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Navigating the Future: Envisioning Metaverse Adoption in Indonesian Tourism Through the Technological–Organizational–Environmental (TOE) Framework

Afrizal Firman [1,†], Ka Yin Chau [2,3,†], Ankita Manohar Walawalkar [4,†] and Massoud Moslehpour [4,5,*,†]

[1] Department of Management Study Program, Sekolah Tinggi Ilmu Ekonomi Ciputra Makassar, Makassar 90245, Sulawesi Selatan, Indonesia; afrizal.firman@ciputra.ac.id
[2] Centre for Quality Standard and Management, The Hang Seng University of Hong Kong, Shatin, Hong Kong SAR, China; gavinchau@hsu.edu.hk
[3] Department of Human Resources, Chongqing Industry Polytechnic College, Chongqing 401120, China
[4] Department of Business Administration, Asia University, Taichung 41354, Taiwan; ankitamw@ieee.org
[5] Department of Management, California State University, 5500 University Parkway, San Bernardino, CA 92407, USA
* Correspondence: mm@asia.edu.tw or writetodrm@gmail.com
† These authors contributed equally to this work.

Abstract: This study explores the factors influencing the adoption of Metaverse technology in the Indonesian tourism sector through the lens of the Technological–Organizational–Environmental (TOE) framework. Data collected from 303 respondents representing academia, government, and industry were analyzed using Structural Equation Modeling (SEM) with SmartPLS 4. The findings reveal that relative advantage, compatibility, top management support, government policy and regulation, and competitive pressure significantly influence the intention to adopt Metaverse technology, while complexity does not. Notably, competitive pressure emerged as the most critical factor, especially among university and government respondents. The study provides theoretical insights into technology adoption and practical recommendations for fostering Metaverse integration in tourism. Despite its contributions, limitations such as sample composition and excluded TOE variables suggest avenues for future research. This work underscores the importance of strategic collaboration among academia, government, and industry to enhance Metaverse adoption in the tourism industry, paving the way for innovation and competitive advantage.

Keywords: metaverse adoption; TOE framework; tourism industry; competitive pressure

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1. Introduction

Tourism has grown exponentially into a multibillion-dollar industry over decades. The industry is driven by technological adoption, such as social media, virtual tourism, and the Metaverse [1,2]. The adoption of an immersive Metaverse has been a part of digital marketing strategies and promotion activities in various domains in the tourism field [3,4]. Buhalis et al. [3] found that the Metaverse has emerged as a disruptive technology with the potential to revolutionize the field of tourism business. This technological advancement is expected to profoundly impact society in the forthcoming decades, offering immersive experiences that seamlessly blend virtual and physical worlds.

The Metaverse is expected to revolutionize the tourism business development, offering prospects for enhancing trip planning, connectivity, and engagement while inducing

significant shifts in customer behavior [3,4]. A tourist could obtain information from the destinations through the immersive Metaverse technology before departure. Also, the Metaverse is an appropriate tool for the tourism and hospitality industries [5].

The Metaverse market is substantial. Its technology development is still in its early stages and is massively applicable in tourism studies, but it still needs to be in the country of Indonesia. Lack of technological advantages of use, perceived complexity of use, and compatibility of use might be the gaps in technological adoption. Similarly, the Metaverse infrastructure and the facilities (financial and R&D) are challenging for tourism management support. On the other hand, government policy and regulation play an essential role in sustaining the technological adoption of tourism business activities and operations, including by users. The competitive pressure dynamic poses a challenge to business performance when adopting technology. Hence, this research utilizes the TOE framework invented by [6] to examine the gaps in intention to adopt the Metaverse that impact the tourism industry in the context of Indonesia.

This framework is widely used as a theoretical perspective on adopting information technology (IT) in business organizations. It analyzes the business level by focusing on technological, organizational, and environmental contexts influencing technological innovations and implementation processes [6,7]. Thus, TOE is an appropriate theory to be implemented in the study of Metaverse adoption in tourism organizations.

Within the technological domain, the primary determinants influencing organizations' acceptance and integration of novel technologies, such as the Metaverse, are relative advantage, complexity, and compatibility. The relative advantage drives enterprises' technology adoption [8]. Enterprises adopt the Metaverse when the technology is an advantage for existing businesses and enhances their performance [9,10]. This research aims to forecast the advantages of utilizing the Metaverse and examine the connection between the relative advantage of the Metaverse and the intention to embrace it within the context of Indonesian tourism.

The complexity has a detrimental effect on adopting information and communication technologies, according to [8,11]. The complexity of the adoption Metaverse affects the tourism innovativeness in operating the technology. Meanwhile, perceiving compatibility is vital in innovative technology as it consists of compatible values and existing operations [12,13]. Further, investigating the tourism sector's evaluation of the complexity and compatibility of adoption intention on the Metaverse is very important in this study.

The significance of top-level decision making in technology adoption within an organizational context is crucial for organizational advancement [14]. Lutfi et al. [15,16] asserted that the presence of top-level support plays a crucial role in promoting the adoption of technology inside a business, thereby emphasizing its significance. Han et al. [14] stated that adopting the Metaverse faces many obstacles for all organizations' stakeholders, particularly in investing financial and infrastructure resources, including research and development (R&D) and marketing centers.

In the environmental context, government policy, regulation, and competitive pressure factors can enhance business growth and competitiveness in technological adoption [11,15,16]. Government policy and regulation significantly increase the confidence and trust in an organization's decision making on the competitive advantages in a dynamic environment [17]. Hoffmann et al. [8] added that competitive pressure affects internal and external dynamic environments in an organization's business operations and performance.

While previous studies have explored Metaverse adoption in various contexts, they often lack a comprehensive analysis of its integration into specific industries, such as tourism. Many of these studies primarily focus on developed economies, neglecting emerging markets like Indonesia, which presents unique challenges, including technological

infrastructure limitations and regulatory gaps [4,11]. Additionally, the role of competitive pressure and government policy as critical drivers of adoption has been underexplored in the context of tourism [15,17]. Moreover, prior studies tend to rely on broad theoretical models and often overlook the integration of distinct stakeholder perspectives—namely those of academia, government, and industry practitioners—limiting the generation of practical, context-specific insights [3,18,19].

This study integrates perspectives from academia, government officials, and tourism practitioners by designing a survey instrument to capture sector-specific insights. Respondents were segmented based on their organizational roles, and each group addressed the same TOE-related constructs through contextually relevant questions. This approach allows for comparative analysis across the three stakeholder groups while maintaining a unified analytical framework, thereby offering a holistic understanding of Metaverse adoption in Indonesian tourism.

While previous research has explored the potential of Metaverse technologies across various sectors, much of it has concentrated on developed economies [4,20] and lacks industry-specific analysis, particularly in tourism, which presents unique technological, regulatory, and stakeholder dynamics [3,21]. Additionally, many studies overlook the complex interplay between institutional actors involved in adoption processes [19]. There remains a critical gap in understanding how Metaverse adoption unfolds in emerging markets such as Indonesia, where infrastructure limitations, policy uncertainty, and diverse stakeholder roles create distinct barriers and opportunities [17,22]. Addressing this gap, the present study applies the TOE framework to examine how technological, organizational, and environmental factors influence adoption intentions while uniquely incorporating the perspectives of academia, government, and tourism practitioners to offer comprehensive, actionable insights.

