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Impact of the COVID-19 Pandemic on the Tourism Industry: Applying TRIZ and DEMATEL to Construct a Decision-Making Model

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Abstract: The impact of the COVID-19 pandemic on the tourism industry is still being sustained, and the response of the tourism industry is an indispensable element that is increasingly recognized. This response has led to the emergence of literature about the impact of COVID-19 on the stakeholders of the tourism industry, thereby contributing to the industry. Nonetheless, the criteria factors and investigated practices for the implementation of decision-making by stakeholders in the tourism industry have not been fully explored. This study adopts *Teorija Rezhenija Izobre-tatelskikh Zadach* (TRIZ) principles and Decision-Making Trial and Evaluation Laboratory (DEMATEL) methods to construct a gap model of tourism stakeholders (GMTS) which solves the tourism industry decision-making problem under COVID-19. With a research background in Taiwan's tourism industry stakeholders made up of 15 expert participants, GMTS identified 11 criteria factors, of which the three most important criteria factors provide decision-making directions. The causal relationship between these criteria factors was examined, and a causal diagram was drawn to clarify the most important criteria factors. This research examined the criteria factor implementation perspective. Travel "bubble zones" that ensure both "safety and quality" were concluded upon under government policies in the countries and regions of the world. Furthermore, the tourism industry is responsible for the overall "planning and management" of the travel "bubble zones". Therefore, the "quality management" criteria factor provides important key decision-making for tourism stakeholders. The research indicates that it is recommended to attach importance to the "quality management" of the international travel "bubble zone" as the priority decision-making criteria factor under the pandemic. Furthermore, conversion policies and tourism regulations are secondary criteria factors for improvement; when these two criteria factors are immediately improved, other criteria factors will be affected simultaneously and the degree of improvement will be weakened. In addition, GMTS was developed for the tourism industry. The article also provides research literature and practice implications for stakeholders in the tourism industry, thereby providing insight for tourism to obtain a clear understanding of how to prepare for the implementation of sustainable development.

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1. Introduction

Zurab Pololikashvili, secretary-general of the UNWTO, stated that "Growth in international tourist arrivals and receipts continues to outpace the world economy and both emerging and advanced economies are benefiting from rising tourism income [1]". In 2019, the total international tourist arrivals worldwide were 1460 million, with total international tourism receipts of USD 1481 billion; Asia and the Pacific had 362 million tourists, with receipts of USD 443 billion [2]. In 2019, in Taiwan, tourist receipts and expenditure totaled USD 535.44 billion, with a total number of tourists of 28.9 million, including inbound and outbound tourists (international travel); the number of people engaging in Taiwanese domestic travel numbered over 160 million [3]. Taiwan has a population of 23.8 million [4].

Tourism is one of the most important industries in Taiwan. On 23 January 2020, Wuhan declared a lockdown. On January 30, the World Health Organization (WHO) declared the outbreak a global health emergency. On 11 March, the WHO declared the outbreak a COVID-19 pandemic; on 20 April, 100% of worldwide destinations introduced travel restrictions; in 2020, the number of international tourists suffered 70% to 75% negative growth; 100–120 million direct tourism jobs at risk, and international tourism could plunge to the levels of 1990 [5]. Tourism mobility led to COVID-19 becoming a global pandemic [6]. The irresistible risk industry is already synonymous with tourism. It is an unstable industry. In 2003, 2 million tourists were lost due to SARS. In 2009, the Global Economic Crisis reduced the number of tourists by 37 million. In 2020, COVID-19 caused a reduction of 1.1 billion tourists, and a loss in international tourism receipts US\$ 1.1 trillion [5]. The tourism industry is the most frequently impacted industry under the crisis [7,8]. Several researchers have highlighted that the impact of COVID-19 on the tourism industry is significant [9–13]. However, impactive decision-making is lacking, and few studies have determined the solutions in the tourism industry. How the tourism industry survives under the crisis context is an urgent issue.

The tourism industry must respond to the tourism disaster caused by COVID-19. The world has been in a panic in the past year, and tourism-related industries have suffered unprecedented significant effects. From the disappearance of international tourists to the instantaneous cessation of the tourism market, many related industries ceased operations. [14]. The COVID-19 pandemic has caused a significant crisis to all of the industries in the world [15], and this crisis has a significant impact on the tourism industry [12]. Scholars believe that global tourism and population movements have caused the emergence or re-emergence of infectious diseases as one inevitable result of such movements [16]. The early evidence of the effects of travel, flights, cruise ships and accommodations under the pandemic is devastating [17]. The global pandemic of COVID-19 has severely hit economic industries such as tourism, hospitality and airlines [18]. The government has forcibly closed hotels, restaurants, attractions and tourism-related businesses [19]. Travel and tourism have always been significant factors in globalization, and are the industries most affected by the COVID-19 pandemic [20]. The COVID-19 pandemic has not been controlled, and the situation is unpredictable; therefore, research is essential for the restoration of tourism and the associated industries [21]. In the COVID-19 pandemic, for the tourism industry to form a new normal [11,22], a new approach to the crisis is required. Nevertheless, to the best of our knowledge, the previous literature has not found a crisis solution for tourism industry stakeholders. Most of the early literature may be limited to the exploration of a wide range of issues related to the quantitative or qualitative nature of second-hand data analysis related to tourism issues [23–27], tourism management issues and related strategic issues under the pandemic [28–33], and the satisfaction issues of accommodation and restaurants under the pandemic [34–37]. Some of the researchers study the economic issues that affect the tourism industry in the COVID-19 pandemic [38–44], discuss the psychological issues of travel stakeholders in the pandemic [45–50], or perform research on Tourism and Virtual Reality (VR) [51–53]. Past research has focused on six functions. When tourism resources are invested, they cannot provide tourism stakeholders with the correct decision-making methods efficiently and quickly. In order to overcome this situation, we propose a decision-making method for tourism stakeholders to address these problems.

The past literature shows the significance of the issues of cooperation between the tourism industry and its partners [54,55]. Tourism stakeholders include tourists, travel companies, travel providers, destination organizations, governments, local communities, and practitioners [11]. Many studies discuss the hospitality industry, the transportation industry, travel companies, and government in the tourism industry, but research discussing a gap model of decision-making is lacking. Therefore, this research will adopt innovative methods to construct a GMTS. Kock and Assaf [56] aimed to advocate for the originality of tourism research. They hoped that tourism scholars would propose an innovative and creative transformation process for the tourism industry [57]. Owing to the fragmented nature

of the tourism industry, any person or organization that can involve disaster management or beneficial participants in the tourism industry is a stakeholder of the industry [58]. Tourism has been widely recognized as a sustainability industry, and stakeholder collaboration for the sustainability of tourism development has been examined [59]. Using *Teorija Rezhnija Izobretatelskikh Zadach* (TRIZ) principles, the Decision-Making Trial and Evaluation Laboratory (DEMATEL) has been applied to complex and interrelated group problems, solving contradictions in the care cloud system and innovating the principles of the long-term care cloud system [60]. Altuntas and Gok [61] adopted the DEMATEL method to evaluate COVID-19 quarantine decisions based on the number of visitors and the local population, solving complex problems and decision-making criteria factors.

This research uses the TRIZ principle to reason about the issues among relevant stakeholders in the tourism industry, to clarify the complex relationship results produced by contradictory problems across industries, to resolve contradictions and innovate principles, and to determine the extent of influence between innovation principles and which principles have exerted the most critical impact. Experts' questionnaires are used from hospitality, transportation, travel companies, academic universities and the government. Methods such as multi-criteria decision-making (MCDM), explanatory structure modeling and DEMATEL are used to determine the degree of influence between the criteria factors, and to make decisions. First, the information on the issues that led to the contradictory system construction is summarized; second, the innovative principles of the system are derived in order to adopt TRIZ heuristic reasoning; third, these innovative principles are evaluated by adopting the expert questionnaire survey approach, which uses DEMATEL to measure the standard steps and compute the key innovation principles, such as the criteria factors and feasibility. This study aims to provide GMTS in order to address this issue; tourism stakeholders will establish the new GMTS to solve the dilemma under the influence of COVID-19 and provide research literature and practical applications in order to bridge the research gap. This article has three aspects. First, this research provides a new model which integrates the TRIZ and DEMATEL methods to solve the problems of tourism stakeholders. Second, this study identifies the decision-making criteria factors implemented by tourism stakeholders so that decision-makers can evaluate their industry's approach to sustainable development. Finally, this study explores the practice of the identified criteria factors that provide stakeholders with insight into the existing capabilities in the implementation of decision-making under crisis, and this research will drive useful implications for stakeholders in the tourism industry. On the contrary, if the relevant stakeholders in the tourism industry cannot make effective decisions to face the crisis, they will not be able to sustain the sustainable operation of the industry.

