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探索未來採用機械人科技於香港旅遊業的潛能

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Investigating the Potential for Robotic Technology Adoption in the Hong Kong Tourism Industry

探索未來採用機械人科技於香港旅遊業的潛能

(Project No: 2018.A6.118.18D)

Final Report

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Executive Summary

Abstract of the Research

Tourism is one of the major pillar industries in Hong Kong but is facing unprecedented challenges worldwide and severe competition from nearby countries in recent years. In coping with the expected challenges ahead, innovation and effective application of advanced technology are a key to achieve competitiveness. The Hong Kong government has recently proposed to invest HK\$17 billion in innovation and smart technologies in hoping to enhance the overall competitiveness of Hong Kong. The adoption of robotic technologies has a high potential to enhance tourists' experiences, reduce operating costs and provide a possible solution to the skilled labor shortage problem typically found in the tourism industry in Hong Kong. However, research in factors affecting the potential robotics adoption in the tourism industry is scarce and little is known from the perspective of industry practitioners on its potential opportunities and challenges. Such information would be valuable for the local government to develop appropriate policies to support the future development and application of this technology. This project aims to (1) explore the level of awareness and knowledge of robotics technology of the managers in airport, hotel, restaurant and theme park in Hong Kong; (2) identify the managers' perceived benefits and opportunities of robotic technology affecting its adoption intention in respective sectors of tourism industry in Hong Kong; (3) identify the perceived "costs" and challenges of robotic technology affecting its adoption intention in respective sectors of tourism industry in Hong Kong and (4) provide recommendations on how the Hong Kong government can better support and facilitate the future application of robotic technology through policy formulation.

There have been many applications of robots mainly on a trial basis in hotels, restaurants and airports in other destinations and has attracted considerable publicity. In order to understand factors affecting the adoption intention of robots by industry practitioners, the Value-based Adoption Model (VAM) is employed in this study. Perceived usefulness and perceived enjoyment are regarded as the major benefits associated with the use of robotic technologies. Whereas perceived fees and technicality are the sacrifice or "costs" side with

such technology adoption.

Qualitative approach based on semi-structured in-depth interviews with 35 managers, among which 18 are hotel managers evenly distributed among three categories of hotel size; 16 are restaurant managers distributed among three different types of restaurant; and one is from the airport. A framework has been developed based on the analysis of findings and the reference of the Value-based Adoption Model (VAM) (Kim et al., 2007).

The findings show that most of the interviewees only have limited knowledge of robotics technology. For those who have never seen a real robot, they mostly heard about robots from websites, social media, newspaper / magazines, TV programs or friends. A minority of the interviewees who had prior experiences interacting with robots have diversified views on the roles of robots in service delivery.

The major benefits and opportunities of robotics technology perceived by managers can be classified into internal aspect and external aspects. The internal aspects are redressing labor shortage problems, ensuring consistency of service quality, enhancing operational efficiency, avoiding human labor problems such as occupational injury, complaints, emotional issues, sick leave etc., and reducing human labor's workload. Whereas for external aspects, these include enhancing customer experience by providing fun and entertainment through interacting with robot, meeting the needs (free from staff interruption) of a new generation of guests, and adding value to marketing in terms of enhancing company image.

There are two aspects of sacrifice / challenges of robotics technology perceived by interviewees, namely 1) technicality which relates to technical problems of robots; and 2) perceived costs which relate to the investments and risks of robot technology application. For technicality related challenges, it includes lack of updated information on robotic technologies, space and infrastructure limitations, lack of local technical support for

installation, modification and maintenance, lack of advanced “intelligent” technology to meet customer needs, difficulty of maintaining the balance between human labor and robots in service delivery, and difficulty in gaining acceptance by all current staff. For perceived challenges, in addition to high investment costs are needed before (the robot itself), during (installation and infrastructure renovation) and after (maintenance, upgrading and back-up labor) robotic installation, there are also risks involved which include security risks, privacy risks, excessive capacity risk, unemployment risk and risk for inconsistent brand image.

研究摘要

旅遊業是香港的主要支柱產業之一，但近年來卻面臨著全球前所未有的挑戰以及附近國家的激烈競爭。為了應對未來的挑戰，創新和有效應用先進技術是提高競爭力的關鍵。香港政府最近建議投資 170 億港元用於創新和智能技術，以期增強香港的整體競爭力。採用機器人技術具有極大的潛力，可以改善遊客的體驗，降低運營成本，並為解決香港旅遊業通常存在的熟練勞動力短缺問題提供可能的解決方案。但是，對於影響旅遊業中潛在的機器人技術採用的因素的研究很少，而且從從業者的角度來看，對其潛在機遇和挑戰所知甚少。這樣的信息對於地方政府制定適當的政策以支持該技術的未來開發和應用將是有價值的。該項目旨在（1）探索香港機場、酒店、飯店和主題公園的管理人員對機器人技術的認識和知識水平；（2）確定管理者對機器人技術的感知利益和機會，這會影響機器人技術在香港旅遊業各個部門的採用意圖；（3）找出影響機器人技術在香港旅遊業採用的意圖的感知技術的“成本”和挑戰，以及（4）就香港政府如何更好地支持和促進機器人技術的未來應用提供建議通過制定政策。

在其他國家的旅館、飯店和機場中，已經有許多主要在試驗基礎上使用機器人的應用，並且已經引起了廣泛的關注。為了了解影響行業從業人員採用機器人的因素，本研究採用了基於價值的採用模型（VAM）。感知的有用性和感知的樂趣被視為與使用機器人技術相關的主要好處。然而，感知的代價和技術性是採用這種技術的犧牲或“成本”方面。

調查結果表明，大多數受訪者對機器人技術的了解有限。對於那些從未見過真正機器人的人來說，他們大多從網站、社交媒體、報紙/雜誌、電視節目或朋友那裡聽說過機器人。少數具有與機器人互動經驗的受訪者對機器人在服務交付中的作用有多種看法。

管理者認為機器人技術的主要好處和機遇可以分為內部方面和外部方面。內部方面是解決勞動力短缺問題，確保服務質量的一致性，提高運營效率，避免諸如職業傷害、投訴、情緒問題、病假等人為勞動問題，以及減輕人為勞動的工作量。而在外部方面，這些包括通過與機器人進行交互來提供娛樂和娛樂，從而滿足新時代客人的需求（不受員工干擾），並通過增強公司形象來增加營銷價值，從而提高客戶體驗。

受訪者認為機器人技術的犧牲/挑戰有兩個方面，即：1) 與機器人技術問題相關的技術性；2) 與機器人技術應用的投資和風險相關的可感知成本。對於與技術性相關的挑戰，包括缺乏有關機器人技術的最新信息，空間和基礎設施的限制，缺乏用於安裝，修改和維護的本地技術支持，缺乏能夠滿足客戶需求的先進“智能”技術，難以維持勞力和提供服務的機器人兩者之間的平衡，和獲取所有現職員工的接受。對於可感知的成本挑戰，除了在機器人安裝之前所需的投資（機器人本身），還包括在安裝期間（安裝和基礎設施改造）以及在安裝之後（維護，升級和後備人工）的投資成本外，還涉及一些風險，包括安全性風險，私隱風險，產能過剩風險，失業風險以及品牌形象不一致的風險。

Summary on Policy Implications and Recommendations

This research project aims to explore the perceived opportunities and challenges by industry practitioners with robotic technologies adoption in hotels, restaurants and the airport in Hong Kong. The findings suggest successfully developing smart tourism is more than just bringing together various digital technologies; instead, the intricate integration among financial resources, physical assets and digital technologies are the keys to success. To facilitate smooth and sustainable progress of such integration, the relationship between the government authorities and the private sector is critical. Based on the perceived challenges and after taking the views of the industry practitioners, the following recommendations are provided for the Hong Kong government to better support and facilitate the future application of robotic technology through various areas:

a) Provide Relevant Education

The government could consider facilitating appropriate educational training from basic to advanced level courses offered in tertiary institutions related to information technology, artificial intelligence or robotics technology. This can help to ensure a continuous supply of local IT talents for tomorrow's workforce, whether in researching, in technical design or in support services. A long-term strategic plan could be in place to attract qualified scholars/experts around the world to come to Hong Kong to cultivate future skilled personnel as needed. The public should be well informed on the long-term vision and direction of the government in smart city development and be educated on the potential and challenges of robotic application given today's technological progress. This would allow industry practitioners to better embrace robotics technology and be open-minded. Support from hotel owners and senior management needs to be sought before contemplating the application of robotics technology in hotels. It would be useful to establish labs or workshops to showcase how robots can provide benefits to their business.