The adoption of Metaverse technology in Indonesian tourism remains limited despite its emergence. This project aims to engage academia, government officials, and practitioners in the tourism area to analyze the proposed model and hypotheses. The examination of elements that impact the aim of the tourism sector to embrace the Metaverse is considered crucial in this research, particularly for individuals within the tourism organization. This study proposes a relationship between the TOE paradigm and the propensity of the tourism industry in Indonesia to adopt the Metaverse. Researchers can produce more thorough findings and conclusions by utilizing this technique, which is particularly advantageous in practical applications of PLS-SEM, such as the one presented in this manuscript.

In addition to predicting and performing model analysis, this analysis aims to identify the important differences in perspectives on the development of Metaverse projects in the tourism industry [23,24]. Therefore, the research objectives and questions are as follows.

Recent studies from Southeast Asia offer emerging insights into the adoption of Metaverse technologies in different industries and service sectors [18,25]. For example, [26] argues that while Metaverse adoption in manufacturing offers substantial benefits, its implementation is hindered by several integration challenges. In another study, [9] explored Metaverse readiness in Vietnamese IT enterprises, highlighting infrastructure and digital skills as key enablers. Ref. [27] examined the development of a Metaverse tourism experience in Korea's Demilitarized Zone, showcasing immersive technology's role in historical education and cultural preservation. In Singapore, government-backed initiatives are piloting Metaverse tourism platforms for virtual exhibitions and guided experiences [21]. While Indonesia is still in the early stages, the regional momentum provides a relevant comparative context, underscoring shared challenges, such as connectivity, regulatory readiness, and digital capacity. This study contributes to this growing Southeast Asian discourse by focusing on Indonesia's unique institutional and stakeholder dynamics.

The main research objectives are to examine the correlation between various independent variables derived from the TOE framework and the dependent variable of intention to adopt the Metaverse within the tourism sector. Also, this research aims to analyze the primary determinants that influence the inclination to adopt the Metaverse inside the industry. Through the objectives, the following research questions address the following: (1) does the TOE model significantly affect the inclination to embrace Metaverse in the tourism industry? and (2) what are the primary determinants impacting the inclination to embrace the Metaverse within the industry?

The remainder of this paper is organized as follows. Section 2 presents the literature review and theoretical foundation, including the TOE framework and hypothesis development. Section 3 describes the research methodology, including instrument design, sample selection, and data analysis techniques. Section 4 reports the results of the measurement and structural model assessments. Section 5 discusses the findings, highlights theoretical and practical implications, and concludes with the study's limitations and directions for future research.

2. Literature Review

2.1. Metaverse in Tourism Industry

Jafar et al. [28] defined the Metaverse as a digital representation of real-world operations. [4] described the Metaverse concept as enabling technologies, features, scenarios, and the physical world. Similarly, the Metaverse enables users to communicate with each other via avatars that resemble them and reproduce their actions in simulating the physical world with 3D digital technology. Nevertheless, Metaverse has become one of the most popular buzzwords in the technology sector due to the rapid development of blockchain technology (BCT), 3D technologies (virtual and physical), VR, AR, IoT, DT, NFTs, AI, cloud/edge computing, and 5G technology [4,29,30]. Furthermore, the Metaverse has been adding features and growing in popularity as an immersive technology in various industries. Accessible and affordable products for creativity and innovation are a common concept of disruptive innovation when it is vital for enterprises to expand their business by adopting technologies like the Metaverse [19].

From the economic and tourism projections, the Metaverse is expected to possess a market value in the trillions of dollars. The Metaverse market size reached USD 40 billion in 2021 and is expected to be USD 1607,12 billion in 2030 [31]. For instance, the Metaverse applies to a virtual and digital platform for business activities in the small and medium-sized enterprises (SMEs) industry [10,32]. Virtual and Metaverse tourism earned a billion dollars in China [1,33]. Tourists worldwide are interested in using Metaverse-Mixed Reality (MR) for travel experiences. Travelers can virtually and physically receive destination information and experiences before deciding on a departure date and post-arrival time using intelligent devices and platforms [3,21,34]. The utilization of Metaverse platforms holds the capacity to fundamentally transform the tourism sector in the future.

Metaverse applications in tourism span several innovative use cases that enhance both pre-trip decision making and on-site experiences. For example, tourism boards and travel agencies are developing immersive 3D destination previews that allow potential travelers to explore landmarks, hotels, and cultural events virtually before booking their trips [3,21,30]. Hotels such as Marriott and travel brands like Qata Airways have piloted virtual showrooms and interactive service previews using Metaverse platforms. Similarly, cultural institutions, including the Louvre and the British Museum, have experimented with Metaverse-compatible VR exhibitions to broaden access to heritage experiences. In the context of Asia, companies in South Korea and Japan are launching city-wide virtual tourism experiences integrating AR/VR tools [18,27]. Although Indonesia is still in the

early stages, initiatives such as VR-enhanced marketing by Bali-based resorts and virtual tours offered by Borobudur Temple suggest emerging interest and opportunities. These examples demonstrate how the Metaverse can significantly enrich the tourism experience, improve customer engagement, and offer new revenue streams across the industry.

In terms of investment, producers and suppliers have invested in improving the Metaverse platform and user knowledge. Meta launched its first Asian Metaverse Extended Reality (XR, which encompasses both AR and VR) base in Taiwan in early May 2022. Meta also collaborated with HTC in the Metaverse to create the next generation of VR glasses. Surprisingly, Foxconn's Ennoconn deals with Google on a Metaverse project with a USD 40 million investment [35]. As one of the first businesses to entirely create the Metaverse project, Meta has a sizable market share today.

In Indonesia, the TOE framework context influencing the tourism sector's adoption intention contributes to guiding future Metaverse projects and investments. The TOE assumes a key point in the forecast, development, and evaluation of technological innovation within the context of the tourism business. Therefore, the objectives of our study need the role of TOE and triple helix (academia, government officers, and practitioners) contributions in navigating the comprehensive future Metaverse adoption intent.

2.2. The Technology–Organization–Environment (TOE) Model

Fleischer et al. [6] asserts that the adoption and implementation of technical breakthroughs are influenced by models pertaining to technology, organization, and the environment. The TOE model aligns well with the inherent ecosystem characteristics of intelligent destinations, as it illustrates that the adoption of information technology is impacted not solely by technological and organizational considerations but also by environmental factors. Further, this study will describe in detail the TOE model definition and the relationship between the model and Metaverse adoption in the tourism industry and how the relationship between variables aligns with the aims of the study.

The technological model (TM) pertains to the characteristics and effects of technology that influence the acceptance and implementation of new ideas and practices among individuals, organizations, and industries [6]. Kumar et al. [8] highlighted the technology application adoption to use the TOE model, which focused on the relative advantage, complexity, and compatibility factors. Because relative advantage, complexity, and compatibility have continuously emerged as important elements in comprehending industry performance [8,33], they are considered in this study to investigate the intention to adopt the Metaverse influences on the tourism industry and to evaluate the factors' predictive power and performance index, which influence the managerial applications.

