



Robots for Hospitality and Tourism in Thailand: Opportunities and Challenges

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ABSTRACT

Technological advancements in robotics significantly impact various aspects of human life. Thailand, being one of the world's top tourist destinations, has taken steps to integrate such smart technology into its economy through the Thailand 4.0 policy. In this study, we aim to investigate the use of robots in the hospitality and tourism sector, and explore the degree of anthropomorphism present in their use in other countries. The study discusses the use of robotics-based on environment, activities, and users involved in hospitality and tourism. We identify potential opportunities for robots to enhance the hospitality and tourism industry in Thailand, and highlight the current challenges and limitations faced in doing so. The adoption of robotics in tourism and hospitality is a business fit that has the potential to revolutionize the industry by enhancing customer experience and improving operational efficiency. Ultimately, we provide insights into the future of technology in Thailand and the successful integration of robotics into the hospitality and tourism sector.

1. INTRODUCTION

Thailand, located in Southeast Asia, is a popular tourist destination known for its delicious cuisine, martial arts, beautiful beaches, and stunning temples. The country's hospitable and open-minded people, affordable cost of living, rich culture, street food, vibrant nightlife, limestone caves and beaches attract millions of tourists every year. Moreover, Thailand serves as a gateway to other countries such as Vietnam, Myanmar, Cambodia, and Laos, offering visas on arrival and free visas for most nationalities.

According to the Ministry of Tourism and Sports, the number of visitor arrivals to Thailand has been steadily increasing over the years, with a total of 22,657,730 arrivals in the first seven months of 2018 alone, representing an 11% increase from the same period in 2017 [1]. The first and second quarters of 2018 saw an increase in tourist arrivals of 15.4% and 10.91%, respectively, compared to the previous year. Figure 1 illustrates the annual arrivals of tourists in Thailand, which reached 38.28 million in 2018, up from 35.35 million in 2017 [1].

The World Travel and Tourism Council [2], tourism in Thailand contributes to 50.4% of GDP, while Bangkok city contributes to 10%. Bangkok city is estimated to have a direct tourism GDP contribution of \$35.5 billion in 2027. It is expected to rank fifth for 2027, as it becomes more reliant on emerging source markets such as India. Thailand 4.0, a

policy vision of the economic model, is authorized with \$45 billion [3], in which more than \$6 billion will be focused on robotics.

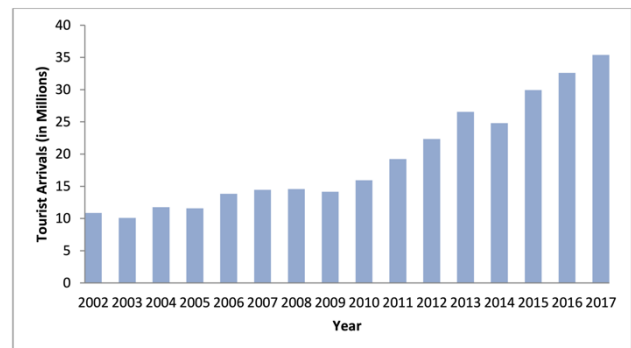


Fig. 1. Yearly tourist arrivals in Thailand from 2002 – 2017, [Department of Tourism, Thailand].

In 2017, thirty international technological firms, including KUKA Robotics, ABB Robotics, and Panasonic, expressed interest in investing in the Eastern Economic Corridor (EEC) scheme [4], which includes Chonburi Province, Chachoengsao Province, Rayong Province, and Samut Prakan Province. This area is the center for export-oriented industries in Thailand, and the EEC scheme involves investment in a range of infrastructure projects,

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including a deep seaport, double-track railway, high-speed train, motorway, and U-Tapao international airport.

