sustainability

MDPI

Article

A Proposed DISE Approach for Tourist Destination Crisis Management

Sunny Sun [1], Lina Zhong [2,*], Rob Law [3], Xiaoya Zhang [4], Liyu Yang [2] and Meiling Li [2]

[1] College of Asia Pacific Studies, Ritsumeikan Asia Pacific University, 1-1 Jumonjibaru, Beppu 874-8577, Japan
[2] Institute for Big Data Research in Tourism, School of Tourism Sciences, Beijing International Studies University, Chaoyang District, Beijing 100024, China
[3] Asia-Pacific Academy of Economics and Management, Department of Integrated Resort and Tourism Management, Faculty of Business Administration, University of Macau, Avenida da Universidade, Taipa, Macau 999078, China
[4] School of Tourism Management, Hangzhou Polytechnic, Xihu District, Hangzhou 311402, China
* Correspondence: zhonglina@bisu.edu.cn; Tel.: +86-010-6577-8440

Abstract: Novel coronavirus (COVID-19) has had a huge impact on the global tourism industry over the past couple of years. Most previous studies investigated tourism crises after the pandemic period. Hence, to minimize the research gap, the present study investigates the impact of COVID-19 on tourism during the pandemic period. By assessing this impact, this paper proposes a D (big data) I (impact module) S (strategy module) E (evaluation module) model to cope with the crisis in order to bring about feasible implications for tourism practitioners and governments. This paper is to provide real-time destination management adjustments. This model is based on a crisis management framework and governance theory through retrieving big data from China Unicom and major travel information delivery sources. The major finding shows that the detailed time points of pandemic information release in the early stage of crisis. In conclusion, through proposing a DISE model, the present study assesses the impact of the major emergency public health crisis, assists destination managers in adjusting tourism-related policy and reflects the priority of recovering tourism after the crisis for effective tourist destination management.

Keywords: impact; COVID-19; tourism; crisis management; DISE model; big data

Citation: Sun, S.; Zhong, L.; Law, R.; Zhang, X.; Yang, L.; Li, M. A Proposed DISE Approach for Tourist Destination Crisis Management. *Sustainability* **2022**, *14*, 11009. https://doi.org/10.3390/su141711009

Academic Editor: Yoonjae Nam

Received: 11 July 2022
Accepted: 1 September 2022
Published: 3 September 2022

1. Introduction

Tourism is easily affected by various types of crises, such as natural disasters, terrorist attacks, political instability, and infectious diseases [1,2]. According to Law [1], infectious diseases are perceived to be the most important factor affecting tourism. Infectious diseases, such as foot-and-mouth disease (FMD), severe acute respiratory syndrome (SARS), and H1N1 influenza adversely hit the tourism industry. For instance, tourism sectors in the UK reported a 60% decline in hotel bookings because of FMD in the middle of 2001 [3]. The recent coronavirus disease 2019 (COVID-19) affected both domestic tourism and international tourism in China. During the early stage of the COVID-19 pandemic period, domestic travel was strictly prohibited, and the whole country's economy was severely affected. International travel was also gradually stopped due to the global outbreak of COVID-19 [4].

The aforementioned infectious diseases have previously and currently had a severe effect on the tourism industry worldwide. Their devastating impacts are reflected in the large drop of the number of tourists, decrease in retail sales, low hotel occupancy rate, and the economy of the country. The prolonged pandemic of COVID-19 has thrown the tourism industry in financial crisis, forecasting a loss in terms of occupancy rate and unemployment more than in the 2001 recession and the 11 September attacks [4,5]. To recover the tourism industry and reduce its losses, there is an urgent need for governments and tourism-related

organizations to make decisions and take corresponding governance measures. Some academic researchers have already carried out some studies to assist the government and tourism organizations in making decisions, such as investigating the general perception of type of risk, building a model to forecast future tourist arrivals, and exploring the effects of infectious diseases on the economic downturn in tourism [6]. Nevertheless, the details of the effects of infectious diseases on tourism, such as comparison of the number of tourist arrivals before and during the pandemic period, was largely ignored by previous studies, although this type of information can provide real-time and valuable information for tourism practitioners to form accurate and corresponding decisions for immediate actions.

Recently, artificial intelligence technologies, such as big data and cloud computing, and other technologies in the global science and technology field have brought a lot of industrial innovation and improvement, including rapid policy response and rational decision-making for agile governance [7,8]. The concept of digital governance is considered a new public management theory paradigm spawned by the combination of governance theory and internet technology. Digital governance is also considered to be an important foundation for the application prospects of agile theory, as it can assist government and tourism practitioners in providing practical solutions to tourism crises [9]. Although previous studies have examined the effects of infectious diseases on tourism after the disease pandemic period, very few prior studies, if any, have tracked the changes before and during the disease pandemic period to provide a real-time, dynamic, and comprehensive overview of the effects of infectious diseases on tourism. Thus, to bridge the aforementioned gap, the present study proposes a crisis management framework based on digital governance theory, which is conducive to comprehensive and objective scientific assessment of the impact of the crisis on the tourism industry and the restoration of the tourism industry [7,8]. As a result, the present study first advocates the DISE model based on crisis management framework and governance theory, and then applies the model to the case of COVID-19 in China.

The main objective of the present study is to propose a model of tourism crisis management in the context of big data and then apply the model to specific crises. In summary, the present study investigates the impact of COVID-19 on tourism before and during the pandemic period and proposes a theoretical model and research framework based on big data that is suitable for impact assessment and policy generation of major emergency public health crises. After that, based on the crisis management framework and proposed theoretical model, this study evaluates the impact of crisis on tourism by identifying the changes in COVID-19-related travel information release and the number of international and domestic tourist arrivals before and during the COVID-19 pandemic period. As a result, on the basis of the proposed DISE Model, this study provides a valuable reference for impact evaluation for tourism practitioners worldwide to take immediate measures or actions if similar circumstances occur in the future.

2. Literature Review

2.1. Crisis Management Framework

Tourism is vulnerable because of its susceptibility to human-induced crises, natural disasters, and infectious diseases. In the context of COVID-19 and the progressively crisis-prone world, developing a crisis management framework is of great importance for any place, particularly tourism destinations [10,11]. Although studies of crisis management frameworks started to receive attention more than two decades ago [12], this area has further research potential due to COVID-19 [13]. Faulkner stated that research should focus more on tourism crises or disaster phenomena [12], the impact of such events on the tourism industry and related organizations and the response of the tourism industry to such events is of great necessary. In addition, the research content mainly includes the impact of the crisis on the tourism industry [14,15], the restoration of disaster-stricken tourist destinations [16,17], and crisis management strategy [18]. In the aforementioned

research context, a recurring theme in the literature is the different impacts of crises and disasters on tourism organizations and destinations.

From the perspective of the impact and evaluation of crisis, most academic researchers have focused on evaluating the impact of the crisis on tourism demand and, consequently, tourism receipts, such as internal and domestic tourist arrivals [19,20]. From the perspective of recovery and related strategies in crisis management, several studies developed disaster management strategies and actions within the hospitality and tourism context [11]. To improve the current state of crisis planning and preparedness, Wang and Ritchie [21] developed an onion model for strategic crisis planning, which consists of the onion system, the key influencing factors, and strategic crisis management. Additionally, researchers conducted research from the stage of disaster occurrence and put forward relevant strategies. Faulkner proposed a disaster management model based on the stages of the crisis evolution, including pre-event, prodromal, emergency, intermediate, long term (recovery), and resolution [12]. Other academic researchers have proposed some strategies and approaches to crisis management that starts with proactive pre-crisis planning, which goes through strategy implementation and ends with evaluation and feedback [22].