b) Provide Funding Support

The government could consider funding support for local companies specializing in robotics technology. This can help local suppliers to develop and sustain especially the high rental charges of offices in Hong Kong, which is often a big challenge to newly start-up companies in particular. Financial support could also be allocated to universities that are doing research relating to robots (particularly relating to Chinese/Cantonese language processing related software), both financially and administratively in terms of the recruitment of overseas' scholars who have relevant knowledge and experiences. The funding could also be made available for application by the private sector if justification could be made that the final product would bring benefits to the whole industry. Such offer would be seen as a gesture of incentive especially to those companies who would like to experiment but financially may not be viable to take the risk. Lastly, it would be worthwhile to consider if government could provide funding support / subsidies / bonus for hotels / restaurants that integrate robotics technology that are backed up by a transparent and rigorous selection and monitoring mechanism. Caution should be made to ensure the industry is not abusing such opportunity for private gains.

c) Act as a Leader

The Hong Kong government could consider acting as a leader to try and use advanced robotic technology as a demonstration in its own departmental operations. This could create awareness and raise the interest of robotic application in real life to the general public, as well as provide participants with first-hand usage experience with this new advanced technology. Feedback could also be provided to the government and the product designer for subsequent product improvement. Most importantly, the attitudes and lifestyle of Hong Kong residents could gradually change when they are familiar with and appreciate more applications of robots. This could make it easier for the general public to accept and even welcome robotic services in hospitality and tourism industries.

d) Launch Product Promotion

To address the lack of product information experienced by the industry, the government could launch more promotional events (e.g. exhibition, conference, trade show) about robotics technology to introduce up-to-date technological developments and products. The government can serve as a coordinator between relevant technology suppliers and various industry practitioners in one platform to showcase their latest offerings. In addition, experts could assess products or technologies that are likely to suit the Hong Kong environment. This could provide industry practitioners with information so they can better select the technologies and products that suit their businesses.

e) Liaise Partnership Formation

The Hong Kong government could also act as a liaison to encourage partnerships or cooperation between local IT companies and overseas (e.g. Japan, Singapore and United States) or mainland Chinese companies. The government could consider the regulations required for new business models to establish with foreign partners. Incentives of different kinds, whether financially, regulatory or infrastructural, could be considered but at the same time to ensure the interests of the Hong Kong citizens and users of the city are well protected.

f) Establish Supporting Policies

The Hong Kong government could consider policies to specifically cater to regulatory challenges that may emerged from robotics technology such as the ethical and security issues from by robotic applications in the commercial world. This may involve setting new standards in design, manufacturing, programming and operation, as well as taking measures to make sure the robotic applications are safe and ethical. The government could also establish relevant supporting policies to enable labor mobility to other employment sectors. This could be in terms of bridging the skill gaps for employees who are working in traditional industries to transform their skill set in which “new” industries can absorb.

Ultimately the government could facilitate a suitable environment in which new businesses and smart solutions can emerge and grow.

政策含義和建議摘要

該研究項目旨在探索在香港酒店，飯店和機場採用機器人技術的行業從業者所感受到的機遇和挑戰。研究結果表明，成功開發智能旅遊不僅僅是將各種數碼技術融合在一起。相反，財務資源，實物資產和數字技術之間的複雜整合是成功的關鍵。為了促進這種融合的順利和可持續發展，政府當局與私營部門之間的關係至關重要。根據所察覺到的挑戰並結合行業從業者的意見，為香港政府提供以下建議，以更好地支持和促進未來機器人技術在各個領域的應用：

a) 提供相關教育

政府可以考慮在高等教育機構中提供與信息技術，人工智能或機器人技術相關的從基礎課程到高級課程的適當教育培訓。這可以確保在研究，技術設計或支持服務方面確保為未來的勞動力持續提供本地 IT 人才。可以製定長期戰略計劃，以吸引世界各地的合格學者/專家來香港，以根據需要培養未來的技術人才。公眾應該充分了解政府在智慧城市發展中的長遠眼光和方向，並應就當今技術進步對機器人應用的潛力和挑戰進行教育。這將使行業從業者能夠更好地接受機器人技術並持開放態度。在考慮將機器人技術應用於酒店之前，需要尋求酒店所有者和高級管理層的支持。建立實驗室或講習班以展示機器人如何為他們的業務帶來收益將非常有用。

b) 提供資金支持

政府可以考慮為本地專門從事機器人技術的公司提供資金支持。這可以幫助本地供應商發展和維持，尤其是香港辦事處租金高昂，這通常對新成立的公司而言是一個巨大的挑戰。在招募具有相關知識和經驗的海外學者方面，也可以在財務和管理上為正在從事與機器人（特別是與中/粵語處理相關的軟件有關）研究的大學提供財政支持。如果有理由證明最終產品將為整個行業帶來利益，則也可以使用私人部門可以使用這些資金。這樣的報價將被視為一種激勵手段，特別是對於那些想嘗試但在財務上可能無法承擔風險的公司而言。最後，值得考慮的是，政府是否可以為集成了機器人技術的酒店/餐館提供資金支持/補貼/獎金，而該技術由透明，嚴格的選擇和監控機制作為後盾。同時應謹慎確保該行業不會濫用這種機會謀取私利。

c) 擔任領導者

香港政府可以考慮擔任領導者，嘗試並使用先進的機器人技術作為其部門運作的示範。這可以提高公眾的認識並提高機器人在現實生活中的興趣，並為參與者提供這項新的先進技術的第一手使用經驗。還可以將反饋提供給政府和產品設計師，以用於後續產品改進。最重要的是，當香港居民熟悉並欣賞機器人的更多應用時，他們的態度和生活方式可能會逐漸改變。這可以使公眾更容易接受甚至歡迎酒店和旅遊業中的機器人服務。

d) 推出產品促銷

為了解決行業缺少的產品信息的問題，政府可以發起更多有關機器人技術的促銷活動（例如展覽，會議，貿易展覽），以介紹最新的技術發展和產品。政府可以在一個平台上充當相關技術供應商與各種行業從業者之間的協調者，以展示他們的最新產品。此外，專家可以評估可能適合香港環境的產品或技術。這可以為行業從業者提供信息，以便他們可以更好地選擇適合其業務的技術和產品。

e) 聯絡夥伴關係組建

香港政府也可以充當聯絡員，以鼓勵本地 IT 公司與海外（例如日本，新加坡和美國）或中國大陸公司之間的伙伴關係或合作。政府可以考慮與外國合作夥伴建立新的商業模式所需的法規。可以考慮採取各種激勵措施，無論是財政方面，監管方面還是基礎設施方面的激勵措施，但同時要確保香港公民和城市使用者的利益得到良好保護。

f) 建立支持政策

香港政府可以考慮採取專門針對機器人技術可能出現的監管挑戰的政策，例如商業世界中機器人應用帶來的道德和安全問題。這可能涉及在設計，製造，編程和操作中設置新標準，並採取措施確保機器人應用安全且符合道德。政府還可以製定相關的扶持政策，使勞動力能夠轉移到其他就業部門。這可以通過彌合傳統行業員工的技能差距來轉變其技能以被“新興”行業吸納。最終，政府可以營造一個合適的環境，使新業務和智能解決方案得以興起和發展。

1. Introduction

Tourism is one of the major pillar industries in Hong Kong, making a contribution of 16.7% to GDP in 2017, compared to merely 6.5% contribution in 1998. In 2018, visitor arrivals to Hong Kong reached a total of 65.15 million, which accounted for an annual increase of 11.4% comparing to 2017 according to the Hong Kong Tourist Board published statistics. Not surprisingly, Mainland China is still the largest source market, representing 76% of total arrivals, followed by Taiwan, South Korea, Japan and the United States (HKSAR, 2018). Indeed, Hong Kong has enjoyed a sustained growth of visitors from the Mainland China since 2003. Such growth has been stimulated by visa liberalization policies such as the Individual Visit Scheme (IVS) and the multiple-entry permits of Shenzhen residents in 2009. Despite these seemingly promising figures, Hong Kong tourism is actually facing unprecedented challenges worldwide and severe competition in particularly from other Asian countries such as Singapore and South Korea due to the sector's maturity and the rapidly evolving environments.

To cope with the challenges ahead, innovation and effective application of advanced technology is not only a key to achieve competitiveness, but also a factor of survival, growth and development in an extremely turbulent tourism market (Ilic and Nikolic, 2018). Over the years, the application of advanced technologies in tourism is evident in facilitating information search and product distribution through the use of the internet and mobile devices (Law, et al., 2014). The evolution of technologies has never stopped and has brought considerable impacts in reducing operating costs, enhancing operational efficiency and customer experiences within the tourism industry. Recently there is a growing attention in the potential exploration of advanced technologies and tools such as artificial intelligence, big data, robotics as well as virtual and augmented reality (Sigala, 2018). In tourism industry where attracting and retaining skilled labor, especially in the operational areas, are a particular challenge to management, the adoption of robots which are equipped with many “smart technologies” seem to be a promising path to go in the near future. By learning the positive impacts that robotic application in other service sectors has brought

in terms of operational efficiency, quality consistency and improved productivity, service robot is generally perceived as a possible solution to cope with these challenges.