Investment in the robotics industrial sector in Thailand is projected to reach 60 billion baht in 2018 [5] with related industrial, automotive, and smart infrastructure. International Federation of Robotics [6] estimated the shipment of industrial robots in Thailand to increase by 350% due to the rise in sales by 30% in 2017 worldwide. Furthermore, government privileges, including reduction of corporate tax by 50% for three years for the companies in high-tech sectors and 300% tax deduction on research and development expenditure, promote the development in robotics. Thailand has successfully developed and implemented robots [7] including assistive robots developed by CT Asia, Fhasai robot developed by Mahidol University for children with autism spectrum disorders, Sensible Tab by TCELS, and arm rehabilitation robots by Tmgi [8].

In this study, we identify opportunities and limitations of deploying robots in the hospitality and tourism industries in Thailand that suit Thai society well. We believe this study acts as a guide in facilitating economical decision and creates a potential to accelerate the success of Thailand 4.0.

2. RELATED STUDIES

Robots are being used in various industries including manufacturing [9]-[11], entertainment [12, 13], education [14]-[16], military [17], medical [18]-[21], cleaning [22], and home environment [23]-[25]. However, application of robotics in hospitality and tourism in Thailand requires detailed analysis of key factors including customer acceptance, service at failure, robotic return on investment, capital investments, expenses, revenues, robot maintenance, job elimination risk study, and environment re-designing.

Design challenges in robots include robotic vision, navigation, mapping, human-robot interface, and artificial intelligence, and emerging advancements in robotics demonstrate successful implementation [26]-[29]. Murphy et al., [30] presents a research study reviewing existing robotics literature considering three robot categories as industrial, professional service, and personal service robots emphasizing the significance of autonomy.

Recent studies [30, 31] explore six robot capabilities with relevant theories for anthropomorphism and thus establishing qualitative metrics for customer acceptance. Tung and Law [32] identify human-robot interaction in future opportunities for consumer and tourist experience with different types of robotic agents, including co-present, telepresence, and virtual agents. Ivanov et al. [31] discuss the behavior of consumers towards the role of robots in accommodation establishments in Iran. In addition to deployment of robots for various applications, the impact of success with robotics deployment with respect to gender roles [33], urban lifestyle [34], environment with successful prior impact on technology [35], and diversity [36] provide

qualitative metrics in identifying and establishing opportunities and limitations of robotics.

We are particularly interested in the role of robotics in Thailand and its impact on Thai society. Maneewarn [37] reflects the need and acceptance of robotic technology in Thai society and in a prior study in Thailand [38] evaluates the performance of service robots in MK restaurants in Bangkok, Thailand.

Considering the uncanny valley theory [39, 40] as shown in Figure 2, industrial robots demonstrate a limited emotional response, which results in limited human likeness. With humanoid robots having better emotional response compared to industrial robots, studies also show an improved human likeness of robots. We identify the region of interest for hospitality-and-tourism-based robots in Thailand as belonging to the rising edge of the uncanny valley for successful human engagement in Thai society. We demonstrate the opportunity for deployment of such robots in the hospitality and tourism industry in Thailand.

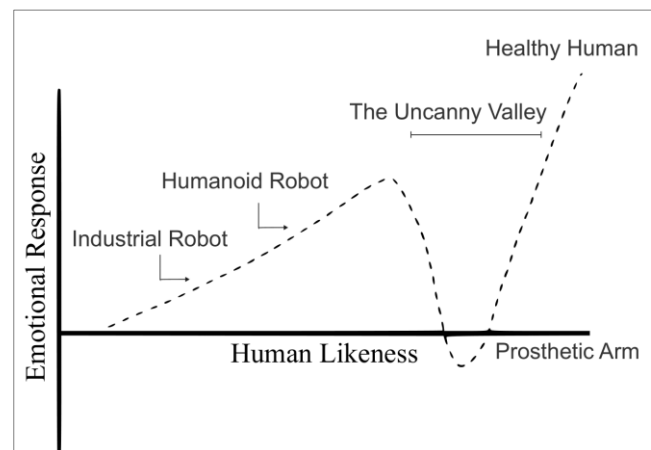


Fig. 2. Uncanny valley response for robots [39, 40].

