

## Article

# The Analysis of Critical Success Factors for In-Town Check-In in Taiwan

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**Abstract:** The Taoyuan International Airport in Taiwan encountered service capacity bottlenecks for insufficient facilities before COV-19 break. In order to increase the service capacity efficiency on check-in, security checks, and customs clearance, the Ministry of Transportation and Communications R.O.C. (MOTC), Taiwan, rerouted the airport traffic flow by implementing the in-town check-in (ITCI) concept to decrease crowding in the airport waiting hall. This research examined the structure of critical success factors (CSFs) for ITICIs, deriving three hierarchies of three dimensions, eight criteria, and 18 evaluation indexes from the previous literature, expert interviews, and analysis results from Analytic Network Process (ANP) via Super Decisions software. The three CSF dimensions were: first-level hierarchy “advantageous environments,” followed by “marketing” and “service value,” which is a second-level hierarchy. The study concluded that the third level item of “transferred vehicles system and management” can play an important key role in ITICIs and “users’ usage preference” has a high correlation to ITCT management strategy. Those findings are expected to be a valuable reference as operating guidelines for Taoyuan Airport MRT Company and management strategy for airport companies.

**Keywords:** Analytic Network Process (ANP); critical success factor (CSF); in-town check-in (ITCI)



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## 1. Introduction

Taiwan is an island with limited natural resources yet a thriving import and export trade. According to the 2019 Henley Passport Index and Global Mobility Report published by Henley and Partners, Taiwan ranked 29th with a Taiwanese passport allowing visits to 148 countries worldwide either visa-free or with a visa on arrival [1]. Over the past decade, Taiwan initiated a policy allowing direct flights between Taiwan and mainland China, which is a policy allowing Chinese citizens to visit Taiwan, and the New Southbound Policy. These three policies resulted in a gradual increase in the volume of people entering and exiting Taiwan, and a continuous increase in the number of passengers traveling by airplane. Among airports in Taiwan, international flights between Taipei and other countries mostly depart and arrive at Taiwan Taoyuan International Airport (TTIA). It is, thus, Taiwan’s principal gateway to the rest of the world. The volume of passengers to TTIA has increased rapidly, with 42.49 million passengers, 233,801 flights, and a daily average of 110,000 passengers entering or exiting Taiwan from the airport in 2018. The volume of passengers reached 144,263 on one day during the Spring Festival period in 2017, which was a new daily passenger record level [2]. This reflects the heavy burden that TTIA carries in air transportation. In response to the constant increase in passenger volumes,

TTIA is continuing to implement an expedited plan for the expansion of Terminal 2 and proceeding with the construction of Terminal 3. In addition, TTIA is devoted to promoting passenger usage of self-service check-in kiosks, online check-in services, self-service bag drop-off, automated border control system (e-Gate), and other automated customer service delivery methods in order to adjust to civil aviation developments and efficiently meet passenger needs on arrival and departure.

As a consequence of convenient and frequent international travel, more airports are reaching capacity for passenger transport, leading to severe delays and traffic congestion at airports and jeopardizing the long-term development of the aviation sector [3]. At the end of July 2013, Taoyuan International Airport Corporation (TIAC) completed its expansion of Terminal 1, which can accommodate 15 million passengers. In addition to Terminal 1, Terminal 2, at the present time, may accommodate 17 million passengers. In total, TTIA can handle 32 million passengers, which cannot meet the current demand of more than 40 million passengers. Crowding at TTIA can be due to the formalities, such as customs and immigration inspections and clearing, and these procedures may influence or delay the arrival and departure of flights [4].

Jiang and Zhang [5] suggest airports with limited capacity can tackle these situations by cooperating with ground transportation operators in providing comprehensive shuttle services, which may decrease the volume of business demand. In addition, Takebayashi [6] indicated that the cooperation between airports and ground transportation service providers (i.e., high-speed railways), without considering bilateral operating profits, may reroute the crowds at densely-populated airports. Airports in the Asian region such as Hong Kong, Malaysia, Thailand, and Korea plan to extend airport ground access transportation to downtown and provide in-town check-in service. For example, Hong Kong International Airport, which provides flights across the world, has an annual volume of 68.5 million passengers, 22% of whom use in-town check-in service (ITCI) and the Airport Express train. Thus, it can be inferred that cooperation between airports and airport ground access transportation service providers effectively reroutes the crowds at airports.

The former Minister of Transportation and Communications in Taiwan, Jian-Yu Chen [7], initiated the “Smart Airport Project for Taoyuan International Airport,” which, after the Taoyuan International Airport Access MRT (mass rapid transit) was opened for operation, included a plan to provide in-town check-in (ITCI) in Taipei Main Station (A1 station) and establish, in addition to the counters with agents, the first kiosk for common use self-service (CUSS) along with six kiosks for self-service bag drop-off to serve as the plan of action for the current congestion at TTIA. Passengers may drop off luggage, select seats, and receive boarding passes in advance in Taipei Main Station. ITCI, more importantly, may serve around one million passengers each year, which not only relieves passenger stress while checking in at airport counters but also reroutes the passengers in the departure hall prior to the completion of terminal expansion or construction at TTIA. Consequently, Taipei Main Station of Taoyuan International Airport Access MRT would become the place for ITCI, serving as an extension for the terminals at the airport to reroute excessive passengers at TTIA. Passengers may, thus, check luggage and receive boarding passes in advance at the downtown station in Taipei and do not have to carry luggage with them when shopping in downtown Taipei or conducting business.

Whether a strategic goal can be implemented successfully depends on many factors and complicated evaluative systems. This research was aimed at developing a measurable critical success factor (CSF) system to assist in comprehensively specifying the endowment structures, constructs, evaluation standards, and items to be assessed, such that the relationships among factors could conceptualize ITCI using limited resource investment and interface integration. This system should also inform the design of comprehensive strategies and marketing plans for ITCIs. Taiwan can benefit from this research to strengthen passenger acceptance rates of the ITCI service and motivations to use ITCI. In so doing, the usage rate of infrastructure will increase, the operational capacity of the airport will be ensured, and the environment for business operations will improve.

## 2. Literature Review

This section reviews relevant research on the current status of ITCIs in Asia, the development of the ITCI for TTIA, and the application of technology delivery in service sectors to accurately determine the current status of the ITCI, planning for the passengers traveling by airplane in metro stations, the features of passengers' check-in, and relevant issues.