According to the Global Innovation Index (GII) 2018 co-published by Cornell University and INSEAD Business school and the United nations' World Intellectual Property Organization, the ranking of Hong Kong has dropped to fourth, behind the regional competitors, Singapore, South Korea and Japan. The GII has been regarded as a leading reference on innovation in the last 10 years, with an aim to capture the multi-dimensional facets of innovation and provide the tools to assist the formulation of government policies in promoting long-term output growth, improved productivity and job growth ("About the Global Innovation Index," 2018). It is believed the Hong Kong government is well aware of these potential threats and has proposed to develop Hong Kong as a smart city in "The Chief Executive's 2017 Policy Address" report. Based on the initial consultation study on Smart City Blueprint for Hong Kong done earlier, a budget of HK\$17 billion is to be invested in innovation and technology sectors and to promote smart manufacturing and research in Hong Kong ("HK\$17b boost," 2018). Research and application of robotics technologies is one of the intended directions in the policy which has a high potential to enhance tourists' experiences and improve the overall competitiveness of Hong Kong as a popular tourist destination. Robots have considerable successful applications in other service sectors such as the health care sector and the financial sector, but the utilization of robots in tourism industry is only apparent in late 2000s and is clearly falling behind.

Examples of robots that have been applied in tourism sectors such as hotels, restaurants and airports are mainly found in other countries and has generated a lot of attention. For example in the early-2010s, the first robot hotel had finally come to reality. Henn-na Hotel announced the opening of the world first robotic hotel in July 2015 which was operated by 80 robots including the cleaning robot that takes care of the cleanliness of the public area; arm robot that stores luggage automatically; and reception robots that perform daily guests' requests (Papathanassis, 2017). Customer facial data used at check-in and for room entrance is recognized by the latest facial recognition system (Northfield, 2015). This

remarkable event had changed the way in service provision and offered a completely new travel experience to the travelers. Food delivery and serving in the restaurant are another application of robots in the restaurant sector. One restaurant in Beijing (China) named “The Dragon Spring Temple” has installed a squat robot dressed in custard-colored robes which helps to deliver the cooked dish to the customer’s tables, though at the moment it stills relies on humans to “lift” the dish by themselves from the robot (Chen, 2016). Some western countries are also planning to have more widespread deployment of robotic technology in the restaurant due to the expected rise of labor costs in the next 5-10 years. For example, a company called Yelp Eat24 plans to use autonomous food delivery robots in San Francisco’s Mission and Petero Hill districts in the near future; so is Domino’s Pizza who is testing the use of pizza delivery robots in Europe and New Zealand (Hamstra, 2017). Lastly the potential of robotic application can also be identified in the airport where the “Airport Guide Robot” and “Airport Cleaning Robot” have been put into trial service in 2017 summer by LG electronics company in Seoul’s Incheon International Airport, South Korea (“LG’s new airport robots”, 2017).

However, research in factors affecting potential robotics adoption in the tourism industry is scarce and little is known from the perspective of industry practitioners on its potential opportunities and challenges especially in Hong Kong. Such information would be necessary and valuable to understand what needs to be done and how the local government can develop appropriate policies to support the future development and application of this technology.

2. Research Objectives

In light of this research gap, this project aims to:

1. To explore the level of awareness and knowledge of robotics technology from managers in airport, hotel and restaurant in Hong Kong
2. To identify managers' perceived benefits and opportunities of robotic technology affecting its adoption intention in respective sectors of tourism industry in Hong Kong
3. To identify the perceived “costs” and challenges of robotic technology affecting its adoption intention in respective sectors of tourism industry in Hong Kong
4. To provide recommendation on how the Hong Kong government can better support and facilitate the future application of robotic technology through policy formulation

3. Research Methodology

Qualitative research methodology was used for this study. Semi-structure in-depth interviews were employed to understand managers' awareness and knowledge, perceived benefits and challenges of robotic technology and their recommendations for the Hong Kong government.

A total of 35 managers participated in the interviews, among which 18 are hotel managers, 16 are restaurant managers and one is from the airport. Purposive sampling was employed to select hotels and restaurants. According to Hong Kong Hotels Association (HKHA), there are 138 hotels in Hong Kong in 2019. To ensure credibility, we sorted these hotels based on the number of rooms into 3 categories: less than 300 rooms, 301 to 500 rooms, and over 500 rooms. The numbers of hotels in each category are 50, 46, and 42 which are fairly similar. For each category, 6 hotels were invited for the interview to ensure representativeness. The samples of restaurants are from fine-dining restaurants, casual dining restaurants and fast-food restaurants. There are 12 managers from fine-dining restaurants, 2 from casual dining restaurant groups and 2 from fast-food restaurant groups. Although the numbers of casual dining and fast food restaurant managers seem small, the interviews are considered sufficient because each manager supervised 6 different brands under their restaurant groups. Table 1 shows the detailed information of the interviewees.

The following questions were asked to answer the objectives:

- 1) What do you know about robotics technology used in our society? How much do you know about robotic technology used in the service sector, in particularly in hotel / restaurant / airport sector in Hong Kong or in other countries?
- 2) What are the perceived benefits and opportunities of adopting robotic technology in a hotel / restaurant / airport?
- 3) What are the perceived "costs" or challenges of adopting robot technology in a hotel?
- 4) What do you see the role of government in the application of robotic technology in tourism industry? How would you like the government to support or facilitate future

application and implementation of such technology through public policy formulation?

Table 1: Information of interviewees

No.	Code Name	Gender	Job Title	Work experience (Year)	Hotel Star Rating	No. of Hotel Rooms	Category	Sector
1	H1	Female	Operations Manager	19	5	32	<i>Less than 300 rooms</i>	Hotel
2	H2	Male	Group Hotel Manager	18	3.5	158		
3	H3	Female	Rooms Operations Manager	19	5	170		
4	H4	Male	Assistant Front Office Manager	15	4	196		
5	H5	Female	Director of Rooms	12	5	262		
6	H6	Female	Director of Front Office	20	5	300	<i>301-500 rooms</i>	
7	H7	Male	Front Office Manager, Hotel Operations	22	4.5	400		
8	H8	Male	Corporate Citizenship Manager	10	4	420		
9	H9	Male	Rooms Division Manager	15	4	430		
10	H10	Male	Director of Rooms	21	5	432		
11	H11	Male	Resident Manager	19	5	471	<i>500+ rooms</i>	
12	H12	Male	Front Office Manager	22	4	500		
13	H13	Female	Rooms Division Manager	20	4	508		
14	H14	Female	Front Office Manager	10	5	562		
15	H15	Female	Assistant Front Office Manager	7	3.5	618		
16	H16	Female	Resident Manager	11	4.5	658		
17	H17	Male	Front Office Manager	7	4.5	1171		
18	H18	Male	Deputy general Manager	10	5	1608		
19	R1	Male	Director Of F&B	19			<i>Fine dining</i>	Restaurant
20	R2	Male	F&B Operations Manager (Western Cuisine)	16				
21	R3	Male	F&B Operations Manager (Chinese Cuisine)	25				
22	R4	Male	Assistant Director of F&B	9				
23	R5	Male	Assistant Food & Beverage Manager	16				
24	R6	Female	Senior Manager, Hotel Food and Beverage	16				

25	R7	Male	Executive Chef & F&B Manager	25	
26	R8	Male	Director of F&B	18	
27	R9	Male	Director of Food and Beverage	33	
28	R10	Male	Food & Beverage Manager	17	
29	R11	Male	Director of Restaurants	12	
30	R12	Male	Assistant Director of Food & Beverage	14	
31	R13	Male	Area Operations Manager	25	<i>Casual dining</i>
32	R14	Female	Central Operations Manager	11	
33	R15	Male	Senior Operations Manager	25	<i>Fast food</i>
34	R16	Female	Area Operation Manager	5	
35	A1	Male	Manager, IT (Planning and Innovation)	11	Airport

Each interview lasted for 45 to 90 minutes. The interviews were conducted in English or Cantonese as preferred by the interviewees. All interviews were audio recorded given consent from the interviewees. To avoid misunderstanding caused from translation, all interviews were transcribed and analyzed in original languages; key findings were then translated into English for report writing. Academics who are professional in both Chinese and English were invited to check the accuracy of translations.

4. Research Findings

To answer the first three research objectives, a framework has been developed based on the analysis of findings and the reference of the Value-based Adoption Model (VAM) (Kim et al., 2007). As shown in Figure 1, interviewees have different levels of awareness and knowledge about the robotics technology in tourism industry in Hong Kong. Their perceived benefits of robotics technology can generally be classified into internal benefits which relate to employees and operation efficiency, and external benefits which relate to customers. The perceived sacrifice (challenges) of robotics technology includes technicality which relates to technical problems of robots, and perceived costs which relate

to the investments and risks of robot technology application. In addition, various recommendations have been proposed by interviewees for the Hong Kong government for future application of robotic technology, which answers the fourth research objective.