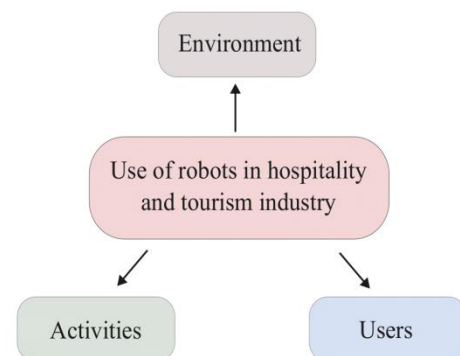


Fig. 3. Proposed approach for qualitative study.

3. CURRENT AND POTENTIAL OPPORTUNITIES

This paper aims to explore the potential use of robots in the hospitality and tourism industry with regard to the environment in which the robots will be deployed, activities

in which robots will engage, and users of diverse backgrounds with which robots will interact as described in Figure 3. emphasizes the vital role played by tourists in Thailand's economy. Analyzing these factors, we identify the suitability of robots for tourist attractions.

3.1. Role of environment

Most tourists who visit Thailand certainly visit several places, starting from the airport to various tourist attractions. They enjoy interacting with people regardless of the differences associated with local language, background, and culture. However, certain settings, such as hotels and hospitals, necessitate official documentation, interaction, and emergency communication. The utilization of robots in such environments reduces workload and labor cost while ensuring efficiency and consistency in repetitive tasks. Figure 4 illustrates the primary focus of this approach in identifying environments and tourist attraction places in which deploying a robot is financially effective and their respective potential applications in tourism and hospitality.

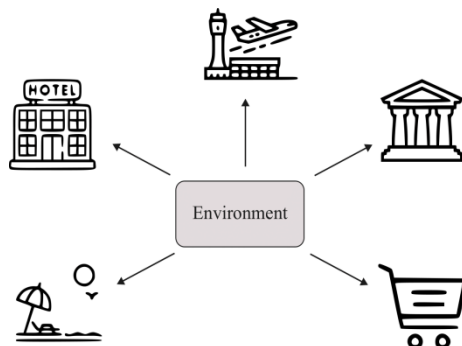


Fig. 4. Use of robots in diverse environment.

3.1.1. Robots in airports

International tourists often form their first and last impression of Thailand based on their experience at the airport. As the number of tourists visiting Thailand continues to rise, it is essential to implement effective and efficient airport systems to reduce stress and complications in the airport environment. One way to achieve this is by deploying various technologies, such as a nonstop surveillance system [41] to identify anomalies, self-traveling luggage [42], and smart luggage carriers.

Social robots can be deployed to provide information on transportation, tourist packages, communication and internet packages, and immigration procedures upon arrival. Special lounge arrangements with service robots in a relaxing environment are also a feasible direction to consider. Japan Forward [43] has implemented different robots, such as The Reborg-X for security, OTTO for carrying heavy baggage, the delivery robot Relay, and Cinnamon and Robocot for various tasks, in Haneda Airport as a trial to attract visitors for the 2020 Olympics. This demonstrates a promising opportunity to deploy such robots at Suvarnabhumi Airport in Thailand with existing facilities.

3.1.2. Robots in markets and shopping malls

Shopping malls in Thailand, particularly in Bangkok, have become a major attraction for tourists due to their well-developed technologies. Most of these malls are strategically built near the Bangkok Mass Transit System (BTS) for easy access. However, given the vastness of these malls, customers often require map directories to navigate through them. To address this issue, shopping malls can implement humanoid mobile shopping robots and smart shopping cart robots to assist customers and facilitate them with effective shopping.

