innovations and new services.

Technology interoperability ensures that different systems, applications, and platforms used for virtual integration can seamlessly exchange data (Bokolo, 2022; Jnr, 2023); this enables tourism businesses to access and utilize a wide range of tourism information (Priporas and Vellore-Nagarajan, 2022); likewise, technology interoperability allows real-time information sharing between different components of the virtual integration system (Bokolo, 2022; Lo *et al.*, 2019), which mediates the relationship between virtual integration for competitive advantage.

Technology interoperability enables real-time information sharing between different components of the virtual integration system; it ensures that tourism businesses can respond quickly and efficiently to changing market conditions, which can be a competitive advantage for tourism products. Thus, the hypothesis 10 is proposed:

> *H10.* Technology interoperability moderates the impact of virtual integration on the tourism products advantage.

Moreover, technology interoperability allows the tourism supply chain as needed (Kumar *et al.*, 2023; Wong *et al.*, 2023); interoperable systems make it easier to gather and analyze data from various sources (Pierdicca *et al.*, 2019; Solmaz *et al.*, 2019), and IOS provides consistent and effective data conversion for tourism enterprises in the tourism supply chain (Ku, 2022a, b, 2023b); transactional information can provide travel agencies with development products and efficiencies in pursuit of new markets.

Interoperable systems can aid in coordinating supply chain activities, from procurement to distribution, by ensuring that information flows smoothly; this coordination can increase the reliability and responsiveness of the supply chain, contributing to a competitive advantage. Thus, hypothesis 11 is formulated:

> *H11.* Technology interoperability moderates the impact of virtual integration on tourism supply chain resilience.

Technology interoperability ensures that customer service systems and databases seamlessly share and update information (Leung and Loo, 2022); it makes it easier to gather and analyze customer data (Weng and Hsu, 2020) and reduce operational costs (Chaturvedi and Binkley, 2021); customer service travel agencies make data-driven decisions, improve service quality, and develop strategies that set tourism products apart from competitors.

Customer service agents can access real-time data about customer preferences, past interactions, and needs to provide more personalized and effective service. This enhanced service quality can differentiate tourism products and create a competitive advantage. Hypothesis 12 is formulated.

> *H12.* Technology interoperability moderates the impact of customer service capabilities on the tourism products advantage.

Technology interoperability ensures that customer service and supply chain teams can communicate seamlessly (Bommu *et al.*, 2023; Islam *et al.*, 2023), it is essential to efficiently coordinate responses to supply chain disruptions (Rai *et al.*, 2022); furthermore, technology interoperability can support adapting supply chain processes to changing conditions or disruptions.

Technology interoperability is a critical factor in moderating the impact of customer service capabilities on tourism supply chain resilience, and it ensures that customer service and supply chain partners can communicate, share data, adapt to changing conditions, make informed decisions, and respond effectively to disruptions for the digital transformation of the tourism industry. This leads to hypothesis 13.

> *H13.* Technology interoperability moderates the impact of customer service capabilities on tourism supply chain resilience.

3. Research methodology

3.1 Research model

Based on the perspective of ROT and digital competencies, the study will draw the relationship between virtual integration, customer service capabilities, tourism product advantage, and tourism supply chain resilience. Figure 1 identifies the above key constructs and central relationships examined in the study.

3.2 Instrument development

We adopted structural descriptions from operational definitions proposed in the existing literature. According to Boudreau *et al*. (2001) recommendations, researchers should validate their instruments even if measurement items are adopted from the literature; thus, with four items of