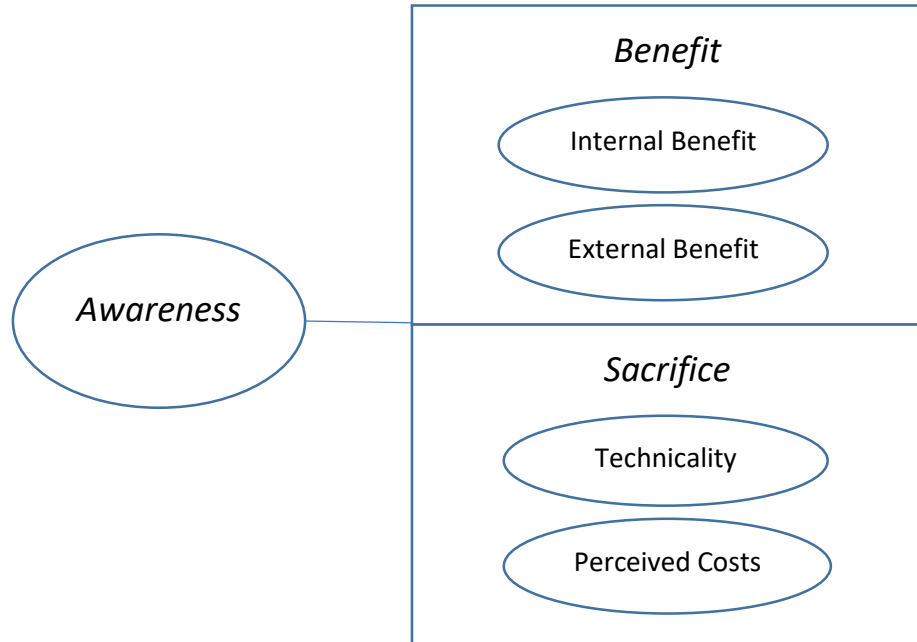


Figure 1: Framework of research findings

4.1 Level of Awareness and Knowledge

The level of awareness and knowledge of interviewees can be identified as limited, medium and high. Most of the interviewees only have limited knowledge of robotics technology. They have never seen a real robot but heard about it from websites, social media, newspaper / magazines, TV programs or friends. They are aware that service robots have been applied in operations in mainland China and in other countries such as Japan, United States, and Singapore. Some of them are confused about the concept of robotics technology and cannot differentiate it from information technology. However, some interviewees have clear understand of robotics technology because they are very interested in it, although they haven't seen a real robot.

R8: I don't know much about robotic. There are automatic scanners in Thailand airport. There also hotels doing automatic or self check-in. I don't know if it's qualifies as robotics technology.

R3: Because I have not seen a robot, I don't know what the benefits or challenges are. I cannot imagine.

H7: When I heard the term “robotics technology”, I think it should be used most frequently in medical area, such as surgery. I searched on YouTube and found that Japan and USA already started use robots in hotels.

H2: I'm very interested in robotics technology and I believe this is the trend for the future. I spend lots of time searching related information on the internet. I think a robot is an object that can move, can answer questions based on stored information and perform specific tasks via voice command. In my understanding, robotics technology is a technology that utilize mechanism to reduce human workload, enhance efficiency and accuracy. Manufacturing industry often use mechanical arms for assembling. However, the technology of service robots in hospitality industry is still not sophisticated.

Interviewees who have actually seen a real robot are considered to have medium level of knowledge of robotics technology. They have seen robots in hotels, restaurants or other public locations and some of them have simple interactions with a robot. They attend workshops, exhibitions or fieldtrips to collect information about robotics technology. The interviewees have different feelings about the experience. Some think the robot is just decoration and not interested to have further interaction while some think it is an interesting experience to interact with a robot.

H10: I've seen once in HK immigration department near Sheung Wan. A robot stood there for providing information. But it was not so practical that people still queued up in front of the staff counter. I didn't have any interaction with the robots. I think it's a bit like decoration. It just gives some information in a robot style or format. It's still using the TV screen in front of the robot.

R6: When I went to a business trip in Shanghai, I lived in a hotel which uses robots to deliver amenities. I required a comb and a chubby robot delivered to my room in two minutes. It said “Hello” when I open the door and said “Goodbye” after I took the comb. I felt surprised at that moment. I feel positive towards service robots and I think it’s a new channel to provide service in the future.

H14: Our hotel pays close attention to information about robotics technology. For example, I have attended the Smart Hotel Exhibition organized by Hong Kong Hotels Association this year. Various technologies including robots were introduced to tourism practitioners. I think this kind of event is very useful.

H18: As one member of the senior management team, I participated in a fieldtrip to visit Alibaba’s FlyZoo Future Hotel in Hangzhou, China. From checking in, delivering food to room service, all the jobs in this hotel are provided by robots and face-scanning computers. However, my Mandarin was not accurate that it took me quite a while to order room service. I think the whole experience was very interesting.

Three interviewees are considered to have high level of knowledge of robotics technology. H11 frequently uses robotics technology and believes that robots will replace human labor in hospitality industry someday in the future. R15 has seek cooperation with universities and Research & Development companies to introduce robotic arms for restaurant operation. A1 holds a bachelor degree in computer science and leads a team to design robots for airport operation. He has rich experience of robot design and robot management compared to other interviewees.

H11: I have seen robotics technology and I have experienced it many times. It’s quite impressive, amazing and interesting. I used to work at one terminal of an airport. Everything is automatic from checking in to transporting luggage. I actually quite like it. And frankly, I don’t need people to help me take my luggage. I was in Los Angeles two years ago. In the LA airport, there was a lounge that literally replaces all humans with technology. They have an open kitchen that all the jobs from food preparation to cooking are done by robots and automation. I have also been to the flagship store of the biggest hotpot chain in Beijing, mainland

China. There were no waiters anymore. I ordered everything online, and robots delivered food to my table. I'm sure it can be done in Hong Kong as well, because this is all due to design. In addition, I think a lot of different areas in hospitality industry will be gradually replaced by robotics technology.

R15: Our company has used robotic arms in our food factory for packaging for two years. In addition, we also use cooking machines in our restaurants. We have cooperated with one university in Hong Kong to design a restaurant which integrates robots to prepare food, cook and deliver food and drink.

A1: I personally believe that we can definitely integrate more robots. There are many types of robotics technology. Robotic arms and service robots are the technologies that we can apply on many occasions. It is mainly because the computer power has been much stronger and artificial intelligence technology has been developed to a higher level. The application of multiple technologies enables robots to have more functions with higher efficiency. Since 2015, we have been thinking about what innovation is. Robotics technology was identified as one of the important aspects. So I began to attend different conferences in the world, especially in Japan, to collect information about robotics technology. However, most of their robots are designed for office or factory purposes, so we started to design robots for airport operation. We have already successfully design three robots for patrolling, inspection and delivery, and one driverless car for luggage transportation.

4.2 Perceived Benefits and Opportunities

The perceived benefits and opportunities of robotics technology by managers can be identified into two aspects: internal benefits and external benefits.

4.21 Internal benefits

The internal benefits are redressing labor shortage problem, ensuring consistency of service quality, enhancing operational efficiency, avoiding human labor problems, and reducing human labor's workload.

4.211 Redress labor shortage problem

Almost all interviewees mentioned that labor shortage problem has becoming more and more severe in tourism industry. They are searching for solutions to address this problem and robotics technology is one of the direction. Some of them already apply information systems to manage customer information. They agree that robots can be integrated into different areas to help redress labor shortage problem to some extent.

H5: Hotel staff need to work 24 hours seven days, robots may be a good alternative of human labor for the overnight shift because many employees don't prefer working in that shift. Robots can replace bellboy to greet guests, check-in, allocate room keys, deliver luggage and escort a guest to the room. Robots can also deliver amenities such as a towel, or a bottle of water. In addition, it is possible for robots can help in housekeeping, especially cleaning, because it is very difficult to recruit room attendants. However, I think delivery is the most potential position can be done by robots in current technology.

R2: We are facing severe problem of labor shortage in restaurant, especially stewarding. Robots can work in back of house, such as stewarding, washing dishes, or preparing food.

4.212 Ensure consistency of service quality

Unlike human labor, robots can ensure consistency of service quality especially for standardized positions, such as food labeling, packaging, food preparation and facility control.

R15: Integrating robotics technology in back-of-house has the biggest potential in Hong Kong. For example, robotic arms can label production date and food ingredients information on the package. The benefits of using robotic arms for labeling are more consistent, more accurate, more efficient and less costs.

H11: It's easier for me manage robots than human labor because robots are more consistent. Once it's set, it's set. It can provide service on time with the same quality. Although robots might have technical problems sometimes, I can always call someone to fix it; and once it's fixed, it's fixed. So I think the consistency is very good.

4.213 Enhance operational efficiency

Most interviewees agree that robots can do repetitive jobs in a more efficient manner. Human labor's memory is limited and sometimes make mistakes; human labor also need time to search information to answer guests' questions. However, robots can recognize guests more quickly, provide more detailed and accurate information in real time. Meanwhile, robots can collect customer information for data analysis which is useful for customer relationship management.