### 2.1. Current Development of ITCIs in Asia

The aviation industry is a typical capitalistic, technical, experience-driven, labour-intensive, high-value industry, characterized by its numerous value-added services, prompting governments around the world to support its sustainable development [8]. To maximize the transportation profits of airport ground access metro systems to downtown areas, governments proactively construct transportation systems from airports to central business districts (CBDs). This provides efficient shuttle services for passengers to seamlessly transfer, shortening the time spent commuting between airports and the places along the rail lines. With stable growth in the volume of aviation transportation in Asia, governments have constructed well-equipped and convenient intermodal transportation systems between international airports and major cities. Among various transportation options for entering or leaving airports, rapid railway transportation systems linking CBDs and airports have indirectly replaced traditional bus transportation systems [9]. Intermodal transportation methods that combine aviation and railways that extend ground services at airports to major CBDs and railway systems, along with ITCI service, not only provide passengers ITCI and luggage drop-off services but also enhance the images of the cities that use such methods, thereby becoming more convenient and attractive to international business and holiday tourists.

Asia (Hong Kong, Malaysia, Korea, and Thailand, for example) has many examples of cooperation between aviation and railway service providers. Taiwan is the fifth to begin providing ITCI services in Asia. A summary of the ITCI services provided in major airports in Asia is shown in Table 1.

**Table 1.** Asia ITCI services summary list.

Country International Airport	Hong Kong International Airport	Malaysia Kuala Lumpur International Airport	Thailand New Bangkok International Airport (Suvarnabhumi) (Terminated)	Korea Incheon International Airport
Airport transits route	Direct route	Direct route commuter route	Direct route commuter route	Direct route
Pre check-in time	Before flight departure 3–24 h	Before flight departure 2–12 h	Before flight departure 3–12 h	Before flight departure 3–24 h
Distance between downtown transit terminal and airport	35.3 km	57 km	28.6 km	58 km
The shortest travel time from downtown to airport	24 min	28 min	17 min	43 min
Number of ITCT cooperated airlines	13	3	1	5
Need to take the Metro Rapid Transit to the airport	YES	YES	YES	YES

Recourses: this study complied.

### 2.2. Development of ITCI for TTIA

In response to the increasing demand of passengers traveling by airplane, convenient airport ground access transportation via railway, in addition to the construction of innovatively-designed and expanded-capacity terminals in airports, is the focus for development in many countries. The completion of construction and operation of airport ground access railways has enhanced the quality of customer service and operational ca-

capacity in Hong Kong International Airport, Bangkok Suvarnabhumi International Airport in Thailand, and Incheon International Airport in South Korea.

In 2002, Taiwan organized a task force that began plans for the first airport ground access metro system. In May 2005, Taoyuan Metro Corporation (TMC) started to draft plans for an ITCI service. In July 2005, TIAC took over the drafting of the ITCI service. In 2006, the construction of the TTIA Access Metro Rapid Transit (MRT) began, and the aviation service at the airport extended to downtown Taipei with a simultaneous plan for an ITCI and luggage processing system in the station, providing passengers with convenient service to commute between the airport and downtown Taipei [10]. The TTIA Access MRT completed construction in 2015, passed the stability test at the end of November in the same year, was in trial operation on 2 February 2017, and was in full operation on 2 March. Bao et al. [11] proposed that the more convenient the airport transportation, the more competitive the airport. Bao et al. [11] also indicated that a 1% increase in the convenience of airport transportation was associated with a 2% increase in the volume of passengers using transportation, suggesting that the airport ground access transportation is an important indicator for airport competitiveness.

The TTIA Access MRT line is 51.03 km in length, has 24 stations in total, crosses three municipalities including Taipei, New Taipei City, and Taoyuan, and serves simultaneously as the airport ground access transportation system and an inter-metropolitan transportation system, linking Taipei Main Station, Taoyuan High-Speed Railway Station as one vital transportation hub [12]. The TTIA Access MRT provides two operation services: “Express” and “Commuter.” The Express service is designed for passengers who are entering or exiting Taiwan and allows passengers to rapidly arrive in downtown Taipei. The commuter service is designed for intra-metropolitan commuters and operates by sharing the same railway as the Express trains. The Express trains consist of five cars (four of which are for passengers and one of which is for luggage), provide 188 seats, and may accommodate around 855 passengers when all seats are full. The Express cars are equipped with reading lights, wireless chargers, flight information, free Wi-Fi, and luggage racks. Luggage cars are equipped with 13 luggage compartments, and the last compartment for luggage has yet to be examined without dangerous, while transporting to the airport, as well as the luggage owners will be contacted for examination. Each luggage compartment may hold 20 pieces of luggage, allowing every train to carry 240–260 pieces of luggage.

The TTIA Access MRT is the first metro line to provide ITCI and luggage drop-off services in Taiwan [13], and it is characterized by its extension of the terminal from the airport to downtown Taipei. This service is not exclusively for passengers who take the Airport Access MRT to the airport. All passengers are capable of using this system to check in and drop off luggage in advance at the downtown Taipei station.

Following the wave of globalization around the world, studying abroad and international trade are becoming more prevalent in Taiwan. Traveling by air is becoming an increasingly critical factor in tourism, reflecting increasing living standards and the growing volume of air passengers (Wang, 2014). Advance check-in not only facilitates passengers’ commuting between downtown areas and airports, but it also reroutes the internal capacity of the airport. Moreover, it alleviates the time-related stress of expansion or construction of airport terminals.

### *2.3. Applications of Technology Delivery to Service Sectors*

Self-service technology increases the efficiency of delivering services and actualizes the digitalization of enterprise service delivery, i.e., it lies in the domain of technological service [14]. The application of technology in hospitality is increasing in hotels, restaurants, and in recreational and civil aviation [15]. For example, services are being introduced, such as self-service meal ordering, virtual tour-guide services, travel self-service stations, and self-service check-in and check-out. Airports are no exception. For example, airports are using self-service check-in kiosks [16], and the “Smart Airport Project for Taoyuan

International Airport” included the installation of the first CUSS in the A1 Station of TTIA Access MRT and six self-service bag drop-off systems [7].

In terms of civil aviation, traditional check-in for traveling abroad is conducted by airline agents. Agents issue boarding passes and receive luggage after inspecting passengers’ travel documents and validating their airline tickets. E-tickets began being issued by United Airlines in the US in 1994, which was followed by the development of automated machines for specific or everyday use at airports, commonly known as self-service check-in kiosks. Online check-in service appeared in the mid-2010s. Subsequently, the time that passengers spend on queuing in front of check-in counters has been considerably reduced [17]. Lovelock and Wright [18] and Srinivasan et al. [19] indicated that self-service techniques have been extensively applied to aviation and that the main advantages of self-service check-in kiosks are as follows. Passengers may check in at the airport via machines, receive boarding passes after selecting or changing seats, and receive invitation cards for the VIP lounge in return for flying frequently. Currently, passengers do not have to spend long times queuing for check-in and luggage drop-off at rush hour [20].