Similarly, there are three stages in the most commonly adopted and recognized effective crisis management framework in addressing natural disasters: pre-crisis, crisis, and post-crisis [23,24]. Crisis management strategies and actions are of great importance, as they place the nature of the disaster into consideration [25]. In contrast with natural disasters, where the durations and strengths of the after-effects cannot be clearly known or predicted, infectious diseases can be controlled and the intensity of their spread can be largely minimized if immediate actions are taken. Ritchie [22] proposed the importance of the pre-crisis period for natural disasters. Before a crisis occurs, attention should be paid to the issue of resilience to disasters. However, the investigation of the pre-crisis stage of infectious diseases has been ignored largely by previous studies, which prohibits taking immediate action to control their spread intensity. Although there have been relevant studies relating to the crisis management framework, there is a growing demand for a crisis management framework for COVID-19, as most existing frameworks do not take health-related crisis into consideration, particularly when emerging technologies such as big data are developing rapidly, which can provide important references for the recovery of the tourism industry [11]. In addition, the prolonged pandemic which is currently affecting global tourism is characterized by high levels of uncertainty, repeatability, and unpredictability [26,27]. Thus, the present study proposes a crisis management framework based on the comprehensive evaluation of the impact of crisis before and during the COVID-19 pandemic period. The proposed crisis management framework is the DISE model, in which D refers to big data, I refers to impact module, S refers to strategy module, and E refers to evaluation module.

2.2. Big Data-Assisted Decision-Making

Recently, advanced data processing technologies such as big data and cloud computing, which are gradually emerging, have strengthened the development of collaborative public services in the digital age and continuously enrich the "toolbox" of public management systems in the public sector for effective tourism decision-making [28]. As a result, big data-assisted decision-making not only saves a lot of manpower and material resources, but also improves the accuracy of the target and improves the efficiency of national and social governance [29]. For example, Zhang et al. [30] proposed a big data-assisted social media analytics for business (BD-SMAB) model, which mainly includes four steps: the information, conceptual design, development, and implementation phases. Weerasinghe et al. [31] used big data to analyze and explore consumer's views on the aspects of New Zealand's health care sector, which includes policy making, planning, funding and clinical care, and provides recommendations for policies and practices, such as precision medicine and big data-assisted clinical decision-making. Additionally, some academic researchers have proposed a dataset to analyze spatiotemporal patterns of tourism in Europe. That is, they

combined emerging big data sources with official statistical data to break the limitations of potential analysis and application related to tourism management and policies in order to be more conducive to the integration of tourism resources [32].

Nevertheless, the aforementioned studies largely ignore the impact of tourism crisis emergencies on tourist destinations, and do not take advantage of the potential role of big data to assist decision-making in overcoming crisis events. In the current situation, where the world is still facing COVID-19, it is of great necessity to explore the role of big data in assisting decision-making, particularly in the application of tourism crisis management by taking advantage of big data technology. Hence, in order to deal with tourism crisis management by making full use of big data-assisted and decision-making, the present study proposes a crisis management framework based on the supporting foundation of big data (D), which is the basis to respond to the public health crisis, COVID-19. As a result, the present study focuses on tracking the effects of COVID-19 on tourism in the pre-crisis stage of COVID-19 and during the pandemic period to assist the decision-making of tourism practitioners when faced with crisis.

2.3. Impact of Infectious Diseases on Tourism

Previous studies have indicated that infectious diseases have considerable impact on society, economy, and tourism [33,34]. Law [1] investigated the perception of three different types of risks (i.e., infectious diseases, terrorist attacks, and natural disasters) of Asian and Western visitors and found that compared with terrorist attacks and natural disasters, Asian tourists perceive infectious diseases to be the biggest threat. Mou et al. [35] further illustrated that the outbreak of COVID-19 hit the global tourism industry from both supply and demand perspectives. From the supply perspective, Yeoman, Lennon, and Yeoman, et al. [36] stated that foot-and-mouth disease (FMD) severely affected Scottish tourism and the country stopped receiving tourists, which in turn caused huge losses for the tourism economy [37]. According to Hoque, Shikha, Hasanat, Arif, and Hamid [4], COVID-19 is expected to have a long-term impact on the tourism industry. From the demand perspective, travel may increase the risk of infection [38] and affect the psychology and behavior of tourists. The psychological shadow caused by the COVID-19 pandemic may reduce the real-time on-site emotional experience of tourists [39]. In terms of consumer behavior, Li et al. [40] pointed out that the COVID-19 pandemic has greatly changed tourists' destination preferences, and tourists prefer to go to destinations with fewer infections and those closer to where they live. In summary, infectious diseases are perceived to be the biggest threat to tourism, and changes in supply and demand will lead to major changes in the tourism field in post-COVID-19 era.

2.4. Agile Governance and Digital Governance

Government plays a vital role when crisis occurs, as it administers the country or region and manages politics. Currently, the development and application of modern information technology have made information collection, processing, and dissemination more convenient. It has also increased the amount of information and knowledge owned by citizens and society, and has provided new concept of political science, including "meta governance", "sound governance", "effective governance" and "good governance" [41].

Compared with governance, agile governance means a set of actions or methods that is flexible, fluid, or adaptable. It is also an adaptive, people-oriented, inclusive and sustainable decision-making process [7]. The concept of agile governance aims to change the way in which policies are generated, reviewed, formulated, and implemented in the information age. Agile governance has the following characteristics: Firstly, from the perspective of extensive participation, policy development using the agile governance model is no longer limited to the government. It also establishes mechanisms to continuously monitor and upgrade policies and maintain checks and balances for all parties to ensure long-term sustainability [42]. Secondly, from the perspective of time sensitivity, the core difference between traditional plan-based decision-making methods and the concept of

agile governance lies in time sensitivity. Agile governance requires continuous preparation for changes in rapid development, actively or passively accepting changes and learning from changes, while contributing to actual or perceivable end-user value [43]. Thirdly, from the perspective of the scientific degree of decision-making, the governance body combines an iterative and cumulative learning process to promote the transformation from planning and control experimentation and implementation strategies. By providing stakeholders with opportunities to continuously share concerns and changing needs, it provides a timely and dynamic evaluation process for new regulations. Digital governance is a new public management theory paradigm spawned by the combination of governance theory and internet digital technology, as Williamson [44] explained the theory of digital governance from the perspective of the decline of the new public management movement and the rise of governance in the digital age. Big data and national governance have gradually entered the research horizon of experts and academic researchers. From the semantic logic to clarify the research horizon, the development of its movement can be divided into two regulatory dimensions: big data governance and the promotion of national governance with big data. The former refers to the big data governance as an important part of national governance, such as the formulation of big data-related quality standards and data monetization; the latter refers to the use of big data and its technological application which can optimize government functions.

In summary, the concept of agile governance sets the direction for the transformation of government governance. In the process of digital governance, "agile" methods are embedded in the governance workflow to form more effective governance methods and effects [45]. Agile governance and digital governance play an important role in the government's governance capabilities, decision-making, and policy implementation and evaluation. Hence, based on the model of "governance-monitoring-feedback-upgrade" dynamic evaluation of agile governance, the present study makes full use of the big data database in digital governance as the underlying database of the DISE model, and applies the DISE model to support government decision-making and form a feedback mechanism to generate policies.

3. Methodology

3.1. The Process of Proposing a DISE Model

By retrieving relevant literature, the results showed that the construction of crisis management frameworks is mostly carried out from three aspects: impact, strategy, and evaluation. In addition, based on crisis management frameworks and governance theory, the DISE model (Figure 1) was proposed. The model introduces the wisdom and rapid variables emphasized by agile governance and modern governance, abstracts environmental variables into big data systems based on digitization and public opinions, further clarifies the input and output system, and adds a feedback mechanism to form an up-down policy generation model. The DISE model includes the big data support foundation (D), the impact (input) module (I), the strategy (output) system (S), and the evaluation (feedback) system (E).