R4: Robots can do better than human labor when providing information because human brain has limited memory and make mistakes inevitably. A robot can provide more accurate and sufficient information, such as seat numbers and the direction of washing room.

R13: Robots can store information like customer preference which can help us to improve customer relationship and provide reference for strategic planning to enhance customer loyalty.

H4: In front office, a robot can be used mainly for greeting and recognizing guests. It helps us to ensure the guest is being welcomed. It helps to improve efficiency, personalization and guest satisfaction. A robot may not have smiles but it can recognize faces and remember names. It can also remember guests' preferences. For our regular guests, it may remember that he / she prefers extra towels in room and get this ready upon their arrivals.

A1: Robots can remember more comprehensive information and provide answers more quickly. Human has limited memory. Although we have prepared many cue cards for them, they not always can provide a good answer. Unless they are very familiar with the airport, otherwise they cannot remember all the information. For example, when a passenger asks information about flight CX123, a staff usually need to check computer system to find related information. However, a robot does not need time to search. It can provide flight information to the passenger immediately. It is a very good real time response. In addition, robots can do facility inspection more efficiently than human labor. Airport is a too big that it's easy for human to feel tired when doing the facility inspection. However, a robot will not make mistakes; it can identify problem and fix the problem via

controlling system. We have integrated robots for patrol and facility inspection for several months and we are satisfied with their performance so far. In this case, robots are the most efficient.

4.214 Avoid human problems

Some interviewees mentioned that the integration of robotics technology can avoid problems of human labor, such as occupational injury, complaints, emotional issues, sick leave, etc.

H18: We are not using robots for cutting costs, because robots are also not cheap. The best of robots is that it can help to avoid occupational injury. For example, the mattress of our hotel is very heavy. Many room attendants have wrist sprain or back injury while doing housekeeping because they need to lift the mattress up. Some employees resigned because of this. Now we have signed a contract with a robotic arm's company to solve this problem.

R5: The benefit of using robots to wash dishes and prepare food is less occupational injury. Although machines can also break down, it is better to hurt a machine than a human.

H7: A robot is more consistent, especially in the aspect of emotion. It does not have emotional problems and will not affect other employees.

R2: It is good that we don't need to buy insurance for human labor, and we can also save the costs of staff benefits if using robots. Robots will not ask for sick leave.

4.215 Reduce employee workload/fatigue

The most potential positions for robots are dangerous, dirty, dull and boring. These tasks are repetitive by nature, highly standardized and usually no direct contact with customers. If robots can replace human labor to do these jobs, it can help to reduce employee workload/fatigue and human labor could have more time to provide face-to-face personal service for guests, which is considered very important for hospitality by most interviewees.

A1: We are not using robots for reduce manpower. We hope our staff can do less 3D1B jobs: 3D means Danger, Dull and Dirty; 1B means Boring. It can help to reduce human labor's workload by using robots. Airport is too big that it is easy

for human to get tired and strain. Robots are now helping us to do petrol, facility inspection and delivery. For example, there are many washing rooms in the airport and the toilet paper need to be replenished in time. The necessary toilet paper is usually very heavy in large amount. Robots can help to deliver toilet paper in this case. In addition, robots also help to transport passenger luggage from the airplane to the arrival hall. It was very hot for a human to drive a car all day under the sun to transport luggage. Currently most employees are happy to work with these robots.

R4: Robots can help to deliver furniture such as tables and chairs in the restaurant. The restaurant's furniture is usually quite heavy that it is difficult for human labor to move around. Employees will ask me to buy some facilities to reduce their workload. Therefore, if robots can help would should be very happy.

R12: Robots can replace human to do aversive jobs in restaurant. For example, stewarding department has the biggest problem of labor shortage. Employees need to wash dishes which are sometimes heavy, and usually have to use chemicals to wash floor. The working environment is also humid and hot. Most people deem that the jobs of stewarding are low-class. It is also difficult to hire waiter / waitress because people nowadays have higher education and not willing to do repetitive tasks, such as drying dishes, folding napkin, and counting linen. These jobs actually can be done by robots.

4.22 External benefits

External benefits include enhancing customer experience, meeting the needs of new generation guests, and adding value to marketing.

4.221 Enhance customer experience

The integration of robots can provide entertainments / fun / joy for customers and thus improve customer satisfaction.

H8: We have used robotics technology to support customer experience. It can provide surprise and magical moments, and out-of-expectation experience to customers. Guests, especially children, feel freshness and engaged when interacting with robots.

R6: Robots can do reception in the restaurant to greet customers. It is simple but provide fun to the customers. I don't think it's a gimmick. The first impression is very important. If customers received a warm or fresh greeting, it would be a very good beginning for their dining experience. In this case, robots can be better than human. Because it is still not easy to train an employee to smile all the time for greeting customers, programing a robot would be much easier.

4.222 Meet the needs of new generation customers

The preference of new generation customers, e.g. Generation Y and Z, are different from the older generation. While older generation prefer to talk to hotel staff, younger generations would rather stay alone and do not like to be interrupted. They do not care about who deliver the service but get what they want in time. In addition, business customers also have not much time to communicate with hotel staff because they usually attend meetings or conference in the daytime and only sleep at hotel room at night. In these cases, robots could be a good option for service delivery.

R6: Luxury hotels can consider to integrate robots to meet the needs of customers. Business guests are more concerned about the rating of hotels, however, they only sleep at hotels at night and will not have much time to talk to hotel staff. Service robots might be welcomed by this kind of customers.

H11: I think at the end of the day service is about the delivery of what you expect. For example, if I sit here and I want a glass of warm water. To be frank with you, I don't care whether it's delivered by a human or a robot. I think that's how the young people see nowadays. I think they ignore about whether the person smile at you or whatever, they don't care about that. They only want their water.

4.223 Marketing values

Robots can be a gimmick and attract customers' attentions. It can contribute to branding, public relation value and enhancing company image.

R1: Robots help us to deliver food and the biggest benefit is to attract the customers. Robots can also sing birthday songs when required by customers. Customers think this experience is very interesting because they haven't seen any other similar in Hong Kong. This is how we differentiate ourselves from other restaurants.

A1: In 2016, we introduced the first service robot, Pepper from Softbank, into public service in Hong Kong. The purpose is mainly for branding and marketing by greeting customers to provide fun experience. The biggest benefit of a robot is it can draw people's attention. It is a very effective way to do retailing marketing / promotion. For example, if we want to promote a certain product, a robot would stand beside, point to the product and take photos with customers who are interested.

H16: Robots can work as an ambassador in the hotel lobby to welcome guests and provide information. It could be a gimmick to provide fun experience to customers especially kids.

4.3 Perceived sacrifice and challenges

There are two aspects of sacrifice / challenges of robotics technology perceived by interviewees: technicality which relates to technical problems of robots, and perceived costs which relate to the investments and risks of robot technology application.

4.31 Technicality

Technicality includes lack of updated information, space & infrastructure limitation, lack of local IT support, lack of advanced technology, the balance between human labor and robots, and the acceptance of current staff.

4.311 Lack of updated information

Most interviewees mentioned that they lack information about the latest development of robotics technology, and details of suppliers for related products although they are interested in the robotics application. They can only search related information via internet, social media or attending exhibitions. The information channels are very limited. Limited

information about types of robots and scarce information about vendors offering service robots are big challenge in the initial phrase for most interviewees.

R14: There is no platform promoting robotics technology application in catering in Hong Kong. This concept sounds very strange to me.

H1: I don't know where to find information because there is not much application in Hong Kong. I would not know a robot can do so many tasks if I did not participate the robot introduction meeting of our company.

H5: We want to apply robotics technology in our hotel operation but we have to find suppliers by ourselves. I searched online, identified potential suppliers and contact them for a trial. I knew a hotel in Singapore using robots and I emailed them for detailed information; they did not reply me however.

H2: Actually there are already many robotics technology products in the market, such as facial recognition; however, no such suppliers take the initiative to contact us in Hong Kong. It is a challenge for us to find them.

R15: There is no suppliers take the initiative to seek partnership. We have to find the suppliers or vendors all by ourselves to get related information.

4.312 Space and infrastructure limitation

Hong Kong is a city with limited space, which is considered to be a major challenge to integrate robots into operation. The size of robots is usually big that it is difficult for them to walk through narrow aisle of hotels or restaurants or kitchen. In addition, the current infrastructure of hotels or restaurants are not compatible with robotics technology and it would be a big challenge to upgrade the current infrastructure such as the lift.

R4: We have tried to use a vacuum cleaning robot in the ballroom. However, the robot was too big to work inside the ballroom. Our staff have to clear tables and chairs for the robot to work. The space is too small for the robot. Due to its huge size, we could not use the cleaning robot on guestroom floor as it block-up the corridor.

H5: We wanted to use a robot called Konica for delivery, however, it did not work because except the robot itself, many infrastructures need to be fully utilized. For example, many sensors need to be installed inside the lift otherwise the robot cannot take the lift by itself. Most of the robot hotels are newly opened but it is difficult for us to fully utilize a robot unless completely renovating the current infrastructure.