However, passengers’ check-in processes differs according to “the way the passengers select,” “the amount of checked luggage,” and “the airlines with which a passenger chooses to fly.” Self-service check-in kiosks relieve passengers from waiting in a long queue before checking in with agents at the counter and allow passengers to help themselves to check in. The main difficulty of using self-service check-in kiosks is associated with passengers’ willingness to use them frequently [21]. Lu et al. [22] indicated that passengers’ decision to use self-service check-in kiosks is closely associated with their ethnicity, with Western passengers using self-service check-in kiosks at a higher frequency (based on U.S. and Australian samples) compared to Eastern passengers (based on Taiwanese and Korean samples). Passenger nationality should, thus, be considered when implementing self-service technology. Moreover, Lu et al. [22] also indicated that business travelers, online ticket buyers, groups with less than three members, passengers that travel abroad frequently, passengers traveling without luggage or with few pieces of luggage to be checked, and younger passengers tended to be more willing to use self-service check-in kiosks than other passengers.

Although widely used in the service sectors, technologically-delivered services have advantages and disadvantages. Self-service check-in kiosks allow passengers to help themselves to check in and drop off luggage without others’ assistance, which is fast and convenient. However, this service lacks interpersonal contact and airlines may not be adequately establishing close interpersonal and interactional relationships with passengers with these methods.

#### 2.4. Critical Success Factors (CSFs)

CSF refers to the comprehensive plan for defining the demands of a system’s information by recognizing its critical factors. In any given system, the success of the implementation of a strategic goal depends on many factors. However, among these factors are several CSFs that play a particularly important role. Identifying and explaining these CSFs through the scientific process of converging and summarizing factors required us to achieve goals that allow researchers to grasp the key points of management under the limitation of systemic resources and serves as a base for system research and development or for the order of resource allocation.

CSFs comprise three concepts: “critical/key,” “success,” and “factor.” The importance of these concepts differ [23]. “Success” refers to the tasks that have been completed, and is the expected results and achieved goals. The outcome of success cannot be generalized because the definition of success differs according to goals. CSFs also differ according to time and lifecycle changes. Managers must verify the CSFs in their industry and efficiently allocate limited resources to establish an advantageous position for themselves within the industry [24].



CSFs have been academically applied to and extensively validated in various management fields and practical situations. Mitchell and Carol [25] proposed that CSFs were important factors in the success of businesses. From a holistic analysis of external environments and industry-level analysis, it is evident that specific competitiveness is the advantage that differentiates a business from its competitors and is determined by the internal analysis of that business. CSFs may serve as the best resources for enterprises to develop strategies through analysis and comparison. Lin [26] proposed that CSFs are the most emphasized dimensions for enterprises and CSFs, through investigation and insightful understanding, assist enterprises in recognizing and controlling the direction and order of allocation of resources to achieve goals gradually and successfully, as well as to establish a competitive advantage.

Although CSFs are applied primarily to enterprise operation and industrial competition, some existing research also applies CSFs to strategic research, including research on marketing strategies using Facebook fan pages [27] and on the promotion of developmental indices for conference and exhibition services [28,29]. There are several previous CSFs' studies on the airport related studies [30–32], such as Taoyuan Aerotropolis, Asia/Pacific Air Passenger Hub, and Safety Management System. However, CSFs have not been applied for ITCIs. This research collected cases of ITCI services globally, interviewed experts, and distributed questionnaires to investigate the CSFs in strategies for promoting ITCI service in airport ground access metro systems. The analytic hierarchy process (AHP) is a popular analysis method for filtering the CSFs from previous studies [28,29,33–36]. In other words, AHP is a useful decision-making tool to build-up a hieratic analytic structure from complicated experts' opinions. Therefore, AHP was adopted as the analytic method in this study.

### 3. Methods

#### 3.1. In-Depth Interviews

In-depth interviews are one of the most common methods for collecting information in social science research. Interviewers ask questions relevant to research objectives with flexible and exhaustive exploration or conduct without flexibility with questions prepared in advance [37]. Via in-depth interviews, the proposed questions under investigation are fielded in conversational interviews that value depth over breadth [38].

The interviewees included operation managers in airlines and experts who were well versed in practical aviation issues. Semi-structured interviews were conducted with a focus on CSFs relevant to the success of the implementation of ITCI strategies. Interviews began by referencing existing research and adjusting the question order and direction according to interviewee experience and answers. However, the interviews still adhered to the research objectives and were conducted by experienced interviewers who had control over the direction of the interviews, which was beneficial for retrieving data required for research findings and obtaining focused results from the interview questions [39].

#### 3.2. Analytic Network Process

Decision-making is an activity that has existed in human society since ancient times. Decision-making is also a process that is indispensable in daily life. Thomas L. Saaty, a professor at the University of Pittsburgh, introduced the Analytic Network Process (ANP), which is an innovative analytic method based on the analytic hierarchy process (AHP) in 1996. AHP is a multi-criteria evaluative method [40] that primarily focuses on the simplification of complicated problems and the decomposition of evaluative factors from top down, maintaining independence across levels or factors to establish a hierarchical system. Since the structure of decision-making issues may only exist in the limitations of hierarchical relationships, complicated issues may distort the structure of fundamental issues and, thus, influence the quality of decision-making. Therefore, a system cannot be constructed based solely on hierarchical relationships because relevance may exist among the factors. Saaty [41] (Figure 1), thus, proposed an ANP method that accounts

for interdependency and may provide feedback to the whole structure in order to form an inter-group network system to ameliorate the drawback of over-idealization in AHP. This system facilitates the application of an evaluative method to practical issues similar to those present in real life [42].

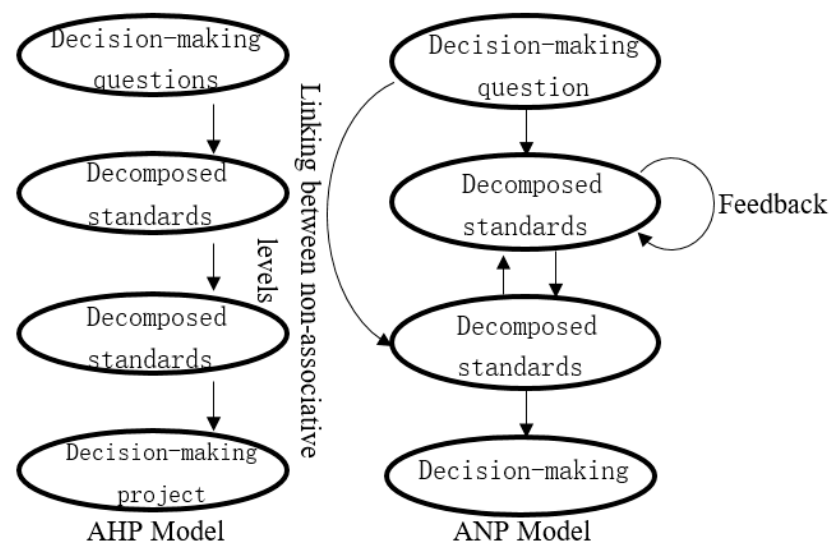


Figure 1. Comparison of AHP and Analytic Network Process (ANP) Models. Source: [43].