The organizational model (OM) refers to the descriptive attributes of organizations, encompassing factors such as their scope, size, and managerial attitudes. It also examines how an organization's features and resources impact its decisions about the adoption of innovative technology [6]. The significance of management support and its role in organizational performance lies in its domination of decision-making strategies. Therefore, top management support is strongly considered to facilitate such technological adoption matters in organizations [36,37]. According to [14,38], adopting Metaverse technologies poses many obstacles for all stakeholders. The significance of top-level support in new technology implementation has been emphasized by [17], highlighting its pivotal role in the decision-making process of organizations. Furthermore, prior research has extensively examined the implementation of top management support [15,39]. Thus, this study considers that the intention to adopt Metaverse technology depends on top management support.

The environmental model (EM) refers to the influence exerted by the external and inter-organizational environment on the operational activities of an organization [6]. Ref. [39] defined the environmental model as a business environment in which an enterprise operates, emphasizing external factors affecting the industry. Shen et al. [38] argued that the environmental model encompasses external elements, including the potential impact of new technology on the organization's competitiveness and efficiency. Lutfi et al. (2022) emphasized that the external elements of the TEO model, such as governmental regulation and competitive pressure, have potential effects on the technology of big data adoption. Regulatory support and competitive pressure have been proven from prior research to play a role and verified by experts [15,16]. These two environmental factors have played a very significant role in the environmental assessment of technological adoption policies and innovation competitiveness. Thus, this section focuses on investigating governmental policy and regulation and the competitive pressure of environmental models affecting and predicting the intention to adopt the Metaverses in tourism.

Although the TOE framework encompasses a broad set of variables across technological, organizational, and environmental dimensions, this study deliberately focused on six core constructs: relative advantage, complexity, compatibility, top management support, government policy and regulation, and competitive pressure. These variables were selected based on their consistent validation in prior empirical studies on technology adoption (e.g., [4,17,39]) and their specific relevance to the challenges facing Indonesia's tourism industry. Other TOE constructs—such as organizational size, IT capability, and technological readiness—were excluded to maintain conceptual focus and ensure model parsimony. While the omission of these variables may limit the model's overall completeness, they were not central to the study's research objectives. Future research is encouraged to incorporate these additional factors to build a more comprehensive understanding of Metaverse adoption dynamics in tourism and other sectors.

2.3. Relationship Between Variables and Hypotheses Development

This section explores the development of the hypotheses and the relationships between the TOE variables and the implementation intention of the Metaverse in the tourism sector. Exploring this section also helps readers understand the context and the goals of this study's objectives. There are six hypotheses described in this study.

2.3.1. Relationship Between Relative Advantage and Intention to Adopt Metaverse

Tourism is one of the critical industries that can take advantage of the Metaverse [3,36]. Gursoy et al. [21] added that technological developments like the Metaverse could strengthen the tourism sector and benefit new prospects. The Metaverse efficiently connects the virtual world to reality by providing chances for tourist participation in immersive interactions [4]. The tourism and hospitality industries have made substantial use of technology, particularly in their adoption of the Metaverse as a means of enhancing consumer experience and facilitating value co-creation [3,38]. Lin et al. [40] consistently stated that relative advantage significantly affected a customer's intention and users' perception of the technology as more valuable. Thus, the intention to adopt the Metaverse has advantages in tourism development over other technologies. As a result of the preceding discussion, the first hypothesis formulates the following:

H1: *Relative advantage has a significantly positive effect on the intention to adopt the Metaverse in the tourism industry.*

2.3.2. Relationship Between Complexity and Intention to Adopt Metaverse

Refs. [2,19] defined complexity (CX) as the extent to which innovation takes place and is challenging to comprehend or utilize. Numerous studies demonstrated that complexity has a detrimental effect on adopting information communication and technologies [8,11]. Ref. [17] found in their study that the perceived complexity of blockchain is significant to an organization's adoption decision. This finding supports the current study of Metaverse acceptance. Moreover, technology acceptance is contingent on its simplicity, user-friendliness, and minimal complexity, and organizations are less likely to adopt technological innovation when it is complex [41]. Ref. [41] argued that simplifying technology is the best method for promoting technology adoption. In this research, tourism organizations will only be able to appreciate the new system's utility if the organization's system is complex in terms of adopting new technology. However, complexity is inversely proportional to Metaverse adoption intention in tourism and needs further investigation. Therefore, the next hypothesis formulates the following:

H2: *Complexity has a significantly negative effect on the intention to adopt the Metaverse in the tourism industry.*

2.3.3. Relationship Between Compatibility and Intention to Adopt Metaverse

In the Metaverse cases, compatibility refers to the perception of the level of ease with which a technology may be assimilated and incorporated into an organization's existing processes and infrastructure [7,10]. According to [4], the Metaverse has been identified as a very suitable platform for visitors to access applications, owing to its compatibility. For instance, the Metaverse study of perceived compatibility has been investigated in Vietnamese information and technology enterprises [9]. On the other hand, the Metaverse facilitates novel interactions with tourism organizations and places, granting travelers the ability to exert control over both virtual and physical aspects of their experiences [3,4]. The assessment of compatibility is of utmost importance when evaluating the suitability of a technology for integration with established sectors and its potential to facilitate widespread adoption [42]. The previous findings support this study in the context of compatibility in Metaverse adoption. Thus, compatibility may influence the tourism industry to adopt the Metaverse. Thus, the next hypothesis formulates the following:

H3: *Compatibility has a significantly positive effect on the intention to adopt the Metaverse in the tourism industry.*

2.3.4. Relationship Between Top Management Support and Intention to Adopt Metaverse

Top management support (TMS) is integral to a company's adoption decision for new technology [17,30]. The significance of executive-level support in demonstrating the adoption of technological breakthroughs within organizational contexts has been emphasized in numerous research studies. For instance, [19] investigated how investments in financial and physical resources for the Metaverse support the actualization and implementation of the hospitality industry. Similarly, Metaverse investment is driving it to become a smart city. An adopting technology (in this study, the Metaverse) requires top-level management support. In the case of Indonesia, the tourism industry management supports Metaverse adoption, which is relatively new and has yet to be investigated in recent studies. Numerous prior research endeavors have consistently demonstrated that the degree of support from upper-level management exerts a substantial influence on individuals' inclination to adopt and utilize technology. Consequently, the formulation of the following hypothesis arises:

H4: *Top management support has a significantly positive effect on the intention to adopt the Metaverse in the tourism industry.*

2.3.5. Relationship Between Government Policy and Regulation (GPR) and Intention to Adopt Metaverse

Government policy and regulation (GPR) encompasses the strategic measures, initiatives, and incentives that a governing body employs to stimulate the adoption of technology [17,40]. With the possibility that widespread adoption of Metaverse platforms will occur during the next decade, it is crucial to assess the associated risks and arrange for appropriate regulation by policymakers. In addressing the Metaverse transition, the role of policymakers is crucial as they should engage with the technology industry to promote an ethical approach to the advancement of Metaverse technologies [4,41]. The government should consider policy and regulation for intention to adopt the Metaverse in the tourism industry, particularly strategic collaboration with related technological industries and academic researchers in policy-making for a policy of data use, privacy security, and online safety [4,43] and Metaverse transactions [4,29]. Furthermore, the next hypothesis formulates the following:

H5: *Government policy and regulation have a significantly positive effect on the intention to adopt the Metaverse in the tourism industry.*

