JPB REVIEW
INTERNATIONAL JOURNAL OF PROFESSIONAL BUSINESS REVIEW
ISSN: 2525-3654
OPEN ACCESS

PRIORITIZING KEY SUCCESS FACTOR OF THE INTERNET OF THINGS APPLICATION IN TOURISM ENTERPRISE

Nguyen Quang Vinh[A], Quang Hung Do[B], Luc Manh Hien[C]

ARTICLE INFO

Article history:

Received 20 February 2023

Accepted 04 May 2023

Keywords:

Tourism Industry;
Internet of Things;
Fuzzy AHP;
Vietnam.

ABSTRACT

Purpose: The objective of this study is to explore critical success factors in Internet of Things applying and their importance level in tourism companies using the fuzzy theory.

Theoretical framework: This paper uses the TOE framework and adds a customer security variable. Therefore, the framework includes four variables technology, organization, environment, and customer security (TOEC) which are the four aspects of this research framework.

Design/methodology/approach: By integrating FAHP and FAHP extension methods, the study finds that the critical success factors for IoT application in tourism companies, including technology, organization, environment, and customer security.

Findings: The result show that, the first ranking is organization factor, the second ranking belongs to technology, customer securities come with third ranking, and the fourth ranking is environment. This result also indicates that IT Human resources, Technology infrastructure, Top management support, and organization readiness are the prioritized critical success factors for IoT applications in tourism companies.

Research, Practical & Social implications: This paper contributes to the understanding of IoT, its features and highlights the importance of new technology and solutions in tourism industry.

Originality/value: This study fills the gap in the TEO model by adding the factor of customer securities so-called TEOC model.

Doi: https://doi.org/10.26668/businessreview/2023.v8i5.2029

PRIORIZANDO FATOR CHAVE DE SUCESSO DA APLICAÇÃO DA INTERNET DAS COISAS NO EMPREENDIMENTO DE TURISMO

RESUMO

Objetivo: O objetivo deste estudo é explorar os fatores críticos de sucesso na aplicação da Internet das Coisas e seu nível de importância em empresas de turismo usando a teoria fuzzy.

Estrutura teórica: Este artigo usa a estrutura TOE e adiciona uma variável de segurança do cliente. Portanto, a estrutura inclui quatro variáveis: tecnologia, organização, ambiente e segurança do cliente (TOEC), que são os quatro aspectos desta estrutura de pesquisa.

Design/metodologia/abordagem: Ao integrar os métodos de extensão FAHP e FAHP, o estudo conclui que os fatores críticos de sucesso para a aplicação de IoT em empresas de turismo incluem tecnologia, organização, ambiente e segurança do cliente.

[A] *Ph.D. in Business. Faculty of Business Administration, University of Labour Social Affairs. Hanoi, Vietnam. Email: quangvinh191081@ulsa.edu.vn Orcid: https://orcid.org/0000-0003-3618-9098*

[B] *PhD. Associate Professor in Economic. Faculty of Information Technology, University of Transport Technology. Hanoi, Vietnam. E-mail: hungdq@utt.edu.vn, Orcid: https://orcid.org/0000-0002-8937-5102*

[C] *PhD. in Management. Faculty of Business Administration, University of Labour Social Affairs. Hanoi, Vietnam. E-mail: hienlm@ulsa.edu.vn Orcid: https://orcid.org/0000-0002-7105-4490 (Corespondent author)*

Resultados: O resultado mostra que o primeiro lugar é o fator organização, o segundo lugar pertence à tecnologia, os títulos do cliente vêm com o terceiro lugar e o quarto lugar é o meio ambiente. Esse resultado também indica que recursos humanos de TI, infraestrutura de tecnologia, suporte da alta administração e prontidão da organização são os fatores críticos de sucesso priorizados para aplicações de IoT em empresas de turismo.
Pesquisa, implicações práticas e sociais: Este artigo contribui para a compreensão da IoT, suas características e destaca a importância de novas tecnologias e soluções na indústria do turismo.
Originalidade/valor: Este estudo preenche a lacuna existente no modelo TEO ao adicionar o fator de títulos de clientes denominado modelo TEOC.

Palavras-chave: Indústria do Turismo, Internet das Coisas, Fuzzy AHP, Vietnã.