The environmental system is the supporting foundation of big data (D), which is the basis to respond to the public health crisis. With the support of big data, the entire industrial policy formulation framework can obtain data sources from multiple related entities, make scientific judgments quickly, and provide rapid supervision to respond to the implementation of the entire policy. Ultimately, feedback of the implementation of the policy can be added to the database to increase knowledge to form a data-based industrial policy generation.

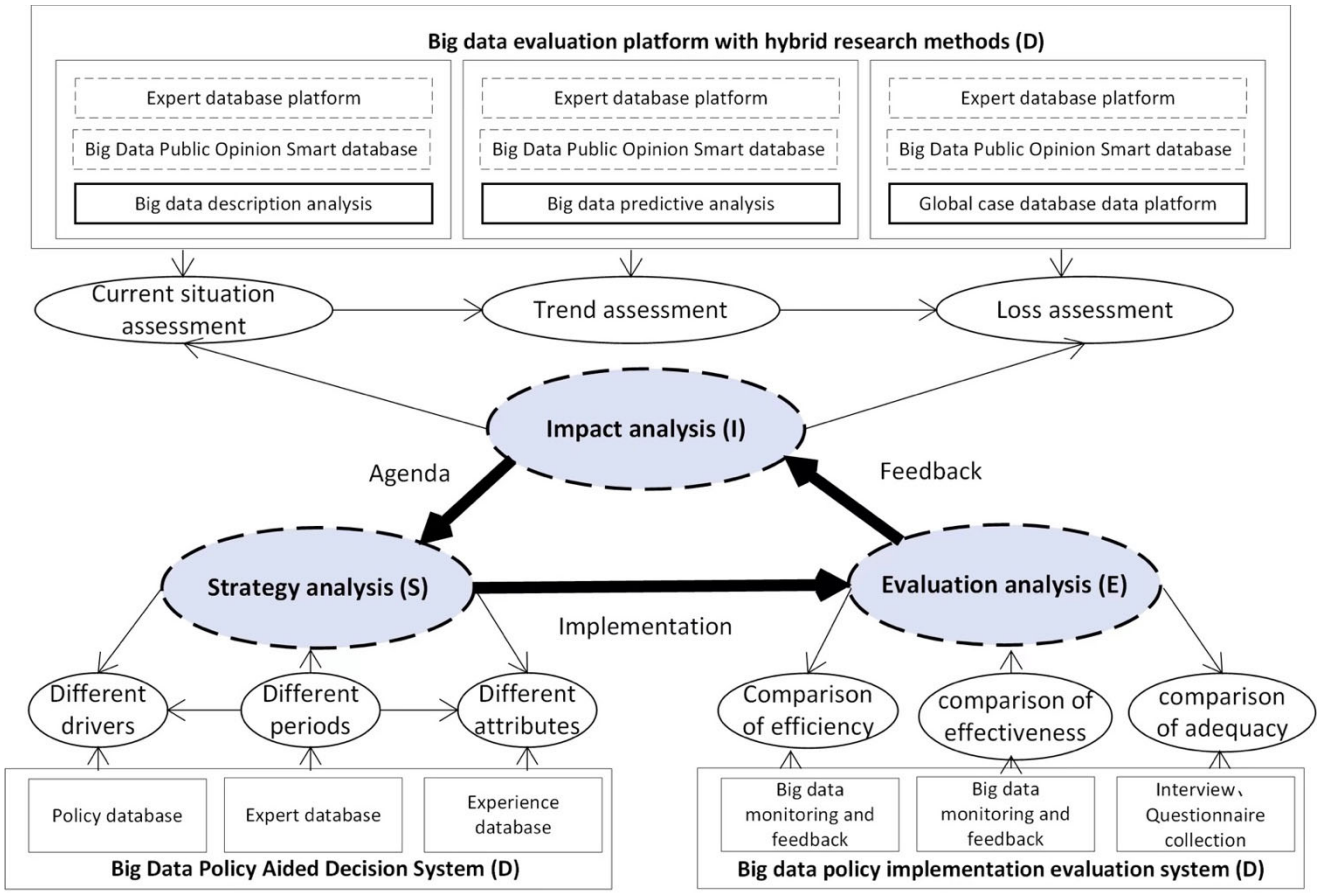

Figure 1. Proposed DISE model of tourism crisis. Source: based on the data retrieved.

The input system is the impact module (I), which is the pre-process of crisis industry policy formulation. It fully analyzes the status quo through hybrid research methods, relying on big data description, quantitative analysis of public opinion, and qualitative analysis of opinions in expert think tank platforms. Specifically, this module uses quantitative analysis of the big data forecasting system and public opinion platforms and the qualitative analysis of the expert think tank system to predict the trend of crisis damage. On the other hand, this module conducts comprehensive loss assessment through the empirical analysis of case databases.

The output system is the strategy module (S), which mainly focuses on three types of driving force, pulling force, and catalysis. In addition, the system selects policy measures from the analysis database based on different time periods (short term, medium term, and long term), different affected areas, and different affected industries, then uses the big data policy implementation monitoring system to monitor policy trends at any time and make real-time dynamic adjustments.

The feedback system is the evaluation module (E), which collects industrial data, economic data, and public and stakeholder opinions through the big data system, and then compares the efficiency, effectiveness, and adequacy of policy implementation. After that, comprehensive feedback is given on the implementation process of the policy in order to provide a basis for decision-making for the next policy formulation.

3.2. Data Collection

Data were retrieved from two sources. The first source is the China Unicom big data, which contain information on tourist arrivals from January to March 2020, through retrieving the mobile signals of tourists. To distinguish from residents and tourists, this study defines residents as people who stay in a certain city for a consecutive six months.

The definition of tourists in this study are people who move from one city to another, as each city has its boundary. Once tourists enter the boundary, their arrivals will be counted.

The second source is from the major travel and COVID-19-related information delivery sources in February 2020. The main sources of travel- and COVID-19-related information delivery include WeChat, Weibo, APP, webpages, and other information distribution channels. In order to ensure the representativeness of the samples, this paper retrieved data from multiple information channels. The samples follow two principles: one principle is that the travel information should be as comprehensive as possible, and the other is that redundant information should be avoided. After sifting through the data, the present study found that during this period, COVID-19-related travel information reached 391 and 362 items on WeChat and Weibo, respectively, followed by APP and Web pages, which contained 294 and 237 pieces of information, respectively. Forums, newspapers, and videos also served as travel and COVID-19 information distribution channels and had nine pieces of information. Taking information retrieved on 7 February 2020 as an example, the top three COVID-19-related travel information distribution channels were WeChat, APP, and webpages, which had 68, 56, and 50 pieces of information, respectively. Data were then analyzed.

To further verify the information obtained from the aforementioned two sources, in-depth interviews were conducted among tourism and hospitality managers and academic researchers. In the initial stage, invitations were sent to tourism and hospitality managers and academic researchers via email. A total of 20 tourism and hospitality managers and academic researchers in Beijing agreed to participate in in-depth interviews. Specifically, the components of 20 interviewees include five tourism academic researchers, and five tourism practitioners, five hospitality academic researchers, and five hospitality practitioners. After verification from tourism and hospitality managers and academic researchers for the aforementioned sources, a data processing system was subsequently established.