2.3.6. Relationship Between Competitive Pressure and Intention to Adopt Metaverse

Competitive pressure (CP) pertains to the degree to which an organization considers the influence of competitors as a significant component in its business operations [7,10,44]. The intention to adopt the Metaverse has a big concern from competitors regarding competitive pressure in innovation progress. For instance, the internet and media industry, such as TikTok, has emerged recently and has been challenging Meta. The Metaverse has had competition among Meta, Microsoft, Nvidia, Apple, Neal, etc. Therefore, scholars have increasingly recognized a company's capacity to alter its business model before being compelled by external pressure as a significant source of competitive advantage [20]. In addition to the Metaverse component, [39] investigated that competitiveness was an external pressure that significantly influenced the utilization of social media platforms within small and medium enterprises (SMEs). Ref. [10] found that there are applications for enhancing the competitiveness of SMEs by adopting blockchain in the Metaverse. For instance, the Indonesia Metaverse project plays a critical and advantageous role in many aspects of competitive technological advantages and tourism competition, including the involvement of SME tourism. Hence, this study applies the competitive pressure influence factor on the intention to adopt the Metaverse in tourism. Based on the discussion, the next hypothesis formulates the following:

H6: *Competitive pressure has a significantly positive effect on the intention to adopt the Metaverse in the tourism industry.*

Figure 1 illustrates the research model, based on the TOE framework, linking key factors to the intention to adopt Metaverse technology in Indonesian tourism.

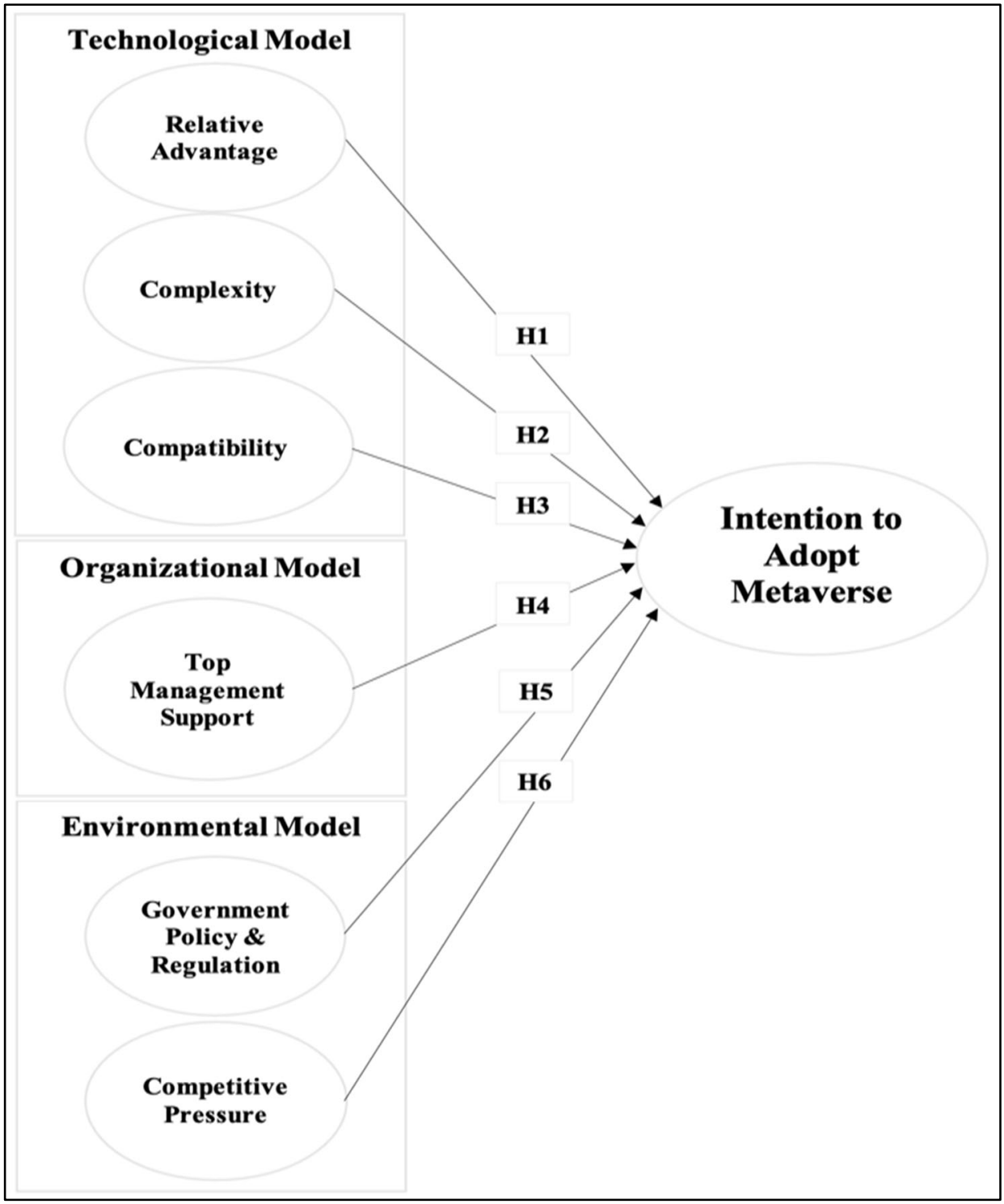


Figure 1. Research model. Source(s): figure by author.

3. Methods

3.1. Research Design

This section discusses the research processes, the research model, the measurement method, the data collection and sample selection, the data analysis, and PLS-SEM techniques. The current study uses a cross-sectional research design and a quantitative technique to examine the association between factors and assess the collected data. The quantitative approach uses primary data collected through an online questionnaire survey.

This study proceeds and analyzes the collected data and summarizes the findings of statistical analyses and the discussion. The initial segment of the questionnaire asks about the demographic characteristics of the participant, encompassing variables such as age, gender, educational background, and occupational status. Table 1 provides an overview of the respondents' demographic characteristics.

Table 1. Respondents' demographic characteristics.

Profile	Categories	Complete *n* = 303 (100%)		University *n* = 113 (37.3%)		Government *n* = 62 (20.46%)		Industrial *n* = 128 (42.24%)	
		Frequency	%	Frequency	%	Frequency	%	Frequency	%
Gender	Male	214	70.63	80	71	39	62.90	95	74.22
	Female	89	29.37	33	29	23	37.10	33	25.78
Age	17–30	46	15	21	18.59	6	9.67	19	14.84
	31–45	151	50	53	46.90	34	54.84	64	50.00
	46–60	91	30	28	24.78	20	32.26	43	33.60
	60>	15	5	11	9.73	2	3.23	2	1.56
Education	High school	16	5.28	5	4.42	-	-	11	8.66
	Professional certificate	2	0.66	-	-	-	-	2	1.57
	Bachelor	86	28.39	7	6.20	12	19.35	67	52.76
	Master	134	44.22	56	49.56	38	61.30	40	30.71
	Doctoral	65	21.45	45	39.82	12	19.35	8	6.30

Source(s): table by author.

The subsequent section examines the independent variables of the TOE model. The third component of the study examines the dependent variable, specifically the intention to adopt the Metaverse.

3.2. Measurement Model

There are five items to measure relative advantage adopted from [39], four items to measure complexity adopted from [17,45], five items to measure compatibility adopted from [45], four items to measure top management support adopted from [39], four items to measure government policy and regulation adopted from [17,46], four items to measure competitive pressure adopted from [39,45], and five items to measure the intention to adopt the Metaverse adopted from [17,45]. The survey employed a five-point Likert scale, with a range from 1, indicating "strongly disagree", to 5, indicating "strongly agree". The questionnaire summary encompasses the variable items and references derived from prior research.