Since ITCI is still a new service in Taiwan, there are no empirical data available for validation. Similar to Lee and Kim's research questions [44], this research topic is also in an ambiguous situation and, therefore, proposes that the features of ANP and AHP lie in the collective opinions of experts, which determine the network structure of interdependent relationships across hierarchies and summarize the advantages and disadvantages of the plans. Since ANP handles issues including interaction effects and feedback, it is more in accordance with the reality than AHP and was, thus, more appropriate for use in this research.

After conducting interviews with six experts in aviation transportation, factors were eliminated that were irrelevant to the research topic as or were misleading, repetitive, and overlapping. In addition, expressions were improved and modified before conducting discussions with experts in aviation and tourism. CSFs for ITCIs were identified after content analysis. The questions were first drafted after a re-examination for inappropriate or missing elements, allowing the questionnaire to be holistic. After completing the first draft of the questionnaire, which covered three constructs and 14 items with statement sentences, the draft was compiled to assess expert opinions using Likert seven-point scales as for the rankings of the importance of all CSFs for ITCIs.

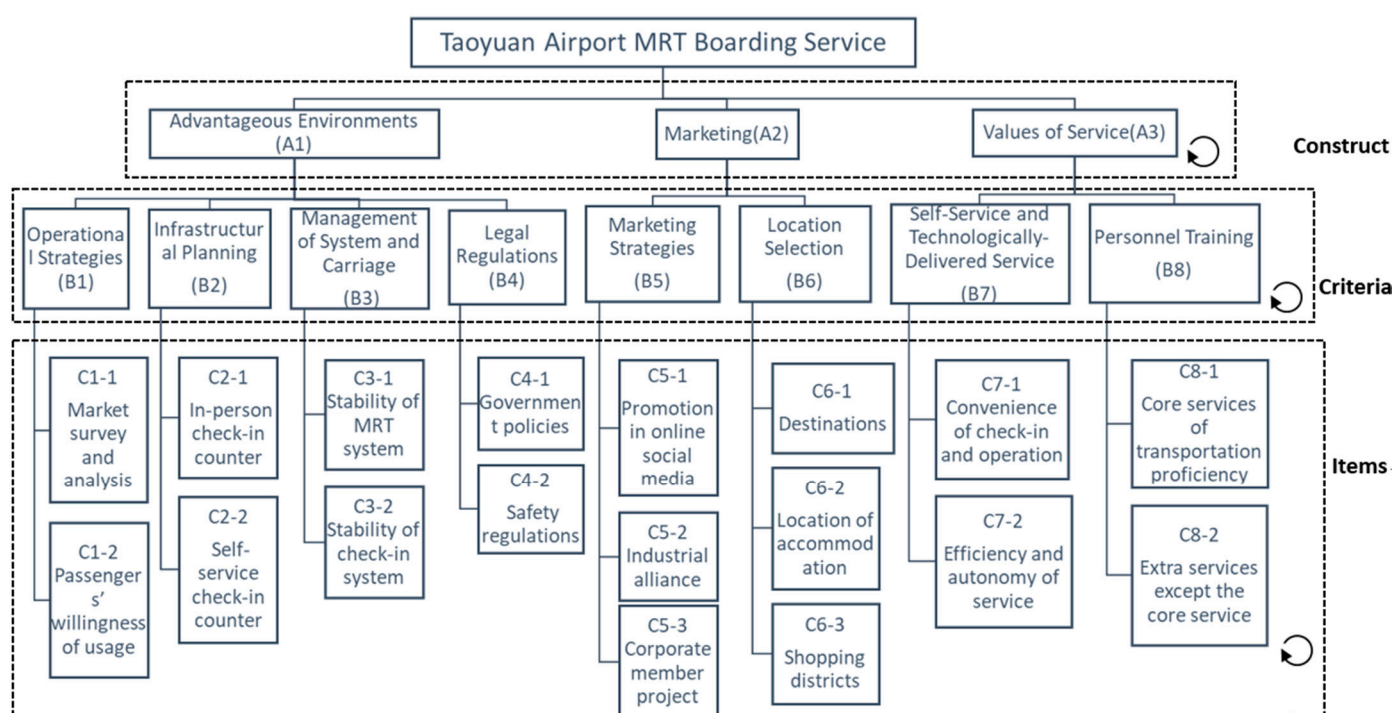
The scale for assessing CSFs for ITCIs was completed and proceeded the expert validity testing. Validity means the accuracy of test results based on testing instruments [45]. The pairwise comparison scale was adopted for ITCIs in Airport Ground Access MRT. Content validity refers to the representativeness of the contents, such as the construct and evaluative standards of testing instruments. Expert validity is based on the experts in a specific field invited by researchers who conduct item analyses of a scale and examine item-by-item to validate whether the items reflect the aims or behaviours that the scale intends to test [46].

Expert validity in this research consisted of the assessment of the appropriateness of item contents and the assessment of the interdependency among constructs and standards. First, in terms of the assessment of the appropriateness of item contents, six experts in aviation transportation and tourism were contacted by mail. These experts then rated the semantic clarity and the appropriateness of contents of the scale. This action was followed by a summary of the recommendations for scale modification to improve the scale contents. The construction and standards for the questionnaire modified based on experts' evaluation

were used to conduct the interdependency assessment across hierarchies, to evaluate the interdependency by focusing on the constructs and standards across hierarchies, to summarize opinions provided by the six experts, and to retain items for the assessment of interdependency to construct the pairwise comparison, according to more than three experts' agreement items within half of the experts' approval.

### 3.2.1. Hierarchical Structure and Measurement Scale

The influential indices were based on the questionnaire items along with the relationships among influential factors to establish the network hierarchy. The number of factors in each hierarchy is not recommended to be more than seven [47]. This research proposed CSFs for ITCI service by reviewing relevant literature and analysing the contents of the expert interviews. Figure 2 shows the hierarchical structure of success factors after the previously mentioned validation process of expert validity.