Figure 1 Research model

Source(s): Figure by author
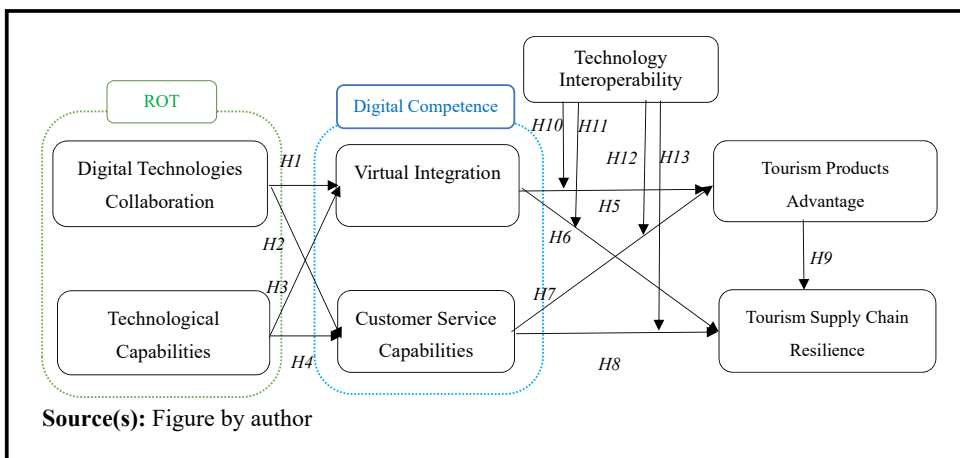
digital technologies collaboration adapted and modified from Tsou and Chen (2023), technological capabilities scales adopted from Ku (2022b), virtual integration operationalized with three items adopted by Bryan Jean *et al*. (2020), customer service capabilities with six items operationalized based on Sok *et al*. (2018), tourism products advantage, with four items operationalized from Cui and Wu (2017), and tourism supply chain resilience scales modified from Ghaderi *et al*. (2023). Lastly, technology interoperability was modified from Hsu *et al.* (2019) study using four items. Table 1 summarizes the survey items of this study.

Survey items featured a Likert 7-point rating scale for respondents to evaluate (1 = completely disagree, 7 = completely agree). This study invited two professors in the field of tourism management and two management information system experts to participate in the **pilot test**, using a double translation protocol to correct the measurement content and ensure its validity. **Next,** twenty-five employees with experience in travel agencies were invited to **pre-test** the Chinese version of the questionnaire, re-identifying faces and content validity and confirming appropriate minor wording corrections to measurements.

3.3 Sampling procedure and data collection

To reach our research purposes, the organization's technological capabilities are an essential factor (Ku, 2022b); likewise, the level of analysis in this study is the firm level. Therefore, we invited the person in charge of the travel agencies' information system to be the survey participants.

Based on statistics from the Tourism Bureau in Taiwan https://www.taiwan.net.tw/statistics; There are 2,800 travel agencies which can be classified into three categories: accounting for 4.15% of wholesalers, 87.87% of travel agencies-direct sales, and 7.98% of retailers; according to our research purpose, EMSs are adapted by travel agencies-direct sales, and wholesalers, operate ERP and stratified random sampling was adopted in the sampling method.

Thus, the priority participant we select to mail the research' questionnaire is the manager of the travel agency; otherwise, considering the classified of the travel agencies, we have confirmed the critical person who is responsible for EMSs or ERP of travel agencies in advance to use the IOS and indicate that the key person responsible for the systems' activities should be delivered to answer. In total, 1,000 travel agencies were used as the sample of the mailing questionnaire, and 384 completed questionnaires were received (return rate of 38.4%).

4. Analysis and results

4.1 Demographics of samples

Sample characteristic analysis displays that 75.8% of the travel agencies-direct sales and 55% of travel agencies employed over 51 staff. Among the participants, 54.4% had accepted IOS above 11 years; Table 2 lists the characteristics of the samples in this study.

4.2 Common method bias (CMB) and endogeneity

CMB is likely to occur when independent and dependent variables are measured simultaneously in a survey (Chin *et al.*, 2012); measurement survey items must be tested for CMB before analyzing the research model (Kock *et al.*, 2021); Harmon's single-factor test method was applied to perform CMB analysis (Baumgartner *et al.*, 2021), which revealed an explained covariance of 19.12%, it showed that no CMB was found in seven structures in this study for the seven underlying structures, indicating that no CMB was identified in this study.