PRIORIZAR EL FACTOR CLAVE DE ÉXITO DE LA APLICACIÓN DE INTERNET DE LAS COSAS EN LA EMPRESA TURÍSTICA

RESUMEN
Propósito: El objetivo de este estudio es explorar los factores críticos de éxito en la aplicación del Internet de las Cosas y su nivel de importancia en las empresas turísticas utilizando la teoría difusa.
Marco teórico: este documento utiliza el marco TOE y agrega una variable de seguridad del cliente. Por lo tanto, el marco incluye cuatro variables tecnología, organización, entorno y seguridad del cliente (TOEC), que son los cuatro aspectos de este marco de investigación.
Diseño/metodología/enfoque: Al integrar los métodos de extensión FAHP y FAHP, el estudio encuentra que los factores críticos de éxito para la aplicación de IoT en las empresas turísticas incluyen la tecnología, la organización, el medio ambiente y la seguridad del cliente.
Hallazgos: El resultado muestra que, el primer ranking es el factor de organización, el segundo ranking pertenece a la tecnología, los valores del cliente vienen con el tercer ranking y el cuarto ranking es el medio ambiente. Este resultado también indica que los recursos humanos de TI, la infraestructura tecnológica, el soporte de la alta dirección y la preparación de la organización son los factores críticos de éxito prioritarios para las aplicaciones de IoT en las empresas turísticas.
Implicaciones de investigación, prácticas y sociales: este documento contribuye a la comprensión de IoT, sus características y destaca la importancia de las nuevas tecnologías y soluciones en la industria del turismo.
Originalidad/valor: este estudio llena el vacío en el modelo TEO al agregar el factor de los valores de los clientes, el llamado modelo TEOC.

Palabras clave: Industria Turística, Internet de las Cosas, Fuzzy AHP, Vietnam.

INTRODUCTION

The explosion of the Internet of Things (IoT) has substantially impacted business, life, and society. The impact of IoT is very diverse in many fields: Infrastructure management, healthcare, construction and automation, transportation, and tourism. It is believed that IoT with artificial intelligence will help people get things done more brilliantly and efficiently (Ly et al., 2018). IoT is essential to business operations. IoT helps businesses understand how their business performs in real-time, providing insights into everything from machine performance to supply chain and logistics. IoT allows companies to automate processes and reduce labor costs. It also cuts waste and improves service delivery, making production and delivery less expensive and providing transparency in customer transactions. Scholars believe that a critical element to the growth of IoT is application innovation, known as Generation 2.0 Innovation, which focuses on user experience (Sreenath et al., 2022). The next generation will face a society

where knowledge is everywhere. Kam et al. (Kam et al., 2015) suggests that enterprises should identify the most significant innovation, then design a model for this application and test it to confirm whether its results consistently meet their expectations. If products or activities have successful results, IoT technologies are effectively transformed.

Tourism is one of the largest industries with high competition, where customers expect innovation at affordable prices. Due to highly competitive pressure and demand for better services at better prices, businesses from this industry have been the front runners of IoT. Based on its ability to provide advanced connectivity and communication between devices, systems, and services, the Internet of Things is expected to cause a boom in the tourism industry. IoT is still in its infancy and is expected to revolutionize the travel industry. Future innovations in IoT will bring even more breakthroughs in the tourism industry. Companies must incorporate IoT into current initiatives to take advantage of future innovations. IoT technology offers a wide range of solutions for tourist destinations and establishments with the objective to attract new visitors, build customer loyalty based on the confidence offer and increase the value proposition to obtain new incomes. Despite IoT's benefits, research on IoT application in Vietnam is still limited (Nguyen et al, 2022). Moreover, there does not exist studies on factors leading to success in IoT application in Vietnam's tourism industry.

The study uses the FAHP method to evaluate the critical factors for IoT applications. Although widely used, AHP often has limitations in combining uncertainty and inaccuracies inherent in mirroring decision-makers' perceptions and judgments to exact numbers used in the AHP model. Therefore, when fuzziness is a common feature of decision-related problems, the FAHP method was developed to solve this problem. It allows decision-makers to express approximations or approximations to inputs using fuzzy numbers (Zadeh, 1965). Many methods have been proposed to calculate and synthesize weights to rank factors. This study uses the fuzzy geometric mean technique to determine the multiplicative and fuzzy geometric mean. The fuzzy weighting of each criterion is suggested by (Hsieh et al., 2004) and is specified in several studies, such as (Sun, 2010) and (Owusu-Agyeman et al., 2017; Yaghoobi, 2018). Therefore, this study applies the FAHP with the ranking fuzzy numbers method by Liou and Wang (Liou and Wang, 1992) to identify critical success factors in IoT adoption by tourism companies. The rest of this paper is organized as follows. Section 2 briefly presents the IoT literature review and the critical success factors for IoT adoption. Section 3 presents the method to identify essential factors. Section 4 presents the empirical and discussion results. Finally, the

conclusions with theoretical and managerial contributions and the limitation and further research are presented in Section 5.

LITERATURE REVIEW

Internet of Things

The concept of IoT emerged decades ago. However, it was in 1999 that the term IoT was coined by Kevin Ashton, a scientist who founded the Auto-ID Center at MIT (MIT's Auto-ID Center) (Ashton, 2009). According to the Global Standards Initiative on the Internet of Things (IoT-GSI), IoT is a global infrastructure serving the information society, supporting intensive (computing) services through objects (both real and virtual) that are interconnected by integrated current information and communication technologies (Li et al., 2015). IoT is a scenario of a world where each object and person is provided with its identifier, and all can transmit and exchange information and data over a single network without needing to be connected to direct human-to-human or human-to-computer interaction (Chen and Kimura, 2020; Kim and Park, 2017; Elkhaldi and Abdullah, 2022). It was stated that "the common interface for the IoT platform consists of a four-layer architecture based on two common interface diagrams with its data flow when connecting to the device and the service layer." In simple terms, IoT is all devices that can connect. The connection can be made via a wireless network (WIFI), broadband telecommunications network (3G, 4G, 5G), Bluetooth, ZigBee, and infrared. Devices can be smartphones, heaters, computers, dishwashers, washing machines, coffee machines, and many other appliances. All devices and objects in a house can be harmoniously connected to create a smart home in which every human thought and action can be recorded and understood (Li et al., 2015). Most prominent is the ability to communicate and understand each other between all devices in the IoT system.

