

ICT Adoption for Tourism Disaster Management: A Systematic Review

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ABSTRACT

The tourism sector is not new to disruptions from natural disasters or human induced crises and has been recalibrating the way they operate and sustain. The scale and impact of the COVID-19 pandemic has highly impacted global tourism and the economies that rely on tourism. It has brought phenomenal challenges to humankind and many tourism organisations are on the brink of collapse and this will have a cascading effect on countries and their citizens for years to come. This paper presents the systematic literature review on the adoption of ICTs in tourism when preparing for and managing disasters. This review was conducted using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) Flow diagram. Out of 585 articles from four databases, 35 peer-reviewed journal and conference articles were included for analysis. Research on potential adoption of ICT and associated tools for tourism disaster management, remains scarce. With the world coming to terms with the “new normal” of social distancing and increased use of ICT tools such as virtual reality, virtual guides, chatbots, social media and contact tracing apps due to pandemic, the investigation of adoption of such tools is long overdue. Within limited empirical studies, this review shows some trends and opportunities for the development of a critical research agenda in this area. Other innovative tools such as AI, GIS, IoTs, and visual story telling have been adopted for managing disasters related to tourism. This research demonstrates the potential adoption of ICT tools for effective disaster management and the subsequent support of global tourism. To counter the catastrophic effect on the tourism industry from COVID-19 pandemic, it is paramount to recognise cultural sensitivities and study how advancement in technology can be harnessed in all contexts. In addition to this, further exploratory research should be conducted to better understand *crisis as an opportunity to develop and adopt foundational and critical ICT systems for the tourism industry*.

Keywords

Tourism, ICT Adoption, Disaster Management, COVID-19.

INTRODUCTION

Over the last few decades we have seen the tourism industry develop a strong dependence on information communication technology (ICT). ICT has supported and allowed accelerated development of many aspects of tourism businesses from booking, advertising, managing, and recommending (Koo et al., 2015, Neuhofer, 2016) to introducing market competitiveness and ease of access to services. Information need is profound in tourism enterprises (Sheldon, 1997). Underscoring the proficient and efficient dissemination of information and services, ICT is core to tourism activities and to rapid interactions with tourists and other stakeholders, supporting communications with targeted stakeholders, personalized information exchange, availability of real-time information, faster settlement for booking and payments etc. (Zelenka, 2009; Jovanović, 2019), which also leads to the digital convergence of tourism value chains.

The tourism industry, however, is also vulnerable and subject to a wide range of disasters and crises which occur haphazardly, from time to time throughout history. Disasters can be unforeseen like natural calamities e.g., earthquakes, hurricanes, bushfires, floods, cyclones etc., whereas crises are also unexpected but could be self-inflicted (Faulkner, 2001, Ritchie, 2009) such as terrorism, political unrest etc. Whether a natural disaster or

a human induced crisis, both types of events can have a colossal impact on the economic activities of the travel and tourism industry (Ritchie, 2008). Considering the heavy reliance of tourism on infrastructure, transportation (Ye et al., 2020) and interdisciplinary relationships to a wide number of industries (Faulkner, 2001), tourism complexity and sustainability during a time of disaster or crisis needs careful planning and management. The ubiquitous nature of ICT has immense potential in facilitating tourism sustainability and supporting complex interactions.

Emerging ICT technologies such as geographical information systems (GIS), internet of things (IoTs), mobile applications (apps), location-based services, geo-tag services, virtual reality (VR), augmented reality (AR), artificial intelligence (AI), social media and smart devices (Ye et al., 2020) provide many opportunities for exploration and adoption of ICT for development of tourism and mitigation tourism crises and disasters. The complex fusion of technological innovation, resources, infrastructure and data to improve operational and process automation and visualization to improve tourist experience is commonly referred to as smart tourism (Buhalis & Buhalis, 2013; Femenia-Serra, 2018). In this study, we have used the term, disaster informatics to refer to the collection, aggregation, sharing, integration, and transformation of data with the use of ICTs during and after disaster and crises. In broader terms, a knowledge-based crisis management system encompasses the use of new technologies and disaster informatics to provide warnings and monitor emergency/chaotic situations during various stages of the crisis: pre-crisis, during crisis and post-crisis stage. Embedding ICT technologies in the management of tourism knowledge acquisition, creation, storage, and propagation can aid strategic planning at national, local and regional levels for quicker information dissemination during a disaster or crisis as well as in the tourism recovery process (Jia et al., 2012).