In addition, cross-sectional data may lead to model misspecification, and variation within exogenous variables may be endogenous to the model (Guide and Ketokivi, 2015). The Ramsey Regression Equation Specification Error Test (RESET) test was used to evaluate the endogeneity of

Table 1	Items in survey

Constructs with references

Digital Technologies Collaboration (DTC) was adapted from Tsou and Chen (2023)
DTC1	Our company can process transaction information in a short time through digital technologies
DTC2	Our company's information system encrypts customers' personal information using a decentralized ledger
DTC3	The digital technologies of our company's infrastructure align with market standards and practices
DTC4	Our management team will develop a digital transformation strategy based on digital technology choices

Technological Capabilities (TC) was adopted from Ku (2022a, b)
TC1	IOS helps us gain market knowledge about our customers, suppliers, and competitors
TC2	Market knowledge embedded in our IOS database
TC3	Our data using the iOS solution is correct
TC4	We update systems such as intranet and electronic bulletin boards based on IOS to facilitate sharing information and knowledge
TC5	We invested in IOS to capture and manage real-time customer information and feedback
TC6	We use the IOS of the supply chain system
TC7	Compared to our competitors, we use higher-quality iOS resources
TC8	We use IOS to fully capture individual customer history, purchasing activity, and transaction issues
TC9	IOS assists our company in being able to differentiate the profitability of our clients

Virtual integration (VI) adopted by Bryan Jean *et al*. (2020)
VI1	We handle order processing and invoicing electronically with our global suppliers
VI2	We electronically monitor the quality of our products with our global supply partners
VI3	We coordinate inventory levels electronically with our global suppliers
VI4	Relying on IOS under the supply chain, we work with global suppliers to forecast and plan tourism products
VI5	Demand forecasting and planning for tourism market development with global suppliers are always available in our information system

Customer Service Capabilities (CSC) was adapted from Sok *et al*. (2018)
CSC1	We will deal with tourists' problems promptly so that tourists are satisfied with our services
CSC2	We can provide timely solutions to tourists' current travel problems
CSC3	We reliably resolve issues related to guest service received from iOS
CSC4	We will listen carefully to tourists' opinions and take appropriate actions to address their concerns about tourism services
CSC5	I will pay attention to tourists' questions about their experiences with tourism services and then use information systems to respond appropriately
CSC6	My abilities enable me to assist clients with travel service delivery questions better

Tourism Products Advantage (TPA) adapted from Cui and Wu (2017)
TPA1	The quality of tourism products offered by our company is superior to that of our competitors
TPA2	Our company provides tourism products that satisfy tourists better than our competitors
TPA3	Tourism products bring unique benefits to tourists
TPA4	The tourism products we offer our tourists outperform our competitors

Tourism Supply Chain Resilience (TSCR) was adapted from was adapted from Ghaderi *et al*. (2023)
TSCR1	My company can quickly recover its activities during a service disruption
TSCR2	My company can adapt to respond positively to operational disruptions
TSCR3	Our company has the appropriate information equipment to respond quickly to environmental disturbances
TSCR4	Our company is well-equipped to respond to temporary financial needs
TSCR5	Our company has the best capabilities to respond positively to the consequences of market changes

Technology Interoperability (TIO) was adapted from Hsu *et al*. (2019)
TIO1	Enabled two distributed processes to share selective data
TIO2	Enhanced coordination among distributed process operations
TIO3	Separated communication models of clients from those of servers
TIO4	Made explicit the common properties of interfaces and reduced the mapping task

Table 2 Sample description (384)

Characteristics		Number	Percentage (%)
Classified of travel agent	Wholesaler	93	24.2
	Travel agencies-direct sales	291	75.8
Employees	Under 10(and = 10) employees	35	9.0
	11–50	99	36.2
	51–100	132	25.7
	Over 101 employees	118	30.1
Total assets (NT$)	Less than 30 million	162	42.2
	30 million – 100 million	184	47.9
	Over 100 million	38	9.9
Experience of adapting	Under 10 (and = 10) years	175	45.6
IOS (years)	Above 11 years	209	54.4

Source(s): The author's work, derived from the statistical analysis of this study (SPSS)

the proposal model (Ramsey and Ramsey, 2006); the result represented was not an issue in the study.

