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The Role of Human–Machine Interactive Devices for Post-COVID-19 Innovative Sustainable Tourism in Ho Chi Minh City, Vietnam

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Received: 18 September 2020; Accepted: 6 November 2020; Published: 16 November 2020



Abstract: In this research article, we aim to study the proposed role of human–machine interactive (HMI) technologies, including both artificial intelligence (AI) and virtual reality (VR)-enabled applications, for the post-COVID-19 revival of the already depleted tourism industry in Vietnam’s major tourist destination and business hub of Ho Chi Minh City. The researchers aim to gather practical knowledge regarding tourists’ intentions for such service enhancements, which may drive the sector to adopt a better conclusive growth pattern in post-COVID-19 times. In this study, we attempt to focus on travelers who look for paramount safety with the assurance of empathetic, personalized care in post-COVID-19 times. In the current study, the authors employ structural equation modeling to evaluate the intentions of tourists both structurally and empirically for destination tourism with data collected from tourists with previous exposure to various kinds of these devices. The study shows that human–machine interactive devices are integrating AI and VR and have a significant effect on overall service quality, leading to tourist satisfaction and loyalty. The use of such social interactive gadgets within tourism and mostly in hospitality services requires an organization to make a commitment to futuristic technologies, along with building value by enriching service quality expectations among fearful tourists. This research shows that tourists mainly focus on the use of such HMI devices from the perspective of technology acceptance factors, qualitative value-enhancing service and trustworthy information-sharing mechanisms. The concept of the tour bubble framework is also discussed in detail. The analysis of this discussion gives us a more profound understanding of the novel opportunities which various administrative agencies may benefit from to position these devices better in smart, sustainable destination tourism strategies for the future so that, collectively, service 5.0 with HMI devices can possibly bring back tourism from being disintegrated. Such service applications are the new social innovations leading to sustainable service and a sophisticated experience for all tourists.

Keywords: AI and VR devices; robots in tourism; COVID-19; tourist interest; revival of tourism; tour bubble; service 5.0; Web 4.0 and 5.0

1. Introduction

COVID-19 has been an unwelcome surprise globally. As COVID-19 has spread around the world, the services industry, which relies on direct human interaction, has suffered a great deal. Services such as tourism, hospitality and aviation have been the most impacted industries. The fear factor and the subsequent melancholic atmosphere have been psychologically affecting people around the world, and this will continue for some time in the future, even after a potential solution or cure for the disease is found [1–3]. According to the World Health Organization (WHO), the rapid outbreak has caused an unprecedented situation in all markets. Significantly, the service sector has been affected the most, as human involvement is more present there than the goods market due to empathy. So, where threats to human health are present, the industry has to bear the brunt of the global situation. Considering psychological evidence, COVID-19 will indeed lead to a reform of the service delivery, consumer engagement and delivery sectors [4]. has been is the most affected service, as the human element has the maximum implications in this sector. All tourism establishments are contemplating finding an alternative plan to tackle the aftermath of the pandemic situation, as tourists will almost certainly not immediately begin to travel again as there is always an element of risk. From aviation to hospitality and wellness, the industry will have to look for a strategy which will sustain them after the period of COVID-19. It will take nearly 18–30 months to reenergize the sector. Internal tourism may bloom slowly, but external tourism still needs a detailed makeover plan. As with all significant destinations with substantial tourism, Vietnam has also suffered, and this has also affected its GDP. On the other hand, with the evolution of Web technologies and development in artificial intelligence (AI)-enabled applications, along with the development of the Internet of Things (IoT) into the Internet of Human Things (IoHT), commercial services are progressing towards adopting the smart tourism sector after COVID-19. These human–machine interactive devices have been targeted for the total revival of the industry, which has been very severely affected by COVID-19. Physical self-service points will arouse some scepticism in the minds of tourists until it is clear that the pre-COVID-19 situations will not return. Now, the most pertinent question will be how to resolve this situation, which very much depends on the digitalized transformation of services. This turnaround could involve the possible amalgamation of the Internet of Human Things (IoHT) and Web 4.0 and 5.0 with robotics [5]. This strategy has the capacity to make the whole tourism ecosystem smart, sustainable and innovative, which could generate trust and security in travellers' minds.

In this work, the authors attempt to focus on both quantitative and qualitative aspects to consider the possibility of sectorial revival along with the interest of tourists towards the adaptation of the devices listed above. These machines are representative of human–machine interaction (HMI). These categorical new social innovations will allow the industry to adhere to COVID-19 restrictions, which are greatly affecting the economy, while still continuing to operate. This study focuses on Ho Chi Minh City (HCMC), Vietnam's most vibrant developed city, which thrives on tourism and is a prominent business hub. The authors aim to foresee how tourists will react to and benefit from these devices. Mankind is taking its first steps towards the age of artificial intelligence, and new technical intricacies are virtually transforming every facet of our daily activities. Service experiences are greatly affected by mathematical algorithms integrated with HMI devices on a day-by-day basis [6,7]. Particularly, this amalgamation presents a very exciting prospect for the usage of these HMI devices [8–10]. The interaction with such virtual assistance methods is currently very common due to the appearance of AI devices, such as Alexa and Siri, in our daily lives. These interactive robots/devices are mostly affecting services such as healthcare, hospitality, tourism and retail. According to an IBM analysis, by the end of 2020, 85% of all service interactions around the world will be done without any human

involvement [11]. However, after these extraordinary promises and pragmatic thoughts regarding HMI devices in research and academia, this field remains in a prototypic, nascent stage of development. However, this field is developing at a brisk pace, and it will soon be necessary to make travelers understand the role of HMI devices in service interaction and delivery.

The responses of both travelers and employees of establishments play a significant role in the incremental development of these HMI devices for their deployment [12]. This paper aims to give substantial output to this ever-growing discussion so that it can fittingly accumulate in various other industries. Any new opportunity provided by these HMI devices is food for thought in post-COVID-19 scenarios. However, these tools offer many ethical and societal issues for service delivery at each level of sustainability that can be addressed by the research fraternity in the future.

This paper aims to conclude the overall significant increase in service quality by HMI, enhancement of tourist engagement and experience for all the service outlets that directly interact with them. These gadgets, equipped with social interactive intelligence and empathy, may bring a sense of security and potential tourists that may eventually culminate in satisfaction and loyalty. In the overall scenario, this step of deploying these devices will be instrumental and decisive for tourism's pervasive development. Though it is a bit on the higher side in terms of cost, it can have the ability to give a distinctive image and enhance the reputation of the country's tourism system. This global pandemic has created ripple effects in the whole tourism sector by significantly affecting travelers' psychic state by affecting physical value-added service and traditional service models [13]. According to the United Nations World Tourism Organization (UNWTO), in 2020, an estimated decrease of 20% in tourists amounted to USD 340 billion [14]. Recent publications explored the effect of the pandemic from perspectives such as social media communication [15,16], localized versus globalized thought of new standard service delivery [17,18], rights of tourists [19] and technology implications [20]. To tackle this pandemic-induced crisis, we need an action plan. So, machine learning-integrated service delivery is required, creating a sense of security in travelers [21–27]. Revival strategies with HMI devices can bring innovative insights for dynamic, sustainable, transformative research and a new standard of service delivery [28]. Though machine learning has further implications for the tourism sector, it can revive the tourism sector in post-COVID-19 times with long-term organizational and practical research implications.

Artificial intelligence (AI) is rapidly entering into the scope of customer service enhancement and service organizations. It adds more value to analytical skills, impromptu thinking and empathetic customer service [29]. It opens avenues where organizations can increase customer experience factors. It is challenging to replace the human element with automated machines to provide objective treatment to all the customers. More frontline services require these AI-enabled devices or applications. AI can always motivate organizations to deploy these devices in frontline service [7]. After the COVID-19 pandemic, it will be one of the possible tools with which to revive, rejuvenate and recalibrate the tourism and hospitality industries in many ways.

The usage of these devices is very much prevalent in in-service consumer research, out of which tourism and hospitality are the leading sectors apart from retail, where service robots and applications are deployed more often. From room service to check-in and check-out, AI applications in the form of robots and chatbots are used for giving better, objective, standardized service [30]. Service robots act as waiters for taking and delivering orders and greeting the customers on arrival; facilitating payments is already in practice in Kunshan, a Chinese city. Service automation opens a Pandora's box for customer's choice [7] and behavior towards the service [31]. With this aspect, chatbots and artificial intelligent devices are increasingly used in the hospitality and tourism sector of late, aspiring to add more new-age experiences in machine learning-induced engagement of personal conversations [32]. AI-enabled devices are becoming more responsive, sophisticated and better equipped to handle customers. With the hope of increasing human-machine interaction in the coming years, it will continue to develop more [33]. Tourists' psychological mindset makes them eager to have an engaging experience with AI-induced machines deployed in various related service hubs.