Internet of Things in Tourism Industry

The tourism industry includes many stakeholders and impacts the global economy. Personalized travel and customer experiences in the travel industry are top of the list regarding IoT innovations. As Qiu et al. (Qiu et al., 2016) indicates that IoT adoption is only possible if the local infrastructure allows the deployment of devices that provide the information and data needed to make real-time decisions and the information that helps with simulations to predict future situations. Therefore, it is essential for tourist destinations to implement a comprehensive information collection, analysis, and distribution system among all actors in the destination's

value chain, thus facilitating the decision-making process for each party in real time (Maglovska and Dimitrov, 2020). According to (Verma and Shukla, 2019), The explosion of IoT technology will drive the future of the hotel industry; it will provide a competitive advantage in the market through the interconnection of devices (sensors, actuators, identification cards, mobile phones.). IoT is streamlining the operations of hotels, airlines, and travel agencies by connecting intelligent devices, systems, and processes. By leveraging IoT technology, the travel industry can improve operational efficiency and create a more personalized guest experience. Ordóñez et al. (Ordóñez et al., 2020) in the study of smart tourist destinations, have proposed five components, including Personal Control; Seamless Travel; Smart Energy Saving; Location Information, and Maintenance and Repairs. IoT technology will change the business model (Babu and Subramoniam, 2016). In this regard, this technology will allow airlines to save time and effort by improving the quality of baggage handling on flights and facilitating the check-in process with many passengers (Car et al., 2019). The virtual assistant-assisted interface helps guests visit by interacting with them and enhancing their stay experience. Sensors attached to the kitchen can check the shelf life of factors such as cookware and beverages and help kitchen staff plan their use accordingly (Maglovska and Dimitrov, 2020). A sensible sensor with AI can suggest recipes with available items to kitchen staff. In addition, hotels can also use IoT for eco-friendly management activities in hotels, including waste recycling and reuse, energy saving, tree feeding, and maintenance (Car et al., 2019).

The Critical Success Factors for IoT Adoption

There have been many studies on the factors leading to success in applying science and technology in enterprises, the earliest of which is the technology, organization, and environment (TOE) model (Tornatzky et al., 1990). Researchers have used the TOE model to assess the key factors leading to success in the application of science and technology and technological innovation (Aboelmaged, 2014; Lian et al., 2014; Liu and Deng, 2015). Besides the TOE model, the technology acceptance model (TAM) and the "Diffusion of innovation" model (DOI) are also widely used in research related to technological innovation (Hsu and Yeh, 2017). TAM is widely used to study innovation phenomena at the individual level (Tsou and Hsu, 2015), while DOI is mainly used to study technological innovation at the market level. However, it has limited consideration of environmental conditions in technology change due to different technical viewpoints (Lian et al., 2014). Li's research (Ly et al., 2018) on IoT in enterprises in Taiwan has identified five factors affecting IoT applications: Connectivity;

mobile devices; innovative technology; Security, and Value. However, their research goes into more technical aspects of the IoT. In summary, the TOE framework is broader, contains organizational factors, and is relevant to this study

In addition to the TOE framework, some of the most significant barriers to IoT adoption are privacy and security concerns, such as resistance to attacks, data authentication, control access and privacy of customers in various activities, such as personal operations, business processes, transportation, and protection of information (Hsu and Yeh, 2017). Furthermore, privacy includes hiding personal information and the ability to control what happens to that information (Cruz-Jesus et al., 2019). In addition, facilitating the exchange of goods and services using IoT has implications for stakeholders' security and privacy (Ahmed et al., 2022; Hughes and Moscardo, 2019). The literature review collected research variables and indicators that can be used to explore the factors influencing IoT adoption in the tourism industry. This paper uses the TOE framework and adds a customer security variable. Therefore, the framework includes four variables technology, organization, environment, and customer security (TOEC) which are the four aspects of this research framework. These dimensions and criteria are listed in Table 1 and Figure 1.