3.3. Establish a Data Processing System

A data processing system was designed with a hybrid research method combining quantitative analysis and qualitative analysis. Based on the DISE model and information retrieval from big data, a set of mixed multi-source big data was formed and the digital system construction was carried out through the process of hybrid big data collection, big data cleaning, qualitative and quantitative big data operation, and big data auxiliary decision-making. Qualitative analysis refers to the analysis of tourism expert opinions.

4. Findings

4.1. Evaluation of Public Opinion of COVID-19-Related Travel Information Release

Based on the obtained data, the findings of this study indicated that compared with other cities in China, Beijing published the most COVID-19-related travel information, followed by Hainan, Anhui, Sichuan, Guangdong, Shanghai, Zhejiang, and Jilin. Among the aforementioned provinces that released travel information, Beijing is the capital city, whereas Hainan, Sichuan, and Guangzhou are recognized as main tourist destinations. Shanghai and Zhejiang are two locations in developed areas in the eastern part of China. Other cities in China, however, did not release much coronavirus-related travel information. The findings indicated that the capital of China (Beijing) paid the most attention to coronavirus-related travel information, followed by destinations that depend mainly on their tourism industry and destinations in developed areas.

Among all the obtained COVID-19-related travel information, the top three hot terms identified were “novel coronavirus”, “COVID-19”, “tourism”, and “culture”, with a frequency of 128, 94, and 84, respectively (Figure 2). News containing the keywords travel and novel coronavirus/COVID-19 were retrieved from 10 January 2020 to 9 February 2020 and showed that the quantity of the news relating to novel coronavirus/COVID-19 and travel can be categorized into three laddering stages. The first stage was from 10 January 2020 to 20 January 2020. During this stage, the number of pieces of information was less

than 100, and the quantity of COVID-19-related travel news received limited attention from the media and the general public. In the second stage (20 January 2020 to 4 February 2020), the number of pieces of information was around 813,000 before 26 January 2020. After 26 January 2020, the amount of COVID-19-related travel information reached almost 2,000,000 pieces when the campus academician Nanshan Zhong delivered information to the public that COVID-19 could be spread through person-to-person transmission. During this stage, the quantity of news and information relating to coronavirus and travel increased drastically. In the third stage (4 to 8 February 2020), the quantity of information reached more than 2,000,000 pieces on 5 February 2020, and the quantity of news and information related to novel coronavirus/COVID-19 travel reached its highest point between 4 February and 5 February 2020. In the future, the quantity of novel coronavirus/COVID-19 and travel information is expected to decrease. In summary, the findings reflected that COVID-19-related travel information/news has been increasing since it entered the public view. In addition, once people found that the virus can affect people and spread easily, attention increased drastically and reached its peak.

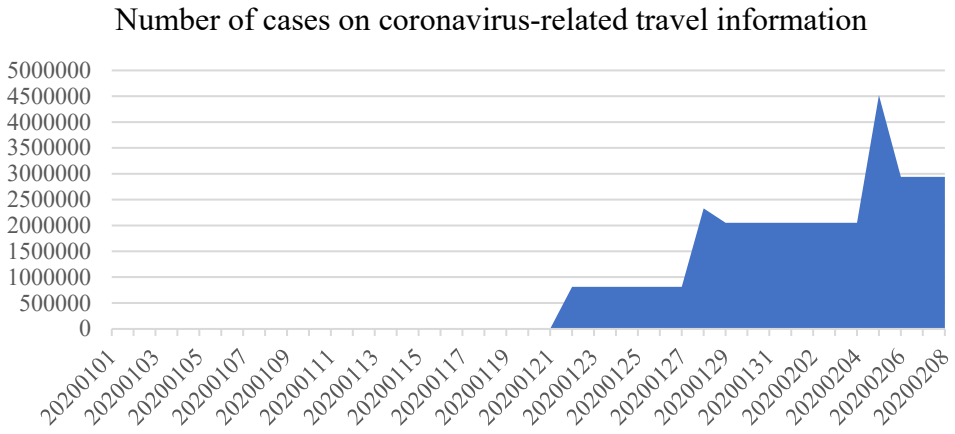

Figure 2. Quantity of news (coronavirus-related travel information).

4.2. Flow Change Assessment of the Impact of COVID-19 on the Number of International Tourist Arrivals

Figure 3 shows the number of international tourist arrivals in China from 1 January 2020 to 8 February 2020 based on the data retrieved from China Unicom. During the first several days, that is, from 1 January 2020 to 3 January 2020, the number of international tourist arrivals in China increased steadily. On 4 January 2020, when the Chinese government activated the "serious response level" regarding infectious diseases (i.e., coronavirus) [46], the first evident change in the number of tourist arrivals was observed. Specifically, the number of international tourist arrivals dropped to 9414 and 39,777 on 4 and 5 January 2020, respectively. The second evident change in the number of international tourist arrivals was observed on 11 and 12 January 2020, when the number of international tourist arrivals dropped to 20,653 and 35,844, respectively. Although the number of international tourist arrivals experienced a slight increase over the next 10 days following 12 January 2020, after Secretary General Tedros Adhanom of the WHO announced that the WHO required more information to decide whether the "2019 novel coronavirus/COVID-19" will be considered "PHEIC" in a news conference [47], the number of international tourist arrivals dropped continually, although the number of international tourist arrival increased occasionally during this period, such as on 4 February 2020. In sum, international tourist arrivals dropped constantly after 4 January 2020 during this period.

Figure 3. International tourist arrivals to China (1 January 2020–8 February 2020).

4.3. Flow Change Assessment of the Impact of COVID-19 on the Number of Domestic Tourist Arrivals

The number of domestic tourist arrivals was also affected severely by COVID-19 because Lunar Chinese New Year is always the peak season for travel among Chinese people [10]. During the Lunar Chinese New Year of 2019, the number of domestic travelers reached 400 million [48]. Figure 4 shows that before the city of Wuhan experienced lockdown on 23 January 2020, the number of domestic tourist arrivals continued to increase because the Lunar Chinese New Year's Eve was approaching (i.e., 24 January 2020). From 23 to 25 January 2020, a trend was observed, indicating a slow-paced increase in the rate of domestic tourist arrivals. After 25 January 2020, the number of domestic tourist arrivals indicated an evident drop. On 30 January 2020, when WHO announced that the "2019 novel coronavirus" was considered "PHEIC" and two days later, on 1 February 2020, the number of domestic tourists decreased by 22.61 million compared with the numbers on 1 January 2020.

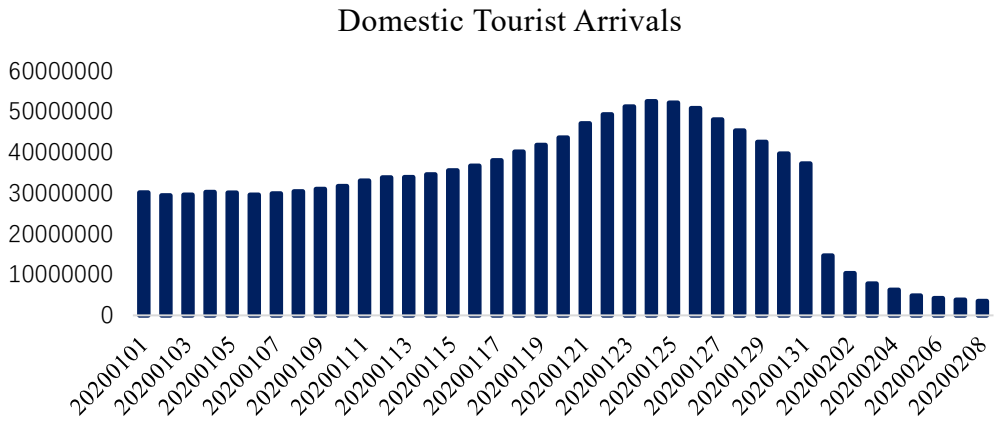

Figure 4. Number of domestic tourist arrivals (1 January 2020–8 February 2020).