2. Literature Review

2.1. The Hospitality Industry and the COVID-19 Pandemic

The COVID-19 pandemic has restricted interpersonal interaction, and many industries, including hotels and tourism, have been severely affected [62]. The uncertainty of economic recovery and the continuous spread of COVID-19 have caused millions of people to suddenly lose their jobs; the hospitality industry was one of the first industries to do so [63]. Hospitality and tourism, especially in parts of Asia, Europe and North America, have been affected in a manner unseen in half a century [64]. Many hospitality businesses face existing global challenges [65,66]. Some of these are significantly detrimental to international hotel industry operations, including the long-term impact of the COVID-19 pandemic [67]. The COVID-19 pandemic has introduced difficulties to hotels in major cities in the United States as they continue to operate [68]. In Hong Kong, COVID-19 is seriously damaging the operations of the global tourism hotel industry [69]. In Malaysia, COVID-19 has severely affected the occupancy rate of hotels, with Kuala Lumpur having the largest number of cancellations [70]. In China, they are studying the impact of the pandemic on the hospitality industry, and whether it will change the lifestyle choices, travel behavior and preferences of tourists in the short and long term [71]. In the Spanish hospitality industry, economic

and tourism activities are generating an economic crisis [72]. In Italy, hotels and bed and breakfasts require financial support [73]. In India, the discussion database papers analyzed the hospitality industry during the pandemic; the first three themes were the recovery of the hospitality industry, market demand and the loss of revenue [74]. In the Vietnamese hotel industry research, the relationship among the hotels' responses to COVID-19 and employee satisfaction was examined [75]. In Seoul, South Korea, the hotel industry is highly vulnerable to health, disasters and other risks; therefore, the number of tourists is insufficient, the occupancy rate is insufficient, and the hotel industry has suffered huge economic losses [15].

2.2. *The Transportation Industry and the COVID-19 Pandemic*

Transportation is the vector through which pathogens are distributed on a regional and global scale. Given that tourism has the characteristic of needing to move [76,77], tourism indirectly supports pandemics. Since the outbreak of COVID-19, the scale of the global crisis has been huge due to restrictions on the use of transportation by countries' authorities around the world; global mobility has ceased [78]. Tourists were infected with COVID-19 on cruise ships, which occurred in countries such as France, Japan, the United States and Australia, resulting in many countries banning cruise ships from docking in their ports [79]. A high risk of influenza infection has been found in transportation vehicles, such as cruises, airplanes, or travel groups [80]. "The spread of covid-19 through frequent long-distance travel, massive cruise ships, and short distance flights" [81]. The COVID-19 outbreak has caused border closures, domestic and international travel has been stopped, and 65 international airlines have reduced flights by 95% [82]. The Allplane website released a piece of news, indicating that the "airline bankruptcy list has been made public"; thirty airlines worldwide declared bankruptcy [83]. "This is an emergency airline around the world is struggling to survive [84]". Approximately 25 million jobs in the tourism industry, the aviation industry, and related value chains are at risk in China during the COVID-19 crisis [84]. In Australia, domestic flights have only reached 10% of their pre-COVID-19 numbers [84]. The demand crisis faced by European airport operations under the COVID-19 pandemic, and the cost to achieve viability [85]. Geneva ATAG indicates that the decline in air transportation this year caused by the COVID-19 pandemic in 2020 will result in the loss of 46 million jobs provided by global aviation [86]. In Malaysia, airlines are facing the risk of bankruptcy, and the airline has asked the Malaysian government to intervene to provide support and assistance to the aviation industry [70]. In Hong Kong, by pre-purchasing 500,000 tickets from Hong Kong-based airlines, the government will provide another USD 260 million in relief to inject liquidity into the airlines [84]. The COVID crisis has led to an unprecedented reduction in the number of tourists, and airport revenues have also dropped significantly [85].

2.3. *COVID-19 Severely Hit the Travel and Tourism Industry*

Due to globalization factors, tourism has been made available to many people, especially the middle class. Therefore, tourism has become one of the largest industrial fields worldwide in the past two decades [87]. The global economic issues caused by the outbreak of the COVID-19 pandemic are unprecedented for the tourism industry, despite it having been previously afflicted by various crises. The tourism industry is the sector most affected by the situation; because the borders are closed, global destinations are inaccessible [88]. The number of international tourists decreased by 1 billion in 2020 [89]. A study in South Korea highlighted that "untact" is a health protection behavior in the tourism industry. The purpose of the research was to explore the impact of COVID-19 risk perception on the behavioral intentions of untact-tourists, based on the framework of the health belief model and extended planning behavior theory; the results provide timely and insightful enlightenment for tourism practitioners [90]. In Vietnam, they studied the impact of COVID-19 on the tourism industry and the government's response, and interviewed 80 tourism practitioners; the results showed that the government's stimulus

plan helped the tourism industry recover, and various practices and opportunities for travel stakeholders were explored [91]. In the Czech Republic, research has discussed the impact of the COVID-19 pandemic on rural tourism [92]. In Queensland, Australia, the relationship between COVID-19 social distancing measures, travel restrictions and cultural tourism in four regions was investigated [93]. In Africa, the current pandemic highlights the fragility of the tourism industry's globalization, and the continent, which relies on global visits and global capital, has suffered huge losses [94].

2.4. Government and the COVID-19 Pandemic

The COVID-19 pandemic, following the Enlightenment and the Industrial Revolution in 1700, is the most recent manifestation of the continuous development and progress of worldwide modernization and globalization [20]. Many exchanges in global economic activity have been reduced, and governments in many countries and regions have imposed unprecedented restrictions on the movement and behavior of their populations [95]. The governments of all regions should face the serious impact of the inbound and outbound tourism travelers on the pandemic, even though the economic contribution of international tourism was previously huge [96]. Therefore, the government's role is critical to the tourism industry's recovery [97,98]. Government warnings and travel bans exacerbate the negative results of the tourism industry [99]. Assuming a link between tourism consumption and the risk of health disasters, because travel increases the risk of infection, governments have imposed travel bans [100]. Therefore, travel companies are required to find innovative conditions [101]. The government needs to seek alleviation measures to support the non-implementation of layoffs, reducing the negative impact of perceptions of job insecurity [15]. In China, research on the social impact of COVID-19 on the tourism and hospitality industry has recommended that government departments and the tourism and hospitality industry tailor travel arrangements according to tourists and apply them to the global tourism market [71]. In Malaysia, the government announced the four phases of the "Movement Control Order," which will involve signing a contract with the tourism industry in Malaysia during the period of the prohibitions and the formulation of effective policies to assist the tourism industry [78]. In Singapore, the research from the SARS experience in 2003 was used for the outbreak of COVID-19 in 2020; the government adopted three measures, including travel, healthcare and community measures, to curb the spread of COVID-19 [102]. A study in Kyoto, Japan analyzed the dynamic process of tourism demand recovery and the applicability of effective policies using the contingent behavior method of quantitative research [103]. In Montenegro, the government, which is focused on tourism, has responded with appropriate macroeconomic policy responses since the outbreak of the COVID-19 [104]. The duration and impact of the crisis on airports will depend on the containment of the virus and the effectiveness of monetary and government fiscal stimulus programs [85].

2.5. Tourism Stakeholders and the COVID-19 Pandemic

Stakeholders in the tourism industry, such as hotels, agents and attractions, are mostly small and medium-sized companies or family-run businesses with "independence" characteristics [105]. Stakeholders might choose to compete or collaborate (or compete and collaborate simultaneously) with their counterparts under different circumstances [106,107]. These stakeholders are the key players in strategic planning, tourism management, or operations [108]. Evidence shows that, during the pandemic, the transportation industry, the hospitality industry, and travel companies are reducing labor and increasing layoffs [65]. Stakeholder relationships come from issues that are critical to creating and distributing value [109]. A study in China analyzed the conflicts between road- and roadless-access tourism in China's large new national park, and a differential tourism stakeholder analysis was conducted [110]. A study in Taichung, Taiwan that used social exchange and stakeholder theory investigated the effect of residents' perceived benefits and costs on the subjective well-being and support of megaevents [111]. A study in Samoa, a tourism

destination in the South Pacific, discussed the COVID-19 pandemic posing a public health threat to Pacific Island countries; the World Health Organization worked with regional stakeholders to respond to Samoa's points on pandemic prevention [112]. In Singapore and Bangkok, a study aimed to curb the on-site vandalism of tourist attractions and participate in tourist attraction management surveys with multiple stakeholders [108]. Collaboration between stakeholders is a criteria factor of disaster management [58]. For the recreation of tourism, stakeholder theory has been adopted to determine the effects of tourism and other events [113,114]. In Canada, a study examined the concept of destination and DMO-related tourism success, and determined whether a relationship existed between the two using research methods such as qualitative research on interview methods and interviews with 84 knowledgeable tourism managers and stakeholders in 25 destinations [113].