Recent studies demonstrate robot-assisted shopping [44]-[47] to be effective and satisfactory as conventional shopping. Given the recent advancements in natural language processing and immersive technologies, robots that can engage tourists in entertainment have great potential for deployment. Robots that have the ability to create flip-flops using customers' foot impressions within 15 minutes [48] and play table tennis [49] could provide the tourists with local cultural experience within a modern environment. Local markets including Chatuchak can have a piece of land dedicated to play local games and practice safe martial arts with robots.

3.1.3. Robots in historical monuments and temples

We explore the potential applications of technology in the tourism industry, and it is essential that we value the significance of cultural and historical heritage. The use of temples and historical monuments for tourism should be approached with respect and sensitivity to the cultural and historical values they represent. We propose such opportunities at the temple and historical monuments.

Assistive robots that can translate and recite ancient tales can contribute to the understanding and appreciation of the rich cultural heritage of Thailand beyond language limitations. However, it is important to ensure that the use of such technology aligns with ethical principles and respects the privacy concerns of individuals who may be featured in the national research studies that are used as part of the robot's programming.

Immersive aids enabled robots equipped with the ability to visualize the materials and construction techniques used in these historic sites will enhance the overall visitor experience, while also promoting a deeper understanding of the cultural and historical significance of the sites. By taking a responsible and respectful approach to the integration of technology in tourism, it is possible to preserve and promote cultural heritage while ensuring that it is enjoyed by generations to come.

3.1.4. Robots in beaches

Tourists are drawn to the southern islands of Thailand for activities such as snorkeling and sightseeing. To assist passengers on boats, ships, and at food and drink stations, as well as to provide entertainment, robots can be

implemented. However, preserving the ecological habitat of the area's many organisms is a major concern. To address this, a cleaning robot project was launched [50] with an inbuilt sand scraper system. Such robots can be used across various beaches and water resources. Additionally, research studies [51]-[54] have focused on underwater robots that can be used for monitoring levels of contaminants in the water, exploring behaviors of aquatic plants and animals, and providing additional entertainment during snorkeling and swimming activities. One of the existing entertainment approaches is by Disney [55], which allows a robot to draw giant sketches on the beach. Such robots can be improved on the construction design from 2D sketches to 3D models.

3.1.5. Robots in hotels

One of the primary concerns for tourists is accommodation, which ranges from back-packers hotels to star-rated hotels. Based on the range of services, hotels can implement various kinds of robots. For instance, Robomow [56] can mow a lawn, and WINBOT [57] can wash windows with the ability to clean glasses of any orientation and hue. Roomba [58] can automatically clean dirt and dust on the floor, and Clocky [59] can be used for alarm settings in guest rooms. Chef robots and robots that can produce ice sculptures [60] and buildings on an architectural scale are affordable artistic implementations.

Innovative robots such as the welcome assistant LAIA [61] to revolutionize the customer experience in hotels with innovative and disruptive interactions and a robot care companion named HOPE [61] to reduce stress and provide companionship to customers can also be implemented. Some hotels, including Hotel Jen Tanglin and Yotel in Singapore, as well as Vdara Hotel & Spa Las Vegas, The Westin Buffalo, and Aloft Cupertino in California, already have robots as members of their team. Henn-Na Hotel [62] in Japan is exclusively staffed with robots for the English language and a female humanoid for the Japanese language at reception, along with a machine for room service to cut costs. Considering the development of hotels and resorts in Thailand, the adoption of similar kinds of robots in hotels is a feasible future implementation for economic growth.

3.2. Role of activities

Thailand offers a diverse range of exhilarating activities that allow tourists to immerse themselves in the country's vibrant culture. While the bustling night markets and lively street life are undoubtedly exciting aspects of the Thai lifestyle, this research study will not delve into them as they are devoid of technology. Instead of finding robots as a replacement for existing jobs which are against the functionalities of tourism and hospitality, we discuss potential opportunities to enrich the experiences of both locals and tourists. Figure 5 shows the subsections of activities this research study explores and highlights existing work and insights on future improvement.