AI has also ignited a massive level of curiosity and expectation across multiple service providers [34]. As per the Gartner hype cycle, it creates a necessary buzz in customer and service providers alike. That is why researchers and academicians all want to have more anticipation of AI-enabled devices' success in defining new consumer experiences in service marketing [35]. There is also a surge of research on different AI ramifications in the tourism and hospitality domains. Processes such as service automation and cognitive interaction are the main impetus on which service providers have recently zeroed. Digitalization induced processes, along with machine learning and big data, are driving AI advancements [36]. Underpinned by cognitive engagement, predictive analytical models help to optimize the service experience with human-machine expertise to the new age tourists. The models also help in predicting the exactness of customer behavior and the likelihood of repeat behavior too. Cognitive engagement is highlighted mostly by human-computer interaction represented by chatbots with round the clock service offering and robots with a sense of security and the belief that customers will get a standardized yet personalized touch of service, which makes everything very much attractive [37]. Human-machine interaction possibilities represent cognition that drives the tourism prospects to be a lot more self-amusing, smarter and prudent.

These AI-induced devices save cost, but the other half speaks that the human touch with the service may decline from time to time, as the mechanical way of every service engagement may attract some negative points in tourists' minds. Anyway, the implications of human-machine interactions with advanced cognitive engagement for enhanced service experience mostly remain untouched. The psychological aspect is unexplored primarily, which the authors want to highlight. The incremental dynamic development in technology has brought these AI-enabled devices into the tourism hospitality service domain [38–40]. These devices are mostly defined as system-integrated, adaptable, autonomous interfaces engaged in customer engagement for interaction while providing service [10]. These devices now come with useful, robust sensors to identify, adapt and interpret a particular service and learn the service process concerning a minimalistic error in the delivery. These recent developments have slowly led to a big revolution in the aviation, travel, tourism and hospitality sectors of late [7,41–43].

Physical self-service points are now a thing of the past as some organizations in the tourism hospitality sector have implemented them for a long time. Now, the most pertaining question is how to use the digitalized transformation of Web technologies along with the Internet of Human Things (IoHT) and robotics in the tourism sector to make the industry smart and sustainable in a real sense [43]. If considered with their actual output, tourism services will have a great deal of value addition for them in new customization, flexibility with an element of curiosity and fun with the tourists [44–46]. Especially in the hospitality sector, which is an essential wing needed for the tourism sector to fly, it will significantly boost these devices as they can be used in every aspect of the service, starting from check-in/-out to personalized service [47].

The deployment of these AI-enabled devices in service will indeed affect the role of human engaging in service. However, these devices should not be considered direct replacements of employees; as for keeping the empathetic touch or humanistic element in the service industry, human labor will always be needed [41,46,47]. Therefore, another central question pops up regarding how these devices can help tourists and institutional set-ups after the COVID-19 pandemic [48,49]. It summarizes the need to have empirical research on how AI-induced tools can help organizations and enhance the tourism and hospitality service industry [40,50].

In tourism and hospitality services, these devices and their responsiveness, impromptu action and keyword identification with relevancy and task specificity determine whether tourists will have an engaging experience or not [51]. Managing these devices with human employees is a very much tiresome job as the employees always believe that they are the symbol of empathy. After the COVID-19 pandemic, there will be a fear factor for using physical services. However, tourists love to have the traditional way of service and engagement due to humans' social nature and value proposition [52,53]. This empathetic social nature now becomes the main hurdle with a new regular operation where tourists will always fear physical touch, sanitization, safety, etc. All care for the safety-first approach.

However, the practice of social distancing over a long period makes people skeptical of physical service, but with these tools, visitors will feel a little bit more at ease. It is always a tricky proposition to manage these devices with good strategic ideas and implementation. It demands the knowledge of using AI devices along with past technology exposure and acceptance [54–57].

Vietnam attracted nearly 18 million tourists in 2019, out of which 60% were from Asia (mainly China and South Korea), 24% were from Europe (France and England), 9% from America and 6% from Oceania and Africa [58]. From 2014, Hanoi, Hoi An and HCMC came in TripAdvisor's top 25 most preferred tourist destinations list for very much scenic natural beauty, sea beaches and military tourism (to see archives of history related to Vietnam's war) [59]. The pandemic of COVID-19 has engulfed almost 50–60% of Vietnam's tourism revenue with the cancellation of tours and hotels. All significant destinations are severely affected with two back-to-back waves of COVID-19. To reignite life into the tourism industry and help it to come out of pandemic, the Vietnam tourism association (VITA) is planning many short-term and long-term strategies. These HMI device implementations can be a long-term strategy, where trained employees will operate the machines [60,61]. The Vietnam National Administration of Tourism (VNAT) comes with a television commercial (TVC), reminding travelers of the beauty and charm of Vietnam. It tries to bank upon Vietnam's strong safety record to attract tourists in 2021 as a safe and enticing destination on the world's tourism map. Socially distanced holiday packages for giving a clear message to tourists of its ability to manage COVID-19 will attract future travel gateways. VNAT tries to woo travelers with high-value travel giveaways on its social media channels. Its first giveaway, which will launch in November, features a pair of international flight tickets from national carrier Vietnam Airlines, valid throughout 2021. In the region, tourism experts believe that Vietnam will become an early leader in reviving travel based on its performance in dealing with COVID-19 and the continued stable political and investment climates [62]. The HCM City Department of Tourism has launched its largest-ever tourism communication and stimulus campaign, 'Hello HCM City,' to kick-start the tourism industry, which has been hit the hardest by the COVID-19 pandemic. It targets making the city a leading metropolitan tourist destination in Asia [63,64].

For all these revival packages, HMI devices can play a significant role in enhancing HCMC's destination image quite a lot as a safe, secure place where travelers will feel better. Here in this research, the authors tried to understand tourists' interests and intention to use AI-induced devices for their working dynamics in life post-COVID-19. They have also tried to give a feasible strategy for various service establishments operating in this sector for their constant penchant for increasing the service quality for tourists' engagement towards achieving excellence after the pandemic. This research also highlights the practical aspect of highlighting the value addition that these devices bring to play and their expert service, which will boost the post-pandemic situation of the tourism sector for regaining the lost ground. For this study, we primarily selected 783 tourists who have planned to visit Ho Chi Minh City (HCMC) but could not due to COVID-19. They have had some experience with these AI-induced devices earlier and consider if they could operate in various tourism and hospitality sectors after the COVID-19 pandemic. HCMC is the biggest commercial hub of Vietnam.

The authors try to project a coherently conceptualized, empirically-tested structural equation model. It includes scales developed in various service quality models, such as perceived usability, perceived comfort for usability, assurance of service, personal involvement, tangibility associated with the service, empathetic service personnel and value-for-money enhancers using AI [65,66]. They represent the social connectivity of tourists' interest in the use of AI devices and technology acceptance model ingredients that represent the interest to use AI [67–70]. Here, with a prominent representation of past HMI-related research, the authors try to give a fair presentation to relational, rational factors of motivation to use [71–73]. The global distribution system and social media and mobile technologies' dynamism have evolved and brought the most significant change in the tourism industry with very long-term effects. The advancement of robotics, AI and service automation technologies (RAISA) combined with virtual reality augmentation allows organizations to decrease costs, increase empathetic services, eliminate the risk of security and improve full information productivity. As such,

that will undoubtedly bring the best transformation for the tourism industry in the coming times [44]. With COVID-19, these will become almost necessary elements to bring back the tourism sector from the brink of the wilderness. These HMI devices are modeled and programmed to bring dual benefits to tourists and the establishments where they operate [74]. Advanced technologies imbued with these HMI devices will certainly have the potential to bring augmented changes, as the revolution is very much robotic and interactive, which it was not in the last-known physical service revolution [75]. As COVID-19 has almost ruled out tourists' direct physical participation, it is now almost certain that the tourism industry will need to use HMI devices for its revival [76].

The authors also consider these devices and their features for providing a holistic perspective to tourists' perceptions. The authors designed the paper with a theoretical and conceptual review for defining the constructs in the next step. Figure 1 shows prominent HMI device prototypes which have the possibility of potential use in post-pandemic situations.



Figure 1. Pictures of human-machine interactive (HMI) devices or similar prototypes which are planned to use in different establishments [77–80].