The construct government policy and regulation (GPR) was measured across all three stakeholder groups to capture their respective perceptions of how governmental frameworks influence Metaverse adoption. While government officers may be involved in shaping policy, their inclusion is essential to understand the intent, clarity, and perceived supportiveness of regulations from within the system. For practitioners and academics, the same construct reflects their external evaluation of policy effectiveness and regulatory readiness. This multi-perspective approach allows for richer insight into alignment (or misalignment) between those who create policy and those who are affected by it. Group-level analyses were conducted to account for potential perceptual differences between stakeholders. Table 2 summarizes the items used to measure each construct in this study, along with the original sources.

Table 2. Questionnaire summary.

Variables	Items	References
Relative advantage (RA) is the degree to which a technology component is seen as offering more benefits to businesses.	Compared to other technologies Metaverse... 1. offers new business opportunities in tourism sector. 2. increases tourism business productivity. 3. strengthens business in tourism sector. 4. improves advertising in tourism sector. 5. improves marketing in tourism sector.	[39]
Complexity (CX) is characterized as the extent to which innovation takes place and is challenging to comprehend or utilize.	1. Metaverse requires extra technical skills to use in tourism sector. 2. Metaverse is difficult to understand from a technical perspective in tourism sector. 3. Metaverse is difficult to understand from a business perspective in tourism sector. 4. Metaverse is complicated to incorporate into tourism business operations.	[17,45]
Compatibility (COM) is the extent to which an invention is perceived as aligning with the prevailing values, past experiences, and requirements of prospective consumers.	Adopting Metaverse is ... 1. compatible with existing technological infrastructure in tourism sector. 2. relevant with business values in tourism sector. 3. compatible with prior tourism business operations. 4. compatible with existing tourism business operations. 5. consistent with needs of business strategy in tourism sector.	[45]
Top management support (TMS) is an integral component of a company's adoption decision for new technology.	Top management... 1. is interested in adopting the metaverse in tourism sector. 2. has shown support for metaverse adoption in tourism sector. 3. considers metaverse adoption as a business strategy in tourism sector. 4. emphasizes R&D, technological leadership, and innovations of metaverse in tourism sector.	[17,39]
Government policy and regulation (GPR) refers to the policies, efforts, and incentives implemented by a government to encourage technology adoption.	1. Government supports policies on adopting metaverse in tourism sector. 2. Government supports economic incentives on adopting metaverse in tourism sector. 3. Government encourages setting up facilities to promote metaverse adoption in tourism sector. 4. Government puts efforts to provide business regulation on adopting metaverse in tourism sector.	[17,46]
Competitive pressure (CP) pertains to the degree to which an organization considers the influence of competitors as a significant component in its business operations.	Tourism sector adopting metaverse... 1. when perceiving pressure from market rivalry' successful in business operations. 2. when rivals adopting technology earlier to stay competitive. 3. to support operations. 4. to increase competitiveness.	[39,44,45]
Intention to adopt metaverse (INT) refers to a user's intention to use or reject technology by adopting specific techniques to assure the technology's continued use.	1. I accept to use metaverse when it becomes available. 2. I will help to adopt metaverse. 3. I intent to reject adopting metaverse. 4. I intent to follow technological trends to use metaverse in the near future. 5. I believe that continued use of metaverse is worthwhile.	[17,41,45]

Source(s): table by author.

3.3. Sampling and Data Collection

This research used primary data collection with an online questionnaire survey and platform (Google Form). The questionnaire was written in English, and the Indonesian version was distributed. As cross-sectional design, the sample selection was targeted to Indonesian academics, government officers, and practitioners in the tourism field and focused on their perspectives about the adoption intention of the Metaverse. The survey was administered to tourism academics, municipal officers, and practitioners, who were located in some areas in Indonesia including Java, Nusa Tenggara, Bali, etc. The selected samples of academics, municipal officers, and practitioners included professors, lecturers, students from academia; middle-upper-level officers from municipal offices; and owners and middle-upper-level staff of resorts, travel agencies, hotels, restaurants, and small-medium enterprises from practitioners.

3.4. Justification for Stakeholder Inclusion

Although the intention to adopt a new technology is typically associated with direct implementers, such as tourism practitioners, this study also includes government officers and academics due to their influential roles in shaping the adoption environment. Academia contributes through research, education, and innovation diffusion, while government officers influence policy, funding, and infrastructure development. Following the triple helix model [47], this study treats all three groups as key stakeholders whose perspectives are crucial to understanding adoption dynamics in a holistic, system-level manner. Therefore, their responses are included not as direct implementers but as co-constructors of the broader Metaverse adoption ecosystem in Indonesian tourism.

3.5. Sample Size Determination

The determination of the minimum sample size for this investigation was based on the study conducted by [47]. The significance level was established at 5%, and a minimum path coefficient of 0.11 was chosen. The minimum required sample size was determined to be 155, with a statistical power of 80%. The obtained sample was 303 to evaluate their perspectives on the research model and meet the eligibility criteria consistent with the research questions and objectives. However, the sample population was selected based on simple random sampling, which focuses on tourism perspectives following the triple helix (i.e., university, government, and industry) by [48]. Tourism is a booming industry that fosters the economy and boosts innovation, which, in this study, was the adoption of Metaverse technological innovation.

3.6. Data Analysis Using PLS_SEM

On quantitative procedure, the collected data and hypotheses built in this study were analyzed with PLS-SEM. PLS-SEM is used to statistically measure a model with a small sample size, although many variables and indicator constructs are present [8,49]. When considering the prediction purposes and theoretical developments, PLS-SEM is an appropriate tool to analyze variance, based on [44]. The study uses SmartPLS 4 and PLS-SEM procedures [23,50]. PLS-SEM was chosen for its ability to handle complex relationships between multiple independent and dependent variables, making it particularly suited for exploring the multifaceted influences on Metaverse adoption in the tourism industry. To verify the credibility and reliability of the PLS-SEM model, we employed bootstrapping techniques and cross-validated the results using a separate dataset. PLS-SEM bootstrapping analyzes the structural model assessment, including inner VIF, the path coefficient (β), significance of estimates (t-statistics), *p*-values, bias-corrected confidence intervals, and effect size (f2). Ref. [51] recommends that the structural model assessment also measure the

in-sample prediction of the coefficient of determination (R2), and out-of-sample prediction of predictive relevance (Stone–Geisser Q2), predictors' path coefficients, and effect size (f2).

4. Data Results

This section undertakes a multifaceted examination of data, intricate model analyses, and evaluative metrics to construct a comprehensive understanding of the subject matter.

4.1. Respondent Profile

The survey gathered valid responses from 303 participants across three stakeholder groups: university (n = 113; 37.3%), government (n = 62; 20.5%), and industry practitioners (n = 128; 42.2%). Table 1 summarizes the demographic characteristics of the respondents. In terms of gender, the majority were male (70.6%), with females representing 29.4%. Participants were predominantly in the 31–45 (50%) and 46–60 (30%) age ranges. The educational background was diverse, with 44.2% holding a master's degree, followed by 28.4% with bachelor's degrees, and 21.5% with doctoral qualifications. These demographics reflect a well-educated and professionally active sample across key sectors involved in tourism and technology adoption in Indonesia.