4.313 Lack of local IT support

Compared to mainland China and other countries, there are very few suppliers of robotics technology in Hong Kong. The application of robots need local technical support from installation, modification to maintenance. Some interviewees complained that no company in HK to provide the needed technical support or/and maintenance service which reduces their intentions and motivations to install and integrate robotics technology into their workplace. In addition, IT companies in Hong Kong are usually hard to sustain for a long time due to many reasons such as high rental costs. After sales service cannot be guaranteed which increases the risks of industry customers.

H18: Why robots can work in mainland China but not in Hong Kong? The most important reason is there is almost no strong IT companies in Hong Kong. Robots can only be a gimmick because lack of local IT support. Hong Kong must have a big corporation that is strong in information technology so as to cover all the aspects from research & development, production, installation to maintenance. The whole system of Alibaba's FlyZoo Future Hotel is all developed by Alibaba itself from reservation, checking-in, facial recognition to online payment. If we want to install the facial recognition system to the lifts of our hotel in Hong Kong, we have to buy the whole system from Alibaba. Otherwise, it is difficult to find a local company to do this. Nowadays it is already not easy to require a lift company to install a CCTV inside the lift in Hong Kong. Companies from mainland China are much easier to deal with than local companies in Hong Kong.

R15: Technology companies in Hong Kong are not easy to sustain. For example, one company was very confident towards their product, a meal ordering system, and sold it to the airport. However, the usage volume of airport was too big that

the system broke down because it was not well developed. Not only the airport, other companies using the same database cannot use the system.

4.314 “Unintelligent” Technology

Most interviewees concern that the existing robots available in the market are not “intelligent” enough to provide service that meet their standards. A robot only can operate in a specific area in specific conditions or otherwise cannot work. Most of the time a human labor still need to assist guests to use robotics technology due to low level of user friendliness. Most importantly, as mentioned by the interviewee from airport, the biggest problem is language. Due to the structural complexity of Hong Kong Cantonese comparing to most commonly used English, no language system/programme is sophisticated enough currently on the market that can allow robots to communicate effectively with the local Hong Kong people.

H5: The robot we used can only work on one floor of our hotel because it does not know how to take the lift. One hotel in Hong Kong already used self check-in but received many bad comments. The machines always show the sentence “Please contact the staff, no room available” because the machines do not know how to allocate rooms. Therefore, machines are not as effective as human labor because the technology is not intelligent enough.

H16: Actually mobile key has been very popular around the world. We talked to some hotels that already use mobile keys for the usage experience. Based on the feedback from operation and customers, not all people would like to use mobile keys because low user friendliness.

H18: My pronunciation of Mandarin was not accurate that the robot did not understand me. I have to repeat my instruction over twenty times to require a towel.

A1: The language technology is not feasible yet. All robots based on the NLP technology cannot be used in Hong Kong. This is the major weakness. Similar to Singapore, people in Hong Kong like to speak mixed language: there is both Cantonese and English in one sentence. Actually, it is difficult to find vendors providing Cantonese language system already. Robotics technology in mainland

China is developed based on mandarin; although they also have Cantonese version, it is based on Guangzhou Cantonese which is different from Hong Kong Cantonese. Therefore, it is indeed a big challenge for a robot to communicate effectively to human.

4.315 Maintain a balance between human labor and robots

Most interviewees deemed that robots cannot replace human because robots are programmed and not as flexible as human. Robots can only perform one specific task of a whole working process while human can do multiple tasks which are more flexible. Robots are reactive to customers' demand while human staff can be proactive to customer needs and predict before customers' requests. In other words human can provide extra service that is beyond customers' expectation while a robot cannot. Most importantly, human service can be felt as "warm" while robotic service is considered as "cold".

R13: A human labor can do multi-functions while a robot can only do one specific task. If a robot break down, the whole process has to stop. However, a human labor can learn to do different tasks and much more flexible.

H7: The biggest difference between human and robots is human labor can provide surprised, personalized and flexible service, while robotic service is preset. For example, when a guest swatting mosquitoes beside a swimming pool, a staff would give a bottle of mosquito repellent to the guest. A robot most likely would not do that.

R6: We aim to provide a good memory to our guests when they leave our restaurant. Human service with warm voice and eye contacts would be more impressed by guests. The whole dining experience would be incomplete with a stiff tone of robot with no eye contacts. Although a robot can replace human to do many things, I doubt that whether robotic service can enhance customer loyalty or the intention for future visit. Robots can provide standardized service, but human can provide service beyond expectation. It is not service without human.

R10: I think the biggest challenge is about service. Robotic service has limitations. We might use a robotic arm to cook, but we cannot guarantee the quality. Especially Chinese food, a robot cannot cook as good as a chef.

R1: The robot can only do part of the service but the customer doesn't pay for part of the service.

4.316 Gain acceptance by all current staff

It might be difficult for all current staff to accept robotics technology due to various reasons such as mindset, knowledge, or worries. Compared to younger staff, elderly employees might resist using machines because they are not familiar with such technology and lack of such technical knowledge. In addition, some staff might even worry about losing their jobs when robots are introduced. Therefore, training and communication are very important to allow current staff understand the benefits of robots and learn to control robots.

R9: For of all, I think the current employees have to be accustomed to work with robots. The robotics technology might be unstable or malfunctioned sometimes. It would be a big challenge for current staff to learn how to handle these situations.

H7: I think the biggest challenge for robotics technology application in hospitality industry is the acceptance of employees. Staff at different ages have different acceptance towards technology. Some employees might not know how to use new technology while some might worry about losing their jobs.

H2: The first challenge is the current staff. Frontline staff might worry about losing their jobs because the major purpose of integrating robots is to reduce human labor and related costs. There will be less job opportunities for frontline employees.

4.32 Perceived costs

The perceived costs include investment costs (acquisition and operation), security risks, privacy risks, excessive capacity risk, unemployment risk and possible risk for inconsistent brand image.

4.321 Investment costs

The decision of integrating a robot or not in daily operation is contingent upon its

acquisition and operational costs. Before integration, industry practitioners need to buy robots. The price can be very different depending on who the supplier is and whether customization of design is needed or not. It may not be very expensive but certainly not cheap. During the integration, there are likely other costs involved such as installation and infrastructure renovation. After integration, to ensure effective operation, there are costs for maintenance / upgrading and labor costs for back-up / assistant. However, it is difficult to calculate the relevant costs and benefits. The uncertain return on investment (ROI) concerned by most owners has discouraged many industry practitioners to step forward for robotic technology application.

H2: Costs are the biggest problem. It is difficult to calculate the return on investment. Because robots can only perform certain duties and when problems occur, the current employees' workload would be increased. This is hard to measure.

H16: I have discussed with my boss about whether we should launch online check-in to redress labor shortage. The answer is no. Besides the investment of machines, there are also human labor costs because human intervention is often required to ensure operation smoothness. In this case, the costs are doubled. However, this can only serve minor groups of customers.

R9: The initial investment costs are very big. We need to design the whole process and the layout of the restaurant to enable robots to work smoothly.

R7: The cost of maintenance is a big problem. For example, we have only used the dish-washing machine for less a year and there are many problems already. The operation frequency is too high and the workload is too heavy. The cost of maintenance is very expensive. So we return to use human labor to wash dishes.

R15: There are many companies in Hong Kong developing robots, but not many are willing to spend time on personalized design for clients. Some middle schools and universities organize robotics design competitions every year in Hong Kong. Some of the designs are really good. However, why these cannot apply on industry? The main reason is it needs a lot of time, money and efforts.

4.322 Privacy risk

Another concern is privacy risk. When using technology, information is very important. Lots of customer information needs to be collected / stored such as finger prints and facial recognition before or during the process. Privacy is rather sensitive in Hong Kong than in mainland China. Therefore, this is one of the main reason that technology development in Hong Kong is lagging behind than in the mainland China and in other countries.

H4: Privacy security could be a concern because a robot or systems could be hacked for data or controlled by others.

H18: Privacy is an important issue because lots of customer information need to be stored in the system.

A1: There are two cameras in our petrol robots and many passengers ask about the purpose of the cameras. Privacy is a very sensitive issue now. Especially European passengers, they would require us to delete their pictures in the database. Actually we do not take pictures, we only store data of facial characteristics.

4.323 Security risk

Interviewees who have visited robot hotels pointed out that it was not feeling safe because everybody can enter the hotel. The safety of guests' belonging is also not guarantee when a robot helps to deliver luggage to guest rooms because sometimes there are valuable belongings inside the luggage. It is concerned by some other interviewees that a robot might accidentally hit the guests especially children when a robot is working.

H1: It is not suitable for a robot to deliver luggage because there might be valuable or fragile items inside the luggage. Some guests might also forget valuable items in their rooms, which might not be noticed by a robot. Robots should better do tasks with low risks so that guests or hotels would not suffer possible lose.

H16: Most of our event guests have big luggage. Our staff have to take the luggage very carefully because we don't know what is inside. So I don't trust a robot to deliver luggage safely.