2. Theoretical and Conceptual Review

2.1. Methodology for Selecting Conceptual Review

To prepare the conceptual outline of this research and extract the supportive articles, the authors tried a different set of catchphrases. First, they used 'human-machine interaction, strategies, and management of post-COVID-19 tourism hospitality sector' in the Scopus database to obtain 50,185 results (345 webpages, 4147 books and 2693 journals), which is a large set to start with. Although with so many results in the database, they lacked post-COVID-19 strategies. Therefore, we used 'virtual, augmented reality for post-COVID-19 tourism hospitality resurgence' as our next set of catchphrases. Here, we found 49,696 results, divided into 311 webpages, 46,724 books and 2661 journals. Here, there was some significance to the topic. So, in the next try, we concentrated on a set of keywords, such as 'artificial intelligence for post-COVID-19 tourism hospitality revival'; we obtained 10,110 results, out of which 93 were from webpages, 9786 from books and 231 from journals. However, we found very little for post-COVID-19 resurgence and tourism hospitality revival. No direct source of literature is present to date (10 September 2020). To increase relevance, we used search engines such as Google and Bing for searching updated webpages and survey reports giving a definite conceptual shape to the theoretical background of this article. So, the authors used recently published information on various human-machine interactive AI and VR devices with their use in the tourism hospitality

sector. From this search, the researchers derived the constructs from the theoretical framework and hypothesis development. It provides detailed know-how of all the relevant theories present in other previous research on human–machine interaction in various fields and tourism, especially technical adoption for the smart tourism sector.

2.2. Human–Machine Interaction (HMI) in Smart Tourism and Hospitality Ecosystem

Of late, these AI-induced devices aim to give more standardized and proper service delivery. AI-enabled female look-alike robots work as executory staff for public offices to reduce direct physical interaction for employees and ensure smooth operation with the safety of all the stakeholders [81]. For generating the ambiance of live matches and public safety during this pandemic, Spot and Pepper, four-legged robotic devices, act as cheerleaders for empty Japanese baseball stadiums [82]. The Japanese government plans to replace the old aging workforce for their safety with robots after the pandemic [83]. In Seoul, the tall humanoid Cobo is working as a cocktail,-making bartender so that customers can feel safe in bars [84]. So, these updated deployments of AI-induced robots have created a significant uproar of further use in all aspects of tourism services, which will have a substantial impact in post-COVID-19 times. Now, tourist engagement is not limited to only greeting devices or helping apps, assisting in planning or guiding through routes; it is very much interactive and much more than what tourists can perceive in terms of safety. These devices help in having public or private spaces where they can accompany tourists and give them the best augmented service possible. In the future, if tourists get stuck due to such pandemics, then robots can help them in reducing stress and loneliness, especially in the case of old-age tourists [85]. Along with their acceptance, these devices are studied mostly with the technology acceptance model (TAM) [67–70]. The unified theory of acceptance using technology (UTAT) considers performance, influence and anthropocentric use [86].

Since no direct research discussed HMI deployment for tourist acceptance and institutional awareness in Vietnam for post-COVID-19 situations, researchers tried to give a strategy that can be feasible, innovative and sustainable. As Vietnam is one of the growing economies in the Association of Southeast Asian Nations (ASEAN) region, and it is mainly thriving on tourism, in the wake of smart tourism and sustainability, this study is very much pertinent, timely and essential. This study highlights smart tourism 4.0 and Web 5.0 in expanding destination tourism with strategies for using these devices judiciously in the post-COVID-19 world.

The real problem is determining how exactly the tourists' experience and engagement are affected by these machines. Human–machine interaction and the Internet of Human Things are prevalent shortly [87]. Human-like appearance, stance and talk make the effect more intriguing and create authentic replacement of physical service for post-COVID-19 measures [88]. So, here, more studies are taken into consideration, such as the theory of reasoned action (TRA), the idea of planned behavior (PB), and the elaboration likelihood model (ELM) [29,89]. The overall success of these devices depends on how the supply side (service providers) can enhance the whole tourism and hospitality service sector with a high degree of rationality and reasonable cost.

If tourists with previous exposure to and positive experiences with these devices find them in the new destination, then the establishment which uses them will have a massive empathetic value addition [29]. These empathetic significances are the cornerstone of all good services in the tourism sector, as HMI focuses on this factor. As machine learning use at different vantage points of effective service makes the tourist get a feel for it, organizations can earn more loyal tourists. Heterogeneity of tourists affect these devices, yet they are developing to address this challenge [90]. However, there is significant adoption and diffusion of these HMI and AI-induced devices into tourism services, but this is very much acting at a snail's pace, which is contrary to the widespread assumption [44]. The researchers observed that though there is a significant awareness among experienced visitors, they still have some hesitancy to overcome this techno-economic perceptual challenge in their minds. They often perceive that these devices may increase costs and may not satisfy service if operated with

less trained employees. However, as in post-COVID-19, doubts over safety hygiene and curbs on social gatherings will be prevalent, tourists will indeed depend on these devices more.

2.3. Significance of Safety Information and Empathetic Service with HMI

The multifaceted aspect of empathy is actualized in tourism for these HMI devices to interpret and identify the tourists' thinking, feelings and activities [91,92]. It is a very much fundamental aspect that defines the service aspect that a very highly knowledgeable tourist can only identify [51]. Empathy is a tool that can promote familiarity and liking and generate interest to use something. It connects the emotional and behavioral aspects of tourists' coherent cognition. Here, post-COVID-19 pandemic, this empathetic understanding will be transformed into safety and hygiene as tourists value it. Since empathy represents one of the fundamental aspects of the SERVQUAL and RATER model [53,93], safety concerns must be the most sought-after norm. It helps to establish the information interaction and set all people into a sense of trust where they can rely on these devices and make them better served. Trust is essential for any service. AI devices sometimes transfer good reactions to tourists that, in return, give the service providers a license of benefit in terms of safe empathetic representation of HMIs, and it results in more committed service by showing lights (red, green, orange and yellow) for safety norms [94]. So, the authors incorporated the empathetic use of these devices in the model as a significant factor.

Information-sharing represents the bidirectional exchange of signals that these AI-induced devices or HMIs give for an activity that improves encouragement for hygiene, which can be a repetitive practice [46]. It is also a mutual sharing of implicit and explicit know-how, which will enhance the significance of necessary hygienic information. That sums up the fact that new information can only be available when new knowledge is in demand from the tourist, as here, it is safe in terms of hygiene. So, in the new typical tourism system, where heterogeneity is very prevalent, this updated knowledge is difficult to observe. Here, visitors have to recognize the importance of specific safety norms and hygienic information to operate these devices. In return, the HMI can be improved if the devices are programmed to render particular standardized or customized new standard details to them on demand. This information sharing and update interpretation is paramount [95]—however, individualistic involvement for safety hygienic information represents this characteristic here.

2.4. Qualitative Service Acceptance from HMI

Information processing is the determining factor of the success or failure of these devices. HMI is very much dependent on the tourist–service provider interaction and subsequent engagement. With the post-COVID-19 scenario, tourists will always look for any updated information that may give them a sense of safety. So, this research is more based on how much these devices are accepted. The adoption of new technology determines how smartly they are operating. New technology and tools and quick adoption among tourists create the best possible chapter of success for the tourism service. It also affects the service stakeholders and how they can be engrossed with these technologies, as these devices are also co-creating value [96].

In this research, both empathetic activities for safety hygiene and new update information processing and sharing make the base of the digital metamorphosis of smart destination marketing through HMI in a post-COVID-19 new standard scenario. So, the authors tried to encompass various emotive factors of tourists, which helped them to better communicate with these HMI devices. Both empathetic and information processing will establish a great deal of communication and bring out good customer engagement and tourist experiences after COVID-19 subsides. AI domain-related technical aspects are very relevant but they are not the primary objective of this research [41,44,45,47,97].

The SERVQUAL and RATER model represents the catalytic factors that propel tourists' interest in trying out these devices in post-pandemic tourism hospitality services. The researchers try to present the reliability and responsiveness of HMIs, which are very much available for better service orientation because those service institutions lagging behind in technology adoption and transformation will find

it very difficult to survive in post-pandemic scenarios, as tourists will always be in fear of physical and social contact.

Like the assurance of service, another equally important factor is reflecting tourists' engagement and experience for a seamless, easy way of interaction which aims for safety. Tangibles here depict the integration of HMI devices with new secure services where all tourists can feel machines' presence. The perceptual notion of HMI will mix into the physical way of service rendering. It will give a new change, called the true digitalization of post-pandemic service innovation in tourism. Individualistic involvement shows the individual's keenness or familiarity with the technology and how much ease and security one can feel after COVID-19 service encounters [95]. In simple terms, it represents a personal, enthusiastic, fast way to try technology for the first time and get a feel of safe service. It signifies secure social acceptance, routinized behavior, intrinsic satisfaction and digitalized familiarity in the community.

Table 1 shows the constructs that combine to provide enhancers of value for money using HMI devices. This value addition is perceptual and determines the service quality provided through these devices in post-pandemic service encounters [71–76,86,98].

Table 1. Constructs of the study.

Construct	Expert Validity
Perceived Hygienic Usability (PHU)	[67–70]
Perceived Safety for Usability (PSU)	[67–73,81]
Assurance of Secure Service (ASS)	[53,57]
Individualistic Involvement (II)	[95]
Tangibility Associated with the Hygienic Service (TAHS)	[53]
Empathetic Secure Service and Update Information Sharing (ESS-UIS)	[46,65,95,99]
Value for Money Enhancers by use of HMI devices (VMEH)	[67,98]
Willingness to Use HMI (WUH)	[68–70]

These are the expert opinions or previous studies from which the factors are derived and tested for their significance and the model construct with HMI devices. We conceptualize these factors from post-COVID-19 scenarios. As HCMC is the biggest hospitality service market for Vietnam for tourism and associated activities, we are very sure that these factors will combine with expert opinions and hold a goodness of fit. It will not disturb the reliability.