4.2. Measurement Model Analysis

The measurement model analysis elucidates the association between latent variables and their corresponding indicators [48]. Thus, this section will show the result of outer loadings, fit indices, CA and CR, AVE, HTMT ratio, and the Fornell–Larcker criterion. The outer loading value was examined to determine convergence validity. The calculated outer loading value (original sample) by PLS-SEM is more significant than 0.70, indicating that 23 items satisfy convergent validity and that 8 removed items are disqualified. Similarly, all criteria were met (Cronbach's alpha >0.70; composite reliability >0.70; AVE >0.50; HTMT <0.85; and Fornell–Larcker square AVE >correlation), including a goodness-of-fit criterion, such as the standardized root mean square residual (SRMR) [51,52]. The SRMR value was 0.048. This value indicates an acceptable fit if it is less than 0.050, according to [48]. Ref. [51] suggests that scholars should consider SRMR fit cut-off values in their research. The recommendation made by regarding the sole criterion for evaluating the fit of a PLS path model is pertinent to the assertion made by [52]. Thus, further analysis could proceed.

4.3. Construct Reliability and Validity

The reliability coefficient of CA, CR, and AVE convergent validity were used to determine the construct's reliability and validity. Convergent validity pertains to the extent to which a measurement demonstrates a positive association with other measures that evaluate the identical underlying construct [48]. Furthermore, AVE exceeded the established threshold of 0.50. Every individual item possessed an outside loading value that exceeded 0.50. In contrast, the CA and CR (rho_A and rho_C) values were above the established threshold of 0.70. All descriptive variables in Table 3 have values greater than 0.70. The outcomes of this study are regarded as positive. Thus, construct reliability and validity results were deemed to be consistent.

4.4. Discriminant Validity

The discriminant validity result was evaluated using a recommendation from [23], namely the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) ratio. For the Fornell–Larcker criterion, the AVE scores for each variable exceeded their correlations with all other variables. The average of the explained variance (AVE) in the study demonstrated a greater magnitude in comparison to the relationship of the factor and the other factors, as seen by the bold diagonal values below. All HTMT values fell within the range of 0.225 to

0.771 and thus did not exceed the HTMT threshold of 0.90. The complete Fornell–Larcker criterion and HTMT ratio results were valid, as shown in Table 4 in this study.

Table 3. Outer loadings, Cronbach's alpha, composite reliability, and AVE.

Variables	Items	Outer Loadings	CA	rho_A	rho_c	AVE
		>0.7	>0.7	>0.7		>0.5
Compatibility (COM)	COM1	0.822	0.909	0.917	0.932	0.734
	COM2	0.856				
	COM3	0.849				
	COM4	0.901				
	COM5	0.853				
Competitive Pressure (CP)	CP3	0.919	0.828	0.829	0.921	0.853
	CP4	0.928				
Complexity (CX)	CX2	0.910	0.873	0.914	0.920	0.794
	CX3	0.855				
	CX4	0.907				
Government Policy and Regulation (GPR)	GPR1	0.882	0.929	0.930	0.950	0.825
	GPR2	0.909				
	GPR3	0.939				
	GPR4	0.903				
Intention to Adopt (INT)	INT2	0.863	0.839	0.839	0.903	0.756
	INT4	0.889				
	INT5	0.857				
Relative Advantage (RA)	RA4	0.954	0.892	0.897	0.949	0.903
	RA5	0.946				
Top Management Support (TMS)	TMS1	0.895	0.906	0.910	0.935	0.781
	TMS2	0.921				
	TMS3	0.888				
	TMS4	0.830				

Source(s): table by author.

Table 4. Fornell–Larcker criterion and HTMT ratio.

ITEMS	COM	CP	CX	GPR	INT	RA	TMS
COM	**0.857**	*0.644*	*0.315*	*0.647*	*0.702*	*0.547*	*0.771*
CP	0.559	**0.923**	*0.251*	*0.726*	*0.757*	*0.579*	*0.659*
CX	−0.294	−0.222	**0.891**	*0.225*	*0.326*	*0.288*	*0.344*
GPR	0.596	0.636	−0.216	**0.908**	*0.660*	*0.477*	*0.663*
INT	0.621	0.631	−0.288	0.585	**0.870**	*0.580*	*0.680*
RA	0.495	0.500	−0.261	0.437	0.502	**0.950**	*0.576*
TMS	0.702	0.571	−0.317	0.610	0.595	0.522	**0.884**

Notes: COM—compatibility; CP—competitive pressure; CX—complexity; GPR—government policy and regulation; INT—intention to adopt; RA—relative advantage; TMS—top management support. The diagonal values in **bold** are the square root of AVE. The values in *italic* and diagonal above present the HTMT ratio. Source(s): table by author.

4.5. Structural Model Analysis

A structural model analysis and bootstrapping (5000 subsamples) results from SmartPLS 4 are displayed in Table 5 and Figure 2, respectively. The structural model presents the hypotheses (path coefficient), original sample (O), standard deviation (STDEV), t-values, *p*-values, bias-corrected confidence intervals, inner variance inflation factor (VIF), effect size (f2), coefficient of determination (R2), and predictive relevance/Stone–Geisser (Q2) to fulfill the satisfaction of inner model evaluation [48]. Accordingly, all the hypotheses are significantly accepted, except CX (H2, β = −0.064, t = 1.398; $p > 0.05$). Meanwhile, RA (H1, β = 0.114, t = 2.229; $p < 0.05$), COM (H3, β = 0.228, t = 3.308; $p < 0.001$), TMS (H4, β = 0.110, t = 1.661; $p < 0.05$), GPR (H5, β = 0.140, t = 1.912; $p < 0.05$), and CP (H6, β = 0.280, t = 3.983; $p < 0.001$) have significantly positive effects on the intention to adopt the Metaverse in the tourism sector. The findings indicate that the VIF collinearity is below the threshold of 3 (ranging from 1.135 to 2.425), and the coefficient of determination for the intention to adopt the Metaverse in tourism has a 53.2% ($R^2 = 0.532$) proportional variance, which aligns with the existing literature.