After the literature review, the tourism and economy of many countries in the world have been severely impacted by the COVID-19 pandemic, including stakeholders in the hospitality industry, transportation industry, travel companies, the government and tourists, etc. The previous research has been extensively discussed, and there is a gap in the existing research; this paper aims to determine the decision-making criteria factors implemented by stakeholders in the tourism industry to overcome this situation, thereby providing insight for tourism to obtain a clear understanding of how to prepare for the implementation of sustainable development.

3. Methods

The research describes the TRIZ principal tools and the process of resolving contradictions. The DEMATEL procedure and application and measure steps are also described.

3.1. TRIZ Principle

The TRIZ method comes from the Russian acronym TRIZ (*Teoriya Rezhnija Izobretatelskikh Zadach*), which translates to "Theory of Inventive Problem Solving". In 1946, the innovative and problem-solving methods created by Soviet scientist Genrich Altshuller and his team were constructed through extensive research comprising literature reviews and information analysis of more than 1 million patents worldwide [115]. The TRIZ method focuses on solving engineering and technical problems and developing innovation and technical strategies (prediction and planning), and is less used for management problems or other disciplines, such as art and culture, books and writing, process improvement, teaching, training, business models and sports [116]. After several years, TRIZ has led to the development of different tools and technologies, which are summarized as follows: 9 windows, 40 invention principles, 76 standard solutions, rules of evolution, ideality and idea results, functional analysis, effect databases, patterns of evolution, contradiction matrices, substance field resources, smart little people, and ARIZ (an algorithm for inventive problem solving) [60,117]. The TRIZ method should solve single-issue problems in engineering, manufacturing and industry. However, the social science system contains more diverse and complex problems [60]. The TRIZ method is widely accepted and has advantages in its innovative ideas and ability to provide solutions [116]. The TRIZ technical solution model analyzes reliability, repeatability and predictability to solve problems [118]. Since the establishment of the TRIZ system, its systematic approach has been able to efficiently find solutions to problems, and its application to social science problems is appropriate [60].

The TRIZ principle has been applied to an airline's problem-solving method, and the evaluation produces a framework that integrates safe operations and service quality to improve the airline's image [119]. Research in eco-innovation (environmental innovation, green innovation or sustainable innovation) showed gaps and opportunities in the field of advancement; based on the analysis framework developed, part of the construction model used ARIZ and TRIZ methods, and the model was verified [120]. The research purposes and exploration of the development of TRIZ involved various open issues related to the way of thinking, effectiveness, and tool availability of the method, research methods,

and qualitative research that analyzes the literature review. The implementation of TRIZ has also been used in bionics, information processing, and the commercial and service industries [121].

3.2. DEMATEL Method

In 1973, the Battelle Association of Geneva Research Center established the DEMATEL, which is used to study complex and difficult issues, and can effectively understand the complex causal relationship structure. By examining the degree of effectiveness between the criteria factors, using matrix calculations to obtain the causal relationship and effective strength between the elements, a network relationship map such as structural equation modeling is established. DEMATEL uses matrices and related mathematical theories to calculate the causal relationship of each element, converts the relationship between the criteria factors' cause and result into the structural model of the system, and is widely used to solve various types of complex research and provide viable options and solutions for problems [60,61,122–125]. Many different techniques of the MCDM method come from literature reviews, aiming to find the significance level of the criteria factors, including AHP and ANP, but the advantage of DEMATEL is that it can examine the impact relationship map among the criteria factors [126]. With the help of these issues, the causal relationship analysis between the criteria factors can be identified [127,128]. Under a complex environment, the method of managing complex processes is very important. MCDM has an important role and is used by different researchers for different purposes, benefiting the solution of complex phenomena [129]. In this complex context, the DEMATEL method can provide a significant role in determining the weights of the criteria factors and formulating strategies [130]. Studies have investigated the readiness criteria factors for medical tourism in the tourism industry, and the results of using DEMATEL data analysis show the significance of various criteria factors [131]. The steps of the DEMATEL method are described as follows [60,132,133]. The four steps of DEMATEL are illustrated in Figure 1.

Figure 1. The four steps of DEMATEL.

Step 1. The average relationship matrix is gained.

A four-level comparison scale design is provided to measure the relationship between the principles, and then pairwise comparisons are made according to the influence and direction of the expert questionnaire between the criteria factors. Then, like the results of these evaluations, the data can be obtained as a direct relationship, $n \times n$, is a non-negative answer matrix, $X^k = [X_{ij}^k]$. Thus, $X^1, X^2, X^3, \dots, X^m$ are the answer matrix of each M expert, each element of X^k being an integer denoted by X_{ij}^k . The diagonal elements of each answer matrix X^k are all set to zero. Formula (1) is used to average the scores of

all of the expert opinions as m . The average matrix $A = [a_{ij}]$ is denoted as the degree to which criteria factor i influences criteria factor j .

$$a_{ij} = \frac{1}{m} \sum_{k=1}^m x_{ij}^k \quad (1)$$

Step 2. The normalized initial direct relationship matrix is computed.

By normalizing the average matrix A as in Equations (2) and (3), the normalized initial direct relationship matrix D is obtained.

$$\text{Let } z = \max(\max_{1 \leq i \leq n} \sum_{j=1}^n a_{ij}, \max_{1 \leq j \leq n} \sum_{i=1}^n a_{ij}); \quad (2)$$

$$\text{Then, } D = A/z \quad (3)$$

Step 3. The total relationship matrix is computed.

Given that the indirect influence between the criteria factors is based on matrix power, the influence of A continuously decreases. Due to the indirect influence between the criteria factors based on the power of matrix D , e.g., $D^2, D^3, D^4, \dots, D^\infty$, the influence of A continues to decrease, such that it can guarantee the convergent solution of matrix inversion, such as a Markov chain matrix. $\lim_{m \rightarrow \infty} D^m = [0]_{n \times n}$ and $\lim_{m \rightarrow \infty} (D + D^2 + D^3 + \dots + D^m) = D(I - D)^{-1}$, where 0 is the null $n \times n$ matrix and I is the $n \times n$ identity matrix. The total relationship matrix T is an $n \times n$ matrix, and is defined through Equation (4).

$$T = \lim_{m \rightarrow \infty} (D + D^2 + D^3 + \dots + D^m) = D(I - D)^{-1}, \text{ as } m \rightarrow \infty \quad (4)$$

$$r_i = [r_i]_{n \times 1} = \left[\sum_{j=1}^n t_{ij} \right]_{n \times 1}^0; \quad (5)$$

$$c_j = [c_j]_{1 \times n}' = \left[\sum_{i=1}^n t_{ij} \right]_{1 \times n}^0; \quad (6)$$

Step 4. Analysis matrix.

t_{ij} ($i, j = 1, 2, 3, \dots, n$) are denoted as criteria factors in the total relationship matrix, where r_i and c_j are the row sum and column sum in the total relationship matrix T , respectively. Through Equations (5) and (6), the sum of the rows and the sum of the columns are shaped as vectors r_i and c_j , respectively. Then, the horizontal axis vector $(r_i + c_j)$ is made by adding r_i to c_j . The vector is named "Prominence" to show the importance of the criteria factors. Similarly, the vertical axis $(r_i - c_j)$ is named "Relation", which can be obtained by subtracting c_j from r_i , which can divide the criteria factors into cause-and-effect groups. In general, when $(r_i - c_j)$ is positive, the criteria factors belong to the cause group. Otherwise, if $(r_i - c_j)$ is negative, the criteria factors belong to the effect group. The cause-and-effect diagram can be obtained by mapping the data set of $\{(r_i + c_j), (r_i - c_j)\}$. This analysis can provide valuable insights for stakeholders when making decisions.

4. Evaluating the Innovative Principles of the GMTS

The evaluation of the GMTS is divided into three parts. First, the information on the issues that led to the contradictory system construction are summarized. Second, the innovative principles of the system are derived by adopting TRIZ heuristic reasoning. Third, these innovative principles are evaluated by adopting the expert questionnaire survey approach, which uses DEMATEL to measure the standard steps and compute the key innovation principles, such as the criteria factors and feasibility.

4.1. Possible Contradictions of GMTS

Constructing the GMTS involves complex relationships among the stakeholders. The contradiction issues, as illustrated in Figure 2, are collected based on the literature review. The basis of the model is thus constructed [60].