2.5. Need for Study

Very few studies have approached this issue of AI (Chatbots and Social Robots) but not HMI, as HMI includes all the artificial intelligence, virtual and augmented reality devices. As they have the power of changing the landscapes of smart tourism, it is imperative to know how it can be proved significant for Vietnam in post-pandemic times. With its applications, AI cannot replace physical human labor altogether. Therefore, it is imperative to study the effect of HMI devices for reviving the already depleted tourism hospitality industry and give a strategical idea that can be helpful. Quantitative studies of this genre will also aim to show HMI-induced applications' intention in helping the tourism industry for future turbulent times.

The future is for machines. It is human beings' responsibility to devise and deploy them to make it convenient, comfortable, safe and secure for all in the tourism sector. If HMI devices are not employed, in the future, if some sort of pandemic strikes again, this crippled industry will not be able to be revived again. Therefore, studies of TripAdvisor and HAPPY COW are included but they show tourists' experiential perception about the place. They have not entered into this genre of HMI device study for smart, innovative tourism. IoT-based studies are included but it is a part, not the whole, of this type of research which accounts for HMI. The next section describes the possible hypotheses for the study with their orientation and development for the constructs.

3. Hypothesis Construction

3.1. Perceived Hygienic Usability (PHU)

The authors considered all the TAM models where it is signified how comfortable the tourist feels using technology to increase output. It is an extension of the cognitive evaluation theory [100]. Here, it represents the bare root of all motivations for using technology post-COVID-19. Here, if a tourist feels like using technology for increasing contactless clean service output only, he or she can use it. Sometimes, it is also synonymous with quality. Here, the authors signify that there will be a positive relationship between perceived hygienic usability with enhancers of value for money by using HMI devices (VMEH).

Hypothesis 1 (H1). *PHU is positively related to VMEH.*

3.2. Perceived Safety for Usability (PSU)

This signifies tourists' expectations in terms of how safe and secure a service the devices can give for post-pandemic times. The tentativeness of use has both positive and negative effects on new devices. It further signifies the degree of comfortability for safety and security of use, causing less stress on tourists [92]. An accessible output-driven approach can be linked with enhancers of value for money by the use of HMI devices.

Hypothesis 2 (H2). *PSU is positively related to VMEH.*

3.3. Assurance of Secure Service (ASS)

A secure guarantee signifies a complex complete form of trust on which one can rely or depend. It is the most significant aspect of tourism hospitality service, which helps tourists and organizations trade-off. Assurance can be the knowledge of secure, reassured service, which will have the ability to inspire trust and dependability among tourists [53]. It leads to long-term loyalty and tourist relationship management. These HMI devices are programmed in such a way to be specialists in rendering the service an updated secure safe service, which the authors believe has a positive relationship with enhancers of value for money by use of HMI devices [101].

Hypothesis 3 (H3). *ASS is positively related to VMEH.*

3.4. Individualistic Involvement (II)

Individual involvement signifies the intrinsic mindframe of indulging in the device to obtain the maximum desired output. It is both behavioral and dynamic [8]. With these devices, if the tourist is experiencing a relatable, secure comfort, he or she will have more involvement with them to gain the maximum value proposition.

Hypothesis 4 (H4). *II is positively related to VMEH.*

3.5. Tangibility Associated with the Hygienic Service (TAHS)

Various activities of late have come into the picture because of HMI devices, which represent tangibles. It can be anything from appearance, machine features or how it communicates correct updated information [53]. Since HMI devices can replace service personnel in public and private places, they can

have the tangibility aspect of service, which is extraordinarily contactless, clean and tourist-friendly. Automation of services by these devices impacts value for money enhancers by the use of HMI devices.

Hypothesis 5 (H5). *TAHS is positively related to VMEH.*

3.6. Empathetic Secure Service and Update Information Sharing (ESS-UIS)

These features are the centripetal force for all the services [54] in the post-pandemic scenario. Empathy represents these virtual humanoids' sensitivity towards the tourists, where they understand the needs and wants of them and provide relevant information, as and when desired. HMI represents the basic features of how effectively these devices can interpret and acknowledge tourists' queries in return for reciprocation lined with an information interchange, which is updated and gives a sense of assured security [99]. These two activities are synonymous with each other for devices, so the authors have kept them in one place. One machine can only share and acknowledge updates and secure information related to security properly. Therefore, both of them collectively can affect willingness to use HMI devices (WUH).

Hypothesis 6 (H6). *ESS-UIS is positively related to WUH.*

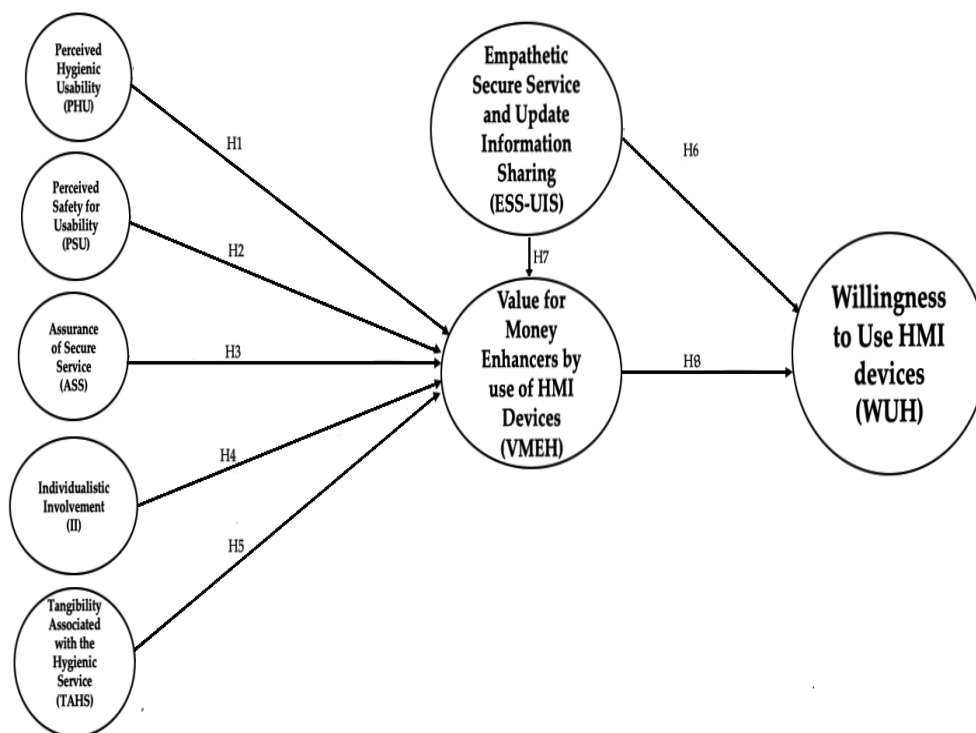


Figure 2. Conceptual model of the study.

3.7. Relation between Empathetic Secure Service and Update Information Sharing (ESS-UIS) with Value for Money Enhancers by HMI Devices (VMEH)

In this study, the researchers consider that the secure, safe and contactless hygienic service given by HMI devices will be an essential situational factor for increasing the value for money spent by tourists. So, this relation will be very much pragmatic. Usually, the more establishments provide a good, safe, hygienic service, the more tourists they can attract in post-pandemic situations.

Hypothesis 7 (H7). *ESS-UIS is positively related to VMEH.*

3.8. Value for Money Enhancers by Use of HMI Devices (VMEH)

It is an attitudinal factor for tourists, which signifies the best possible use of technology adoption. They create long-term loyalty and patronage [102]. They are contingent on various circumstances, including every way possible for enhancing service in the post-pandemic scenario. Value for money is what every tourist hopes for. It becomes the sole driving force to use some technology or affects willingness to use HMI devices (WUH).

Hypothesis 8 (H8). *VMEH is positively related to WUH.*

The conceptual model for this study is represented in Figure 2, where all the theoretical relations can be seen as discussed in the above section.

4. Research Methodology

The researchers combine qualitative and quantitative methods to analyze real data. From previous related research on service quality, the technology acceptance model of machines and robots (as mentioned in Table 1), we finalized our constructs. Their definition and the dimensions were constructed by discussing with the managers, as they are the critical stakeholders of the whole process. We had these discussions when we collected their views. It helped us to decide the importance of these HMI devices for various tourism systems, mainly in HCMC hotels and tour operations. The managers were asked some questions, such as: i. What are their views about probable tourist behavior to the prototypes of HMI devices installed in their organization?; ii. What do they think about replacing physical services with these HMI devices and future job prospects?; iii. What is the potential role of physical employees after deploying the prototype devices?; iv. What is the overall turnaround of service delivery they are expecting after using these devices?; v. What would be the implications of these devices in the overall scenario from different associated sectors of tourism. Their answers helped us in giving robust support to our discussion and conclusions. Their general thinking and perception of the devices enabled us to draw a full judgment for the items and it helped us validate our findings.