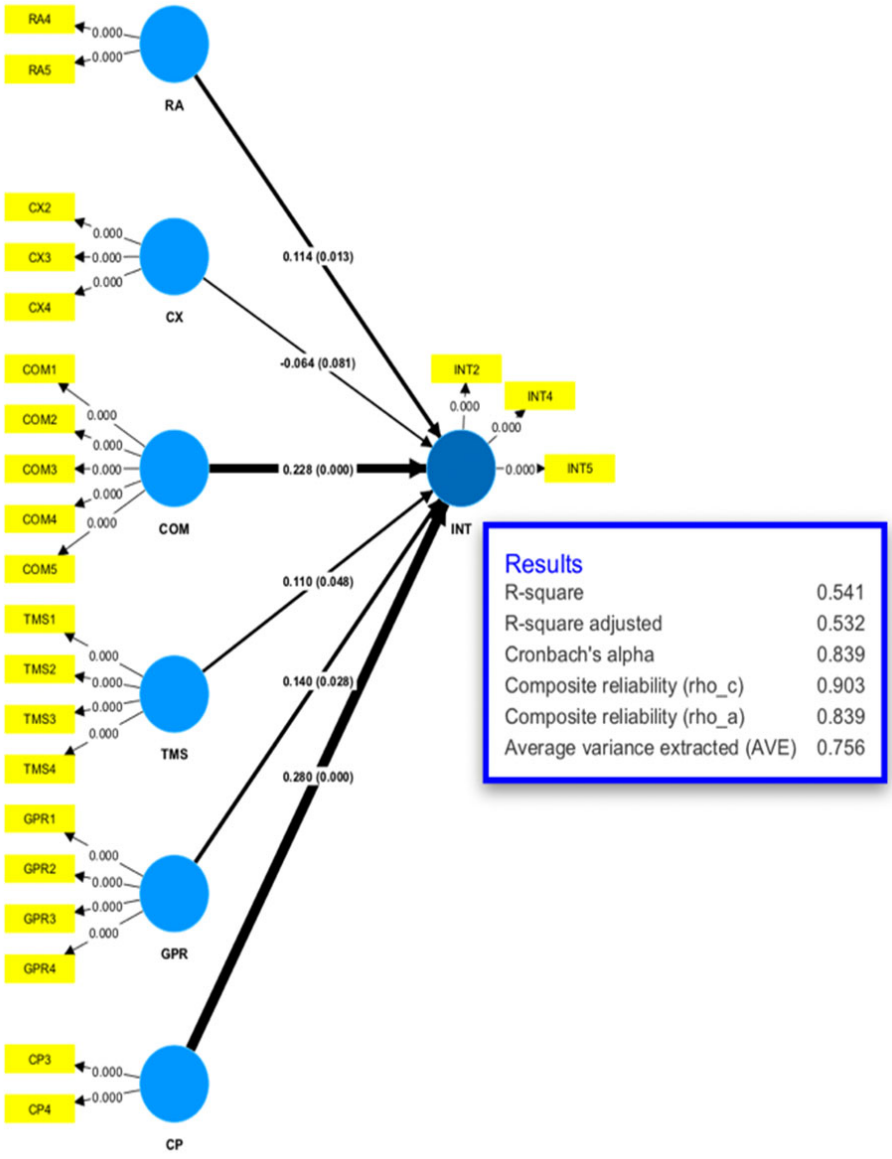


Figure 2. PLS-SEM result. Source(s): figure by author.

Table 5. Structural model analysis result.

Hypotheses (Path)		O	STDEV	T Values	*p* Values	Bias-Corrected Confidence Intervals (95%)		VIF	f^2	R^2	Q^2
H1	RA → INT	0.114	0.051	2.229 *	0.013	0.034	0.203	1.546	0.018	0.532	0.511
H2	CX → INT	−0.064	0.046	1.398	0.081 ns	−0.143	0.009	1.135	0.008		
H3	COM → INT	0.228	0.069	3.308 ***	0.000	0.112	0.338	2.282	0.050		
H4	TMS → INT	0.110	0.066	1.661 *	0.048	0.006	0.224	2.425	0.011		
H5	GPR → INT	0.140	0.073	1.912 *	0.028	0.020	0.258	2.071	0.021		
H6	CP → INT	0.280	0.070	3.983 ***	0.000	0.168	0.400	1.989	0.086		

Notes: * = $p < 0.05$; *** = $p < 0.001$; ns = non-significance. Source: table by author.

In addition to measuring Stone–Geisser (Q2), a positive value for the Q2 statistic in the structural model denotes the existence of predictive relevance. In contrast, a Q2 score less than 0 indicates a deficiency in the model's predictive significance. The findings derived from the PLS-SEM in this structural model demonstrated satisfactory levels of predictive validity. The stated inclination to incorporate the Metaverse into the tourism industry is Q2 = 0.511. Accordingly, the Q2 values represent greater predictive importance for the adoption intentions of the Metaverse. Similarly, the values of variance in the endogenous constructs (R^2) in this study are substantial, as they are >0.26 [49,50]. The R^2 statistic result indicating the coefficient of determinants of the research model represents substantive and proportional effects on the dependent variable (INT) in this study.

5. Discussion and Conclusion

This section ends with the results summary, research implications, and limitations and future research. The objective of this study is to enhance the existing body of literature and research pertaining to the substantial significance of the intention to use Metaverse technology within the tourist industry as viewed through the lens of the TOE model (RA, CX, COM, TMS, GPR, and CP) and the triple helix (i.e., academia, government officers, and tourism practitioners) in Indonesia, which focuses on technological innovation and boosting tourism economics. The newest SmartPLS 4 application was adopted to examine the data using PLS-SEM procedures in this study. To the best of our knowledge, this study is the first application in the field of the tourism industry using a combination model of the TOE and the triple helix and a statistical tool of PLS-SEM.

5.1. Results Summary

The framework for this research was established based on the interrelationships among factors identified in prior studies, as outlined in the literature review. Nevertheless, there is a scarcity of scholarly studies that have examined the correlation between the TOE model and the objectives associated with the adoption of the Metaverse within the Indonesian tourism sector. Furthermore, the objective of this study was to assess the viewpoints of academia, government officers, and practitioners in this regard. Consequently, the existing body of literature strongly corroborates the findings of this study. Moreover, the study findings have made a significant contribution to the emergence of novel insights and discoveries that were previously overlooked. This section presents an analysis of the research findings and explores their potential implications.

5.2. Theoretical Implications

This study contributes to theory in three distinct ways. First, it extends the TOE framework by integrating it with the triple helix model to analyze Metaverse adoption across multiple stakeholder types—academia, government, and industry. This multi-actor perspective is rarely explored in tourism technology research and provides a more comprehensive understanding of ecosystem-level innovation readiness. Second, it validates the applicability of the TOE framework in the context of emerging technologies like the Metaverse in an under-researched market—Indonesia. Third, the study reveals nuanced stakeholder-specific patterns in adoption intention (e.g., competitive pressure being more influential for academia and government), which can inform differentiated theoretical models in future research.

The study examines and verifies the theoretical implications of six objectives. Therefore, the findings of the study yield multiple theoretical ramifications. First, the relative advantage has a notable favorable impact on the intention to adopt the Metaverse. Metaverse technology is beneficial for digital advertising and marketing operations to enhance tourism business activities and to provide better specific technologies for user experience and value creation [3,4,34]. The Metaverse encourages the rapid development of virtual technology and improves users' ability to acquire high-quality senses, thereby enabling a multisensory, immersive, virtual travel experience [53]. This finding implies the Metaverse has relative advantages compared to other technologies.

Second, the complexity is not a barrier for business sectors and individuals, especially tourists, to adopt the Metaverse, as it has been determined that innovative metaverses can be adopted more easily and that users who adapt to technological advancement are more likely to engage in innovative and creative economics. Adoption intentions in the Metaverse [54] and hospital information systems [13] have supported this conclusion. This finding suggests that the complexity factor should not be considered a part of future TOE studies.

Third, compatibility has a substantial impact on the intention to adopt the Metaverse [4,33,36], as higher levels of technology compatibility are associated with higher intentions to adopt them [41]. Accordingly, compatibility has become a key influence on the sustainability of Metaverse technology in usage [3]. This is in line with various studies that found compatibility could integrate with Metaverse tourism marketing [3] and is a key influencing factor for online platform adoption [55] and technology Industry 4.0 [56].

Fourth, top management support has a significantly positive effect on the intention to adopt the Metaverse. According to the literature, top management decisions are crucial to determining the implementation of technological innovation [9,55] and establishing a research innovation and development center, physical facilities for technological development [17,19,39], and Metaverse tourism marketing [3]. This study suggests that top management should consider Metaverse opportunities to inspire customers and provide valuable information that has the potential to influence purchasing and marketing decisions.