- A. The government prohibits the tourism industry under COVID-19, and the international travel contradictions are as follows:
 1. The government is worried about the spread of the virus due to the flow of tourists increasing the risk of spreading the virus, so the government closes the borders to prevent the spread.
 2. Travel requires tourists to go to the destination to be completed, and international travel of tourists must use transportation to reach the destination to complete the tour.
- B. The contradiction between the transportation industry due to space constraints and the inability of air to flow effectively is as follows:
 1. The capacity of tourist transportation is limited. Given the limited space of airplanes and cruise ships, the air cannot flow effectively of infection.
 2. The cost of travel cannot be based on quantity. Therefore, increasing the space of tourists in a limited space will greatly increase the cost.
- C. Travel companies need to regulate the risk of travel infections, and tourists are worried about international travel:
 1. Travel company regulations increase travel costs, and travel regulations must have pandemic prevention equipment, such as masks.
 2. Tourists are unwilling to increase travel costs; after various costs have increased, tourists will reduce their willingness to travel internationally.
- D. Droplet infection between people in tourist hotel rooms at close range:
 1. The operation of tourist hotels increases costs, and hotels cannot effectively maintain social distance due to close contact, easily spreading the virus.
 2. Travel cannot be effectively controlled; the number of guest rooms in a hotel is limited. If it is divided into several hotels, the travel company cannot control it.
- E. In the international pandemic outbreak, therefore, the government closed the borders and transportation vehicles could not operate effectively internationally:
 1. The government has closed the borders due to the pandemic, barring tourists from international travel and preventing tourists from causing the risk of infectious diseases.
 2. The transportation means cannot operate without tourists, causing transportation to stop operating and causing dilemmas.
- F. In the safety structure of the hotel industry, improving the space under the pandemic is not easy, and the lack of improvement in the space distance will cause a high risk of infection:
 1. The hotel industry cannot easily and effectively improve the space because of safety regulations and the construction of the structure under the government regulations.
 2. There is a high risk of infection caused by the hotel's space and distance; tourism must be improved to stay safe.

Government	E Contradictions 1. Closed borders 2. Dilemma in operation	Transportation Industry
A Contradictions 1. Infectious virus of mobility. 2. Visit destination		B Contradictions 1. Limited space 2. Unquantifiable cost
Travel Company (Intermediaries)	C Contradictions 1. Cost increase 2. Unwilling to increase	Tourist
D Contradictions 1. Difficult to operate 2. Uncontrollable		F Contradictions 1. Space problem 2. High risk of infection
Hotel Industry (Hospitality)		

Figure 2. Issues with the GMTS. “Problems with the LTC cloud system [60]”.

4.2. Application of TRIZ Reasoning Innovation Principles

The premise of constructing the GMTS is to use TRIZ to solve the contradictory issues of the system. COVID-19 tourism topics are innovative and transformative in paradox research because contradictions help creative and innovative thinking [11,134]. In this research, TRIZ is used to obtain innovative principles for the solution of the inherent contradictory types of GMTS. Figure 2 shows six contradictions, namely, A–F. The derivation of the six main contradictions is further described below, among which the TRIZ parameters and innovation principles are summarized in Tables 1–6. These are from Kaplan, pages 39–54 [60,115]. The principle of TRIZ is a process of solving real-world problems with heuristic reasoning. However, under the lack of a scientific basis, existing deviations in professional knowledge may cause differences or feasibility problems. The DEMATEL research method obtained from the scientific theoretical MCDM model can correct possible errors caused by human bias.

- Contradiction Relationship (A): between governments and travel companies—mobility; The infectious virus and tourist arrive at the destination to complete the tour.

The contradiction of the GMTS is that the government is worried about the spread of the virus that causes COVID-19, but travel requires tourists to go to the destination to complete the journey. Based on the contradiction matrix, the TRIZ innovation principle is obtained, and the innovation principle is obtained through the reasoning of the GMTS, A1–A4 Table 1. According to the government’s anti-pandemic viewpoint, the government is worried that the mobility of international travel will cause the spread of the virus. Travel companies have cooperated with the government’s policy to transform international travel into domestic travel. Although an oversupply exists, the government has proposed a plan to stimulate the tourism market to help travel companies to tide over the difficulties. According to the definition, the “undesired result” is that the contradiction parameter in the TRIZ contradiction matrix is #15 (Duration of action of a moving object), and the parameter used to improve this feature is #31 (Object-generated harmful factors). Corresponding to 40 innovative principles using heuristic reasoning to solve tourism in real society, the four TRIZ innovation principles contradicted by the GMTS are: (A1) under a different

context, the government will update the tourism policy in a timely manner to achieve optimal results; (A2) transforming international travel into domestic has a positive effect; (A3) replace international travel with the expansion of on domestic homogeneous travel destinations; (A4) more travel “bubble zones” should be developed to ensure the safety of pandemic prevention.

Table 1. Innovative principles for travel companies and the government.

Issues of the GMTS	Innovative Principles Derived from Heuristic Reasoning for the GMTS
The government is worried about the spread of the virus of travel mobility and travel need tourists to go to the destination to complete	(A1) Under different context, the government will update the tourism policy in a timely manner to achieve optimal results (A2) Transforming international travel into domestic has a positive effect. (A3) Replace international travel with the expand on domestic homogeneous travel destinations. (A4) To conclude with more travel “bubble zones” to ensure the safety of pandemic prevention.
TRIZ parameters	Innovative principles derived from reasoning for TRIZ
Undesired Result (conflict): #15 Duration of action of moving object #31 Object-generated harmful factors	#15 Dynamicity, Optimization #22 Convert harm into benefit, Blessing in disguise #33 Homogeneity #31 Use of porous materials

- Contradiction Relationship (B): between the transportation industry and tourists—capacity is limited and cost cannot be based on quantity.

Airplanes, cruise ships and buses in the tourism industry, as well as hotels in the hotel industry, have limited space and cannot effectively circulate risk of infection. If the space for tourists is increased, the cost will increase significantly, and the price cannot be based on quantity. According to the definition, the “undesired result” is that the contradiction parameter in the TRIZ contradiction matrix is #23, Loss of substance, or #8, Volume of stationary object. This item is addressed through the contradiction matrix and the TRIZ innovation principle pointed out in heuristic reasoning, as shown in B1–B4 in Table 2.

Table 2. Innovative principles for the transportation industry and tourists.

Issues of the GMTS	Innovative Principles Derived from Heuristic Reasoning for the GMTS
The contradiction between the transportation industry due to space constraints and the inability of air to flow effectively.	(B1) Adjust the space separation distance in transportation vehicles cabins in advance. (B2) Improve the atmosphere circulation system of transportation vehicles cabins. (B3) Change the density of transportation cabins in response to the characteristics and number of tourists. (B4) Transport vehicles often use disposable consumables or items that are cleaned and restored to keep the cabins clean, such as alcohol disinfection or items that can mask the respiratory system.
TRIZ parameters	Innovative principles derived from reasoning for TRIZ
Undesired Result (conflict): #23 Loss of substance #8 Volume of stationary object	#10 Prior action #39 Inert environment or atmosphere #35 parameter change, changing Properties #34 Rejection and regeneration, Discarding and recovering

- Contradiction Relationship (C): between travel companies and tourists—the travel company regulates the increase in travel costs, and the tourists are unwilling to increase travel expenditures.

Table 3. Innovative principles for travel companies and tourists.

Issues of the GMTS	Innovative Principles Derived from Heuristic Reasoning for the GMTS
The travel companies regulates the increase in travel costs and the tourist travel costs are unwilling to increase expenditures.	<p>(C1) The travel company arranges various travel-related matters such as cabin interior, and must identify the safety of preventing diseases.</p> <p>(C2) Travel companies arranging travel-related matters must identify the operational procedures to eliminate the risk of infection in advance and make them available to tourist inspection.</p> <p>(C3) The travel company should compulsorily obtain a health quarantine certificate for each tourist each time when performing international travel to prevent infectious diseases.</p> <p>(C4) In this COVID-19 pandemic, travel companies can improve the overall quality and value of travel.</p>
TRIZ parameters	Innovative principles derived from reasoning for TRIZ
Undesired Result (conflict):	#35 parameter change, changing Properties
#35 Adaptability or versatility	#10 Prior action
#36 Device complexity	#28. Replacement of a mechanical system with fields
	#29 Pneumatics or hydraulics

In a pandemic, travel companies must pay more for the related costs of tourist equipment and budget in the travel regulations to prevent tourists from becoming infected due to international travel. However, because the number of tourists continues to increase various travel costs, such as air ticket fares, hotel rates and insurance costs, tourists have reduced their willingness to travel internationally and encounter conflicts. According to the definition, the “undesired result” is that the contradiction parameters in the TRIZ contradiction matrix are #35, Adaptability or versatility, and #36, Device complexity. This item is addressed through the contradiction matrix and the TRIZ innovation principle pointed out in the heuristic reasoning, as shown in C1–C4 in Table 3.

- Contradiction Relationship (D): between travel companies and the hospitality industry—the increased cost of tourist hotel operation and the ineffective control of the travel company.