4.1. Research Procedures

The exhaustive study stands on a combination that is both quantitative as well as qualitative. Therefore, we described a mixed method of analysis. These two types of studies integrate two stages. Open-ended interview type questions were calibrated by the scaling framework of Spiggle [103] with symbolic richness for construct clarity. Quantitative questions were treated as per the logic of the constant comparison method of Goulding [104].

- a. Stage 1: A set of five open-ended questions was given to the managers of different establishments, such as hotels and tour operations. A basic level of their psychology towards HMI devices could thus be understood. It also helped in knowing their perspective for using these HMI devices in different places, post-pandemic situations and the activities that they can plan for them.
- b. Stage 2: Constructs with their related items are administered via questionnaire to tourists who had planned to visit HCMC but canceled due to COVID-19 but can come in post-COVID-19 new typical situations.

The researchers used a convenient nonprobability sampling here for the quantitative survey. All the establishments from where data were collected are more or less similar. The survey duration for each future tourist was 10–20 min. They were contacted through various Facebook groups and travel groups. Photos of devices and a few of their details were also given in the questionnaire for clarity. Firstly, tourists were exposed to a screening question to judge their previous experiences with these devices. Then, demographic items were included in the questionnaire, such as:

- a. Gender (male; female)

- b Age in range of years (20–29; 30–39; 40–49; 50–59; 60–69; 70–79)
- c Annual income in USD (under 20,000; 20,000–39,999; 40,000–59,999; 60,000–79,999; 80,000–99,999; over 100,000)
- d Education level of respondent (secondary school; graduate; masters; and more than masters)
- e Employment status of respondent (student; unemployed; employed; self-employed; and retired)
- f Marital status of the respondent (single; married with children; married without children; and other)

The authors selected valid, correctly-answered 783 samples out of the 850 respondents who responded that can be used to create a model for all goodness of fit tests.

4.2. Data Collection Process

The questionnaire preparation method followed the instructed methods on Internet, phone, mail and mixed-mode surveys—the tailored design method [105]. However, the questionnaire was digitally prepared by Google forms directly linked with Microsoft Excel to be recorded. Questionnaires were distributed on major social media apps (e.g., Facebook Messenger and Instagram, where tourists love to post their travel pictures). Furthermore, the researchers introduced the questionnaire link to various Facebook groups and travel vlogs on YouTube to gather more data, which will be authentic. The respondents who understand different HMI technologies and devices for service enhancement were only considered. The authors considered Asian (Korean, Japanese, Taiwanese, Chinese), European (Italian, French, German, Spanish, English), North American (American) and South American (Brazilian) travelers. They all had previous experience using chatbots, concierge robots, interactive voice-response systems (IVRS) and digital voice assistant robots for service. There were also frequent HCMC visitors who had visited on more than one occasion in the last 3–4 years. They also had plans for a future visit, as HCMC is a business hub and a rich cultural heritage site. These data was collected after the first outbreak of COVID-19 around May last weeks to the end of June when regular international flights have not operated, and hotels are all closed for regular international tourists.

A mixed-method study was used to get a consistent conclusion. Both qualitative and quantitative data support each other and provide a better understanding of the topic [106–108]. Interviews with experts of prominent hotels, restaurants and tour operators regarding deployment of these HMI devices in post-pandemic times formed the qualitative analysis. Their opinions were collected in the form of notes. The five main interview questions and their responses were validated and recorded for the much-valued conclusion to have significance and robustness [109]. The interview questions were translated into Vietnamese to understand better and use back-referencing; the responses were also translated into English for our analysis. Typically well-renowned hotels have their restaurants, wellness services and total tour package manners under one umbrella. So, out of all such managers, four were hotel and restaurant managers and one was an operating tour manager. These managers have a better idea of how they may use the HMI devices correctly in the future, so there is always a rationale for obtaining first-hand information from them through an interview.

The research design first went with thematic sections by axial coding; then, the exploratory study was analyzed by construct validity, including categorical presentation, comparison, judging integrating and iterating dimension. Senior persons from the establishments who have rich experience in handling tourists and exposure to these kinds of devices were taken to label them as experts. The establishments mostly thought of using these devices for information exchange, order reciprocation, serving and cleaning.

The researchers tried to minimize the survey's common method bias by selecting a pre-tested format of Dillman's online form [110]. The questions did not have any ambiguity for understanding. At the beginning of the survey, researchers informed the respondents that the responses are meant for academic research, having no business proposition and no right or wrong answers. They were free to answer as they thought appropriate. For the subjective response, the assumed experts were

encouraged to give frank, honest opinions that they think, without thinking of social, commercial desirable answers for the HMI devices in post-COVID-19 scenarios.

5. Data Analysis

5.1. Descriptive Statistics

The survey instrument had 29 items and was based on a five-points Likert scale, where one denotes strongly disagree and five depicts strongly agree. Tables 2 and 3 show the study's descriptive statistics. Table 2 is for the senior managers or expert officials of the establishments, and Table 3 is for the tourists who participated with full answers to the questions.

Table 2. Descriptive statistics of the managers or experts.

Manger or Expert	Gender	Age	Experience in Industry	No. of Devices They Want to Use Post-COVID-19
Expert 1	Male	38	11	2 robots, for the front office and door service
Expert 2	Male	42	17	4 robots for multiple services
Expert 3	Male	36	10	3 robots for booking, front service and room service
Expert 4	Male	37	12	4 robots for booking, payment and room service
Expert 5	Male	44	15	4 robots for booking, payment, room service and entertainment

Table 3. Descriptive statistics of tourists' profiles.

Item Definition	Frequency	Percentage
Gender		
Male	485	61.94%
Female	298	38.05%
Age		
20–29 yrs	39	4.98%
30–39 yrs	431	55.04%
40–49 yrs	141	18.00%
50–59 yrs	118	15.07%
60–69 yrs	34	4.34%
70–79 yrs	20	2.55%
Education		
Secondary school	57	7.27%
Graduate	455	58.10%
Masters	124	15.83%
More than Masters	147	18.77%
Annual Income		
Less than USD 20,000	32	4.08%
USD 20,000–39,999	435	55.56%
USD 40,000–59,999	148	18.90%
USD 60,000–79,999	125	15.96%
USD 80,000–99,999	34	4.34%
More than USD 100,000	9	1.14%
Employment Position		
Student	21	2.68%
Unemployed	32	4.08%
Employed	419	53.50%
Self-employed	287	36.65%
Retired	24	3.06%
Marital Status		
Single	98	12.51%
Married with children	218	27.84%
Married without children	467	59.64%

5.2. Statistical Analysis

The partial least square-based structural equation modeling (PLS-SEM) helped in analyzing the structural model better as it is best suited where the sample size is relatively smaller. It gives the best result without multivariate normal distribution in the nascent stage of development for a somewhat smaller sample size [111–115]. For judging reliability and validity, the researchers studied the convergent validity (CV), composite reliability (CR) and discriminant validity (DV) for all factors. A confirmatory factor analysis (CFA) helped in ensuring CV for all the elements. Here, the researchers dropped the second item of empathetic, secure service and updated information sharing and the third item of perceived safety for usability for reliability. The validity of the model to be robust is as shown in Tables 4–6. All other items are loaded correctly and are acceptable at 0.05 significant levels [116]. The CR of each construct is substantial, as they are more than 0.7 [111]. The DV of the model is shown, with the diagonal numbers representing square roots of average variance extracted (AVE) and non-diagonal numbers depicting interrelationships of factors, as shown in Table 6.

Table 4. Factors and items with their codes.