Cities in China are categorized further into two types (Type A: Figure 5 and Type B: Figure 6) based on the tourist flow (i.e., domestic tourist arrivals) from 1 to 15 January and from 16 to 30 January 2020. Type A refers to cities where tourist flow was heavily affected by COVID-19, whereas Type B denotes the cities where tourist flow was less affected by COVID-19. For example, tourist flow in Beijing (a Type A city) was affected by COVID-19 the most among the 10 selected cities. In normal cases, these 10 cities have always had a large number of tourists over the past few decades [49,50]. In contrast, for Type B cities, even when the issue of COVID-19 appeared, tourist flow still increased and reached the highest on 24 January 2020 (i.e., Lunar Chinese New Year's eve). After that, along with the ongoing seriousness of the pandemic, tourist flow continued to drop. Hence, findings

indicated that compared with small cities such as Dazhou and Zhumadian, changes in the tourist flow in big cities such as Beijing and Shanghai were more obvious.

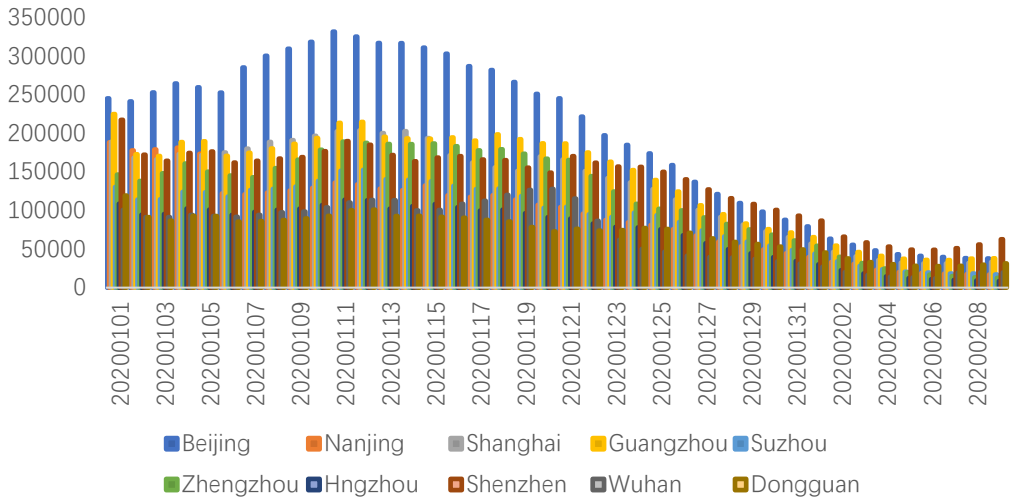

Figure 5. Change in tourist flow in main cities in China (Type A).

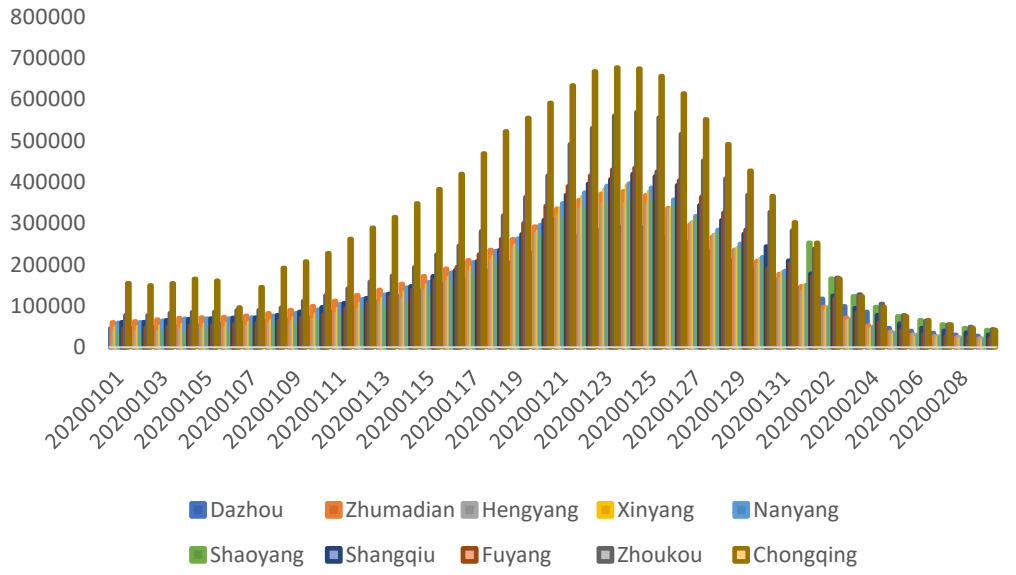

Figure 6. Change in tourist flow in cities in China (Type B).

4.4. An Establishment of Data Processing System

Figure 7 illustrates the whole process of the data system establishment based on the DISE model and the findings of the present study proves its applicability, which includes database establishment, database processing, and the three practice processes of impact analysis, strategy analysis, and evaluation. In other words, the system first obtained various data from the big database, such as GPS data, public opinion data, and mobile phone signaling data. The data were then preprocessed. After that, the rules were found from the data through text analysis, cluster analysis and other methods. Finally, the impact of the crisis was predicted, crisis management strategies were formulated, and post-crisis assessments were conducted. Firstly, the bottom layer of the data system was multi-source and multi-dimensional big data from government and data companies. After data collection and cleaning, data analysis and correlation, a series of policy databases for decision-making were formed, including a key industry database, a regional economic database, an expert think tank database, an experience policy database, etc. Secondly,

different big data algorithms were used to carry out text analysis, content clustering and trend prediction based on the basic database. At the same time, various research methods were included in the data, such as big data analysis, in-depth interviews, and text analysis to improve the scientific decision-making ability of the model.