**Figure 2.** Hierarchical structure of CSFs for ITCI in TTIA Ground Access MRT. ↻ means: indicates interdependency.

The First Level: Three Constructs that Influence ITCI in Airport Ground Access MRT

- Advantageous environments (A1): This refers to the strategies and comprehensive operational direction for operators to develop ITCI service, including four criteria: operational strategies, infrastructure planning, system management and carriage, and legal regulations.
- Marketing (A2): This refers to the marketing strategies for promoting passenger usage of ITCIs, including two standards: marketing strategies and location and site selection.
- Values of service (A3): This refers to the capacity and strength of the ITCI service, including two standards: employee training and self-service and technologically-delivered service.

The Second Level: Eight criteria for ITCI in Airport Ground Access MRT

- Operational strategies (B1): This refers to using market surveys to analyze target customers, which benefits operators in terms of their adjustment of operational directions to satisfy passenger needs and to establish an advantageous base for enterprises.



- Infrastructure planning (B2): This refers to the circulation plan for in-person and self-service check-in counters in terminals, which is the most important part of space design for operators.
- Management of system and carriage (B3): This refers to the stability and safety of vehicles and check-in systems, which is the primary factor influencing passenger satisfaction.
- Legal regulations (B4): This refers to the regulations on software and hardware for carriage, which are based on relevant international and domestic aviation laws and may influence the strategies for the ITCI.
- Marketing Strategies (B5): This refers to the promotion based on intra-industrial and inter-industrial cooperation, embedded advertising and promotional strategies in online media may promote passenger usage of the ITCI.
- Location and site selection (B6): This refers to the efficiency and convenience of special interest locations for sightseeing, accommodation, and shopping near ITCI sites.
- Self-service and technologically-delivered service (B7): This refers to passenger attitudes toward self-service and technologically-delivered service, which is based on passenger satisfaction with service, convenience, and autonomy. This may influence passenger satisfaction with the quality of service.
- Employee training (B8): This refers to airline employee professionalism with respect to the transport core values of the ITCI and their familiarity with non-transport core values of the ITCI (additional consultation services), which is the most important aspect that may influence passenger perceptions of professionalism regarding the ITCI.

The third level: the evaluative items for each standard are listed in Table 2.

**Table 2.** Evaluative items for ITCI service in TTIA Ground Access MRT at the third level.

Evaluative Standards	Evaluative Items
Operational Strategies B1	C1-1 Market survey and analysis: collecting users' demographic information (age, nationality, destination) to find target customers.
	C1-2 Passengers' willingness of usage: acceptability, loyalty, and word-of mouth effect of using ITCI in reality.
Infrastructure Planning B2	C2-1 In-person check-in counter: passengers may use in-person check-in counters to ameliorate the sense of risk of being exposed to a new service.
	C2-2 Self-service check-in counter: passengers may use self-service check-in kiosks to receive boarding passes and drop off luggage by themselves, saving the time spent while waiting at the counter.
Management of System and Carriage B3	C3-1 Stability of MRT system: the punctuality and safety of the carriage of passengers and luggage.
	C3-2 Stability of check-in system: the comprehensiveness of connection between the check-in system and airport.
Legal Regulations B4	C4-1 Government policies: the government's supportiveness for developing ITCI.
	C4-2 Safety regulations: efficiently screening out passengers on blacklist and ensuring the safety of checked luggage.
Marketing Strategies B5	C5-1 Promotion in online social media: playing clips or relevant advertising media on social media (Facebook, YouTube, etc.)
	C5-2 Industrial alliance: cooperation with airlines and promotion using videos of public welfare on planes.
	C5-3 Corporate member project: inter-industrial cooperation that provides special offers for ticket fees.
Location Selection B6	C6-1 Destinations: surrounding scenic spots (recommended for one-day tours).
	C6-2 Location of accommodation: the convenience of commuting between the site and hotels.
	C6-3 Shopping districts: temporal efficiency for commuting between the site and shopping districts.

Table 2. Cont.

Evaluative Standards	Evaluative Items
Self-Service and Technologically-Delivered Service B7	C7-1 Convenience of check-in and operation: kiosks for self-service check-in or luggage drop-off use simple languages of selection and operational directions and provide customers with a more convenient check-in method.
	C7-2 Efficiency and autonomy of service: customers have control and may avoid contacting service agents at best to autonomously use the service more efficiently and flexibly.
Employee Training B8	C8-1 Core services of transportation proficiency: airline employees' professionalism of contents and the operation of the infrastructure for the check-in service.
	C8-2 Extra services except the core service: in-site airlines personnel's familiarity of the transport connection inside and outside the stations of Airport Ground Access MRT and surroundings.

### 3.2.2. Research Sampling

Logical consistency is required because ANP-based questionnaires require a consistency test. Participants must primarily consist of experts. The participants in this research comprised experts from the government, academic, and industrial sectors. These included industry experts, such as managers of airlines and travel agencies, government personnel from TTIA, Kaohsiung International Airport, and TMC, and academic experts including professors studying aviation services and tourism. Questionnaires were formally distributed in 2017 by mail, collectively totaling 15 surveys.

## 4. Results and Analyses

The questionnaires covered the explanation of ITCI service CSF constructs, criteria, and items. Among the 15 distributed questionnaires, 10 were successfully collected, yielding a response rate of 67%. To ensure the logicity of responses, a pairwise consistency test was conducted. Responses that passed the consistency test were subsequently considered valid. Otherwise, the contents of the questionnaire were to be modified. Teng [48] suggested that the ratings of relative importance of  $n$  factors under a single standard are completely consistent when the CI value is zero and that the ratings among decision-makers or experts are inconsistent when  $CI > 0.1$ . This research applied the Super Decisions software to calculate the weighted values and conduct the consistency test. All the ANP expert questionnaires collected had a CI values of  $\leq 0.1$ , indicating that the 10 questionnaires passed the consistency test.

After confirming the results for the consistency test, the relatively prioritized weights for each item, criterion, and dimension were calculated. The calculative process for the test of consistency and weighted indices was as follows.

### 4.1. Calculative Eigenvectors and Consistency

There were three ANP layers, including the mutual comparison and comparison of interdependency across layers of constructs, criteria, and evaluative items.

It was necessary to integrate the information about the preferential judgments of experts because the process for experts to evaluate the importance of each evaluative criterion or item might involve cognitive differences in subjective preference. Saaty [41] noted that there are two methods for integration, including pool first integration and pool last integration, with the former favoring the geometric mean method and majority rule and the latter adopting the arithmetic mean method. However, Chiang [49] concluded there is no significant effect or difference between the geometric mean and arithmetic mean methods by using simulation data. Pool first integration was adopted, thus, following Saaty's suggestion [40] to use the geometric mean to integrate the composite scores of group decision-making. Excel was used to calculate geometric means and Super Decisions (<http://www.superdecisions.com>) for the following calculation. In the Super Decisions software, the pairwise comparison matrix automatically calculates the consistency ratio

(CR) for the data.  $CR \leq 0.1$  indicates the consistency of pairwise data. Conversely,  $CR \geq 0.1$  suggests that data require revision or that responses on the questionnaires are not reliable.