Factors and Items	Codes
Perceived Hygienic Usability	
HMI devices are useful in increasing the cleanliness service experience for smart tourism in the post-pandemic scenario.	PHU1
HMI devices will make the total tourism experience secure, safe and peaceful in the post-COVID-19 scenario.	PHU2
HMI devices will be helpful in the service process in the smart tourism ecosystem after the COVID-19 pandemic.	PHU3
Perceived Safety For Usability	
The use of HMI devices will increase safety perception of tourists towards smart tourism in post-pandemic times.	PSU1
Repeated past exposure to HMI devices will make it reliable and convenient for tourists to trust after the COVID-19 pandemic.	PSU2
The use of HMI devices will restrict the tourist's safety experience during post-pandemic situations.	PSU3
Value for Money Enhancers by use of HMI Devices	
The use of HMI devices for the tourism sector enhances the value for money more than traditional services in post-pandemic times.	VMEH1
Satisfaction by use of HMI devices in the tourism service sector after COVID-19 times.	VMEH2
Willingness to pay more for the safety and cleanliness of HMI devices after a pandemic.	VMEH3
Willingness to use HMI devices	
I want to use the devices if exposed to them for security.	WUH1
I want to use them soon for all services to be safe and hygienic in post-pandemic times.	WUH2
These are easier to use and feel like using them even after COVID-19.	WTU3
Assurance of Secure Services	
HMI devices employed in the tourism service environment are safe to deal with.	ASS1
HMI devices can give correct standardized services as they can be programmed accordingly.	ASS2
Individualistic Involvement	
Feel secure and safe interacting with HMI devices post-pandemic times.	II1
Feel more risk-free interacting with HMI devices than human beings post-COVID-19.	II2
HMI devices are more hygienic to handle than humans in the tourism service sector as a contactless concept will be the norm.	II3
Tangibility Associated with the Hygienic Service	
HMI devices in the tourism sector provide tangibility and a visual treat to tourists post-pandemic times.	TAHS1
HMI devices provide an ultra-modern outlook visually to the tourism service providers than human beings.	TAHS2
HMI devices create curiosity and anxiety in tourists, which encourages them to try the service.	TAHS3
Empathetic Secure Service and Update Information Sharing	
HMI devices can understand the specific safety needs of tourists better than human beings due to programming.	ESS-UIS1
HMI devices can give customized and personalized attention to tourists for hygiene purposes.	ESS-UIS2
HMI devices can be available whenever the tourist feels secure and convenient, which enhances the service experience.	ESS-UIS3

Table 5. Factor loading for model.

Factors	Items_Code	Factor Loading (>0.7)	Mean	Sta. Deviation	Comp. Reliability	Av. Variance Extracted
Perceived Hygienic Usability	PHU1	0.914	3.581	0.912	0.914	0.765
	PHU2	0.881				
	PHU3	0.896				
Perceived Safety for Usability	PSU1	0.924	3.321	0.681	0.924	0.868
	PSU2	0.941				
Assurance of Secure Services	ASS1	0.871	3.514	0.712	0.841	0.728
	ASS2	0.841				
Individualistic Involvement	II1	0.871	3.263	0.941	0.882	0.715
	II2	0.864				
	II3	0.818				
Tangibility Associated with the Hygienic Service	TAHS1	0.832	3.461	0.817	0.913	0.708
	TAHS2	0.841				
	TAHS3	0.781				
Empathetic Secure Service and Update Information Sharing	ESS-UIS1	0.783	3.258	0.881	0.918	0.813
	ESS-UIS3	0.936				
Value for Money Enhancers by use of HMI devices	VMEH1	0.914	3.518	0.878	0.942	0.827
	VMEH2	0.928				
	VMEH3	0.889				
Willingness to use HMI devices	WUH1	0.921	3.608	0.961	0.978	0.871
	WUH2	0.962				
	WUH3	0.974				

Table 6. Discriminant validity for model.

Factors	PHU	PSU	ASS	II	TAHS	ESS-UIS	VMEH	WUH
Perceived Hygienic Usability	0.878							
Perceived Safety For Usability	0.768	0.918						
Assurance of Secure Services	0.567	0.662	0.836					
Individualistic Involvement	0.645	0.731	0.802	0.841				
Tangibility Associated with the Hygienic Service	0.589	0.631	0.675	0.701	0.798			
Empathetic Secure Service and Update Information Sharing	0.778	0.761	0.792	0.803	0.856	0.868		
Value for Money Enhancers by use of HMI devices	0.718	0.737	0.785	0.679	0.849	0.885	0.916	
Willingness to use HMI devices	0.617	0.701	0.731	0.821	0.779	0.866	0.781	0.961

5.3. Structural Model and Its Analytical Representation

Figure 2 represents the path coefficients of the model, which signify the strength between dependent and independent factors. R² value in Tables 7 and 8 indicate the variance that occurred due to the independent factor. Here, age, gender and education are the study’s control variables, as these are essential variables for the TAM [71–73].

Table 7. Summary of hypothesis decision statistics.

Factors	Hypothesis	Standardized Coefficient	R ²	Decision
PHU-VMEH	H1	0.159 **	70.71%	Supported
PSU-VMEH	H2	0.229 **		Supported
ASS-VMEH	H3	0.216 **		Supported
II-VMEH	H4	0.141 **		Supported
TAHS-VMEH	H5	0.221 **		Supported
(ESS-UIS)-WUH	H6	0.128 **		Supported
(ESS-UIS)-VMEH	H7	0.161 **		Supported
VMEH-WUH	H8	0.712 **		Supported

The criterion variable is the willingness to use AI-induced devices in tourism services

** p < 0.05.

Table 8. Summary of model fit statistics.

Measurement	Value	HI99	Conclusion
Standardized root mean squared residual (SRMR)	0.0112	0.0118	Supported
Discrepancy unweighted least squares (DULS)	0.0125	0.0175	Supported
Geodesic discrepancy (DG)	0.0277	0.0224	Supported

From the above Figure 3, along with Table 7, the authors believe that all eight hypotheses have less than 0.05 so all of them have significant positive relations. Perceived hygienic usability, perceived safety usability, assurance of secure service, individualistic involvement and tangibility associated with clean service all have a positive effect on value for money enhancers by using HMI devices. Then, empathetic service and update information sharing have a positive impact on value for money enhancers by the use of HMI devices and on willingness to use these machines. Similarly, value for money enhancers by the use of HMI devices has a positive impact on the desire to use HMI devices.

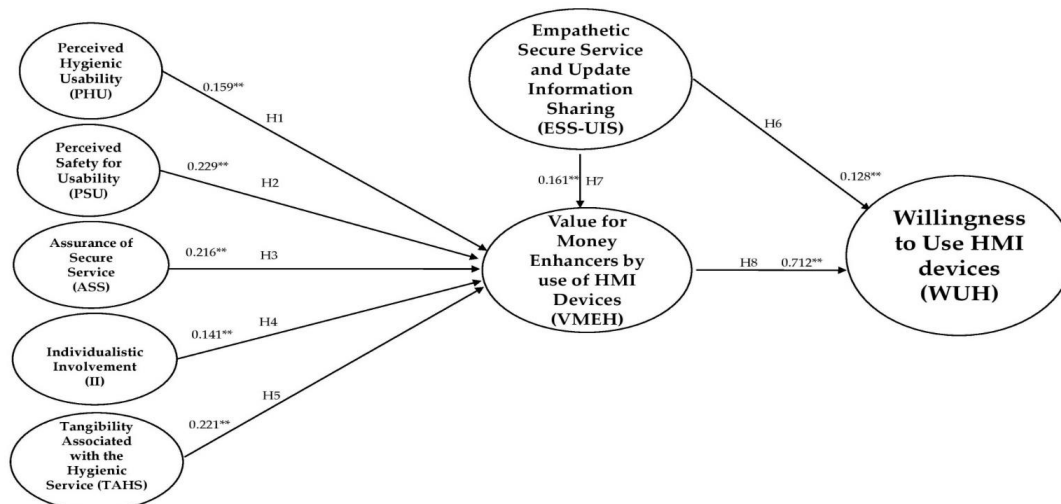


Figure 3. Results for the proposed model of study. (** $p < 0.05$).

This research aims to give both theoretical and empirical measurements of tourists’ willingness to use HMI devices in post-COVID-19 situations for making a way of rejuvenating the smart tourism of HCMC. The value enhancers perceived by tourists and empathy and update information sharing have a substantial impact on the willingness to use HMI devices, with an R-square value of 70.71%, as shown in Table 8. The goodness of fit and robustness of the model were determined by the standardized root to mean square residual, discrepancy unweighted least squares and geodesic discrepancy [117–120], which are represented in Table 8. It shows that one cannot reject the model at alpha 0.01. Hence, it shows that all the factors for using the HMI devices are valid [121–124]. So, the smart tourism sector must consider the use of these devices for the factors mentioned, as tourists are curious and, simultaneously, interested in using these devices for post-COVID-19 situations as they perceive safety, security and hygienic contactless service to be more effective through these machines.

5.4. Interview Analysis

These devices may be most suitable for different tourism-related establishments, preferably hotels, restaurants and tour operators. There will be a high likelihood of tourist interaction with HMI devices, so the professional experts or managers who will oversee these devices will give their opinions. Professional arguments of the managers will certainly match with service delivery. As these managers are in charge of service delivery and tourists’ satisfaction and well-being, it is essential to have their

opinion to give a more logical, holistic, supportive analysis of our quantitative output. The interview analysis revolved around what they think and how much they are emphasizing certain aspects of service delivery. The study of their interview suggested some keywords and the spatial integration of how they are feeling. These aspects indeed represent a more collaborative qualitative aspect, meaning the rationale of analyzing interviews. We can also perform a quantitative analysis of these managers for more human resource management aspects as part of our future research project but it is not in the scope of this research. From the interviews with experienced personnel working with various institutions related to tourism, the authors summarize their opinion as follows.