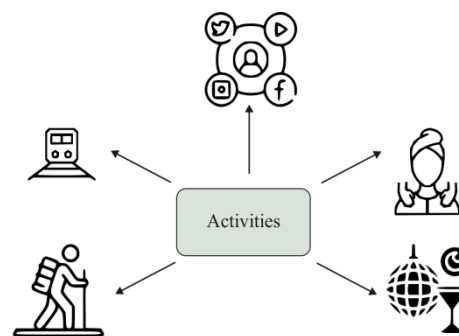


Fig. 5. Use of robots in diverse activities.

3.2.1. Robots for social-media engagement

Tourists have shown a keen interest in spending time with robots, which has become a popular activity in the technological era. Robots, especially humanoid ones, have been widely recognized as a source of entertainment and attraction for people seeking satisfaction, self-enjoyment, and social media attention. Kaneko et al. [63] have replicated human activities in humanoid robots, making them even more appealing to tourists. Moreover, social robots, like those that offer opportunities for interaction such as a high-five bot [64], have made experience with robots even more engaging.

Leveraging the attention generated by current robots Samsung Bot Care [65], Gita Bot [66], and Kuri [67], existing robots can be deployed strategically in the central areas of tourist attractions to draw in diverse tourists and increase local visits. For instance, CaddyTrek R2 [68] can be employed in advanced golf settings to assist with carrying tasks that might appeal not only to tourists but also to the local population in Thailand. Similar to dogs and cats cafes in Thailand, a cafe that features robotic dogs like Genibo [69] might attract the younger generation to experience a futuristic setting.

This could be used at sudden emergency situations like during a pandemic to provide essential services. By designing robots to have diverse built-in features that allow face recognition, respond to touch, and express emotions through motor functions and natural language processing might allow more engaging tourist activities in general, which is beneficial from an economic perspective.

3.2.2. Robots for nightlife

The utilization of robots to assist with local activities in Thailand could potentially improve the income and appeal to tourists. Tourists who are on holidays are often interested in engaging in the nightlife of the country, particularly in Bangkok, which offers exposure to the modern infrastructure and culture. Bangkok boasts a variety of options, ranging from street food and local street markets to sky bar lounges. Deployment of robots in the hospitality industry can be seen as a significant advancement in

Thailand in such settings. For instance, there are already robots operating as bartenders [70], robots in kitchens [71], and coffee shops [72] with robotic arms to serve coffee. This can help to improve the efficiency and speed of service while also providing a unique and memorable experience for guests. Additionally, robots can be used to welcome tourists in nightclubs [73] and perform as DJs [74], pole dancers [75], and servers [76] to enhance the nightlife experience.

3.2.3. Robots for hiking

Tourists visiting tropical countries with natural attractions often enjoy engaging in various adventurous activities, such as hiking and exploring caves, mountains, and waterfalls. These activities provide a sense of euphoria, which makes them particularly appealing. In Thailand, hiking is one of the most popular adventure activities for tourists. The northern region boasts of various mountain ranges, while the southern region has limestone cliffs and marble caves that attract international tourists. However, these places can be hazardous and require active surveillance and a strong discovery management during emergencies. To enhance safety, rescue robots have been proposed in previous studies [77]-[80]. Additionally, drones can be used to capture images and videos of such environments for effective management of the hospitality and tourism system. By incorporating these technologies, tourists can enjoy hiking and other adventurous activities with increased safety and security.

3.2.4. Robots for travel

The use of robot assistants in the tourism industry has great potential to enhance the hospitality experience for guests. By providing services such as currency exchange, maps, and transportation booking, robot assistants can significantly improve the convenience and ease of navigating new places. This is particularly important in the hospitality industry, where guests often expect a high level of service and attention to their needs. For instance, in hotels, robot assistants can be used to greet guests upon arrival, provide them with information about the hotel's amenities and services, and even escort them to their rooms. Similar to the bicycle implementation [81, 82] in Bangkok, hoverboards and three-wheelers can also increase tourist attractions improving the economical benefits.