#### 4.2. Super Matrix Calculation

The pairwise comparison matrices of each criterion that passed the consistency test went through the processing of eigenvectors using Super Decisions before becoming super matrices. The calculation for a super matrix involves three processes: unweighted super matrix, weighted super matrix, and limiting super matrix. According to the literature on ANP, the limiting super matrix may converge as a constant, and this constant may serve as the base for choosing alternatives. Limiting super matrices are shown in Table 3.

#### 4.3. Ranking Criteria Weighting

Following the previously mentioned processes yielded the criteria weighting, i.e., the indices for CSFs of the ITCI service. The results for the weightings of constructs, criteria, and evaluative items are shown in Table 4.

#### 4.4. Results from the Analyses

This research adopted the ANP method, which retains the advantages of the traditional analytic hierarchical method and considers the interdependency across layers. Results from the analyses found that an advantageous environment (0.4103) was the most important construct influencing the strategies for the ITCI service, followed by marketing (0.2692), and value of service (0.3205). The discussion of these results regarding three important constructs, i.e., advantageous environment, marketing, and value of service, follows.

##### 4.4.1. Advantageous Environment

An advantageous environment ranked first among the CSFs for the ITCI service. In terms of evaluative criteria, infrastructure planning (0.1267) had the highest weighting and was followed by management of system and carriage (0.1173), operational strategies (0.0682), and legal regulations (0.0361). In terms of the evaluative items, the stability of the MRT system (0.2183) showed the highest weighting, followed by stability of the check-in system (0.1813), passenger willingness to use (0.1594), self-service check-in counter (0.0738), safety regulations (0.0553), government policies (0.0475), in-person check-in counter (0.0420), market survey and analysis (0.0063), and check-in counter (0.0420). Table 3. Limiting the super matrix of evaluation items for the ANP model.

##### 4.4.2. Marketing

Marketing ranked last on the weightings of constructs. In terms of evaluative criteria, marketing strategies (0.1770) showed the highest weighting and was followed by location selection (0.0974). In terms of the evaluative items for standards, the shopping districts (0.0222) showed the highest weighting, followed by destinations (0.0214). The interdependency existed only between the previously mentioned criteria. Items that were not interdependent might not be compared in terms of weighting.

##### 4.4.3. Value of Service

The value of service ranked second on the weightings of constructs. Evaluative criteria included self-service and technologically-delivered service (0.2212) and employee training (0.1562). The order of evaluative items, from high to low, was convenience of check-in and operation (0.1215), efficiency and autonomy of service (0.0221), core values of transportation service proficiency (0.0220), and extra services except the core service (0.0068).

**Table 3.** Limiting super matrix of evaluation items for ANP model.

Items	Constructs Criteria	A1						A2						A3					
		B1	B2		B3		B4		B5		B6		B7		B8				
	G	C1-1	C1-2	C2-1	C2-2	C3-1	C3-2	C4-1	C4-2	C5-1	C5-2	C5-3	C6-1	C6-2	C6-3	C7-1	C7-2	C8-1	C8-2
G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-1	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0	0	0	0.0063	0	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063
C1-2	0.1594	0.1594	0.1594	0.1594	0.1594	0.1594	0.1594	0.1594	0	0	0	0.1594	0	0.1594	0.1594	0.1594	0.1594	0.1594	0.1594
C2-1	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0	0	0	0.0420	0	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420
C2-2	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738	0	0	0	0.0738	0	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738
C3-1	0.2183	0.2183	0.2183	0.2183	0.2183	0.2183	0.2183	0.2183	0	0	0	0.2183	0	0.2183	0.2183	0.2183	0.2183	0.2183	0.2183
C3-2	0.1813	0.1813	0.1813	0.1813	0.1813	0.1813	0.1813	0.1813	0	0	0	0.1813	0	0.1813	0.1813	0.1813	0.1813	0.1813	0.1813
C4-1	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475	0	0	0	0.0475	0	0.0475	0.0475	0.0475	0.0475	0.0475	0.0475
C4-2	0.0553	0.0553	0.0553	0.0553	0.0553	0.0553	0.0553	0.0553	0	0	0	0.0553	0	0.0553	0.0553	0.0553	0.0553	0.0553	0.0553
C5-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C5-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C5-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C6-1	0.0214	0.0214	0.0214	0.0214	0.0214	0.0214	0.0214	0.0214	0.0214	0	0	0	0.0214	0	0.0214	0.0214	0.0214	0.0214	0.0214
C6-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C6-3	0.0222	0.0222	0.0222	0.0222	0.0222	0.0222	0.0222	0.0222	0.0222	0	0	0	0.0222	0	0.0222	0.0222	0.0222	0.0222	0.0222
C7-1	0.1215	0.1215	0.1215	0.1215	0.1215	0.1215	0.1215	0.1215	0.1215	0	0	0	0.1215	0	0.1215	0.1215	0.1215	0.1215	0.1215
C7-2	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0	0	0	0.0221	0	0.0221	0.0221	0.0221	0.0221	0.0221
C8-1	0.0220	0.0220	0.0220	0.0220	0.0220	0.0220	0.0220	0.0220	0.0220	0	0	0	0.0220	0	0.0220	0.0220	0.0220	0.0220	0.0220
C8-2	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0.0068	0	0	0	0.0068	0	0.0068	0.0068	0.0068	0.0068	0.0068

Table 4. Weighting values of the ANP model.

Object	Constructs			Criteria			Items		
	Statement	Weighting Value	Rank	Statement	Weighting Value	Rank	Statement	Weighting Value	Rank
CSFs of the ITCI service	Advantageous Environments (A1)	0.4103	1	Operational Strategies (B1)	0.0682	3	Market survey and analysis (C1-1)	0.0063	8
							Passengers' willingness of usage (C1-2)	0.1594	3
				Infrastructure Planning (B2)	0.1267	1	In-person check-in counter (C2-1)	0.0420	7
							Self-service check-in counter (C2-2)	0.0738	4
				Management of System and Carriage (B3)	0.1173	2	Stability of MRT system (C3-1)	0.2183	1
							Stability of check-in system (C3-2)	0.1813	2
				Legal Regulations (B4)	0.0361	4	Government policies (C4-1)	0.0475	6
							Safety regulations (C4-2)	0.0553	5
CSFs of the ITCI service	Marketing (A2)	0.2692	3	Marketing Strategies (B5)	0.1770	1	Promotion in online social media (C5-1)	0	-
							Industrial alliance (C5-2)	0	-
							Corporate member project (C5-3)	0	-
				Location Selection (B6)	0.0974	2	Destinations (C6-1)	0.0214	2
							Location of accommodation (C6-2)	0	-
							Shopping districts (C6-3)	0.0222	1
				Self-Service and Technologically-Delivered Service (B7)	0.2212	1	Convenience of check-in and operation (C7-1)	0.1215	1
							Efficiency and autonomy of service (C7-2)	0.0221	2
Values of Service (A3)	0.3205	2	Personnel Training (B8)	0.1562	2	Core services of transportation proficiency (C8-1)	0.0220	3	
						Extra services except the core service (C8-2)	0.0068	4	