Fifth, government policy and regulation have a substantial, favorable influence on individuals' inclination to adopt the Metaverse. This result is consistent with previous studies. For instance, in making policies of data protection and privacy [4,43] as well as business transactions [4,57], the government should consider supporting policies and regulations for Metaverse adoption, particularly in collaboration with enterprises and researchers. In addition to the Metaverse feature, the government should also consider policy and regulation for virtual reality and augmented reality adoption, as these technologies can be used as effective marketing tools and have enormous potential for the tourism industry [4,5].

Sixth, competitive pressure has a positive effect on the intention to adopt the Metaverse. The more pressure the market rivals put on adopting the Metaverse as a business tool to boost their operations, the more competitive it becomes. For instance, Metaverse adoption has been implemented in Korea [19,27] and offers perceived pressure on business competitiveness through innovation and technological advantages [20]. This study found that competitive pressure supports operations and increases competitiveness in the Metaverse adoption. This finding was validated by academics, government officers, and practitioners, who agreed that the influence of competitive pressure is of utmost importance in attaining a competitive edge.

Overall, the findings of this study align with many prior works, particularly those highlighting the importance of relative advantage, compatibility, and competitive pressure in driving adoption intentions. However, this study also offers new insights by identifying stakeholder-specific patterns, for instance, the stronger influence of competitive pressure among academic and governmental respondents, which is less commonly emphasized in previous tourism research. Additionally, while some earlier studies reported mixed results regarding the role of complexity in adoption decisions (e.g., [8,17]), this study found it to be non-significant, suggesting that perceived complexity may be less of a barrier in sectors already accustomed to digital transformation. These nuanced findings underscore the need for context-sensitive models when applying the TOE framework in diverse industries and regions.

5.3. Practical Implications

The study of intention on Metaverse adoption is still in its early stages in tourism; therefore, this field contributes very important insights to academia to improve the research collaboration in Metaverse tourism, to the government to support policies and regulations in Metaverse development in Indonesia, and to tourism practitioners to support tourism marketing and operations using Metaverse advantages as a business tool.

The practical contributions of this study are directed toward three key stakeholder groups. For tourism practitioners, the study identifies top management support and competitive pressure as the most decisive factors, suggesting that internal leadership and market dynamics are crucial levers for driving adoption. For government agencies, the findings highlight the importance of policy clarity and infrastructure readiness, offering direction for regulatory design and investment strategies to stimulate innovation in tourism. For the academic sector, the results point to a need for stronger alignment between research initiatives and industry needs, particularly in training, digital content creation, and collaboration with tourism enterprises. These insights enable each stakeholder group to tailor their actions and collaborations to facilitate Metaverse integration in Indonesia's tourism sector.

The practical implications for academia in this study show that academia does not support the technological factors of relative advantage, complexity, and compatibility as the aspects to push the adoption intention of the Metaverse. It shows that the organizational factor of top-level management and the external factor of competitive pressure are the most important aspects to take advantage of in decision making for Metaverse technology implementation. The academic community underlines the importance of top-level management support for research and development facilities and infrastructure related to Metaverse technology. This support is vital due to the competitive challenges faced by the tourism sector.

Tourism organizations in Indonesia can begin leveraging the Metaverse by creating virtual reality (VR) tours of destinations to enhance marketing efforts and customer engagement, allowing travelers to explore locations before booking. Developing gamified experiences, such as virtual scavenger hunts or reward systems, can further increase cus-

tomer interaction and loyalty. To support these initiatives, organizations should invest in AR/VR hardware and software while partnering with technology providers to develop tailored Metaverse solutions for hotels, resorts, and travel agencies. Workforce training is essential, with workshops and programs aimed at upskilling employees in Metaverse technologies, including VR/AR content creation and managing virtual customer interactions. Organizations can foster innovation by piloting small-scale projects like VR-assisted booking systems or AR-enhanced site navigation, using customer feedback and ROI measurements to scale successful efforts. Collaboration with academia and tech startups is vital, allowing organizations to access cutting-edge research on user preferences and co-develop innovative applications for tourism.

In light of the favorable effects stemming from top management support or practitioners, it is advisable for tourism organizations to place emphasis on internal workshops and training modules facilitated by top management in order to expedite the adoption of the Metaverse. This factor shows the pivotal role that facilitating the technological invention of Metaverse plays [55], especially in tourism marketing strategies and destinations [3]. Therefore, the promotion of Metaverse technology implementation within the tourism industry by top-level management is encouraged to leverage its potential benefits and overcome the challenges that hinder the adoption of this innovative solution.

Simultaneously, government agencies should support Metaverse adoption by offering tax breaks or subsidies for tourism businesses adopting these technologies, alongside grants for R&D in AR/VR-focused projects. Establishing clear regulatory frameworks is crucial, with guidelines on data privacy, security, and ethical use of Metaverse platforms. Governments must also invest in digital infrastructure, such as expanding high-speed internet and 5G networks in tourist destinations and creating innovation hubs where tourism businesses can test and deploy Metaverse solutions. Public awareness campaigns are necessary to educate tourists and businesses on the benefits of Metaverse technologies, promoting these advancements through digital marketing aimed at local and international markets. Finally, fostering collaboration through regular forums and public–private partnerships will enable the sharing of resources and expertise, ensuring a cohesive approach to Metaverse adoption that positions Indonesia as a leader in innovative tourism.

5.4. Limitations and Future Research

This study has several limitations that future research may address. First, although the research followed the triple helix model, involving academics, government officials, and industry practitioners, the distribution of respondents across these groups was uneven—particularly with a lower representation from government officers. To gain a more balanced and comprehensive perspective, future studies should aim for a more equitable sample distribution. Collaborating directly with government institutions may also provide deeper insight into how policy influences the adoption of emerging technologies such as the Metaverse.

Second, while the inclusion of all three stakeholder groups supports a system-level perspective on Metaverse readiness, a key limitation lies in measuring "intention to adopt" across actors with inherently different roles. Practitioners are typically the primary implementers, whereas academics and government officials act more as enablers or influencers. Although this study accounted for these roles by segmenting stakeholder responses and interpreting them within context, the shared use of a single adoption construct may blur operational distinctions. Future research could design stakeholder-specific instruments or analyze intentions separately to reflect the different mechanisms through which each group supports or constrains adoption. Additionally, longitudinal studies could explore how intention develops into actual adoption across time and across these distinct roles.

Third, the construct of government policy and regulation (GPR) was assessed across all stakeholder groups. While this allows for a broad perspective on perceived policy support, it may also introduce bias—particularly from respondents directly involved in policy-making. Government officers may have more optimistic views of regulatory clarity and effectiveness compared to external stakeholders. Future studies may consider restricting policy perception measures to external stakeholders or distinguishing between policy design and policy impact using separate constructs.

Finally, this study focused on six key variables drawn from the Technological–Organizational–Environmental (TOE) framework. Future research could expand this scope by incorporating additional constructs, such as observability (technological context), firm size and entrepreneurial orientation (organizational context), and legal frameworks or perceived technological trends (environmental context). Such additions may further enrich understanding of the dynamics that influence Metaverse adoption across various tourism sectors and regions.

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