To ensure safety, a robot has to “operate” slowly. However, this would decrease operational efficiency, which is considered as one major benefit of the use of robot.

R4: We have tried to use a robot in the banquet to make cocktail for the guests. All kinds of spirits are prepared at the back of the robot. For safety concerns, the robot works slowly. However, there are too many guests in the banquet that the operation efficiency is low. It costs 45 seconds for the robot to make a cup of cocktail while human labor can pre-pour many cups which is much faster.

H5: We have tried a robot at the guest floor. For safety concerns, it “walks” slowly at the aisle. However, the robot is too big that it blocks the aisle that many guests have to follow it.

A1: Transportation speed is usually what we concern. To ensure safety, a delivery robot is designed to walk as slow as a human. However, customers would prefer the delivery as quickly as possible. Therefore, it is a challenge for us to ensure safety and service efficiency at the same time (e.g. deliver a meal to a customer at the boarding gate within 15 minutes).

4.324 Excess capacity risk caused by robotics

While low operation efficiency is a concern for service robots in the front line, the high operational efficiency of robots in the factory has caused problem of excessive capacity due to insufficient demand.

R15: Excess capacity is a problem of using robotic arms for production. Without a certain level of demand, it is not economical to use robotic arms. To meet to goal of cutting costs, the robotic arms have to keep working for 24 hours. However, there is no such amount of demand in Hong Kong to consume the products produced by robots. Actually the problem of excess capacity is very serious in mainland China. For example, I have visited a factory in Qingdao. They invested 22 billion to build an automatic factory that produce 240 thousand dumplings per hour. They have to keep looking for buyers for the dumplings.

4.325 Unemployment risk

Unemployment is another consequence caused by robotics technology application. Many people might be jobless especially in tourism industry. It is a challenge for the government to find solutions for these people.

H11: I think more towards the human side is--we all know that in very advanced countries, the population is really declining a lot, like Japan. You already see the huge decline simply because of technological advancement. So I think the biggest problem that will face is that there will be lots of people becoming jobless because a lot of jobs have been replaced by machine. Even jobs like doctors, surgeons, they're being replaced by different kinds of new technologies. It's quite a gloomy picture to think, right? But that's how I see.

4.326 Potential risk for inconsistent brand image

Many interviewees mentioned that the application of robotics technology needs to be consistent with the hotel/restaurant's brand image. If a luxury hotel integrated robots to provide service, it might harm this hotel's brand image of personalization. The "cold" service of robots also is considered not matching with the "warm" service of hospitality and catering industry which most people normally associated with. Therefore, many interviewees agreed that robots are more suitable for budget hotels whose guests do not have high expectation on personal service but more on efficiency.

H14: Our brand is more focused on human. We would always consider the benefits / feelings of our customers and employees before launching any new strategies. Therefore, if the goal is to make customers and employees happy, we would not use technology to replace human to solve problems.

H10: The core value of our hotel is human touch. It would be difficult for the hotel to gain good reputation if we overly using robots to deliver services to guests. It'll be difficult to control the robot also. I'm sure there are more and more new hotels opening with better hardware than us. They have more advanced technologies. It's hard for us to catch up. We are always proud of providing a "human-touch" service. That differentiates our hotel. If we use robots in most of the areas, how can we prove ourselves is better than the others?

H8: The biggest challenge is public perception towards our brand. Our brand aims to provide excellent service, and personal service meets the expectation of our customers. Therefore, we would not integrate robots into our service operation. We would continue to provide personalized service through human interaction.

*H6: Personal service is an important part of luxury, which is our selling point.
Robotics service does not match with our brand value.*

5. Policy Implications and Recommendations

The ultimate aim for building a smart city is to improve and make the lives of local citizens easier, more secure, more efficient and more fulfilling. However, to successfully develop a smart city is more than just bringing together various digital technologies such as digital sensors, Internet of Things, artificial intelligence or even smart infrastructure. Apart from the needed provision of financial budget by the government, the intricate integration among financial resources, physical assets and digital technologies are the keys to success. To facilitate smooth and sustainable progress of such integration, the relationship between the government authorities and the private sectors is critical. A thorough understanding on the needs and challenges from the industry's perspective therefore is vital for the formulation of effective policy by the government who must make deliberate efforts in creating such environment.

Based on the perceived challenges and after taking the views of the industry practitioners, the following recommendations are provided for the Hong Kong government to better support and facilitate the future application of robotic technology through various areas in terms of education, funding support, promotion, demonstration, liaison, and policy formulation.

5.1 Provide Relevant Education

The trend of robotic applications in the hotel, tourism and restaurant industries is rather promising in the near future. Lack of technical expertise is one major complaint in the industry. The government could consider facilitating appropriate educational training from basic to advanced level courses offered in tertiary institutions related to information

technology, artificial intelligence or robotics technology. This can help to ensure a continuous supply of local IT talents for tomorrow's workforce, whether in researching, in technical design or in support services. To achieve this end, a long-term strategic plan could be in place to attract qualified scholars/experts around the world to come to Hong Kong to cultivate future skilled personnel as needed. At the same time, the public should be well informed on the long-term vision and direction of the government in smart city development. They need to be educated on the potential and challenges of robotic application given today's technological progress. This would allow industry practitioners to better embrace robotics technology and be open-minded. It is critical that the support from hotel owners and senior management are sought before contemplating the application of robotics technology in hotels. It is common that these people have limited knowledge on the technical capabilities and potentials of robots when applying in the operations, thus it would be useful to establish labs or workshops to showcase how robots can provide benefits to their business.

R1: The first step is to set up open schools for training, to educate new high-tech people who specialize in those sectors and can be the main employees / leaders. I believe if robotics technology is the trend it might need a lot of engineers. We might need people who are specialized in robots for restaurants, hotels, or airport.

A1: The support from senior management is very important if a company wants to integrate robotics technology. However, the imagination of most senior management is usually limited. Therefore, we set up an innovation lab (show room) at the airport to show one or two robots. Senior managements can visit the lab and know more about the capabilities of robots. They will then introduce to their companies if they are interested.

5.2 Provide Funding support

Funding support provided from the government is a consideration to address concerns on investment costs from the industry. First, it is suggested by the interviewees that government could consider funding support for local companies specializing in robotics

technology. This can help local suppliers to develop and sustain especially the high rental charges of offices in Hong Kong, which is often a big challenge to newly start-up companies in particular. Most importantly, the price of robots would decrease due to lower costs of research and development. This could motivate industry practitioners to integrate robots into their daily operation. Similarly, the government could also support universities that are doing research related to robots, both financially and administratively in terms of the recruitment of overseas' scholars who have relevant knowledge and experiences. Due to the complexity and uniqueness of Chinese/Cantonese language structure, the development for Chinese/Cantonese language processing related software is particularly needed for widespread future application of interactive robots in the tourism sector. The funding could also be made available for application by the private sector if justification could be made that the final product would bring benefits to the whole industry. Such offer would be seen as a gesture of incentive especially to those companies who would like to experiment but financially may not be viable to take the risk. Lastly, it would be worthwhile to consider if government can provide funding support / subsidies / bonus for hotels / restaurants that integrate robotics technology that are backed up by a transparent and rigorous selection and monitoring mechanism. Cautious should be made to ensure the industry is not abusing such opportunity for private gains.

H11: I think for government, the first thing is to show support, that's for sure. I would say funding in terms of the R&D for certain government agency or even the HKHA, the Hong Kong hotel Association. I don't think it's conflict with private companies. I don't see it as a competition but more an encouragement. And the best way to do it is to fund the companies which are really serving the public. For example, MTR. I use it every day. There is a driver in the train from Tung Chung to Admiralty. But from Admiralty to Ocean Park, the train is driverless. I think the next one the government can provide funding support is driverless buses. The government should start investing in all these public transportation technologies.

H5: We get the green funding from government for the two electric buses operating currently in our hotel. Government could provide similar funding to robotics technology application. Otherwise, many hotels would not consider robotics

technology because the costs are too expensive. Especially independent hotels like us, we don't have financial supports like international hotel chain groups.

5.3 Act as a Leader

The Hong Kong government could consider acting as a leader to try and use advanced robotic technology as a demonstration in its own departmental operations. For example, public facilities (e.g. library) and transportation could take the lead to integrate service robots in their daily work. This could create awareness and raise the interest of robotic application in real life to the general public, as well as provide participants with first-hand usage experience with this new advanced technology. Feedback could also be provided to the government and the product designer for subsequent product improvement. Through this process, the benefits and weaknesses of robots in operation can better be observed by tourism industry practitioners which are very useful in determining how such technology can benefit their business before committing heavy investment. By the government itself acting as a “launching customer”, such experiences may even stimulate further innovative solutions to specific challenges. Most importantly, the attitudes and lifestyle of Hong Kong residents could gradually change when they are familiar with and appreciate more applications of robots. This could make it easier for the general public to accept and even welcome robotic services in hospitality and tourism industries.