Due to the nature of unpredictable disaster or crisis events, tourism disaster management research has focused on some popular theories. For example, Faulkner and Russell (1997) adopted chaos theory and complexity perspectives to analyse tourism disasters. Theory of image restoration (Benoit, 2000) has been employed to attract tourists during and after major crises such as the Gulf oil spill (Muralidharan & Dillistone, 2011) Arab Spring (Avraham, 2015) and Nepal Earthquake (Ketter, 2018; Lama & Pradhan, 2018). Some scholars have combined the theory of image restoration with situational crisis communication theory to analyze their study in tourism. The latter i.e., situational crisis communication theory was focused more on developing strategies to overcome reputational threats (Coombs & Holladay, 2002) of tourist destinations. According to Park et al. (2019), the informational needs of tourism stakeholders vary depending on the situational context of the crises. Post-crisis communication through social media provides assurance, support and trust to tourists who are planning their travel amid the disaster/crisis situation (Huertas & Oliveira, 2019; Schroeder & Pennington-Gra, 2015). The effective use of ICT helps promote confidence and transparency to make informed decisions and choices about safety by the individual tourist and to mitigate risks to their future travel experiences. Coupled with this, journalistic media coverage of celebrity and social media influencers generate tourism interest for reinvigorating inbound tourist arrivals in post-disaster recovery (Rucińska, 2014) This salient feature of online media in conjunction with other ICT applications like GIS and IoTs helps to continuously attract potential tourists and maintain the sustainability of tourism businesses and resources of the areas that have suffered from recent and far-reaching disasters.

TOURISM AND THE IMPACT OF COVID-19

Nonetheless, the recent unprecedented coronavirus (COVID-19) crisis has drastically hit the tourism industry worldwide, with a decline of 72% and 71% in international tourist arrivals in 2020 and 2021 respectively, in comparison to 2019 (UNWTO, 2022). For the tourism industry, the situation is bleak. As Gretzel et al. (2020) pointed out; it is important to relate to the historical theory and practices before the pandemic to understand how to envision processes on the other side of the crisis. Our understanding of tourism operations and practice prior to the pandemic will allow us to better apply and adopt ICT to tourism operations and practice post pandemic.

The tourism industry is highly impacted by COVID-19 as it relies on human resources for service delivery. Various governments have imposed different kinds of movement restrictions, and many tourism businesses, including airlines, permanently closed their business. It is evident that ICT has been widely used during the COVID-19 pandemic, however, applied in areas such as contact tracing apps, chatbots, drones, VR and AI. As suggested by Garfin (2019), the thoughtful use of ICT effectively mitigates the negative impacts of and improves people's lives during a crisis. Seyitoglu and Ivanov (2021) and Lau (2020) also predicted that the collaboration between ICT developers and the travel and tourism industry could help to minimise the COVID-19 stress and enhance the chance of business survival. Many studies on ICT usage in tourism during the COVID-19 pandemic primarily focused on potential use and advantage of virtual reality or virtual tours (Ilkhanizadeh et al. 2020; Fennell, 2021; Viñals et al., 2021), using social media for interactions as well as examining the possible use of innovative tools such as AI and chatbots to enhance the virtual tour experience (Hasan et al., 2021). Sánchez and Palos-Sánchez (2021) looked at whether virtual reality could help promote

small tourism businesses during the pandemic. Similarly, Fennell (2021) investigated the impact of virtual tours during the pandemic and found that such tools can be effective. Research on the use of location-based games and contact apps found that such tools could help minimise the people gathering during pandemic (Ide, 2021). Mardhiyani et al. (2021) implemented the visual storytelling model through Instagram to increase tourists in a destination and found that such efforts helped in branding and raising awareness for tourists. Obembe et al. (2021) examined the key factors that have impact on public sentiments and the role of social media during a crisis by analysing tweets and news articles in tourism.