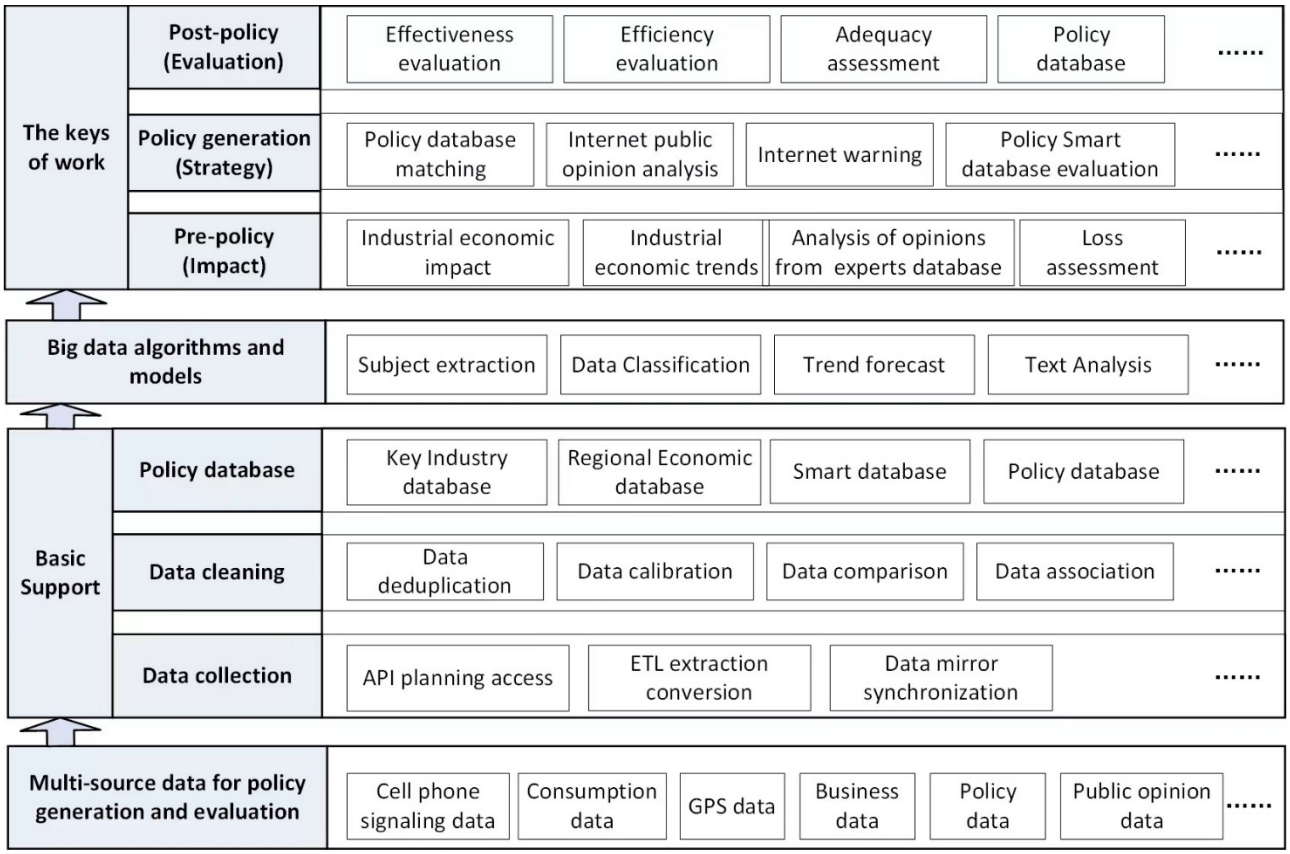

Figure 7. A data processing system based on the DISE theoretical model. Source: based on the data retrieved.

Thirdly, using this data system, a comprehensive and rapid assessment was conducted for a series of key industries and regional economic impacts, such as economic trends, and loss accounting caused by public crises. Finally, according to the digital analysis of the impact and the recommendation of the policy database and the evaluation of the expert policy smart database, a series of policy opinions were put forward for the development of key industries and regions. During the implementation of the policy, comprehensive data evaluation and public opinion monitoring are to be carried out on the policy. After the policy is terminated, the policy is to be comprehensively evaluated through the data system, and the evaluation results to be given back to the experience database of the decision-making system to provide important decision-making references for the next decision.

4.5. Tourism Expert Evaluation

By analyzing the information from the expert database in the system and the industry experts database on assessing the impact of the new coronavirus on tourism, the findings showed that the content mainly includes three parts, namely the loss assessment of the tourism industry during the pandemic, the prediction of the development trend of the tourism industry after COVID-19, and the strategy to alleviate the impact of the epidemic on the tourism industry.

In terms of the loss assessment of the tourism industry during COVID-19, although it occurred during a period of repeated tourism climaxes and the development of the tourism industry and the coexistence of risks are normal, tourism and related industries suffered huge losses. A study by Gong et al. [51] showed that the overall tourism economy has been greatly affected by COVID-19 pandemic. One aspect of this is that the domestic tourism market and the inbound tourism market were basically stopped, and the outbound tourism market also suffered from heavy losses. Another aspect is the impact on the traditional tourism industry structure, especially in the industry chain of the tourism industry. Although state-owned enterprises such as large scenic spots and airlines have relatively strong anti-risk capabilities and are less affected, many of the travel agencies and hotels which are private enterprises were hit harder. Many travel agencies, hotels, and homestays have suspended operations. In addition, other experts also conducted loss assessments from the perspective of tourism industry sensitivity and industry recovery [52].

From the perspective of the development trend of tourism after the pandemic, the development of the tourism industry that has been hit hard by COVID-19 will be more difficult over the next year, but the tourism market will rebound greatly after the pandemic period. In addition, Tan et al. [53] made a more detailed prediction of the tourism market. This study believed that the recovery time of the tourism industry will generally take from 13 to 15 months. Domestic tourism, especially short-distance tourism, will recover first, followed by outbound tourism, and then inbound tourism.

In terms of the strategy to alleviate the impact of the pandemic on the tourism industry, the tourism industry is very fragile and its ability to deal with risks or crises is not strong. Thus, in addition to the active self-recovery of the enterprises themselves, the policy support of the state and the government is indispensable [54]. In addition, it is encouraged that the international community cooperates with each other and countries introduce and share various emergency systems [55]. Specifically, the focus should not be put on notifying travel agencies and other related companies to deal with refund. Instead, more attention should be paid to the detailed guidance on the losses of travel agencies in order to effectively perform the planning and development of the tourism industry after the pandemic. During this process, many academic researchers have pointed out that making full use of advanced technologies such as big data to effectively perform digital governance will play an important role in the recovery of the tourism industry, which suffered from emergencies such as COVID-19.

5. Discussion and Implications

The findings showed that coronavirus-related travel information can be categorized into three stages. In the initial stage, when information about COVID-19 was initially released, coronavirus-related travel information release was limited. After transmission information was delivered by an authoritative person, its popularity reached the highest in a one-week period. In other words, releasing pandemic-related travel information within one week can help reassure local residents and tourists who are travelling in a certain destination.

During the pandemic period, by comparing the number of international tourist arrivals before and during the pandemic period, findings showed that in the initial stage, the number of international tourist arrivals continued to increase. Nevertheless, when the Chinese government activated a "serious response level" on infectious diseases, the number of international tourist arrivals started to drop continuously. These results provide useful information for tourism practitioners about the timing of the change in the number of international tourist arrivals. Specifically, the point at which the sudden change in tourist arrivals occurred was when the government released its "serious response level" to the infectious disease. Being informed of the time point of the sudden change in tourist arrivals can assist destination managers in delivering pandemic information to local residents to avoid unnecessary travel, making real-time adjustments to travel policies for the reference

of tourists from other countries and regions, and coordinating with relevant parties to prepare for the post-crisis tourism recovery of the destination.

Furthermore, regarding the changes in the number of domestic tourists affected by COVID-19, many destinations, particularly the capital city, were affected the most by COVID-19, followed by tourism cities, and then cities in developed areas. Second-tier cities were less affected by COVID-19. Thus, knowing the size of the effects of COVID-19 on the number of tourist arrivals in different types of cities can assist tourism practitioners in taking different actions to recover tourism in the destination based on priority. The recovery priority for destination managers to consider is the capital city, followed by the tourism cities, and then developed areas. For example, destination managers can consider putting more effort into the capital city than tourism cities and developed areas in terms of tourism recovery after the pandemic. In other words, recovering tourism in the capital city should be considered as a priority.

The most significant theoretical contribution of this paper is that it puts forward a DISE model based on the data retrieved, as most previous studies focused on the three-stage crisis management framework instead of investigating the effects of the infectious disease on tourism after the disease's pandemic period. Hence, this study contributes to the evaluation of the effects of infectious disease on tourism before and during the pandemic period. Based on the crisis management framework and governance theory, the findings of the present study extend this model by applying the crisis management theory and agile governance by using travel information and the changes in the number of tourists before and during the pandemic period. Additionally, the present study constructed a data processing system for policy making based on big data by applying the proposed DISE model. Finally, a data processing system was proposed and verified using mixed research methods, including big data analysis and content analysis.