Table 4. Innovative principles for travel companies and the hospitality industry.

Issues of the GMTS	Innovative Principles Derived from Heuristic Reasoning for the GMTS
The increased cost of tourist hotel operation and the ineffective control of tourism.	<p>(D1) The volume density of hotel cabins must be adjusted according to the characteristics of tourist and the tourist numbers.</p> <p>(D2) Travel companies should establish contact groups during each trip to increase contact frequency and effective control.</p> <p>(D3) The hotel industry obtains tourist information and quarantine certificates in advance when administer accommodation business to prevent infectious diseases.</p> <p>(D4) In context of infectious diseases, travel companies and the hotel industry have advanced the concept of a single prevention room, which reverses the traditional concept of a two-person travel room.</p>
TRIZ parameters	Innovative principles derived from reasoning for TRIZ
Undesired Result (conflict): #37 Difficulty of detecting and measuring #23 Loss of substance	<p>#35 parameter change, changing Properties</p> <p>#18 Mechanical vibration/oscillation</p> <p>#10 Prior action</p> <p>#13 Inversion, the other way around</p>

After the outbreak of the pandemic, droplets spread from people to people in various regions, especially at close distances. The hotel industry was greatly affected. Hotels cannot effectively maintain social distance due to space factors. Therefore, the number of guest rooms in hotels is limited. If maintaining social distancing and staying in other hotels separately are desired, travel companies will not be able to effectively control the tourist situation. According to the definition, the “undesired result” is that the contradiction parameter in the TRIZ contradiction matrix is # 37, Difficulty of detecting and measuring, and #23, Loss of substance. This item is addressed through the contradiction matrix and the TRIZ innovation principle pointed out in heuristic reasoning, as shown in D1–D4 in Table 4.

- Contradiction Relationship (E): between the government and the transportation industry—in the international pandemic outbreak, the government closed the borders, and transportation vehicles could not operate effectively internationally.

In the global pandemic, governments of various countries and regions closed their borders to avoid the risk of infectious diseases. Airplanes, cruise ships and buses in various places have completely ceased operations, and the transportation industry has suffered serious closures. According to the definition, the “undesired result” is that the contradiction parameter in the TRIZ contradiction matrix is #11, Stress or pressure, and # 26, Quantity of substance. This item is addressed through the contradiction matrix and the TRIZ innovation principle pointed out in the heuristic reasoning, as shown in E1–E3 in Table 5.

Table 5. Innovative principles for the government and the transportation industry.

Issues of the GMTS	Innovative Principles Derived from Heuristic Reasoning for the GMTS
The international pandemic outbreak, therefore, the government closed the borders and the transportation vehicles could not operate effectively internationally.	(E1) Change the structural quality of the transportation system and effectively prevent disease infection. (E2) The design of the transportation vehicle cabin was changed, and the space replaced the straight line with the curve, and the curved surface replaced the plane. (E3) Take advantage of the occurrence of the pandemic to quickly change the Overall pandemic prevention structure of transportation vehicles.
TRIZ parameters	Innovative principles derived from reasoning for TRIZ
Undesired Result (conflict): #11 Stress or pressure #26 Quantity of substance	#3. Local Quality #14. Spheroidality, Curvilinearity #36. Phase transformation #10 Prior action (repeat)

- Contradiction Relationship (F): between tourists and the hotel industry—the safety structure of the hotel industry introduces difficulties in improving the space during the pandemic, and the lack of improvement in the space distance will cause a high risk of infection.

The structure of the government-managed hotel industry is significant in its construction regulations, and hotels cannot arbitrarily change their building structure; the inability to improve the space distance immediately will effectively lead to a high risk of infection. The hotel's space and distance introduce a high risk of infection, and the reduction in hotel accommodation rates has caused problems. This conflict has caused a dilemma in the hotel industry. According to the definition, the “undesired result” is that the contradiction parameters in the TRIZ contradiction matrix are #6, Area of moving object, and #31, Object-generated harmful factors. This item is addressed through the contradiction matrix and the TRIZ innovation principle pointed out in the heuristic reasoning, as shown in F1–F3 in Table 6.

Table 6. Innovative principles for tourists and the hotel industry.

Issues of the GMTS	Innovative Principles Derived from Heuristic Reasoning for the GMTS
The safety structure of the hotel industry is not easy to improve the space under the pandemic, and the lack of improvement in the space distance will cause high risk of infection.	(F1) Without damage to the structure, it is effectively divided into separate tourist hotel rooms to prevent infection. (F2) Convert harm into benefit. The space saved in the hotel will be added to useful facilities for tourists, such as independent reading rooms. (F3) Change the hotel space to use composite materials to prepare for appropriate adjustments at any time.
TRIZ parameters	Innovative principles derived from reasoning for TRIZ
Undesired Result (conflict): #6 Area of moving object #31 Object-generated harmful factors	#1 Segmentation #22 Convert harm into benefit #40 Composite materials

4.3. Evaluating DEMATEL Innovation Principles

Through the invented reasoning method in TRIZ heuristics, innovative principles and criteria factors have been derived from the contradiction between COVID-19 and stakeholders in the tourism industry. Simultaneously, it must be ranked against these

innovative principles. In this research, steps will be provided to analyze the relationship among the key principles of the DEMATEL method.

Step 1. DEMATEL expert questionnaire design and proposition

Using the DEMATEL method to assess the relationship among stakeholders in the complex tourism industry is appropriate. The innovative principles and criteria factors derived from TRIZ heuristic reasoning are converted, and the propositions are in the DEMATEL questionnaire format. In the questionnaire, experts are required to choose scores of 0, 1, 2, 3, or 4, which indicate the degree of influence. Here, 0 represents no influence, 1 represents low influence, 2 represents medium influence, 3 represents high influence, and 4 represents extremely high influence.

Step 2. Questionnaire survey of tourism stakeholders and experts

During the pilot test of the questionnaire in this study, we invited two researchers, professors, and associate researchers from academic research universities. They participated in the pre-test and confirmed the appropriateness of the questionnaire's propositions and term explanations. For the formal questionnaire, we invited two tourism experts from government officers, three experts from travel companies, three experts from the transportation industry, three experts from the hotel industry and two experts from the university tourism field to conduct the DEMATEL survey. A total of 15 experts were invited, with an average seniority of 27 years.

Step 3. Compute and analyze DEMATEL

The official questionnaire was completed between December 2020 and February 2021. Due to the COVID-19 pandemic, borders and travel bans, all countries and regions are still closed, and tourism stakeholders' industries are in a period of vulnerability. The 13 complete expert questionnaires were conducted over three months. The valid questionnaires were analyzed by referring to the DEMATEL method.

Step 4. DEMATEL causal diagram analysis results

The study obtained 11 criteria factor scales based on the TRIZ invention principle. Following the four-score survey results of the expert questionnaire, DEMATEL was used to compute the causal relationship among various criteria factors, and a diagram was constructed to explain the significance of the criteria factors. The DEMATEL data were integrated with cause-and-effect diagrams to produce quantitative objective analysis, which proves the contribution of this research.

5. Results

5.1. General Analysis of DEMATEL

In this research, the expert questionnaire of innovation principles obtained by tourism stakeholders in TRIZ heuristic reasoning adopted DEMATEL matrix analysis to obtain the results to construct the GMTS aspect. This questionnaire was derived from the tourism industry. Experts in the stakeholder industry, comprising five organizations—namely, the government, tourism companies, the transportation industry, the hotel industry, and universities—were invited. A total of two pre-test questionnaires and 13 formal expert questionnaires were individually administered through the survey, based on the experts' professional experience evaluation and knowledge related to TRIZ's problem-solving to prove the validity of expert evaluation. Table 7 provides details.

Table 7. Background of the experts.

Stakeholders	No	Experts Organizations/Title	Seniority
Pilot	1	National Central University/professor	35
Questionnaire	2	Feng Chia University/associate researcher	26
Government	3	Tourism Bureau, Republic of China (Taiwan)/deputy director	17
	4	Taoyuan City Government/deputy district chief	15
Travel Company	5	Poa International Travel Agent/general manager	30
	6	Hsi Hung Travel Service Co. Ltd./director	30
	7	Grandee Express Crop/chairman	40
Transportation Industry	8	EVA Airways Corporation/director	26
	9	Overseas Travel Service (Airlines & Cruises GSA)/general manager	20
	10	Chinese Maritime Transport Ltd./senior manager	46
Hotel (Hospitality) Industry	11	Shangri-La's Far Eastern Plaza Hotel Taipei/manager	14
	12	Le Méridien Taipei/supervisor	10
	13	Sunworld Dynasty Hotel Taipei/manager	33
Academic University	14	Tungnan University Tourism Department/associate professor	30
	15	Ming Chuan University Tourism field/assistant professor	35

According to the expert questionnaire, the DEMATEL formula was used to compute the causal relationship among the various criteria factors of the influence matrix; see Table A1 (in Appendix A).