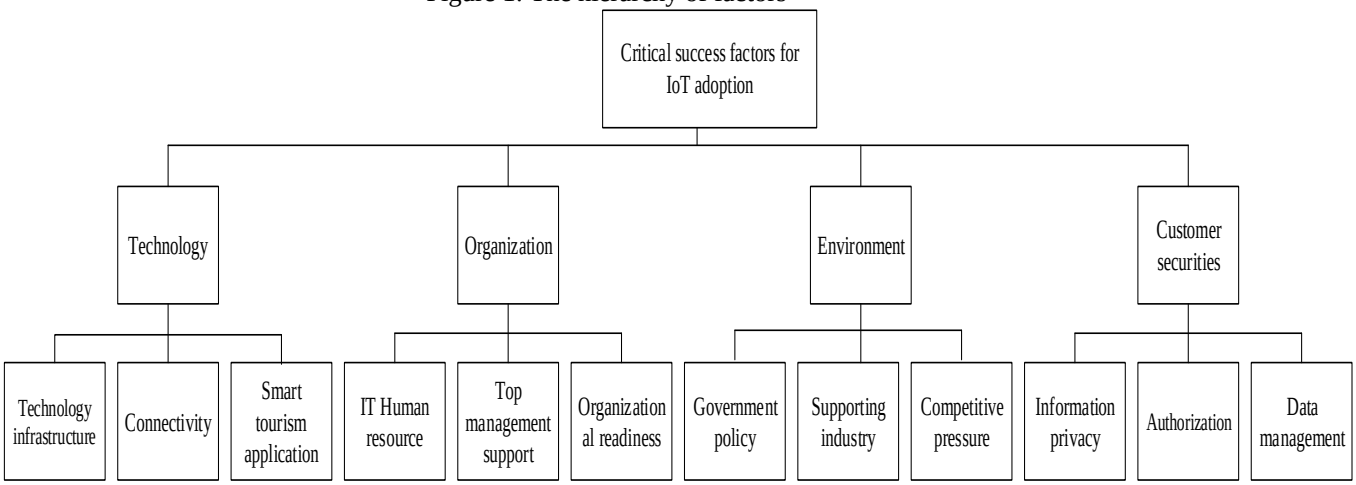
Table 1: Dimensions and criteria

Criteria	Sub-criteria	Definition	Source
Technology	Technology infrastructure	The technology infrastructure includes hardware and software components to support an enterprise's application of IoT	(Hsu and Yeh, 2017)
	Connectivity	IoT integration means bringing together new IoT devices, IoT data, IoT platforms, and IoT applications in an end-to-end deployment landscape.	(Hsu and Yeh, 2017)
	Smart tourism application	Provide innovative travel services such as web, mobile services, and cloud computing	Authors
Organization	IT Human resource	A human resource is a person in the company's workforce, whether part-time, full-time, freelance, or contract employees.	(Hsu and Yeh, 2017)
	Top management support	As senior management, the CEO and other senior managers take the time to review plans, track results, and solve management problems.	(Hsu and Yeh, 2017)
	Organizational readiness	Organizational readiness indicates the relationship between people, processes, systems, and performance measures.	(Hsu and Yeh, 2017)
Environment	Government policy	Government policy is a declaration of government political activities, plans, and intentions relating to IoT.	(Hsu and Yeh, 2017)
	Supporting industry	Supporting industries manufacture production parts and tooling to apply the IoT	(Hsu and Yeh, 2017)
	Competitive pressure	Competitive pressure is when a company typically faces pressure due to its competitor's IoT application.	(Hsu and Yeh, 2017)
Customer securities	Information privacy	A highly desirable consideration from customers when adapting IoT technologies or products	(Ly et al., 2018)

Criteria	Sub-criteria	Definition	Source
	Authorization	A function that allows authorized users to look up the best-defined data in the database when they need.	(Ly et al., 2018)
	Data management	A user filter mechanical feature for document access, operation, and control.	(Ly et al., 2018)

Source: Prepared by the authors (2023)

Figure 1: The hierarchy of factors



Source: Prepared by the authors (2023)

METHODOLOGY

Fuzzy triangular numbers represent data collected from the survey and the experts' ratings. To determine each criterion's fuzzy mean and fuzzy weight, this research applies the suggestion of Hsieh et al. (Hsieh et al., 2004).

Defuzzification is the step in which fuzzy weights are converted to nonfuzzy values, best nonfuzzy performance (BNP) index is applied in this study. This study use sugession of Saaty (Saaty, 1980), if the value of the consistency ratio, CR < 0.1, is acceptable.

The next step of the research is to rank the indicators based on the combined results of the impact indicators. Liou and Wang's ranking method is applied. Liou and Wang's method is a commonly used method with wide application among the many ranking methods. To summarize, suppose there are fuzzy triangular numbers $Ai, i = 1, 2, \dots, n$. The total analytical value for each fuzzy number $Ai = (li, mi, ui)$ is given in Eq. (1).

$$S^{\alpha}(A) = (1/2)\big((u_i - l_i)\alpha + (l_i + m_i) - 2X_{min}\big) \quad (1)$$

where $X_{min} = \inf \bigcup^{n}_{i=1} \{x = \mu A_i (x) > 0\}$ $\alpha \in [0,1]$ and α is the only number that can express optimism in the assessment: α = 0 for the decision maker pessimistic decision makers, $\alpha = 1$

for optimistic decision makers and α = 0.5 for moderate decision makers. When $Xmin = 0$, the formula is calculated as in Liou and Wang.