4.3 Measurement model

The PLS-SEM technique (SmartPLS software Version 4.1) was applied in this study (Raza *et al.*, 2024). First, the validity and reliability of the survey items were evaluated, and factor loadings helped quantify the extent to which each observed variable loads onto or is associated with each factor. In the model, the loading of each item should be higher than the discrimination threshold of 0.70 (Li *et al.*, 2022). The reliability metric is considered the overall reliability of the acquisition, and each composite reliability (CR) of the structure must exceed the minimum standard of 0.70. Convergent validity computes the average variance extracted (AVE) for each measure concerning its latent factor. A high AVE value (typically above 0.5) indicates that the measure shares more variance with its latent factor than with measurement error (Dahl *et al.*, 2023). Table 3 lists the validity of the measurement model.

Three indexes were used to assess discriminant validity (Becker *et al.*, 2023), including the cross-loading of the measurement model, Fornell-Lacker criterion (Henseler *et al.*, 2015), and heterotrait–monotrait ratio (HTMT) method (Radomir and Moisescu, 2020); cross-loadings must be above the threshold of 0.7 to be considered acceptable for the model (Yuan *et al.*, 2023), as appeared in Table 4. Moreover, all Fornell-Lacker criterion and HTMT values are significantly lower than 1 with a confidence interval of 95% (Table 5); the Fornell-Lacker criterion, HTMT ratio, and the analysis results show that the research model has good convergent validity.

Table 3 Descriptive statistics of constructs

Constructs	Cronbach's alpha	rho_A	CR	AVE
DTC	0.917	0.918	0.941	0.801
TC	0.938	0.939	0.948	0.669
VI	0.907	0.908	0.931	0.729
CSC	0.945	0.946	0.956	0.786
TPA	0.957	0.958	0.969	0.886
TSCR	0.912	0.912	0.934	0.739
TIO	0.896	0.901	0.928	0.762

Note(s): CR: Composite Reliability; AVE: Average Variance Extracted
DTC stands for Digital Technologies Collaboration; TC for Technological Capabilities; VI for Virtual Integration; CSC for Customer Service Capabilities; TPA for Tourism Products Advantage; TSCR for Tourism Supply Chain Resilience; and TIO for Technology Interoperability
Source(s): The author's work, derived from the statistical analysis of this study (SmartPLS, Version 4)