3.2.5. Robots for massaging

Thai massage therapy is a traditional relaxation method to realign, channel, and strengthen the core energy of muscles, tissues, bones, and mind that has played a significant role in the tourism and hospitality sector. Even though replication of Thai massage is possible with recent innovations in soft robotics, we will not be considering it as a replacement option in this study. This is because we believe the pressure techniques that are associated with such therapy will not be well imitated by robots. However, similar to western tourism industry, general massage robots [83, 84] can be

implemented as an entertainment service for tourists in shopping malls and large markets, especially in Chatuchak Market and Khaosan Road.

3.3. Role of users

We highlight the importance of discussing opportunities for using robots by diverse users, specifically tourists in Thailand. We emphasize that tourists in Thailand come from diverse backgrounds, gender, age groups, and job roles, making each individual unique with significant interests. While we focus on a few user sub-sections and discuss the potential applications of robotics for them, as shown in Figure 6, we acknowledge that many of these opportunities can be transferable to other user sub-sections as well.

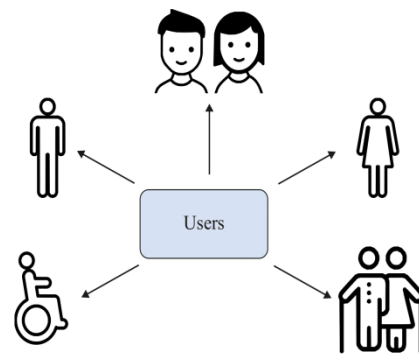


Fig. 6. Use of robots in diverse users.

3.3.1. Robots for kids

Robots can play a significant role in enhancing the tourist experience for kids. The current generation of kids shows great curiosity and amusement towards robots, making them a great user-case for entertainment while their parents are busy shopping or spending more time in tourist attraction spots. By using animal characterized or animated robots with popular characters from Disney and Marvel, kids can be delighted and engaged for extended periods. Additionally, personalized board game robots can keep kids occupied and entertained.

Developing amusement parks and theme parks based on robots with virtual reality and augmented reality can provide another avenue for entertainment and immersive experience for kids. For those interested in programming, exposure to robots can be beneficial. Certain robots such as Dash robots actively help improve science, technology, engineering, and maths (STEM) skills, while others like BB-8 smart droid, Cozmo, Ollie, and Miposaur are popular among kids. Emerging robotic technologies [85] can be adopted for tourist kids to create unforgettable memories of their stay in Thailand.

3.3.2. Robots for men

We evaluate the potential opportunities that robots can provide in a traditional Thai society based on the popularity score by men and women. Robots enabling men to practice

cooking traditional Thai cuisine, such as the famous dish 'Pad Thai,' while offering an enjoyable experience through sharing the process with other tourists is the one of the popular choices for deployment. Social robots sharing information related to tour packages, shopping promotions, entertainment, and nearby bars and restaurants can also among other applications preferred by male users during our study.

Further opportunities include mini-robots that can update details on sports, monitor exercise patterns, and reward users with a free healthy drink during promotions. Other types of robots, such as those that demonstrate traditional Muay Thai fighting techniques, game-playing robots [86, 87], and robots providing specific services [88, 89] can also be utilized in the hospitality and tourism industry. It is important to note that even though these robots are primarily focused on men due to popularity bias, they can also be used by any active users who share the same interests.

3.3.3. Robots for women

We evaluate the potential opportunities for the use of robots by adult tourists, with a focus on female users in traditional Thai society. Our qualitative analysis suggests that female tourists may be more likely to use robots that cater to their specific needs. Notably, shopping is a popular interest among women, and robots equipped with high-tech imaging capabilities for assessing skin nature, as well as those that can assist with make-up application [90], and offer advice on the latest styles of jewelry and clothing, are likely to be well-received. Additionally, robots with exceptional greeting skills and attractive features are expected to generate heightened interest among tourists. Moreover, female tourists may also benefit from general-purpose robots that are capable of diverse applications, as discussed in the context of male users and various environments and activities.