Three steps were used to analyze the DEMATEL results. First, we computed the total relationship matrix based on the results of the expert questionnaire. Second, as shown in Table 8, we computed the significance of the criteria factors ($ri + cj$) and ($ri - cj$) based on the total relationship matrix. ($ri + cj$) and ($ri - cj$) were used as the coordinates to construct the causal diagram. Third, in order to obtain the key influence criteria factors, this study set the threshold value as the standard deviation plus the average value to adjust it appropriately [60,135].

Table 8. The significance of the criteria factors.

Criteria Factors	ri	cj	ri + cj	ri - cj
A1 Optimization Policy	6.994	7.212	14.207	−0.218
A2 Conversion Policy	7.531	7.128	14.659	0.404
A3 Internationalization Strategy	6.811	7.005	13.816	−0.195
A4 Quality Management	7.514	6.228	13.742	1.287
B1 Distance Control	6.218	6.455	12.673	−0.236
B2 System Management	6.559	6.448	13.007	0.111
B3 Humanized Management	6.532	6.800	13.332	−0.268
B4 Cleaning Management	6.936	7.164	14.100	−0.228
C1 Tourism Regulations	7.081	6.973	14.053	0.108
C2 Transparency Strategy	6.852	6.951	13.803	−0.099
C3 Mandatory Policy	6.800	6.884	13.684	−0.084
C4 Upgrade Strategy	6.230	6.414	12.644	−0.184
D1 Space Management	6.507	7.147	13.653	−0.640
D2 Security Control	6.377	13.617	19.994	−7.241
D3 Hotel Regulations	6.520	6.769	13.289	−0.248
D4 Health Management	5.045	6.268	11.313	−1.223
E1 Structure Management	6.456	6.237	12.694	0.219

Table 8. *Cont.*

Criteria Factors	ri	cj	ri + cj	ri – cj
E2 Space Design	6.144	5.443	11.587	0.702
E3 Structure Preparation	6.140	6.174	12.314	−0.035
F1 Guest Room Management	6.446	6.428	12.874	0.018
F2 Hotel facilities Management	6.038	5.643	11.681	0.394
F3 Hotel Material Preparation	6.431	5.921	12.352	0.511

The total relationship matrix was used to select the threshold value. Below the threshold value, the value is considered to have the least impact on the relationship, and can therefore be ignored. This finding helps to clearly show the causal relationship among the criteria factors. The key influence threshold value of this study was set as the standard deviation plus the average value, with 0.344 as the standard. This determined 11 important criteria factors. According to the 11×11 matrix of the expert questionnaire, which was then computed by DEMATEL, the results were $A2 > A1 > B4 > C1 > A3 > C2 > A4 > C3 > D1 > B3 > D3$, as shown in Table 9.

Table 9. The value above the threshold of the criteria factors.

Criteria Factors	ri	cj	ri + cj	ri – cj
A1 Optimization Policy	6.994	7.212	14.207	−0.218
A2 Conversion Policy	7.531	7.128	14.659	0.404
A3 Internationalization Strategy	6.811	7.005	13.816	−0.195
A4 Quality Management	7.514	6.228	13.742	1.287
B3 Humanized Management	6.532	6.800	13.332	−0.268
B4 Cleaning Management	6.936	7.164	14.100	−0.228
C1 Tourism Regulations	7.081	6.973	14.053	0.108
C2 Transparency Strategy	6.852	6.951	13.803	−0.099
C3 Mandatory Policy	6.800	6.884	13.684	−0.084
D1 Space Management	6.507	7.147	13.653	−0.640
D3 Hotel Regulations	6.520	6.769	13.289	−0.248

5.2. Causal Diagram

The value above the threshold was used to draw the causal diagram in Figure 3. By subtracting cj from ri, the vertical axis (ri – cj) named “relationship” can be obtained, which can be identified as the cause group in Figure 3.

Figure 3. Causal Diagram. If $(r_i - c_j)$ is negative, the criteria factors are grouped into effect groups. The findings indicate that the causal diagram is described as follows. The evaluation criteria factors include the conversion policy (A2), quality management (A4) and tourism regulations (C1) as the criteria factors cause group. The optimization policy (A1), internationalization strategy (A3), humanized management (B3), cleaning management (B4), transparency strategy (C2), mandatory policy (C3), space management (D1) and hotel regulations (D3) are the criteria factor effect groups.

5.3. Cause Group Analysis of the Criteria Factors

After we adopted the DEMATEL matrix analysis, the resulting causality affected the GMTS criteria factors. However, their performance may affect the overall goal and direction. The criteria factors in the cause group should attract more attention. In the causal diagram (Figure 3), the single-headed arrows represent the direction of the effect of the criteria factors on others; the double-headed arrows represent effects in both directions. For example, (A4) directly affects (A2, A3, B3, B4, C1, C2, C3, D1, D3) and is mutually affected by A1 among all of the criteria factors in the cause category. The highest quality management (A4) had an $(r_i - c_j)$ score of 1.287, meaning that A4 has a greater impact on the entire GMTS. In addition, Table 9 shows that, among all of the causal relationships, the influence c_i of A4 is 7.514, ranking in the top two. Therefore, A4 has a significant impact on the other criteria factors. Generally, A4 is the main criteria factor that has attracted more attention in the theory and practice of GMTS. The second is (C1), of which the $(r_i + c_j)$ score of 14.053 is a very high score among all of the GMTS criteria factors, and of which the $(r_i - c_j)$ score of 0.108 is positive, affecting the other criteria factors. Finally, in (A2), the $(r_i - c_j)$ score is positive, showing that A2 is also a causal criteria factor of the GMTS. However, its $(r_i + c_j)$ score of 14.659 is the highest among all of the GMTS criteria factors. A2's ability to improve the GMTS, according to r_i is 7.531 score and c_j is 7.128 score, it has a high impact on other criteria factors.

5.4. Effect Group Analysis of the Criteria Factors

The criteria factors in the effect group are often susceptible to the influence of other criteria factors, making the effect criteria factors unsuitable as key success criteria factors. Nevertheless, discussing the effect criteria factors is still necessary to find out the feature of each criteria factor. (D1) ($r_i + c_j$) ranks second at the end, indicating that it is an easily affected criteria factor in the meaning of the GMTS. Furthermore, the score of ($r_i - c_j$) of (D1) is -0.640 , which is the minimum value among the impact criteria factors. In order to further explain this phenomenon, the influence degree ($r_i + c_j$) is 13.653 . The influencing criteria factors are relatively small, meaning that (D1) is one of the most easily affected criteria factors (Figure 3), and obviously will affect other criteria factors and the GMTS. In the causality diagram, (C2) is the effect criteria factor, and ($r_i - c_j$) is -0.099 , which is slightly lower than zero. This finding shows that (C2) is only slightly affected by other criteria factors and has a considerable impact on the GMTS. (C2) ($r_i + c_j$) is 13.803 as the intermediate score, which can be marked as an impact standard basis. The (A1) ($r_i + c_j$) score of 14.207 ranks second and the (B4) 14.100 score of 14.100 ranks third, but because the ($r_i - c_j$) scores are negative, improvement is needed. However, these results have little effect on GMTS. The same applies for (A3), (C3), (D3) and (B3).

6. Discussion

This study selected the threshold value through the total relationship matrix. A value higher than the threshold value is considered to have the greatest impact on the relationship. In total, 11 criteria factors were adopted to improve the construction of the GMTS. According to the analysis results, several management implications were derived. Owing to its impact on the effect group criteria factors, the cause group criteria factors must be focused on in advance [136]. Past studies have shown that the cause group criteria factors are difficult to implement, while the effect group criteria factors are easy to implement [137]. Furthermore, the criteria factors in the effect group are easily affected by other criteria factors, and predicting the impact on other criteria factors when they are implemented is difficult, resulting in further difficulties in implementation.