Theses weighting values revealed the CSFs required for ITCI service. In terms of evaluative criteria, the highest three were self-service and technologically-delivered service, marketing strategies, and employee training. The most important three evaluative items for ITCI service were stability of the MRT system, stability of the check-in system, and passenger willingness to use.

## 5. Conclusions and Management Implications

The Ministry of Transportations and Communications in Taiwan proposed policies and initiatives relevant to the Smart Airport Project for Taoyuan International Airport, among which the ITCI service was the most important. For the further development of the ITCI service, this research surveyed experts in aviation transportation and tourism to explore the CSFs for ITCI service. The results serve as a reference for operators and managers to reduce airlines employees' stress of facing crowds in front of check-in counters at the airport and to enhance passengers' positive images of the aviation delivery service system.

### 5.1. Conclusions

This research was based on a literature review and expert interviews. Tests of expert validity and a synthesis of expert opinions were completed. Evaluative items of relative importance and interdependent criteria were identified by drawing upon expert consensus on the construction of evaluative constructs for ITCI service. In total, there were three main constructs, eight evaluative criteria, and 18 evaluative items.

An advantageous environment was the most important of the main hierarchical constructs, followed by value of service, and marketing. However, the differences in the weightings of these three constructs was not significant. This indicated that experts believed that the three constructs were equally essential aspects for the TMC to consider in the provision of the ITCI service.

For an advantageous environment, experts considered infrastructure planning to be the most important factor, followed by management of system and carriage, operational strategies, and legal regulations. These rankings suggest that, when planning for comprehensive operations, the circulation of check-in counters should be emphasized. Moreover, the maintenance methods for system stability and carriage are the CSFs for passenger satisfaction. Using a market survey to analyze target customers is beneficial for adjusting operational strategies to establish an advantageous base for the enterprise. Eventually, legal government regulations may also influence the efficacy of the ITCI service.

For marketing, including marketing strategies and location selection, experts considered marketing strategies to be the most important. This assignment of importance suggests that, when promoting the ITCI service, emphasizing issues relevant for marketing strategies is crucial for understanding users' interests and needs, encouraging passenger use of the service, and providing customer-oriented marketing initiatives by focusing on different target customers to motivate more passengers to use the service.

Results from the expert evaluation of value of service indicated that self-service and technologically-delivered service was the most important criterion. Since people have daily access to information technology, technologically-delivered service systems are becoming service innovations for the aviation industry. This finding is consistent with the extant literature, which indicates that self-service check-in shortens the time spent on checking in and waiting in queues at transportation sites [20]. For the ITCI service in this investigation, checking in, selecting seats in advance, and outside transportation sites, frees passengers the typical waiting times due to the closure of airline in-person check-in counters. ITCIs offer convenient, autonomous, and more efficient service. If ITCI service is promoted appropriately, it will create beneficial outcomes for airports, airlines, and passengers. Putting employee training into practice is essential in ITCT service provision, particularly because employee professionalism and service familiarity have direct and indirect effects on passenger attitudes [15].

#### 5.1.1. Adopting Management and Marketing Strategies to Motivate Passenger Willingness to Use

For operational strategies, including market survey and analysis and passenger willingness to use, experts considered passenger willingness to use to be the most important, i.e., passenger acceptance levels of the ITCI service. Hsu et al. [50] found that user satisfaction had a positive influence on future usage. This research suggests that, to further investigate the attitudes that motivate passengers to use ICTIs, related to inclinations for future usage, actual behaviors of users, influence the context of decision-making, and accordingly signal improvements for management and marketing.

#### 5.1.2. Discovering the Key Issues of Infrastructure Planning for a Self-Service Check-In

For the two evaluative items for infrastructure planning, including in-person check-in counters and self-service check-in counters, the experts ranked the latter to be more important than the traditional in-person check-in counters when it came to their effects on the decision-making for passengers traveling by airplane. Lin [51] observed that self-service check-in benefits airlines in terms of their flexibility for dispatching employees, cost-saving, and a resulting average customer wait-time decrease. Compared with in-person check-ins, self-service passengers can save time in queues at airports, yielding more convenient customer experiences as well as benefiting the airport by allowing personnel to be allocated on a more flexible basis.

#### 5.1.3. Playing a Critical Role of Management of System and Carriage

The stability of the MRT system was the most important factor for the ITCI service, followed by the stability of the check-in system, implying that the stability of vehicles may have an effect on passenger willingness to use. The punctuality of arrival of either passengers themselves or checked luggage is most important. Furthermore, from the passenger perspective, it is also important that the check-in system connect to the main system without error. There was no significant weighting value difference between these two factors. Ju [52] suggested that TTIA was an important gateway for Taiwan. Thus, the running speed of the Airport Ground Access MRT system represents the competitiveness of Taiwan, and more passengers will take the Airport Ground Access MRT if the commuting time between the airport and major business districts was reduced to around 20–25 min. This research confirms that the stability of the check-in system and carriage also promotes passenger willingness to use the ITCI service.

#### 5.1.4. Building a Mechanisms of Management for Homeland Security and Border Enforcement

For legal regulations, safety regulations were the most important, followed by government policies, indicating that experts considered homeland security and border enforcement to be more important than government policies for technologically-delivered services. Therefore, it is suggested to put safety regulations into practice by avoiding any possibility of inadequate supervision or security loopholes. However, the difference in weightings between these two was not significant.

#### 5.1.5. Diffusing the Influence of Online Social Media

For marketing strategies, experts considered promotion in online social media to be the most important, which was followed by corporate member projects and then by industrial alliances. In the current competitive digital generation, enterprises extensively use online social media marketing. Feng and Chen [53] observed that passenger willingness of usage increases if instant information or interactive services are provided on social media platforms. Additionally, word-of-mouth information from social media expands the potential users of ITCI services.