3.3.4. Robots for disabled

One area where robots can be particularly helpful is in assisting disabled individuals during tourism and hospitality. One way that robots can assist disabled individuals is by providing mobility assistance. For example, robots can be designed to act as personal assistants to wheelchair-bound individuals, helping them navigate through busy airports or crowded tourist attractions. These robots can be programmed to recognize and avoid obstacles, and can even be equipped with sensors to detect changes in terrain or elevation.

Another area where robots can be useful is in providing communication assistance. For individuals who are deaf or hard of hearing, robots can be programmed to translate spoken words into text or sign language, allowing them to communicate with others more easily. Robots can also be used to assist individuals with speech impairments by acting as a voice synthesizer or by translating their written words

into spoken language. Robots can also be designed to provide personal assistance to disabled individuals during their travels. For example, robots can be programmed to help with tasks such as carrying luggage, finding accessible restaurants or accommodations, or even providing medication reminders. While there are no current robots in deployment, we have identified opportunities to provide such services, to allow robots to assist individuals with disability to feel more independent and confident during their travels in Thailand.

3.3.5. Robots for elders

Elderly tourists are a significant segment of visitors to Thailand who seek to explore the country's temples, religion, beaches, and local culture. To assist them in their exploration, assistive social robots have been proposed by various researchers. For instance, a study [91] reviews the potential of assistive social robots in elderly care, while Dias et al. [92] discuss current trends and developments in this area. Similarly, a systematic review of the effects and effectiveness of robots for elderly care [93] is proposed which can be leveraged directly for the tourism sector.

While existing robots like PARO [94], Care-O-bot [95], and Huggable [96] provide care, companionship, and support to elders, their potential in the hospitality and tourism sector remains largely unexplored. A personalized robot that offers medical reminders, emergency details, food, medical records, and tour applications filtered for age can provide significant support to elderly tourists during their stay. This would enhance their independence and help accelerate the success of Thailand 4.0.

We discuss benefits of robots for tourism and hospitality in Thailand including their potential ability to provide personalized services, improve communication with guests, and offer a unique and innovative experience that sets Thailand apart as a tourist destination. We also highlight the ability of robots to assist in areas such as language translation, cultural interpretation, and providing information on local attractions and events which will improve the overall quality of the travel experience.

4. LIMITATIONS AND CHALLENGES

The hospitality and tourism industry in Thailand stands to make remarkable technological advancements with the use of robots. However, it is important to note that there are limitations and challenges that come with the use of robots in these sectors.

We believe the application of robotics will not replace existing jobs, but instead create more job opportunities for engineering graduates. These opportunities will include technical maintenance, administration, communication, marketing, and management. Job opportunities in the field of research and development and information technology will also accelerate in the future. Thailand receives international tourists from diverse backgrounds and

countries, with China being the top source of tourists, followed by the UK, Russia, USA, Japan, Korea, India, and Singapore. Most tourists are interested in exploring every aspect of Thailand, which highlights the role of artificial intelligence and robotics as a viable option to improve the quality of tourist experience. Although there may be technological limitations, proper maintenance services and available human assistance can overcome such issues, given the current skilled workforce of Thailand.

The use of robots, particularly drones, in surveillance has become a growing social concern due to issues of data privacy and security. Drones equipped with cameras can capture high-resolution images and videos of public spaces, which can be used for various purposes, such as crime prevention, border security, and disaster response. However, the collection, storage, and analysis of such data can be potentially invasive and threaten individual privacy. There are concerns that the use of drones for surveillance can lead to the indiscriminate gathering of data, which can be used to monitor the activities of individuals without their consent, profiling, tracking, and identification, which can pose a risk to personal safety and civil liberties. As the use of robots in tourism and hospitality becomes more widespread, it is important to develop policies and regulations that protect individual privacy rights and ensure the responsible use of these technologies.