Practically, this study provides references to governments for tourism governance and crisis management. One of the core functions of the proposed model and data processing system is to detect crises in time and prevent crises in advance. For governments, it can pool wisdom from various sources and use big data to better govern the tourism industry and manage the crisis.

6. Conclusions

In conclusion, the present study proposes a DISE model and then constructs a data processing system based on the proposed DISE model to assess the impact of major emergency public health crises, assist destination managers in adjusting tourism-related policy, and determining the recovery priority of the affected regions.

Specifically, the findings are expected to provide real-time and immediate actions/decisions/measures for tourism practitioners, particularly destination managers and policy makers. As the major findings indicated that the announcement from an authoritative person and WHO can largely increase the quantity of COVID-19-related travel information and affect the number of international and domestic tourist arrivals, determining the time to release pandemic-related information to residents and tourists should be considered by destination managers.

In conclusion, the findings of the present study are beneficial for tourism practitioners for effective decision-making, real-time destination management, and post-pandemic tourist destination recovery preparation when local residents and tourists are facing major emergent public health crises. The findings can also enrich the research on tourism crisis management and the impact of COVID-19 on tourism. In addition, the present study contributes to the latest literature in proposing a DISE model to assess the impact of COVID-19 on tourism and assisting destination managers in making immediate reactions relating to destination management and post-crisis destination recovery preparation. Thus, closely tracking the effects of COVID-19 on tourism can serve as a reference for the immediate and accurate measures that should be taken to control infectious disease and help the tourism industry recover.

Although there are important discoveries revealed by this study, one limitation is that the COVID-19 pandemic is a dynamic process. As such, the model should be tested on tourism crisis management to enhance its general applicability. Another limitation is that this study focuses on the case of China. Further studies are needed to investigate how the model responds to the tourism crisis in different countries. Future studies can also adopt quantitative research methods, such as by proposing hypotheses to empirically test the relationship between various variables.

Author Contributions: Conceptualization, S.S. and L.Z.; methodology, X.Z.; software, X.Z.; validation, S.S., L.Z. and R.L.; formal analysis, X.Z.; writing—original draft preparation, S.S., L.Z. and X.Z.; writing—review and editing, S.S., L.Z., R.L., L.Y. and M.L.; supervision, L.Z. and R.L.; project administration, L.Z.; funding acquisition, R.L. All authors have read and agreed to the published version of the manuscript.

Funding: This project was partly supported by a research grant funded by the University of Macau.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data will be available upon request.

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

References

1. Law, R. The perceived impact of risks on travel decisions. *Int. J. Tour. Res.* **2006**, *8*, 289–300. [CrossRef]
2. Luo, Q.; Zhai, X. "I will never go to Hong Kong again!" How the secondary crisis communication of "Occupy Central" on Weibo shifted to a tourism boycott. *Tour. Manag.* **2017**, *62*, 159–172. [CrossRef]
3. Blake, A.; Sinclair, M.T.; Sugiyarto, G. uantifying the impact of foot and mouth disease on tourism and the UK economy. *Tour. Econ.* **2003**, *94*, 449–465. [CrossRef]
4. Hoque, A.; Shikha, F.A.; Hasanat, M.W.; Arif, I.; Hamid, A.B.A. The effect of Coronavirus (COVID-19) in the tourism industry in China. *Asian J. Multidiscip. Stud.* **2020**, *3*, 52–58.
5. AHLA. Covid-19's Impact on the Hotel Industry. Available online: https://www.ahla.com/covid-19s-impact-hotel-industry (accessed on 13 February 2022).
6. Rosselló, J.; Santana-Gallego, M.; Awan, W. Infectious disease risk and international tourism demand. *Health Policy Plan.* **2017**, *32*, 538–548. [CrossRef]
7. Janssen, M.; Van Der Voort, H. Agile and adaptive governance in crisis response: Lessons from the COVID-19 pandemic. *Int. J. Inf. Manag.* **2020**, *55*, 102180. [CrossRef]
8. Liu, Y.; Teichert, T.; Rossi, M.; Li, H.; Hu, F. Big data for big insights: Investigating language-specific drivers of hotel satisfaction with 412,784 user-generated reviews. *Tour. Manag.* **2017**, *59*, 554–563. [CrossRef]
9. Williamson, B. Governing software: Networks, databases and algorithmic power in the digital governance of public education. *Learn. Media Technol.* **2015**, *40*, 83–105. [CrossRef]
10. Lai, Y.; Brimblecombe, P. Regulatory effects on particulate pollution in the early hours of Chinese New Year, 2015. *Environ. Monit. Assess.* **2017**, *189*, 1–14. [CrossRef]
11. Hao, F.; Xiao, Q.; Chon, K. COVID-19 and China's hotel industry: Impacts, a disaster management framework, and post-pandemic agenda. *Int. J. Hosp. Manag.* **2020**, *90*, 102636. [CrossRef]
12. Faulkner, B. Towards a framework for tourism disaster management. *Tour. Manag.* **2001**, *22*, 135–147. [CrossRef]
13. Arbulú, I.; Razumova, M.; Rey-Maquieira, J.; Sastre, F. Measuring risks and vulnerability of tourism to the COVID-19 crisis in the context of extreme uncertainty: The case of the Balearic Islands. *Tour. Manag. Perspect.* **2021**, *39*, 100857. [CrossRef]
14. Blake, A.; Sinclair, M.T. Tourism crisis management: US response to September 11. *Ann. Tour. Res.* **2003**, *30*, 813–832. [CrossRef]
15. Eugenio-Martin, J.L.; Sinclair, M.T.; Yeoman, I. Quantifying the effects of tourism crises: An application to Scotland. *J. Travel Tour. Mark.* **2006**, *19*, 21–34. [CrossRef]
16. Cartier, E.A.; Taylor, L.L. Living in a wildfire: The relationship between crisis management and community resilience in a tourism-based destination. *Tour. Manag. Perspect.* **2020**, *34*, 100635. [CrossRef]
17. Cheer, J.M.; Milano, C.; Novelli, M. Tourism and community resilience in the Anthropocene: Accentuating temporal overtourism. *J. Sustain. Tour.* **2019**, *27*, 554–572. [CrossRef]
18. Paraskevas, A.; Altinay, L. Signal detection as the first line of defence in tourism crisis management. *Tour. Manag.* **2013**, *34*, 158–171. [CrossRef]
19. Pizam, A.; Smith, G. Tourism and terrorism: A quantitative analysis of major terrorist acts and their impact on tourism destinations. *Tour. Econ.* **2000**, *6*, 123–138. [CrossRef]