First Expert (E1) Hotel/Restaurant Operation Manager.

This expert thinks that after COVID-19 times, this idea is useful for testing. If they can help in promoting techno-tourism where tourists are interested in using HMI devices, then it will be an added advantage. It will create a tool for a unique selling proposition for having a distinct image.

Therefore, the authors conclude that organizations can enhance tourist engagement and experiences based on the empathy of secure service and update information sharing and the assurance of service. Tourists always look for those factors which can assure you of security, safety and good hygienic use.

Second Expert (E2) Hotel/Restaurant Operation Manager.

This expert believes that these HMI devices are cool; they may be something like the gadgets of TRANSFORMERS (American movie). These devices will be comfortable and they can be accommodating in giving customization and proper service to tourists who look for individualistic involvement. Since tourists cannot understand the Vietnamese language, one can lift this language barrier with the use of these devices. It can be beneficial in showing a different picture of HCMC tourism-associated organizations in various aspects. It will enhance the destination image of HCMC globally by enriching the visitors' experience.

The authors conclude that tourists can be happy to be served by these HMI devices to give them a sense of differentiation. The value proposition of service will be manifold. It will provide a different image of HCMC in post-COVID-19 times. This techno-tourism is very much a thing for future sustainability.

Third Expert (E3) Hotel/Restaurant Operation Manager.

This expert shows concern for these devices' deployment. The problem is with apt management and replacement of physical association with the tourists in post-COVID-19. With these devices, employees will focus more on more extensive ways of enhancing tourists' service experience. This opinion also concerns the level of awareness about these devices and their mode of operation.

Here, the authors summarize that the perceived use and safety can propel the tourist's mind to use the devices. Assurance of service is what makes all these devices work better in this contactless service environment. They believe that these devices can act with human employees but cannot replace the employee's humanistic touch. With virtual and real services, tourists will feel cared for, which will help the establishment a lot.

Fourth Expert (E4) Hotel/Restaurant Operation Manager.

This expert shows that there can be a techno-eco system for both HMI devices and humans working to better service. It is beneficial for the establishment in the long run and brings name and makes the country a technologically superior one. This expert opinion is also on the money expenditure on setting all these up.

Here, the authors believe that if these devices give the best value-added service and help generate a name for the establishment, then there is no harm in spending money on them in post-pandemic situations. Here it can be a way of rejuvenating the depleted tourism system.

Fifth Expert (E5) Tour Operation Manager associated with Hotel.

This expert signifies the tourists' involvement and how effectively the machines can deliver service. The opinion speaks about tourists' previous experiences with these devices in another place and whether the service delivery can be effective; employees have to keep an eye on these applications and devices. Since organizations have to spend a lot of money on them, the tools need to be in perfect operational mode post-COVID-19 times.

Here, the authors give the opinion that individual involvement and tangibles of hygienic services have to consider setting up the technological system for better service delivery in post-pandemic times. We have tried to represent a thematic analysis for the interviews to determine the relevancy of the content described in Figures 4 and 5. Figure 4 illustrates the keywords which come out prominently from the scope of talks that focus on the use of HMI devices, the safety of service, hygiene, assurance for tourists, the value of the tourism industry, better tourism establishments and pandemic, to name the prominent ones. Post-engagement feedback is also very relevant for the input. Figure 5 represents the frequencies or trends of content for the keywords, such as HMI devices (green), post-engagement feedback of tourists (violet), qualitative service (blue), tourists (fluorescent blue) and use of HMI devices (crimson). They categorically signify the findings of the quantitative analysis too.



Figure 4. Cirrus representation of the keywords of interviews.

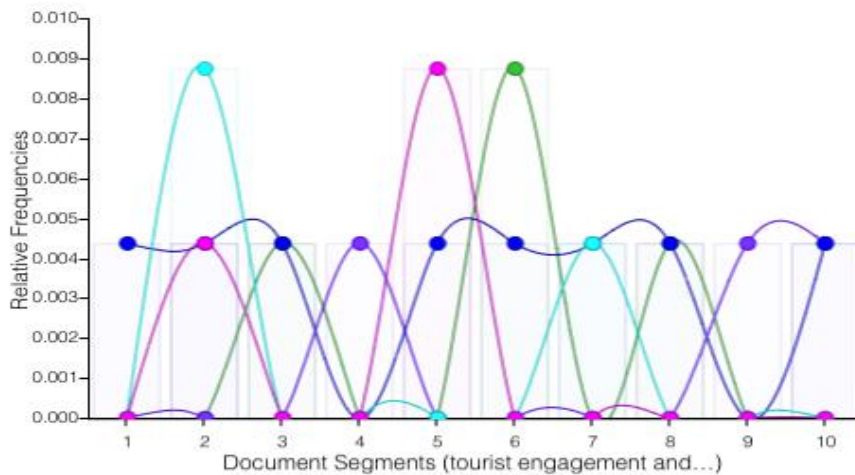


Figure 5. Document segments for relative frequencies of the content.

6. Strategic Discussions and Future Scope

6.1. Discussions

This paper tries to give a framework for future post-pandemic times. It contributes to strategize the previously known literature research that addresses critical elements of a secure tour bubble. It helps to give a tangible strategy called a tour bubble framework that addresses HMI devices' proactive features, as shown in Figure 6. Since there are no research papers published on HMI device implications for the post-pandemic revival of tourism, this paper has an element of uniqueness. However, this paper considers empathetic service to have a role in value addition, which is not considered for service robots in the hospitality sector [125]. Compassionate service in terms of security, hygienic services and updated information on all aspects of COVID-19 will make the tourist feel comfortable with the use of the devices and generate trust. This empathetic service is also a core ingredient of tourist satisfaction, which will, in turn, very much translate to happiness. The tour bubble concept also represents this aspect where post-service expectations of tourists coincide with empathetic actions. Tourists are coming to a new country or destination; if the goal destination shows a warm, compassionate service to them, they feel wanted and secure. The subsequent quarantine period and their well-being will establish a sense of satisfaction and safety that will translate to happiness. This practice can make tourism prosper between two countries that will form a tour bubble agreement for their tourists. It is a mutual symbiotic way of flourishing after the COVID-19 pandemic.



Figure 6. Tour bubble framework.

Although dealing with the design of HMI devices is beyond the scope of this research, the depleted tourism system's socio-economic condition can be rejuvenated by following strategies such as those represented in Figure 7—the researchers discuss the safety information, hygienic knowledge, security management, value addition and cost involvement for HMI devices. An empathetic, secure service equipped to give updated information and value addition plays the most important factor for tourism revival [126]. Still, it is at the higher side of cost but it will help the tourism system to prepare for any such future scenarios if they come. The authors propose a term tour bubble that will manage the whole process of tourism in a secure, limited environment. It will limit human interaction and eradicate the possibilities of any such threat. Future researchers can also study the tour bubble for tourists in their country of origin with that of Vietnam. Suppose there can be a tourism memorandum of understanding between Vietnam and these countries from which tourists come for a revival of tourism with the tour bubble. In that case, a sense of security, safety and contactless tourism can enhance to the next level. Organizations can promote cultural heritage tourism with these devices in HCMC for Cu Chi tunnels [127]. A better pragmatic understanding of the role of these devices

can only enhance the service quality and design. The considerable cost is always a factor of concern, but the return on investment is the main trigger of HMI devices in post-pandemic times.

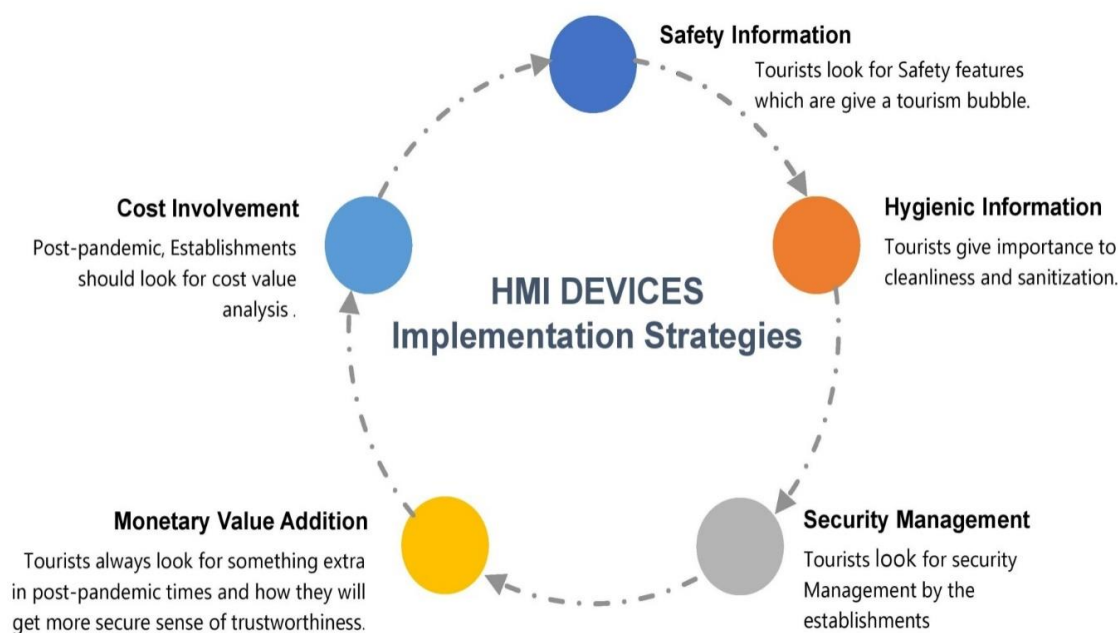


Figure 7. HMI devices and strategy implementation vantage points.