The study found that when constructing the GMTS, the focus was on the four criteria factors of quality management (A4), conversion policy (A2), transparency strategy (C2), and space management (D1). After analyzing and drawing the causal diagram, (A4) was the cause group. When implementing tourism quality management, government departments only interact with the optimization policy (A1). Simultaneously, (A1) affected all criteria factors and was not affected by other criteria factors. It was regarded as the first significant criteria factor to implement GMTS. (A2) was the cause group, namely, the implementation of the government unit transformation policy, and (A1, B4 and C1) interact with each other, which can be regarded as the second criteria factor in the implementation of the criteria factors. (C2) was the effect group, namely, the intermediate value of the transparency strategy of the travel company among the 11 criteria factors, indicating that (C2) was the basic criteria factor in the entire GMTS. (D1) was the effect group; the space management of travel companies and the hotel industry were also the criteria factors that were most affected when the GMTS was executed. The results analysis showed that the improvement effect criteria factors group (A1, A3, B3, B4, C2, C3, D1, D3) and the cause criteria factors group (A2, A4, C1) can reach the effect criteria factors. In terms of the DEMATEL data computed, the (A2) conversion strategy was the most important criteria factor affecting GMTS. However, in the causality diagram (A4), quality management was the least affected by other criteria factors when the GMTS was constructed, meaning that the government's quality management will not be affected by other criteria factors. This research quality management means "to conclude with more travel bubble zones", which was the first GMTS criteria factor considered. The "travel bubble" enables tourists to travel to allied countries without quarantine, reducing the risk of travel to destinations [82]. Furthermore, it was proven that the government's conversion policy (A2) and tourism regulations (C1) are of almost the equal importance. The losses and recovery caused by the

pandemic require government assistance [10,82,97,98,104,138]. This echoes past research. The causal diagram shows that the optimization policy (A1), cleaning management (B4), and space management (D1) were in the effect group. The three criteria factors were the most susceptible to the impact of each criteria factor; indeed, these three criteria factors were not difficult to implement. A problem arises when the implementation of the other criteria factors are changed under the context, and these three criteria factors were also affected. They were the most vulnerable part of the GMTS. The three criteria factors of mandatory policy (C3), humanized management (B3) and hotel regulations (D3) were in the effect group, and were not the primary criteria factors to be implemented. However, the other criteria factors have little impact on these three criteria factors, it was a relatively stable criteria factors in the implementation of GMTS. Finally, internationalization strategy (A3) was in the effect group, which does not considerably affect other criteria factors, nor was it the criteria factors that was mainly affected. (A3) can be regarded as a criteria factors that was implemented later.

6.1. Implications for Research

This study is the first to extend TRIZ principles and two DEMATEL methods to construct a GMTS; 15 experts participated in the research, there were 13 experts' questionnaires, and they examined the decision-making criteria factors implemented by tourism stakeholders to address the issues of the pandemic crisis. Decision makers can evaluate the sustainable development of their industry; that is, stakeholders can use GMTS to solve the dilemma when the crisis affects the tourism industry. This innovative model is the first time that it has been applied to the crisis of the tourism industry, and it contributes to the academic literature. Kock and Assaf [56] aimed to advocate for the originality of tourism research. They hoped that tourism scholars would propose an innovative and creative transformation process for the tourism industry [57]. Previous research discussed crisis decision-making regarding tourism, international tourism product decisions [47], tourists' decision-making on tourist destinations [26], tourism risk perception and tourists' decision-making behavior [50] and hotel room rate decision-making [69]. However, research discussing a gap model of decision-making is lacking. Our findings are that the government's decision-making to establish "bubble zones" in quality management (A4) and the travel companies to promote products in "bubble zones" destinations can improve the problem of stakeholders under the impact of the COVID-19 pandemic. In Hong Kong, China, the "travel bubble" plan allows tourists to travel to the country without quarantine, and the relationship between the destination of the COVID-19 pandemic "travel bubble" and travel intent has been investigated [82]. In Ho Chi Minh City, Vietnam, qualitative and quantitative methods were used to discuss and study the human-machine interactive (HMI) technologies and the psychological factors in the "bubble zones" of tourist destinations [53]. In the Pacific, this is a commentary article; the COVID-19 pandemic has caused travel restrictions, and the economies of these 22 countries have been severely hit; as Australia and New Zealand are effectively managing COVID-19, the "bubble" plan may allow the tourism that many countries depend on to begin flowing again [139]. The previous discussion was on the tourism "bubble zones" and the tourism industry. This study aimed to provide GMTS to address this issue; tourism stakeholders will establish the new GMTS to solve the dilemma under the influence of COVID-19. In addition, it was also found that conversion policy (A2) and tourism regulations (C1) are criteria factors that need to be improved. However, when the two criteria factors are immediately improved, other criteria factors will be affected simultaneously, and the degree of improvement will be weakened. The two criteria factors are necessary for future improvement. This article has developed new insights on COVID-19 and tourism stakeholders to bridge the gap in the literature.

6.2. Implications for Practice

The government must solve the dilemma of the tourism industry under the pandemic situation, and its most important task is to conduct the effective quality management (A4) of the tourism “bubble zones”. The health and safety strategy of travel companies, the management of space density in the transportation industry, and the distance and equipment integration of the hotel industry all require government policy support and implementation. These improvement processes should not incur excessive expenses for tourists. Therefore, the government can make decisions to improve the issues affecting tourism in the pandemic. Travel companies are the most important operators in arranging travel groups, and as stakeholders in the tourism industry, they are the travel intermediaries planning the tour itinerary for tourists. Travel companies must propose a set of management regulations for the health and safety of tourists. Such regulations include transparent travel health and safety instructions, discussing the timely adjustment of cabin space in the transportation industry, introducing effective hotel equipment pandemic prevention concepts, cooperating with government policies to plan travel quality management strategies suitable for tourists, and implementing quality management. These steps can achieve sustainable conditions for stakeholders in the tourism industry under the pandemic.

In the past, there have been many and huge crises in the tourism industry, and when the stakeholders of the tourism industry face every crisis, they can only passively respond to the impact of the crisis and wait for the crisis to pass to restart the mechanism of tourism. However, this COVID is different from the previous crisis. Nature magazine stated that “the virus cannot be completely eradicated within a few years” [140].

In practice, the transportation industry and hospitality industry are unable to immediately improve the space and density of cabins due to legal safety regulations and structural regulations. Travel companies are constrained by the transportation industry and the hospitality industry, and cannot propose methods to implement safe behaviors. Increasing travel costs are not what the tourists expect. The government is unable to propose effective compulsory regulations, and tourism stakeholders will face a significant impact during the pandemic crisis. In this study, a GMTS method was constructed, and a decision-making model that can solve the problem of the stakeholders in the tourism industry was proposed. The TRIZ principle and the DEMATEL method were adopted to analyze the most important quality management (A4) criteria factors for improvement, providing practical insights. The criteria factors in decision-making in the event of a crisis in the tourism industry can solve the crisis problem. It further suggested criteria factors for the improvement of tourism-related industries for the purpose of sustainable development of the industry.

7. Conclusions and Contribution

7.1. Conclusions

Tourism has become one of the most important industries in the world. Tourism has also caused disasters and crises such as viruses and infectious diseases due to tourist mobility. It affects economic benefits, employment opportunities and international exchanges. These effects have become more and more important. Many discussions have been held about the COVID-19 pandemic, and extensive debates have been conducted in academic research. However, the modeling constructions of stakeholders in the tourism industry have rarely been studied. To the best of our knowledge, this paper is the first to adopt TRIZ and DEMATEL methods to study this phenomenon. The COVID-19 pandemic is an ideal test-bed for this study, and this research will drive useful implications for stakeholders in the tourism industry.

This study surveyed the contradictions and conflicts among stakeholders of the tourism industry, such as the government, travel companies, the transportation industry and the hospitality industry in the COVID-19 pandemic, and established the criteria factors for the implementation of a GMTS. The study constructed a 22-item relationship matrix under the heuristic reasoning of the TRIZ invention principle. After analysis by DEMATEL

to obtain the key impact criteria factors, the threshold value was adjusted appropriately to obtain 11 important relationship criteria factors, a new model was constructed and the key criteria factors were determined. The value of the model was confirmed in the survey. The three most important criteria factors of the DEMATEL matrix were computed and the data were analyzed, and that significantly affected the criteria factors in the decision-making.

The three criteria factors of the conversion policy (A2), optimization policy (A1), and cleaning management (B4) were the most important criteria factors for the GMTS to make immediate decisions in this study. In other words, when the tourism industry is affected by a pandemic, the stakeholders of the tourism industry will produce significant criteria factors in the decision. However, another indicator that is more important is the criteria factors relationship. When the cause group is a positive number, the higher the relationship, the higher the degree of importance, and the higher the willingness to improve these criteria factors. Simultaneously, when the effect group is a negative number, this represents the criteria factors that are affected. Therefore, no space is available for improvement in the comparison of these criteria factors. The criteria factor of the conversion policy (A2) has the highest importance, followed by quality management (A4) and tourism regulations (C1).