To perform the pairwise comparison between fuzzy parameters, the linguistic variable is defined corresponding to the evaluation levels according to the following Table 2.

Table 2: Linguistic variable

Numerical rating	Linguistic variable	TFN
1	Equally important	(1,1,1)
2	Intermediate value between 1 and 3	(1,2,3)
3	Essentially important	(2,3,4)
4	Intermediate value between 3 and 5	(3,4,5)
5	Strongly important	(4,5,6)
6	Intermediate value between 5 and 7	(5,6,7)
7	Very strongly important	(6,7,8)
8	Intermediate value between 7 and 9	(7,8,9)
9	Extremely important	(8,9,10)

Source: Prepared by the authors (2023)

Fourteen experts were selected to participate in the survey, including IT professionals, tourism business executives, and university lecturers. Out of the returned responses, four questionnaires had inappropriate answers. So, their responses were excluded from the analysis. Therefore, the results of this study are based on the feedback of 10 experts. Table 3 presents information of the experts.

Table 3: Information of the experts

No.	Position	Experience	Education	Organization
1	Vice-president	15	PhD	University
2	IT Lecturer	18	PhD	University
3	Head of IT Department	15	PhD	University
4	IT Specialist	10	PhD	Research Institute
5	IT Specialist	10	PhD	Research Institute
6	Manager	10	Master	Tourism business
7	Manager	15	Master	Tourism business
8	Sales manager	9	Master	Tourism business
9	Head of Marketing	15	Master	Tourism business
10	Project Manager	10	Master	Tourism business

Source: Prepared by the authors (2023)

RESULTS AND DICUSSIONS

Results

Through the steps of FAHP analysis, fuzzy mean (r), weight $(\widetilde{r})$, and BNP values are obtained. The local index ranking of indicators related to key success factors to IoT application is shown in Table 4.

Table 4: Key success factors of IoT application ranking by local index

	r	W*	BNP	Ranking
Technology	**(1.36, 1.53, 1.66)**	**(0.26, 0.34, 0.42)**	**0.34**	**2**
Technology infrastructure	(1.22, 1.37, 1.47)	(0.36, 0.44, 0.52)	0.44	1
Connectivity	(0.86, 0.95, 1.05)	(0.25, 0.31, 0.37)	0.31	2
Smart tourism application	(0.72, 0.77, 0.86)	(0.21, 0.25, 0.31)	0.26	3
Organizational	**(1.54, 1.84, 2.12)**	**(0.30, 0.40, 0.54)**	**0.41**	**1**
IT Human resource	(1.29, 1.56, 1.75)	(0.36, 0.49, 0.65)	0.50	1
Top management support	(0.72, 0.83, 0.96)	(0.20, 0.26, 0.35)	0.27	2
Organizational readiness	(0.69, 0.77, 0.92)	(0.19, 0.24, 0.34)	0.26	3
Environment	**(0.51, 0.59, 0.67)**	**(0.10, 0.13, 0.17)**	**0.13**	**4**
Government policy	(1.27, 1.38, 1.46)	(0.38, 0.45, 0.51)	0.45	1
Supporting industry	(0.75, 0.83, 0.90)	(0.22, 0.27, 0.32)	0.27	3
Competitive pressure	(0.82, 0.88, 0.98)	(0.25, 0.29, 0.34)	0.29	2
Customer securities	**(0.53, 0.61, 0.74)**	**(0.10, 0.13, 0.19)**	**0.14**	**3**
Information privacy	(1.30, 1.60, 1.83)	(0.34, 0.49, 0.68)	0.51	1
Authorization	(0.86, 1.04, 1.25)	(0.23, 0.32, 0.46)	0.34	2
Data management	(0.52, 0.60, 0.74)	(0.14, 0.19, 0.28)	0.20	3

$*\ \mathrm{CR} < 0.1$

Source: Prepared by the authors (2023)

Table 4 shows the indicators' r, w, and BNP values in the model of priority for Technology indicators. The result shows that Technology infrastructure is ranked as the first importance in technology factors ($BNP = 0.44$). The second factor is Connectivity (0.31), and the last ranking is Smart tourism application ($BNP = 0.26$). For organizational indicators, the result shows that IT human resource is ranked as the first importance in organisational factors ($BNP = 0.5$). The second factor is Top management support (0.27), and the last ranking is Organisational readiness ($BNP = 0.26$). For Environment indicator, the result shows that Government policy is ranked as the first importance in Environment factors ($BNP = 0.45$). The second factor is Competitive pressure (0.29), and the last ranking is Supporting industry ($BNP = 0.27$). The result shows that Information privacy is ranked as the first importance in Customer securities factors ($BNP = 0.51$). The second factor Authorization (0.34), and the last ranking is Data management ($BNP = 0.20$).