Table 4	Cross-loadings analysis						
Item	DTC	TC	VI	CSC	TPA	TSCR	TIO
DTC1	*0.879*	0.546	0.488	0.536	0.289	0.498	0.400
DTC2	*0.919*	0.544	0.472	0.613	0.360	0.451	0.426
DTC3	*0.906*	0.503	0.423	0.617	0.424	0.424	0.419
DTC4	*0.875*	0.497	0.450	0.607	0.404	0.426	0.416
TC1	0.521	*0.833*	0.517	0.477	0.298	0.569	0.383
TC2	0.492	*0.846*	0.523	0.446	0.263	0.582	0.354
TC3	0.468	*0.827*	0.478	0.449	0.261	0.465	0.313
TC4	0.436	*0.815*	0.501	0.444	0.272	0.473	0.350
TC5	0.525	*0.808*	0.494	0.472	0.292	0.551	0.355
TC6	0.439	*0.801*	0.502	0.438	0.252	0.533	0.308
TC7	0.460	*0.814*	0.491	0.463	0.311	0.532	0.353
TC8	0.477	*0.822*	0.559	0.548	0.445	0.519	0.396
TC9	0.475	*0.793*	0.506	0.488	0.336	0.527	0.379
VI1	0.421	0.492	*0.840*	0.466	0.269	0.634	0.522
VI2	0.328	0.526	*0.848*	0.380	0.249	0.635	0.437
VI3	0.468	0.547	*0.863*	0.490	0.337	0.632	0.471
VI4	0.493	0.545	*0.851*	0.566	0.395	0.606	0.466
VI5	0.465	0.542	*0.867*	0.512	0.343	0.612	0.459
CSC1	0.559	0.479	0.466	*0.872*	0.558	0.400	0.463
CSC2	0.551	0.496	0.485	*0.893*	0.546	0.430	0.478
CSC3	0.610	0.493	0.539	*0.882*	0.570	0.451	0.539
CSC4	0.595	0.541	0.492	*0.885*	0.562	0.499	0.471
CSC5	0.618	0.529	0.542	*0.890*	0.536	0.529	0.500
CSC6	0.593	0.520	0.491	*0.895*	0.523	0.495	0.470
TPA 1	0.354	0.309	0.316	0.571	*0.940*	0.278	0.400
TPA 2	0.378	0.367	0.354	0.566	*0.935*	0.273	0.464
TPA 3	0.383	0.356	0.370	0.588	*0.956*	0.287	0.435
TPA 4	0.437	0.375	0.370	0.607	*0.935*	0.309	0.471
TSCR1	0.365	0.515	0.627	0.415	0.209	*0.847*	0.421
TSCR2	0.425	0.546	0.657	0.425	0.216	*0.890*	0.425
TSCR3	0.430	0.553	0.610	0.463	0.283	*0.847*	0.434
TSCR4	0.486	0.569	0.610	0.491	0.317	*0.844*	0.463
TSCR5	0.452	0.593	0.632	0.482	0.289	*0.870*	0.442
TIO1	0.405	0.359	0.459	0.452	0.362	0.426	*0.852*
TIO2	0.405	0.309	0.463	0.486	0.389	0.387	*0.893*
TIO3	0.402	0.435	0.516	0.493	0.444	0.500	*0.886*
TIO4	0.410	0.402	0.480	0.485	0.437	0.449	*0.859*

Note(s): DTC stands for Digital Technologies Collaboration; TC for Technological Capabilities; VI for Virtual Integration; CSC for Customer Service Capabilities; TPA for Tourism Products Advantage; TSCR for Tourism Supply Chain Resilience; TIO for Technology Interoperability

Source(s): The author's work, derived from the statistical analysis of this study (SmartPLS, Version 4)

4.4 Structural model

The evaluation model goodness-of-fit (GOF) is measured by the coefficient of determination (R-squared) (Hair *et al.*, 2019); Table 6 presents the results of GOF. Statistics **R**-*squared* over 0.30, and the variance calculated for 41.7% of virtual integration, 49.2% of customer service capabilities, 40.6% of tourism products advantage, and 56.7% of tourism supply chain resilience; in addition, the effect size (*f2*) was from 0.00 to 0.316, which were less than 0.33 of critical recommended value (Ibarra-Cisneros and Hernandez-Perlines, 2020); as exhibited in Table 7, it shows that the research model has good interpretability.

Variance inflation factor (VIF) assesses whether there is collinearity between constructs (Assaf and Tsionas, 2021). Moreover, it suggested that the VIF estimates of the research model were lower than 3.3 (Goodhue *et al.*, 2017); the results pointed that the VIF was between 1.27 and 2.23, which shows that there is no collinearity problem in this study; moreover, five indexes identified the