Tsai et al. [54] noted that enterprises may establish a system of membership and use data-mining techniques to extract the characteristics of purchasing from members'

transactional records, which may be applied for precision marketing. Lo et al. [55] argued that, if operators discover clients of higher interest and important potential clients, it is suggested to allocate limited resources appropriately and implement effective marketing strategies to secure a competitive advantage. Therefore, TMC and airlines that provide the ITCI should display ITCI visual interpretive digital news everywhere in the stations and MRT cars of TTIA Ground Access MRT to convey messages to target ITCI users. The values and benefits of ITCI use should be communicated by sending brochures and publications to corporate members and using storytelling narration on websites and social media platforms.

#### 5.1.6. Locational Values of ITCI

For location selection, the weighting of shopping districts was slightly higher than that of destinations. Lee and Lu [56] suggested that the usual destination for Kaohsiung MRT passengers was associated with the shopping districts around the MRT stations. In addition, passenger impressions of shopping districts surrounding MRT stations was positively correlated with those interviewees who may take again, will take again, and will recommend family and friends to take. Another study also indicated that, from the consumer perspective, shopping districts are expected to be more than mere shopping sites including recreational activities [29]. Tsai [57] indicated that international conferences and exhibitions may develop with the recent growth trend in international trade. The A1 station, e.g., Taipei Main Station, which is a transportation junction that integrates shopping districts and six-rail terminal stations via the TTIA Ground Access MRT, is a benefit that ITCI created in the CBD. In short, the geographical location of the Taipei ITCI with the convenience of commuting among destinations increases usage willingness while visiting Taiwan.

#### 5.1.7. Examining on Rationale Value of ITCI with a Technological Application

Two evaluative items for self-service and technologically-delivered service were the convenience of check-in, operation, efficiency, and autonomy of service. For convenience of check-in and operation, the interactive relationship between passengers and technologically-delivered service to meet user needs must be prioritized, i.e., strengthening the cognitive usefulness of the technological infrastructure. In addition, the application design, including software and hardware, must fulfill the physiological, sensory, psychological, and cognitive characteristics of user friendliness in operating, controlling, and presenting perceived ease of use.

In terms of the efficiency and autonomy of service, according to Dabholkar's definition of "autonomy" [58] is having a right for decision-making for the contents of a service with adjusting, improving, and modifying competences. Yang's explanation of autonomy for air passenger service [59] included the reselection of seats, cancellation of check-in, renewal and exchange of mileage accumulations, and selection of privileges for higher-class flights for frequent flyer members. The service features of the ITCI should provide advance check-in service, luggage drop-off, seat selection, and boarding pass collection in areas outside of airports. Then, ITCI passengers do not have to bring luggage with them when sightseeing, shopping, working, or traveling in downtown areas, as well as having a more comfortable schedule to do so.

#### 5.1.8. Innovation Benefits on Employee Training

The two evaluative items for employee training included core values of transportation service proficiency and extra services in addition to the core service. Since the ITCI is a self-service option with technology devices, passengers have to pay a learning cost in the initial period of usage. The interface of self-service is a human-computer interaction under mechanical interaction [60], and previous research has indicated that the digitalized service may jeopardize customer loyalty, bringing more difficulty to customer relationship management [61]. Promoting ICTI locations and giving incentives to ICTI surrounding

organizations to attract more users are all suggested for consideration [62]. During the ICTI start-up period, service employees were deployed at the B1 level by TMC, along with related airline staff, to introduce, guide, and explain the service. Employees should receive pre-training before deployment, such as on the core services of transportation proficiency. The training should cover operational techniques and obstacle removal for self-service technology, advising on ticket rescheduling, cancellation, and return, providing travel information, instructing on self-service luggage drop-off, advising on transit and transfer, handling of incidents and accidents, and informing on non-transport core services (e.g., animal or plant quarantine at arrival or departure and consultations on tax refunds for foreign tourists). Hsiao [63] argued that employee training to enhance professionalism positively influences passenger service quality perceptions.

### 5.2. Management Implications

This research categorized, analyzed, and described the CSFs for the ICTI service in the TTIA Ground Access MRT. Three implications for management and the authorities concerned are as follows.

#### 1. Advantageous Environment

There are several ICTI-friendly service recommendations: using luggage drop-off mobile applications along with the check-in system, cooperating with the business resolution projects proposed by Société Internationale de Télécommunication Aéronautiques (SITA) with telecom services including the departure control system of various airlines for passengers, staying updated on mobile applications with the status regarding luggage in conveyors using the barcodes on luggage while X-ray examination installed in the terminal of conveyors before being sorted, and informing whether luggage has transferred to appointed channels of cargo handling.

#### 2. Marketing

Using marketing approaches tactically, from the original creative thinking, and adopting narratives for passengers to use the ICTI service, let passengers complete self-service check-in, seat selection, and luggage drop-off, and still have time for downtown sightseeing, shopping at the airport, and boarding directly after business trips. These initiatives might encompass depicting a smart trip scenario, persuading passengers of the benefit from the time not spent on waiting in queues, and the advantages of efficient planning and schedule updating, by sparking passenger understanding and acceptance of the ICTI service of automatizing and simplifying the procedures of travel.

#### 3. Value of Service

The constructs of value of service had two evaluative criteria, self-service and technologically-delivered service and personnel training. Self-service has been defined as customers completing the activity of service by themselves without direct contact with service providers [64], suggesting that the original intent of ICTI self-service with technologically-delivered is to make customers complete parts of the check-in activity by themselves outside of airports without the assistance of service providers. Therefore, self-service and personnel service are in a mutually exclusive relationship of “waning and waxing.” Although, there was some personnel service provided at ITCT and mainly in its start-up phases. While current technology applications have extensive functions and user-friendly designs, some people due to a lack of familiarity are reluctant or even decline to use them [65]. To avoid these negative effects with use and resource waste of the ITCT, passengers should be helped to get used to self-service check-in kiosks at airports and to become more familiar, new service accessibility outside airports. This assistance should extend to passengers who have not used self-service and technologically-delivered services by personnel near the machines, guiding travelers to become more experienced in ICTI usage.

### 5.3. Limitations and Future Studies

There are several limitations to this study. First, ITCI is a new checking-in service in Taiwan, as well as in other countries, so the ITCI research is still in an infancy stage without much previous research for reference purposes. This is an exploratory research study that interviewed academic and industry experts to derive the CSFs of the hierarchical system from ANP analysis. After the ITCI applications gain more experience, it is suggested that the future studies should invite ITCI managers and operators to contribute further ITCI operational perspectives. Second, this study was completed ahead of the ITCI official operation, which meant that there were no tourist opinions representing the demand side. Future studies should investigate tourist satisfaction to sufficiently reflect the CSFs of ITCIs from the usage viewpoint. This will help transportation operators in enhancing and improving the service quality of ITCIs.

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