R12: I think the government could integrate robotics technology in public libraries as a demonstration. The library service nature is similar with hospitality service. This could increase the confidence of hospitality industry to apply robots.

A1: Government should act as a leader in the aspect of robotics technology application. If government does not take the lead to tackle the problem of language processing, it is difficult to apply high technology platforms, such as Amazon Elixir, Google Home or Tmall Genie, on our daily life. Then it is difficult to realize the vision of smart city.

5.4 Launch Product Promotion

To address the lack of product information experienced by the industry, the government could launch more promotional events (e.g. exhibition, conference, trade show) about robotics technology to introduce up-to-date technological developments and products. The government can serve as a coordinator between relevant technology suppliers and various industry practitioners in one platform to showcase their latest offerings. In addition, experts could assess products or technologies that are likely to suit the Hong Kong environment. This could provide industry practitioners with information so they can better select the technologies and products that suit their businesses.

H10: for promotion, there can be more exhibitions and introductions. Government should take to lead to introduce robotics technology to the hotel industry, what you can do and what you should do, give us some guidelines, rather than nowadays we are just finding out in our own ways, to make the change. It would be quite difficult for the hotel itself. Giving us some direction on which approach we can head towards, and then take the lead. That would be much easier for us to explore further.

R8: Government should share / promote the best practices of hotels in other countries to make the industry operators aware of the robotics technology available; the HK government can share with Singapore / USA / Japan government to provide certain robotic products and provide more opportunities to involve, because we don't even know about it, we don't know these things exist.

5.5 Liaise Partnership Formation

Apart from introducing suppliers, the Hong Kong government could also act as a liaison to encourage partnerships or cooperation between local IT companies and overseas or mainland Chinese companies. Robotics technology has advanced in other countries such as Japan, Singapore and United States. Technology companies from mainland China (e.g. Shenzhen) are also developing service robots. To facilitate this, the government could consider the regulations required for new business models to establish with foreign partners.

Incentives of different kinds, whether financially, regulatory or infrastructural, could be considered but at the same time to ensure the interests of the Hong Kong citizens and users of the city are well protected also.

H4: If the government confirmed the direction of robotics technology, they need to do more marketing to encourage partnership between overseas companies and local companies to develop high-tech technology.

A1: I think encouraging technology business is more important than providing funding. There are many good IT companies in mainland China. How can the government attract these companies cooperate with local companies in Hong Kong? I think this is very important because we need local support. The government should act as a liaison to line-up strong IT companies from mainland China or overseas with local companies in Hong Kong, and provide service to industry practitioners.

5.6 Establish Supporting Policies

The Hong Kong government could consider policies to specifically cater to regulatory challenges that may emerged from robotics technology such as the ethical and security issues from by robotic applications in the commercial world. This may involve setting new standard in design, manufacturing, programming and operation, as well as taking measures to make sure the robotic applications are safe and ethical. On the other hand, as more and more jobs are expected to be replaced by more sophisticated robots in the near future, the government could also establish relevant supporting policies to enable labor mobility to other employment sectors. This could be in terms of bridging the skill gaps for employees who are working in traditional industries to transform their skill set in which “new” industries can absorb. Ultimately the government could facilitate a suitable environment in which new businesses and smart solutions can emerge and grow.

H11: The government can come up with policies and laws relating to the use of technology. I think this should not be overlooked. When all the social media came out like Facebook or Twitter, government was actually didn't have a very good

control on it. There are a lot of loopholes and gray areas. It's all happening right now. In the future, if I'm hurt or injured by a robot when visiting a restaurant, who will be liable? Would the property be liable, or the company of the robot? or is this my own bad luck?

A1: Government should be more open minded in the policy formulation. Technology is a double-edged sword. It will create some new business while disrupt some traditional business. The government should consider how to balance through policy formulation in this process.

6. Conclusion

The competitive environment in the hospitality and tourism industries is expected to continue and become even more intense in the coming years. Hotel and restaurant owners/operators in many destinations are confronting the challenges of attracting the younger generation to work in operational areas. The advanced development of robotic technology naturally draws considerable attention in recent years and provides a possible way to solve labor shortage problem and lower overall staffing cost. While the application of robots in operation could improve work efficiency and quality consistency, and help to reduce human fatigue and possible injuries, its values appear mainly confined to operational work which are repetitive and predictable by nature. The actual potential of robots in higher-level work or how effective such technologies can be applied in various aspects of work remains largely ambiguous to many industry practitioners. The lack of appropriate and useful information channel implies most robotic adoption decisions mainly rest on the own efforts of senior managers or owners to do their own research. While the power of sophisticated technical capabilities of advanced robots may not always be realized in the industry due to limited knowledge and experiences, what can be observed is that innovative technologies could potentially create positive marketing impact and enhance a company's image especially to a new generation of customers. This sends an important message to management in tourism and hospitality industries that embracing advanced technology is crucial to innovation and competitiveness in today's digital era.

In contrary to innovation, traditional belief of "human-touch" in high class service is still perceived by many industry practitioners in Hong Kong as "essential" and should never be replaced by service robots, though such view tends to be less persistent for a younger generation of management staff. It is generally believed that robots can and should mainly assist back-of-house tasks which do not have direct interaction with customers. The senior managers' trust towards robots is relatively low because they think the technology is not "intelligent" enough to meet their requirements. To some extent such belief are influenced by the presence of negative publicity materials or past experiences of robot usage including

mechanical faults, inflexible and cumbersome maneuvering, unsuitable infrastructure design and inability to communicate effectively with humans. The current state of robotic technology is still a long ways from completely “substituting” human workers in service sectors; yet one should not underestimate the enormous potential of artificial intelligence. Together with the advancement of cloud technologies, perhaps it would take less time than expected for a robot to accomplish “creative” and complex analytical tasks which reflects a domain of middle management in an organization.

The tourism industry at large is one of the major pillars of the Hong Kong’s economy, making substantial contributions both to the GDP of the economy, employment and business opportunities. To develop and transform a city to a smart city, “smart tourism” is a crucial piece that cannot be overlooked. Such development involves heavy investment in infrastructure, advanced technologies in communication and data analytics, and co-operation among many commercial stakeholders in different shapes and forms. The Hong Kong government therefore could take a leadership role to stimulate and apply innovative technologies (e.g. robotic technologies) into practice. Deliberate efforts could also be made by the government to foster a supportive environment in various aspects including legal, social, educational and financial so that local residents, local enterprises, technical experts and foreign investors are well aware of the best roles they can play to put Hong Kong into the road of success.

References

- About the Global Innovation Index. (2018, June 10). Retrieved from <https://www.globalinnovationindex.org/about-gii>
- Chen, T. P. (2016, July 25). In China, a robot's place is in the kitchen. Wall Street Journal. Retrieved from <https://www.wsj.com/articles/in-china-a-robots-place-is-in-the-kitchen-1469393604>.
- Hamstra, M. (2017). Machines for hire. *Restaurant Hospitality*, 101(5). Retrieved from <https://search.proquest.com/docview/1895300340?accountid=16210>.
- HK\$17b boost for Hong Kong's innovation and technology sector aimed at fintech startups (2018, June 20). Retrieved from <http://www.scmp.com/news/hong-kong/economy/article/1916519/hk17b-boost-hong-kongs-innovation-and-technology-sector-aimed>
- HKSAR (2018). Tourism performance. Retrieved from http://www.tourism.gov.hk/english/statistics/statistics_perform.html
- Ilic, I. & Nikolic, A. (2018). Implications of modern technology development for the tourism sector of the Republic of Serbia. *Ekohomhka*, 64(1), 37-52.
- Kim, H. W., Chan, H. C., & Gupta, S. (2007). Value-based adoption of mobile internet: An empirical investigation. *Decision Support Systems*, 43(1), 111-126.
- Law, R. Buhalis, D. & Cobanoglu, C. (2014). Progress on information and communication technologies in hospitality and tourism. *International Journal of Contemporary Hospitality Management*, 26(5), 727-750.
- LG's new airport robots will guide you to your gate and clean up your trash (2017 July 21). Retrieved from <https://www.theverge.com/2017/7/21/16007680/lg-airport-robot-cleaning-guide-south-korea-incheon>.
- Northfield, R. (2015, July 1). Robot Hotel. *Engineering & Technology*, 10(6), 50-51.

Papathanassis, A. (2017). R-Tourism: Introducing the Potential Impact of Robotics and Service Automation in Tourism. *Ovidius University Annals: Economic Sciences Series* (1), 211-216.

Sigala, M. (2018). New Technologies in tourism: From multi-disciplinary to anti-disciplinary advances and trajectories. *Tourism Management*. 25(1), 151-155.

Details of the Public Dissemination Held

1. An externally refereed conference paper entitled “Roadmaps and Challenges of Robotic Integration in Hotel Operation: The Insiders’ Perspective” was presented at the *Asia-Pacific Conference on Business and Social Science – Smart City* in Nagoya, Japan on 20-22 January 2020.
2. We plan to publish articles in refereed academic journals based on the research findings in the coming future.