Table 4 also indicates the prioritizing of the main factors of IoT applications. The result shows that the Organization factor is ranked first in the IoT application model (BNP =0.41). The second factor is technology (0.34), the third factor is customer securities, and the last ranking factor is the environment (BNP = 0.20). The *CR < 0.1 indicates the acceptable consistency ratio suggested by Saaty (1980).

The study continues to determine the global index for each indicator to evaluate the overall coefficient for the indicators. The overall index shows the contribution of each indicator to the common goal (successful IoT application). The overall index of each indicator in the

structure is calculated by multiplying the partial index by the index of the main factor; for example, index of technology infrastructure will be $(0.36, 0.44, 0.52) * (0.26, 0.34, 0.42) = (0.094, 0.150, 0.218)$.

The Eq (1) is applied to rank the fuzzy number with total integral value. Take the factor Technology for example:

$S^{\alpha} = (1/2)\,[(0.218 - 0.094)\,\alpha + (0.094 + 0.150) - 2 * 0.094]$ and $\alpha = 0.5$ for moderate decision makers, we have $S^{\alpha} = 0.059$.

Table 5: The global scores and ranking of key success factor of the IoT Application in the Tourism Enterprise

Indicators	**Global score**	**Final weight (S^{α})**	**Ranking**
Technology infrastructure	(0.094, 0.150, 0.218)	0.059	2
Connectivity	(0.065, 0.105, 0.155)	0.043	5
Smart tourism application	(0.055, 0.085, 0.130)	0.034	7
IT Human resource	(0.108, 0.196, 0.351)	0.105	1
Top management support	(0.060, 0.104, 0.189)	0.054	3
Organizational readiness	(0.057, 0.096, 0.184)	0.051	4
Government policy	(0.038, 0.059, 0.087)	0.022	9
Supporting industry	(0.022, 0.035, 0.054)	0.015	11
Competitive pressure	(0.025, 0.038, 0.058)	0.015	12
Information privacy	(0.034, 0.064, 0.129)	0.039	6
Authorization	(0.023, 0.042, 0.087)	0.025	8
Data management	(0.014, 0.025, 0.053)	0.015	10

Source: Prepared by the authors (2023)

Table 5 shows the global scores of the twelve indicators' impact on the IoT application in the tourism enterprise. From the result, IT human resource is ranked as the first factor of IoT application ($S^{\alpha} = 0.105$), the second factor is technology infrastructure ($S^{\alpha} = 0.059$), Top management support is ranked as the third factor ($S^{\alpha} = 0.054$), the fourth factor indicated by organizational readiness ($S^{\alpha} = 0.051$), the fifth is connectivity indicator ($S^{\alpha} = 0.043$), information privacy is ranked as the sixth ($S^{\alpha}=0.039$), smart tourism application is ranked as the seventh ($S^{\alpha} = 0.034$), the eight belong to authorization ($S^{\alpha} = 0.025$), ranking as the ninth is government policy ($S^{\alpha} = 0.022$), the tenth belongs to data management ($S^{\alpha} = 0.015$), the eleventh is supporting industry ($S^{\alpha} = 0.015$), and the last ranking, the twelfth belongs to competitive pressure ($S^{\alpha} = 0.015$).

DISCUSSIONS

The key success factors to IoT application in tourism companies' model have developed based on the TEO model with four factors including Technology, Organization, Environment,

and Customer Securities was indicated from this study. The local scores show the ranking of four primary variables. The first-ranking is organization factor, the second-ranking belongs to technology, customer securities comes with third - ranking, and the fourth-ranking is environment. This study confirmed the previous papers conducted by applying the TEO model in analyzing the IoT application enterprises (Aboelmaged, 2014; Hsu and Yeh, 2017; Tsou and Hsu, 2015). However, this study fills the gap in the TEO model by adding the factor of customer securities so-called TEOC model. The result of global scores indicated the importance of IT Human resources, Technology infrastructure, Top management support, and organization readiness are the most critical key success factor to IoT application in the tourism industry. Three indicators are indicated as the lowest score, which includes data management, Supporting industry, and Competitive pressure. Studies (Hsu and Yeh, 2017; Ly et al., 2018) have shown the ranking factor related to IoT applications. However, their studies only show the cause-effect diagram. While other studies (Lee et al., 2011; Lin, 2009) just noted a much smaller number of parameters or criteria and have not evaluated customer securities.

CONCLUSION

This study prioritizes critical success factors for IoT applications in tourism companies. While previous studies use the TEO and TAM models (Aboelmaged, 2014; Lian et al., 2014; Liu and Deng, 2015; Tsou and Hsu, 2015), research is lacking the critical success factors for IoT application in tourism industry based on expert opinions. Dunn (Dunn, 2005) argues that expert judgment based on their knowledge and experience will lead to objective and reliable results. Furthermore, although the Fuzzy and AHP have been used extensively in tourism research, they have yet to be combined FAHP and Liou and Wang's ranking method to evaluate the critical success factors of IoT applications in tourism companies with the global score. This study contributes to the construction of specific critical success factors for IoT applications in tourism companies from the perspective of tourism and IT experts. The results indicate specific key factors and classify them into four main factors. Moreover, the authors added factors, Customer securities: Information privacy, Authorization, and Data management, are developed from the Ly's research (Ly et al., 2018) and have a high ranking in the model. In this study, customer security is ranked as the third critical success factor for IoT applications in tourism companies. Besides, the global score of the information privacy indicator also ranked as the sixth factor contributing to this study's total tourism IoT application model.