Table 5	Fornell–Larcker criterion and heterotrait-monotrait at ratio							
Item	Constructs	DTC	CSC	TPA	TC	TIO	TSCR	VI
Fornell-Larcker criterion	DTC	0.895						
	CSC	0.664	0.886					
	TPA	0.413	0.620	0.841				
	TC	0.584	0.576	0.374	0.818			
	TIO	0.464	0.550	0.471	0.435	0.873		
	TSCR	0.502	0.529	0.305	0.646	0.508	0.860	
	VI	0.512	0.568	0.375	0.622	0.551	0.730	0.854
Heterotrait-Monotrait at ratio	DTC							
	CSC	0.711						
	TPA	0.439	0.651					
	TC	0.629	0.609	0.391				
	TIO	0.512	0.596	0.504	0.468			
	TSCR	0.550	0.569	0.327	0.698	0.559		
	VI	0.559	0.610	0.400	0.672	0.610	0.803	

Note(s): DTC stands for Digital Technologies Collaboration; TC for Technological Capabilities; VI for Virtual Integration; CSC for Customer Service Capabilities; TPA for Tourism Products Advantage; TSCR for Tourism Supply Chain Resilience; TIO for Technology Interoperability
Source(s): The author's work, derived from the statistical analysis of this study (SmartPLS, Version 4)

Table 6	Measure the goodness of fit (GOF): *R square*	
Items	R *square*	R *square adjusted*
Virtual Integration	0.421	0.417
Customer Service Capabilities	0.494	0.492
Tourism Products Advantage	0.414	0.406
Tourism Supply Chain Resilience	0.573	0.567

Source(s): The author's work, derived from the statistical analysis of this study (SmartPLS, Version 4)

Table 7	*f* Square the effect size (f^2)						
Item	DTC	CSC	PA	TC	TIO	TSRC	VI
DTC		0.302					0.058
CSC			0.250			0.043	
PA						0.007	
TC		0.107					0.274
TIO			0.035			0.023	
TSRC							
VI			0.000			0.316	

Note(s): DTC stands for Digital Technologies Collaboration; TC for Technological Capabilities; VI for Virtual Integration; CSC for Customer Service Capabilities; TPA for Tourism Products Advantage; TSCR for Tourism Supply Chain Resilience; TIO for Technology Interoperability
Source(s): The author's work, derived from the statistical analysis of this study (SmartPLS, Version 4)

predictive accuracy of the structural model (Yusif *et al.*, 2020), as proved in Table 8; indicates that the research model has a good fit.

5. Discussion and implications

This study demonstrates that digital technologies collaboration impact on virtual integration (t = 3.581*, p < 0.05) and customer service capabilities (t = 10.596 ***, p < 0.001), that technological capabilities impact virtual integration (t = 8.010 **, p < 0.01) and customer service

Table 8	Model fit summary	
Items	Saturated model	Estimated model
SRMR	0.046	0.077
d_ULS	1.517	4.120
d_G	0.849	0.923
Chi-square	1899.474	1940.424
NFI	0.859	0.856
Source(s): The author's own work, derived from the statistical analysis of this study (SmartPLS, Version 4)		

capabilities ($t = 5.858$ **, $p < 0.01$) were supported. Compared to past research, the results of the study are compatible with those of Adhiatma *et al.* (2023) and Almunawar and Anshari (2022) works; digital technologies collaboration and technological capabilities are two significant factors that lead to tourism supply chain resilience; in addition, the virtual integration impact on the tourism products advantage ($t = 8.010$ **, $p < 0.01$) was supported, but the impact on tourism supply chain resilience ($t = 0.126$, $p > 0.05$) was not supported in the study. This finding is similar to Hadjielias *et al.* (2022) and Romero *et al.* (2023). In addition, the role of technology interoperability in moderate virtual integration affects the tourism products advantage ($t = 1882$, $p > 0.05$) was not supported, but the impact on tourism products advantage ($t = 2.51$*, $p < 0.05$) was supported; likewise, its moderate customer service capabilities effect on tourism products advantage ($t = 1.569$, $p > 0.05$) was not supported and impact on tourism supply chain resilience ($t = 2.457$ *, $p < 0.05$) was supported. As Pierdicca *et al.* (2019) and Solmaz *et al.* (2019) stated, interoperability allows different components of the tourism supply chain, such as booking systems, payment gateways, and reservation systems, to work together seamlessly. This integration leads to streamlined and efficient operations of tourism enterprises. Finally, Table 9 lists the hypothesis testing results.