6.2. Future Scope of the Study

This study opens a Pandora's box for the future research scope on similar or associated reviews on the Internet of Human Things (IoHT) along with Web 5.0 applications in tourism and other interrelated services [128]. If closely observed, this type of study is more or less showing the path for new-age research on different aspects of service, such as how to regain the trust of tourists in post-COVID-19 scenarios. One can research the moving parts in the future. In COVID-19 pandemic situations such as those in South Korea and Russia, these devices give a ray of hope to keep the tourism industry afloat.

7. Future Implications and Limitations of the Study

This paper tries to bring a distinct way of enhancing the post-COVID-19 tourism service. We have tried to portray the possibility that with these devices and their deployment, if tourism can be revived, then HCMC as a destination can be very prominent on the world tourism map. Therefore, there is mention of destination tourism. In Vietnam, tourism packages are mostly run by tour operators with the help of the hospitality sector. As such, there is an amalgamation of hospitality in the tourism aspect of the paper.

7.1. Conceptual Implications

The results highlight that with the use of these devices, there can be a superior unique proposition for tourism establishments to revive in the post-COVID-19 scenario. With every dynamic change in the technological field, there will be an up-gradation of Web 5.0 from Web 4.0. Service 4.0 will not be so significant, say, after ten years. Therefore, perceived hygienic use and safety of use can be significant factors in adopting these service 5.0 evolutions. So, considering the dynamism of technical developments, with HMI devices with the Internet of Human Things, service delivery can be beneficial. This multidimensional aspect of service delivery will be a new thing for practice.

7.2. Managerial Implications

- a. As the study includes expert opinions, the managers or executives working in direct service engagements can benefit immensely from the results. Our research brings both quantitative and qualitative aspects of the factors and it represents a good picture for the future. Robots cannot fully replace humans; this should be adhered to, and the device's deployment can be a milestone in creating a more positive service experience [72]. This motivation can be beneficial for all emerging technologies, such as those in Vietnam. All devices and applications need to be continuously upgraded for a better service experience and to represent technologically superior establishments' know-how. The concept of a tour bubble for a group of tourists, starting from the onset of the journey to the culmination, if managed well, will create a distinct possibility of enhancement of the destination image of HCMC post-COVID-19. The results highlighted that HMI devices offer a differentiated experience that helps tourism establishments to create sustainable value in the post-COVID-19 scenario. HMI devices are considered a source of revival for the tourism industry that will bring a positive multidirectional impact on tourists' engagement for service 5.0. Web 4.0 and 5.0 will lead to the dynamic technological adoption of these devices. Our results collectively enrich how human-machine interactive tools can digitally affect the tourism sector in its revival by giving empathetic service and creating a safe, hygienic service experience.
- b. In the section below, the researchers highlight different managerial operations and see the implications of HMI devices.

a. Strategic implications in Operations

Where more automated service is given in place of physical delivery by HMI devices, there will be an increased co-participation of tourists in designing a more empathetic service. This can be achieved by personalized and updated service delivery. Self-service operations where the tourist becomes the service provider are viewed as a shift in process. As such, the new thematic term *Prourist (Provider + tourist)* can be a significant change that these HMI devices may bring to service operation. HMI implementation also signifies the reengineering process of delivery in scheduling and planning aspects. They might improve environmental sustainability by reducing waste and leading to less energy consumption.

b. Facility design implications

In the future, the premises of hotels, restaurants and airports, among others, would be used by a wide variety of mobile robots (wheeled, legged, flying or underwater), such as security robots, robot guides, robot waiters, room service delivery robots, robotic vacuum cleaners/lawnmowers/pool cleaners, entertainment robots, delivery drones, etc. When the hospitality premises are more robot-inclusive, the same task can be performed by a less intelligent robot and vice versa; an environment that is not robot-inclusive would require a more intelligent robot to navigate through it. Therefore, the robot-friendliness of hospitality facilities will be a new *competitive advantage* for travel, tourism and hospitality companies.

c. Human resource implications

The hottest discussion regarding HMI device adoption relates to the future of human employees. Still, there are pros and cons. On the positive side, HMI devices would *save employees' time* from performing tedious and repetitive tasks. On the other hand, HMI will reduce human jobs, especially those whose tasks can easily be automated. That is why many employees perceive RAISA technologies as a *threat* to their jobs and *resist* using them. However, we will always say technology will help humans evolve from the crisis, not that they can fully replace them, as the human touch to all physical services will always be a factor of a long-term association.

d. *Financial implications*

From a financial perspective, HMI devices' use allows for significant *labor costs savings* because they can work 24/7 and may serve numerous customers simultaneously. On the other hand, HMI devices are associated with various financial costs for acquisition, installation, maintenance, updates and fees for hiring specialists to operate and maintain the devices.

e. *Marketing implications*

The adoption of HMI devices allows the *integration of* suppliers and travel, tourism and hospitality companies. HMI devices would transform the perception of tourism and hospitality products. In the future, we will observe the division of travel, tourism and hospitality companies into two main large groups—'high-tech' vs. 'high-touch' companies, with various shades of grey in between them. 'High-tech' tourism companies will rely mostly on HMI devices, while 'high-touch' ones will prefer to use human employees. HMI will change the *distribution* of tourism products as well. For example, it is already possible to order food or search for information about destinations via digital voice assistants. HMI allows the implementation of *automated pricing* of products based on sets of rules and *real-time data* on customers' buyer behavior. In extreme cases, they would enable *personalized pricing*, i.e., a separate price for every customer based on his/her willingness to pay, leading to revenue maximization.

7.3. *Limitation of the Study*

Some experts raise the issue of loss of jobs and what will happen to human touch. The authors can only conclude that this aspect needs to be researched more elaborately, but this can only be done after deploying them. Without deployment, we cannot jump to any conclusions. Therefore, not addressing this issue can be one limitation [129–131].

The second one is that the authors have not considered those tourists who do not have previous experience with these devices in another place, so it is very much pruned. Those who do not have such experience can substantially contribute to the research if taken into consideration differently, which this study lacks [132–134]. We have only tried to signify the tourists' interest or intention to use these HMI devices for better service satisfaction in the post-pandemic situation. However, we have plans to analyze these devices' empathetic service from aspects of mental well-being, complex thinking in distress, reaction in the panic situation along with personalized service and new programming aspects of these devices. It is a different study which we will conduct separately on virtual machines and AI robots, which is more related to computers and neural network study.

8. Conclusions

There authors want to conclude that this research gives practical and qualitative importance to the existing literature of robotics, AI and the Internet of Things on service delivery. With emerging technologies in ASEAN countries, Vietnam can explore more on this aspect. Our study signifies tourists' acceptance of these HMI devices for the post-pandemic scenario. These findings encourage transferring an employee's current role from more of a standard one to a technically superior one where all these devices can be controlled. The tour bubble framework will help the depleted tourism sector to bounce back with more assurance. Concerning service 4.0, it is moving to service 5.0, assisting more customer engagement and bringing artificial intelligence and augmented virtual realities to the tourism sector, so that if some unwanted emergencies happen in the future, then tourists' experiences can still be enriched.

Author Contributions: Conceptualization, N.T.T.V.; methodology, S.R.M. and V.V.; software, S.D.; validation, N.T.D., D.X.H.M., and S.R.M.; formal analysis, S.D.; investigation, P.T.D.; resources, N.T.T.V.; data curation, S.D.; writing—original draft, S.D. and V.V.; writing—review and editing, S.D. and V.V.; visualization, S.D.; supervision, N.T.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Ho Chi Minh City’s Department of Science and Technology (HCMC-DOST) and the Institute for Computational Science and Technology (ICST) under the project: *Research The Impact of Artificial Intelligence (Ai) on Using Tourism Products And Services In Ho Chi Minh City: Application of Research on Consumer Behavior Through The Impact of Technology: Funding grant contract number: 33/2020/HD-QPTKHCN; dated 6 July 2020.*

Acknowledgments: We acknowledge all the tourists who have given responses through the survey.

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

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