It is also important to note that we only explore the possibilities of the study of robots as a physical agent, while there are also virtual agents that can be considered for several applications in hospitality and tourism. Additionally, existing hotels in Thailand have their unique styles that focus on entertainment and outreach. The behavior of tourists varies for example in a shopping scenario, from shopping malls to street markets in Thailand and it is important to note that not everyone enjoys technological advancement. While the application of robotics for various environments, activities, and users is an achievable implementation for the hospitality and tourism industry in Thailand, it is important to consider the limitations and challenges associated with the use of robots, and to ensure that the services provided cater to the needs of all locals and tourists.

5. SECONDARY BENEFITS

The primary aim of this study is to find potential opportunities for robots in the tourism and hospitality industry to provide entertainment and assistance in Thailand while we also identify secondary benefits of deploying such robots to address environmental and social challenges that cannot be ignored with increased tourism. One important secondary benefit of using robots in the tourism industry is their ability to address environmental issues such as air pollution [97]. By implementing inbuilt smog vacuum cleaners, robots can help to clear the air of harmful particles and even repurpose them into beautiful jewelry.

Additionally, robots can autonomously monitor pollution levels in urban environments, providing valuable data for city planners and policymakers.

Another benefit of using robots in the hospitality industry is their ability to assist with transportation and traffic analysis. In Thailand, where congestion is a major issue [98], robots can use drones [99] or other means to evaluate traffic flow and provide real-time data to tourists and locals alike. This data can help people make informed decisions about where to go and how to get there, ultimately improving the efficiency of the transportation system and reducing traffic congestion. Finally, robots can also play a role in emergency response and local natural disaster management [100]. By incorporating emergency alert systems, robots can continuously monitor environmental conditions and provide timely warnings to visitors and staff in the event of a natural disaster in a local community. This can help to minimize damage and protect both the economy and people of the affected area. By leveraging their unique capabilities, robots have the potential to accelerate the success of the industry and benefit society as a whole.

From an economic perspective, exploring multiple business models presents great potential. While our main focus has been on franchising and direct business models, there are additional opportunities to conduct market research and analyze potential business customers, competition, and market demand. To ensure commercial viability, it is advisable to perform a feasibility study on specific ideas discussed in this study. By emphasizing the benefits of utilizing robotics solutions, such as enhanced efficiency, reduced labor costs, and increased customer satisfaction for both tourists and businesses, and establishing strong partnerships with brands and technology providers, significant economic growth can be achieved.

6. CONCLUSIONS

The use of robots in the hospitality and tourism industry in Thailand has great potential at the current economic stage of the country. The application of robotics will improve hospitality and tourism services and provide opportunities for the development of the country. This study includes various robots that are being implemented in other countries and available applications of robots in significant tourist attractions in Thailand. The study discusses the use of robotics-based on environment, activities, and users involved in hospitality and tourism.

We explore current limitations and potential challenges while highlighting the demand for robots in tourism in Thailand. We address ethical practice and privacy towards future research in robotics in Thailand. To our knowledge, no previous studies have analyzed existing robots to identify future opportunities for robotic applications in the tourism and hospitality sector to benefit Thai society. As such, it can serve as a fundamental study to inform the current approach and development of future robots and smart hospitality and

tourism in Thailand. We believe with increasing tourist arrivals and government investment towards robotics and technology, Thailand 4.0 will modernize the hub of Southeast Asia.

The adoption of robotics in tourism and hospitality is a business fit that has the potential to revolutionize the industry by enhancing customer experience and improving operational efficiency. The future of robotics in tourism and hospitality is promising, and it is expected that the deployment of robots will continue to increase in the sector. Thailand 4.0 presents a unique opportunity for businesses in the country to embrace the use of robots and position themselves as leaders in innovative and technology-driven services.

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