5.1 Implications for research

This study makes three contributions to the field of digital transformation and management of information systems. **First,** it supplements the tourism digital transformation and future supply

Table 9	Results of Hypothesis testing		
Hypotheses		t *value*	Results
(H1) Digital Technologies Collaboration → Virtual Integration		3.581*	Supported
(H2) Digital Technologies Collaboration → Customer Service Capabilities		10.596***	Supported
(H3) Technological Capabilities → Virtual Integration		8.010 **	Supported
(H4) Technological Capabilities → Customer Service Capabilities		5.853**	Supported
(H5) Virtual Integration → Tourism Products Advantage		7.473**	Supported
(H6) Virtual Integration → Tourism Supply Chain Resilience		0.126	Not Supported
(H7) Customer Service Capabilities → Tourism Products Advantage		10.039***	Supported
(H8) Customer Service Capabilities → Tourism Supply Chain Resilience		3.272 *	Supported
(H9) Tourism Products Advantage → Tourism Supply Chain Resilience		1.607	Not Supported
(H10) Technology Interoperability x Virtual Integration → Tourism Products Advantage		1.882	Not Supported
(H11) Technology Interoperability x Virtual Integration → Tourism Supply Chain Resilience		2.510*	Supported
(H12) Technology Interoperability x Customer Service Capabilities → Tourism Products Advantage		1.569	Not Supported
(H13) Technology Interoperability x Customer Service Capabilities → Tourism Supply Chain Resilience		2.457*	Supported
Note(s): *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$			
Source(s): The author's work, derived from the statistical analysis of this study (SmartPLS, Version 4)			

chain competition by combining the ROT and digital competencies, thereby unveiling two significant factors that affect the tourism products' advantage and tourism supply chain resilience through the digital transformation for travel agencies (Figure 1). Hence, the research is one of the few studies that consider the moderating effect of technological interoperability on digital transformation and the factors that can enhance tourism supply chain resilience. **Second,** there are clear benefits of adopting digital technologies; tourism digital transformation will increase revenue, reduce operational costs, improve customer satisfaction, and increase market competitiveness for tourism enterprises. Virtual integration and customer service capabilities should also be significant influencing variables in improving tourism products' competitive advantage and supply chain resilience. **Third**, this study shares a unique perspective on the digital transformation model, specifying that technology interoperability plays a crucial role in the tourism supply chain by enhancing communication, efficiency, and collaboration among various stakeholders.

5.2 Implications for practice

The study's findings highlight the importance of digital transformation in the application of digital technologies to the digital transformation of travel agencies and further propose specific practice topics for them.

First, travel agencies' digital transformation could involve operational inefficiencies, customer service challenges, or marketing difficulties. Based on our findings of H1 and H2, digital technology collaboration for travel agencies involves identifying innovative solutions that can improve their operations, enhance customer experiences, and increase efficiency.

For travel agencies, through IOS, tourists can seamlessly and promptly reserve tourism products from digital travel agencies. The advantageous functions of digital technologies collaboration will enhance customer interaction management, lead tracking, and personalized marketing efforts of travel agencies; future managers should take advantage of the competitive advantages of digital transformation; travel agencies will use data to identify customer preferences and trends and optimize digital marketing strategy.

Second, technological capabilities emphasize that managers stay informed about the latest market knowledge and technology trends that benefit travel agencies. This may include advances in data analytics and customer relationship management. Based on our findings of H3 and H4, using data analysis tools to extract insights, identify customer preferences, and optimize marketing strategies has become an essential technical capability for travel agencies.