20. Wang, Y.-S. The impact of crisis events and macroeconomic activity on Taiwan's international inbound tourism demand. *Tour. Manag.* **2009**, *30*, 75–82. [CrossRef]
21. Wang, J.; Ritchie, B.W. A theoretical model for strategic crisis planning: Factors influencing crisis planning in the hotel industry. *Int. J. Tour. Policy* **2010**, *3*, 297–317. [CrossRef]
22. Ritchie, B.W. Chaos, crises and disasters: A strategic approach to crisis management in the tourism industry. *Tour. Manag.* **2004**, *25*, 669–683. [CrossRef]
23. Racherla, P.; Hu, C. A framework for knowledge-based crisis management in the hospitality and tourism industry. *Cornell Hosp. Q.* **2009**, *50*, 561–577. [CrossRef]
24. Coombs, W.T.; Laufer, D. Global crisis management–current research and future directions. *J. Int. Manag.* **2018**, *24*, 199–203. [CrossRef]
25. Hall, C.M. Crisis events in tourism: Subjects of crisis in tourism. *Curr. Issues Tour.* **2010**, *13*, 401–417. [CrossRef]
26. Berbekova, A.; Uysal, M.; Assaf, A.G. A thematic analysis of crisis management in tourism: A theoretical perspective. *Tour. Manag.* **2021**, *86*, 104342. [CrossRef]
27. Goh, H.C. Strategies for post-Covid-19 prospects of Sabah's tourist market–Reactions to shocks caused by pandemic or reflection for sustainable tourism? *Res. Glob.* **2021**, *3*, 100056. [CrossRef]
28. Bramwell, B.; Lane, B. Critical research on the governance of tourism and sustainability. *J. Sustain. Tour.* **2011**, *19*, 411–421. [CrossRef]
29. Ju, J.; Liu, L.; Feng, Y. Citizen-centered big data analysis-driven governance intelligence framework for smart cities. *Telecommun. Policy* **2018**, *42*, 881–896. [CrossRef]
30. Zhang, H.; Zang, Z.; Zhu, H.; Uddin, M.I.; Amin, M.A. Big data-assisted social media analytics for business model for business decision making system competitive analysis. *Inf. Process. Manag.* **2022**, *59*, 102762. [CrossRef]
31. Weerasinghe, K.; Scahill, S.L.; Pauleen, D.J.; Taskin, N. Big data analytics for clinical decision-making: Understanding health sector perceptions of policy and practice. *Technol. Forecast. Soc. Chang.* **2022**, *174*, 121222. [CrossRef]
32. e Silva, F.B.; Herrera, M.A.M.; Rosina, K.; Barranco, R.R.; Freire, S.; Schiavina, M. Analysing spatiotemporal patterns of tourism in Europe at high-resolution with conventional and big data sources. *Tour. Manag.* **2018**, *68*, 101–115. [CrossRef]
33. Chen, Y.-C.; Kang, H.-H.; Yang, T.-C. A study on the impact of SARS on the forecast of visitor arrivals to China. *J. Asia-Pac. Bus.* **2007**, *8*, 31–50. [CrossRef]
34. Kuo, H.-I.; Chen, C.-C.; Tseng, W.-C.; Ju, L.-F.; Huang, B.-W. Assessing impacts of SARS and Avian Flu on international tourism demand to Asia. *Tour. Manag.* **2008**, *29*, 917–928. [CrossRef] [PubMed]
35. Mou, N.; Yuan, R.; Yang, T.; Zhang, H.; Tang, J.J.; Makkonen, T. Exploring spatio-temporal changes of city inbound tourism flow: The case of Shanghai, China. *Tour. Manag.* **2020**, *76*, 103955. [CrossRef]
36. Yeoman, I.; Lennon, J.J.; Black, L. Foot-and-mouth disease: A scenario of reoccurrence for Scotland's tourism industry. *J. Vacat. Mark.* **2005**, *11*, 179–190. [CrossRef]
37. Abbas, J.; Mubeen, R.; Iorember, P.T.; Raza, S.; Mamirkulova, G. Exploring the impact of COVID-19 on tourism: Transformational potential and implications for a sustainable recovery of the travel and leisure industry. *Curr. Res. Behav. Sci.* **2021**, *2*, 100033. [CrossRef]
38. Yang, Y.; Zhang, H.; Chen, X. Coronavirus pandemic and tourism: Dynamic stochastic general equilibrium modeling of infectious disease outbreak. *Ann. Tour. Res.* **2020**, *83*, 102913. [CrossRef]
39. Yang, Y.; Ruan, Q.; Huang, S.S.; Lan, T.; Wang, Y. Impact of the COVID-19 outbreak on tourists' real-time on-site emotional experience in reopened tourism destinations. *J. Hosp. Tour. Manag.* **2021**, *48*, 390–394. [CrossRef]
40. Li, X.; Gong, J.; Gao, B.; Yuan, P. Impacts of COVID-19 on tourists destination preferences: Evidence from China. *Ann. Tour. Res.* **2021**, *90*, 103258. [CrossRef]
41. Sørensen, E. Metagovernance: The changing role of politicians in processes of democratic governance. *Am. Rev. Public Adm.* **2006**, *36*, 98–114. [CrossRef]
42. Soe, R.-M.; Drechsler, W. Agile local governments: Experimentation before implementation. *Gov. Inf. Q.* **2018**, *35*, 323–335. [CrossRef]
43. Lappi, T.; Karvonen, T.; Lwakatare, L.E.; Aaltonen, K.; Kuvaja, P. Toward an improved understanding of agile project governance: A systematic literature review. *Proj. Manag. J.* **2018**, *49*, 39–63. [CrossRef]
44. Williamson, B. Political computational thinking: Policy networks, digital governance and 'learning to code'. *Crit. Policy Stud.* **2016**, *10*, 39–58. [CrossRef]
45. Han, R.-b. Analysis of Rural Digital Governance and Its Practice Orientation from the Perspective of Agile Governance. *J. South China Agric. Univ. (Soc. Sci. Ed.)* **2021**, *20*, 132–140.
46. Post, S.C.M. Hong Kong Activates 'Serious Response Level' for Infectious Diseases as Wuhan Pneumonia Outbreak Escalates. Available online: https://www.scmp.com/news/hong-kong/health-environment/article/3044654/hong-kong-activates-serious-response-level (accessed on 13 February 2022).
47. Caixin. WHO: Different Opinions Exist Regarding Whether to Consider "2019 Novel Coronavirus". Public Health Emergency of International Concern (PHEIC). Available online: http://www.caixin.com/2020-01-23/101507521.html (accessed on 13 February 2022).

48. Chinanews. Domestic Travellers in Lunar Chinese New Year 2019 Reached 415 Million. Available online: http://www.chinanews.com/cj/2019/02-11/8750406.shtml (accessed on 13 February 2022).
49. Yang, X.; Gu, C.; Wang, Q. Urban tourism flow network structure construction in Nanjing. *Acta Geogr. Sin.* **2007**, *62*, 609–620.
50. Yin, P.; Lin, Z.; Prideaux, B. The impact of high-speed railway on tourism spatial structures between two adjoining metropolitan cities in China: Beijing and Tianjin. *J. Transp. Geogr.* **2019**, *80*, 102495. [CrossRef] [PubMed]
51. Gong, B.; Zhang, S.; Yuan, L.; Chen, K.Z. A balance act: Minimizing economic loss while controlling novel coronavirus pneumonia. *J. Chin. Gov.* **2020**, *5*, 249–268. [CrossRef]
52. Foo, L.P.; Chin, M.Y.; Tan, K.L.; Phuah, K.T. The impact of COVID-19 on tourism industry in Malaysia. *Curr. Issues Tour.* **2020**, *24*, 2735–2739. [CrossRef]
53. Tan, W.; Zhao, X.; Ma, X.; Wang, W.; Niu, P.; Xu, W.; Gao, G.F.; Wu, G. A novel coronavirus genome identified in a cluster of pneumonia cases—Wuhan, China 2019–2020. *China CDC Wkly.* **2020**, *2*, 61–62. [CrossRef]
54. Zhu, H.; Wei, L.; Niu, P. The novel coronavirus outbreak in Wuhan, China. *Glob. Health Res. Policy* **2020**, *5*, 1–3. [CrossRef]
55. Adhikari, S.P.; Meng, S.; Wu, Y.J.; Mao, Y.P.; Ye, R.X.; Wang, Q.Z.; Sun, C.; Sylvia, S.; Rozelle, S.; Raat, H. Epidemiology, causes, clinical manifestation and diagnosis, prevention and control of coronavirus disease (COVID-19) during the early outbreak period: A scoping review. *Infect. Dis. Poverty* **2020**, *9*, 1–12. [CrossRef] [PubMed]