In addition to the matrix analysis, the direction of the arrows in the causal diagram implies important management implications. The causal diagram in Figure 3 indicates that the quality management (A4) arrows point to 10 criteria factors, which are only with the optimization policy (A1). The double arrows indicate that they influence each other, meaning that quality management will not be affected by the 10 relationship criteria factors when implementing GMTS decision-making, resulting in the most significant improvement effect. Second, the conversion policy's (A2) single arrow affects internationalization strategy (A3), humanized management (B3), transparency strategy (C2), mandatory policy (C3), space management (D1) and hotel regulations (D3). Double arrows indicate that tourism regulations (C1), cleaning management (B4) and optimization policy (A1) influence each other. If quality management (A4) is used as a decision-making improvement, it will affect the relationships of the six criteria factors, but the influence of a criteria factor may weaken the degree of improvement under the two-way influence, and the improvement effect cannot be evaluated. Finally, tourism regulations' (C1) single-arrow affects optimization policy (A1), cleaning management (B4), space management (D1), internationalization strategy (A3) and transparency strategy (C2). Double arrows indicate that the criteria factors affect each other with conversion policy (A2). Quality management (A4) will affect five criteria factors, but it will also be affected by two criteria factors, and the improvement effect is limited. This study indicates that quality management (A4) is the most important decision-making criteria factor for stakeholders in the tourism industry; quality management is found in the relationship between the government and travel companies. This study clarified the degree of influence of key criteria factors and the causal relationship among many complex criteria factors, and determined the most important criteria factors. This finding is a significant outcome of this research.

This research background in Taiwan adopted TRIZ principles and DEMATEL methods to construct a GMTS, which solved the tourism industry decision-making problem under COVID-19. We solved three problems. First, this research provided a new model GMTS to solve the issues of tourism stakeholders. Second, the research identified the decision-making criteria factors implemented by tourism stakeholders, quality management, conversion policies and tourism regulations that decision-makers can use to evaluate their industry's approach to sustainable development. Finally, it examined the criteria factor implementation perspective. Travel "bubble zones" that ensure both "safety and quality" were concluded upon under government policies in countries and regions of the world. Furthermore, the tourism industry is responsible for the overall "planning and management" of the travel "bubble zones". Therefore, the "quality management" criteria factor provides important key decision-making for tourism stakeholders.

7.2. Contribution

The present study contributes to the literature in several important aspects. First, it provided an innovative model that integrates the TRIZ and DEMATEL methods to resolve the conflicts and contradictions of the issues of stakeholders in the tourism industry, and identifies the decision-making criteria factors implemented by tourism stakeholders so that decision-makers can evaluate their industry's approach to sustainable development. Second, this study explored the practice of the identified criteria factors that provide stakeholders with insight into the existing capabilities in the implementation of decision-making under a crisis to bridge the research gap. Finally, in the process of constructing GMTS, the key criteria factor relationships that prioritize addressing contradictions and conflicts have practical value. The paper also provides research literature and practice implications for stakeholders in the tourism industry.

8. Limitations and Future Research

8.1. Limitations

This research reviewed the literature for a macro study of tourism stakeholders. The data came from the Asian island country of Taiwan. However, the industry model of tourism stakeholders is alike all over the world. Subsequent studies can adopt sample tourism stakeholders from different industries and countries to examine the validity of the results. This research used the TRIZ principle to formulate an expert questionnaire and then analyzed it with the DEMATEL matrix. The key criteria factors were determined by just 13 experts of tourism stakeholders. Increasing the number of tourism stakeholders involved can enable broader discussions on the implementation of GMTS. In addition, the key criteria factors in this study were concentrated during the COVID-19 period, and these key criteria factors should be further explored in the post-implementation stage.

8.2. Future Research

Further studies will benefit from similar research that can focus on meso and micro issues in the post-COVID-19 pandemic. For subsequent research, micro studies could be conducted in areas such as the catering industry, education departments, tourism destination management organizations, or retail stores. Data sources could be collected. Micro research could be conducted on a single industry, such as the criteria factor relationship among travel companies and related stakeholders. In the research method, the qualitative research interview method was used to deeply investigate each tourism industry and obtain key criteria factor relationships. After the DEMATEL analysis, the weights were analyzed and the problems were solved. Critical future research needs to understand these changes and make greater contributions to the tourism industry in the post-pandemic era.

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Appendix A

Table A1. Influence matrix.

	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	F1	F2	F3
A1	0.306	0.353	0.341	0.305	0.314	0.317	0.334	0.355	0.343	0.345	0.341	0.315	0.345	0.320	0.334	0.296	0.300	0.260	0.297	0.311	0.274	0.287
A2	0.382	0.325	0.372	0.331	0.338	0.335	0.356	0.376	0.366	0.368	0.363	0.333	0.368	0.340	0.357	0.329	0.330	0.288	0.324	0.340	0.300	0.309
A3	0.344	0.340	0.289	0.296	0.306	0.307	0.323	0.338	0.331	0.332	0.325	0.308	0.341	0.311	0.325	0.295	0.294	0.256	0.293	0.306	0.270	0.281
A4	0.376	0.376	0.367	0.284	0.338	0.340	0.355	0.373	0.362	0.362	0.363	0.339	0.373	0.338	0.354	0.331	0.327	0.289	0.324	0.337	0.296	0.309
B1	0.314	0.309	0.299	0.272	0.243	0.281	0.298	0.312	0.305	0.303	0.298	0.284	0.309	0.284	0.290	0.269	0.273	0.236	0.271	0.274	0.239	0.253
B2	0.331	0.327	0.320	0.284	0.297	0.256	0.315	0.327	0.319	0.317	0.314	0.292	0.327	0.295	0.311	0.288	0.290	0.253	0.285	0.291	0.253	0.267
B3	0.334	0.326	0.323	0.284	0.295	0.295	0.269	0.327	0.312	0.314	0.309	0.291	0.328	0.291	0.308	0.286	0.290	0.249	0.287	0.292	0.254	0.267
B4	0.354	0.349	0.345	0.303	0.318	0.317	0.326	0.301	0.338	0.335	0.333	0.308	0.345	0.312	0.329	0.299	0.304	0.263	0.299	0.309	0.266	0.283
C1	0.361	0.352	0.349	0.311	0.323	0.320	0.339	0.357	0.299	0.346	0.341	0.315	0.348	0.319	0.333	0.311	0.303	0.266	0.302	0.318	0.277	0.291
C2	0.344	0.338	0.337	0.300	0.310	0.304	0.324	0.343	0.340	0.289	0.334	0.309	0.345	0.315	0.322	0.300	0.296	0.256	0.290	0.308	0.266	0.281
C3	0.341	0.331	0.329	0.298	0.306	0.306	0.322	0.346	0.339	0.332	0.284	0.301	0.339	0.311	0.322	0.297	0.293	0.259	0.293	0.302	0.269	0.280
C4	0.318	0.315	0.309	0.268	0.279	0.280	0.292	0.310	0.304	0.301	0.296	0.242	0.310	0.282	0.293	0.269	0.269	0.236	0.268	0.283	0.246	0.258
D1	0.329	0.327	0.320	0.280	0.292	0.293	0.310	0.326	0.312	0.315	0.312	0.289	0.282	0.292	0.307	0.290	0.283	0.246	0.279	0.296	0.257	0.271
D2	0.323	0.320	0.315	0.282	0.285	0.283	0.298	0.317	0.312	0.310	0.312	0.288	0.317	0.250	0.299	0.275	0.275	0.242	0.274	0.283	0.252	0.264
D3	0.327	0.320	0.316	0.283	0.291	0.291	0.305	0.325	0.319	0.323	0.321	0.292	0.330	0.296	0.267	0.289	0.281	0.243	0.273	0.294	0.261	0.273
D4	0.251	0.251	0.244	0.221	0.222	0.226	0.237	0.251	0.245	0.247	0.240	0.227	0.257	0.227	0.239	0.193	0.220	0.187	0.212	0.232	0.204	0.214
E1	0.320	0.319	0.314	0.280	0.295	0.295	0.309	0.325	0.316	0.315	0.310	0.289	0.319	0.287	0.306	0.282	0.244	0.247	0.286	0.284	0.250	0.264
E2	0.305	0.305	0.297	0.262	0.278	0.280	0.297	0.307	0.297	0.298	0.295	0.272	0.305	0.275	0.291	0.267	0.273	0.202	0.270	0.273	0.243	0.253
E3	0.307	0.307	0.297	0.268	0.283	0.282	0.296	0.309	0.298	0.294	0.290	0.276	0.302	0.271	0.287	0.265	0.273	0.237	0.230	0.273	0.240	0.253
F1	0.325	0.321	0.316	0.281	0.285	0.283	0.303	0.320	0.312	0.309	0.306	0.289	0.328	0.291	0.307	0.288	0.277	0.246	0.276	0.251	0.257	0.274
F2	0.298	0.299	0.293	0.258	0.271	0.271	0.289	0.301	0.290	0.289	0.288	0.269	0.306	0.273	0.284	0.263	0.262	0.233	0.261	0.275	0.206	0.258
F3	0.322	0.320	0.315	0.277	0.285	0.285	0.302	0.319	0.311	0.307	0.307	0.286	0.322	0.291	0.304	0.285	0.277	0.247	0.279	0.296	0.262	0.231

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