Managers should gain insight into successful innovations in travel agencies. Learn how technologies change travel agencies and determine where to differentiate yourself in the tourism supply chain. Likewise, in the future, travel agencies must continue to invest in and monitor the development of digital technology capabilities, collect, and analyze market data for evaluation through the digital transformation process, leverage the benefits of digital transformation, and make rapid adjustments to strategies to achieve continuous improvement.

Third, virtual integration for travel agencies involves recommending integrating various digital technologies and online services to create a seamless, interconnected tourist experience. Virtual integration can enhance customer service, streamline operations, and increase the agency's competitiveness (H5); however, virtual integration enables global suppliers to coordinate inventory levels electronically, which will improve in the future.

Conversely, virtual integration also allows global suppliers of travel agencies to monitor the quality and changes of tourism products electronically; in the future, travel agencies will be more capable of forecasting product demand with partners in the IOS synchronously while integrating and cooperating with global suppliers.

Fourth, travel agencies must improve customer service during the digital transformation to enhance customer experience and maintain competitiveness in the tourism market. According to the findings of H7, solving travel agencies' specific customer service problems has become one of the critical factors for the success of travel agencies' digital transformation; unique customer service planning satisfies travel agencies to improve customer service capabilities effectively.

In the future, travel agencies must develop and implement a system that allows tourists to communicate, interact, and provide feedback through omnichannel. Moreover, they must enhance their digital capabilities in handling tourist issues promptly throughout the tourism supply chain, better help customers solve problems related to service provision, and make tourists satisfied with the service.

Finally, technology interoperability is critical to ensuring that various systems and technologies can work together seamlessly as part of travel agencies' digital transformation (H10-H13). In digital transformation, travel agencies recommend integrating existing systems (booking engines, CRMs, payment gateways) through well-documented APIs to achieve data exchange.

Moreover, digital transformation requires promoting standardized data formats and protocols to ensure seamless data exchange between systems. Therefore, supply chain members must jointly develop data exchange standards to make digital transformation successful in the future.

Digital transformation emphasizes the importance of data-based analytics for enterprises to understand customer behavior, optimize marketing efforts, and make data-driven decisions. Future digital transformation strategies for travel agencies include understanding the evolving landscape of the travel industry and producing innovative solutions to stay competitive and meet changing customer expectations. In addition, travel agencies need to understand emerging technologies and technological intelligence and analyze evolving consumer behavior and global events to shape the future advantages of the industry through digital transformation.

6. Conclusions

As travel agencies leverage collaborative digital technologies, they can enhance the features, accessibility, and overall appeal of their products, contributing to a competitive edge in the tourism supply chain; the research suggests that travel agencies with advanced technological capabilities are better equipped to increase tourism product advantage and build resilient tourism supply chains; these capabilities may include real-time data analytics, predictive modeling, and adaptive technologies that enable businesses to respond swiftly to disruptions and uncertainties in the tourism environment.

The study highlights that digital technologies facilitate virtual integration, allowing for seamless communication and collaboration across different supply chain nodes. This integration enhances coordination, efficiency, and adaptability when facing challenges. Moreover, the findings underscore the significance of customer service capabilities in the tourism industry. Businesses that provide excellent customer service through digital channels are more likely to attract and retain customers. The interplay between digital technologies collaboration, technological capabilities, virtual integration, and customer service ability creates a holistic impact on the overall competitiveness of travel agencies.

6.1 Limitations and future recommendations

This study identifies seven factors from theory and existing literature that are likely to change with context and the digital transformation of travel agencies. For example, when the context of the study is to understand the impact of technology transfer due to globalization on supply chain operations, the adoption rate of digital technologies collaboration may be an essential factor to be included in the list of factors. Simultaneously, future research can discuss the stage performance of digital transformation from different theories, including punctuated equilibrium and digital

government evolution models that can provide different insights. Likewise, we discussed the moderating effects of technology interoperability, which significantly affects tourism supply chain resilience; future research can increase research on Introducing compromise as a critical construct for digital innovation.

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