This result indicates that IT Human resources, Technology infrastructure, Top management support, and organization readiness are the prioritized critical success factors for IoT applications in tourism companies. Tourism enterprises need to focus on critical directions such as investment in technology, including hardware and software. Developing and perfecting the plan for IoT application in business and marketing, including strengthening the resources of the local IT staff, strengthening the implementation of online marketing and e-commerce tools—at the same time, building unique and novel tourism products, ensuring the accuracy and reliability of the information, products, and services.

Invest in building a website with a smartphone-friendly interface, enhancing the integration of online payment tools to promote retail channels on mobile platforms, Digitizing data, and exploiting big data warehouses. In addition, it is necessary to strengthen social networks. Applying online tourism business models (buying and selling hotel rooms, online tours) to gradually shift to an e-commerce model in tourism (e-tourism) when conditions on travel include adequate technology infrastructure and legal corridor. Building and fully operating an e-commerce system in tourism according to G2B, B2B, and B2C models.

In conclusion, the following recommendations are proposed for the tourism industry to enhance its IoT adoption: (1) FAHP method is a valuable method for ranking the Key success factors in IoT applications and insightful decisions making; (2) organization and technology are two main factors that companies should focus resources on to achieve higher efficiency in IoT applications; (3) The high-ranking indicator in the model of IoT application include Technology infrastructure, IT Human resources, and Information privacy, which companies need to improve; and (4) There are two indicators, Information privacy and Authorization of Customer Securities factor, which have high priority to get the customer confidence and satisfaction with the service provided by companies.

There are limitations in this study, including relevant literature research, owing to limited access to data systems; only four main factors and twelve indicators are considered; the survey was only conducted with ten experts. Therefore, the proposed properties in this research need a study with more experts and other empirical research methods to demonstrate this research study.

REFERENCES

Aboelmaged MG (2014) Predicting e-readiness at firm-level: An analysis of technological, organizational and environmental (TOE) effects on e-maintenance readiness in manufacturing firms. *International Journal of Information Management* 34(5). Elsevier: 639–651.

Ahmed M, Abdou M and Elnagar A (2022) The Impact of Implementing the Internet of Things (IoT) on Customer Satisfaction: Evidence from Egypt. *Journal of Association of Arab Universities for Tourism and Hospitality* 0(0): 0–0. DOI: 10.21608/jaauth.2022.123022.1304.

Ashton K (2009) That 'internet of things' thing. *RFID journal* 22(7). Hauppauge, New York: 97–114.

Babu S and Subramoniam S (2016) Tourism Management in Internet of Things Era. *Journal of Information Technology & ...* (April). Available at: https://www.researchgate.net/profile/Sindhu_Babu/publication/324835058_Tourism_Management_in_Internet_of_Things_Era/links/5ae6dc5e0f7e9b9793c7de04/Tourism-Management-in-Internet-of-Things-Era.pdf.

Car T, Pilepić Stifanich L and Šimunić M (2019) Internet of Things (Iot) in Tourism and Hospitality: Opportunities and Challenges.: 163–173. DOI: 10.20867/tosee.05.42.

Chen L and Kimura F (2020) *E-Commerce Connectivity in ASEAN*. Available at: https://think-asia.org/bitstream/handle/11540/11861/0_E-Commerce-Connectivity-in-ASEAN_FINAL.pdf?sequenc.

Cruz-Jesus F, Pinheiro A and Oliveira T (2019) Understanding CRM adoption stages: empirical analysis building on the TOE framework. *Computers in Industry* 109. Elsevier B.V.: 1–13. DOI: 10.1016/j.compind.2019.03.007.

Dunn K (2005) Doing qualitative research in human geography: Interviewing. *Qualitative Research Methods in Human Geography'.(Ed. I. Hay.) pp*: 50–82.

Elkhaldi, A. H. ., & Abdullah, G. A. . (2022). The Effect of Cloud Computing's Advantages and Components on Time Savings and Data Privacy for the Quality of Electronic Banking Services. *International Journal of Professional Business Review*, 7(3), e0601. https://doi.org/10.26668/businessreview/2022.v7i3.601

Hsieh T-Y, Lu S-T and Tzeng G-H (2004) Fuzzy MCDM approach for planning and design tenders selection in public office buildings. *International journal of project management* 22(7). Elsevier: 573–584.

Hsu CW and Yeh CC (2017) Understanding the factors affecting the adoption of the Internet of Things. *Technology Analysis and Strategic Management* 29(9). Taylor & Francis: 1089–1102. DOI: 10.1080/09537325.2016.1269160.

Hughes K and Moscardo G (2019) ICT and the future of tourist management. *Journal of Tourism Futures* 5(3): 228–240. DOI: 10.1108/JTF-12-2018-0072.

Kam C, Kompella S and Ephremides A (2015) Experimental evaluation of the age of information via emulation. In: *MILCOM 2015-2015 IEEE Military Communications Conference*, 2015, pp. 1070–1075. IEEE.

Kim K-H and Park D-B (2017) Relationships among perceived value, satisfaction, and loyalty: Community-based ecotourism in Korea. *Journal of Travel & Tourism Marketing* 34(2). Taylor & Francis: 171–191.

Lee Y-C, Li M-L, Yen T-M, et al. (2011) Analysis of fuzzy Decision Making Trial and Evaluation Laboratory on technology acceptance model. *Expert systems with applications* 38(12). Elsevier: 14407–14416.

Li S, Xu L Da and Zhao S (2015) The internet of things: a survey. *Information systems frontiers* 17(2). Springer: 243–259.

Lian J-W, Yen DC and Wang Y-T (2014) An exploratory study to understand the critical factors affecting the decision to adopt cloud computing in Taiwan hospital. *International Journal of Information Management* 34(1). Elsevier: 28–36.

Lin LC (2009) An integrated framework for the development of radio frequency identification technology in the logistics and supply chain management. *Computers & Industrial Engineering* 57(3). Elsevier: 832–842.

Liou T-S and Wang M-JJ (1992) Ranking fuzzy numbers with integral value. *Fuzzy sets and systems* 50(3). Elsevier: 247–255.

Liu S and Deng W (2015) Very deep convolutional neural network based image classification using small training sample size. In: *2015 3rd IAPR Asian conference on pattern recognition (ACPR)*, 2015, pp. 730–734. IEEE.

Ly PTM, Lai WH, Hsu CW, et al. (2018) Fuzzy AHP analysis of Internet of Things (IoT) in enterprises. *Technological Forecasting and Social Change* 136(April). Elsevier: 1–13. DOI: 10.1016/j.techfore.2018.08.016.

Maglovska CR and Dimitrov N (2020) the Internet of Things in a Hotel Context. (Tisc): 416–433.

Ordóñez MD, Gómez A, Ruiz M, et al. (2020) IoT technologies and applications in tourism and travel industries. *Internet of Things - The Call of the Edge: Everything Intelligent Everywhere*: 367–386. DOI: 10.1201/9781003338611-8.

Nguyen, H. K., Hoang, T. D. L., Hoang, T. T., & Nguyen, L. K. (2022). Increasing Technology-Based Driver's Productivity Under Covid-19 Pandemic in Vietnam: the Significant Contribution of Consumer Behavior. *International Journal of Professional Business Review*, 7(4), e0617. https://doi.org/10.26668/businessreview/2022.v7i4.e617

Owusu-Agyeman Y, Larbi-Siaw O, Brenya B, et al. (2017) An embedded fuzzy analytic hierarchy process for evaluating lecturers' conceptions of teaching and learning. *Studies in Educational Evaluation* 55. Elsevier: 46–57.

Qiu GP, Sun SP, Wang FT, et al. (2016) Architecture-Oriented Design Method for Smart Tourism City Internet of Things System. *source: Advances in …* (February 2021). Available at: https://www.researchgate.net/profile/William-S-Chao/publication/335158373_Architecture-Oriented_Design_Method_for_Smart_Tourism_City_Internet_of_Things_System/links/602340b5a6fdcc37a815e1cf/Architecture-Oriented-Design-Method-for-Smart-Tourism-City-Intern.

Saaty TL (1980) Analytic hierarchy process Wiley Online Library.

Sun CC (2010) A performance evaluation model by integrating fuzzy AHP and fuzzy TOPSIS methods. *Expert Systems with Applications* 37(12). Elsevier Ltd: 7745–7754. DOI: 10.1016/j.eswa.2010.04.066.

Sreenath, S. G. P. ., Parashuram, A. ., & Devlanaik, H. . (2022). Impact of Digitalization and Changing Consumer Preferences and Choices on Virtual Shopping of Retail Sector in Bangalore. *International Journal of Professional Business Review*, 7(4), e0563. https://doi.org/10.26668/businessreview/2022.v7i4.e563

Tornatzky LG, Fleischer M and Chakrabarti AK (1990) *Processes of Technological Innovation*. Lexington books.

Tsou H-T and Hsu SH-Y (2015) Performance effects of technology–organization–environment openness, service co-production, and digital-resource readiness: The case of the IT industry. *International Journal of Information Management* 35(1). Elsevier: 1–14.

Verma A and Shukla V (2019) Analyzing the Influence of IoT in Tourism Industry. *SSRN Electronic Journal*: 2083–2093. DOI: 10.2139/ssrn.3358168.

Yaghoobi T (2018) Prioritizing key success factors of software projects using fuzzy AHP. *Journal of software: Evolution and process* 30(1). Wiley Online Library: e1891.

Zadeh LA (1965) Fuzzy sets. *Information and control* 8(3). Elsevier: 338–353.