A few studies (Lemy et al., 2021; Perić & Vitezić, 2021) have been conducted to understand the consumer behaviour and intentions before and after the pandemic. Kock et al. (2020) argued that the COVID-19 pandemic could create a paradigm shift on tourists' behaviour, perceived risk and decision making. Amidst increased discourse on ICT usage for tourism disaster management, studies investigating the readiness and preparedness for the digital transformation of various stakeholders during and after the pandemic have also been conducted (Sorooshian et al, 2021, Sorooshian, 2021).

Considering the potential usefulness of ICT adoption by the travel and tourism industry to support a range of activities for tourism disaster and crisis management, as indicated by its use throughout the pandemic we conducted a systematic literature review to answer the following questions:

- What is the status of ICT adoption in the context of tourism disaster management?
- How is ICT assisting in planning and managing disaster events i.e., response and recovery for tourism?
- What future research agenda or direction could be developed for travel and tourism ICT adoption?

The term 'e-tourism' refers to the overall use of ICT in tourism and is an established field of research. As discussed by Gretzel et al. (2020), e-tourism should be adopted on two emerging fronts: 1) the rapidly changing new reality and prospects for change in the long term; and 2) a focus on transformative research.

This literature review aims to highlight research conducted in ICT adoption for tourism crises and disasters. The remainder of our paper is structured as follows: First, we describe the methodology of the literature review, which includes a description of data collection and data selection of relevant papers. Then, we present the results obtained from the systematic literature review, which includes a description of what was found in papers. Finally, implications, limitations and future direction for tourism disaster research are briefly discussed.

METHODS

The purpose of our paper is to investigate the state of ICT adoption research for disaster management within the tourism industry. Systematic literature reviews have been recognized by the research community as an important mechanism to identify research gaps by searching, identifying, synthesizing, evaluating, and combining the results from published articles for a topic (Shafiee et al., 2019). Moher et al. (2009) developed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) Flow diagram, which provides clear guidelines for conducting systematic literature reviews and meta-analyses. The diagram categorises the research process into three simple steps: initial search of literature, selection of relevant articles and review of selected articles to synthesize information accurately and reliably. Figure 1 below shows the results for this paper.

Initial search

To investigate the use of ICTs in the context of disaster management for tourism, we have used some of the largest and most used databases to search for the relevant research articles in this study. They are: Scopus, Web of Science, EBSCOHost and Google Scholar. Most of them allow searching for a wide range of sources from interdisciplinary areas. Our review was conducted in December 2021.

The adoption of ICTs in tourism is broad and multi-faceted. Boolean operators were therefore used to capture and filter relevant articles on tourism and disaster management. For example, Boolean operator 'OR' is used to capture any of these terms related to ICTs, 'technology', 'online', 'internet', 'social media', 'ICT', 'digital' in either titles, abstracts, or keywords. Similarly, another 'OR' is used to incorporate both words 'disaster' and 'crisis' in either titles, abstracts, or keywords, with 'AND' to join the main search term 'tourism' in titles. The word tourism is truncated to 'touris*' to capture both tourism and tourists. Google Scholar does not have flexible features and so included all of these terms in research paper titles. By using these search terms, the selected databases exhibited a total of 585 results (227 by Scopus; 188 by Web of Science; 105 by EBSCOhost and 65 by Google Scholar) as shown in the figure below.

The search results from the databases were exported to MS Excel using the Zotero application (zotero.org). This application helped to arrange the results from different databases to a single format for further processing.

Selection

An explicit set of inclusion and exclusion criteria was then employed to assure the extraction of the data was relevant to tourism and disaster management. In addition to the exclusive search terms, research articles published only in the English language were extracted. Similarly, only papers published in peer-reviewed journals and international conferences were included and non-peer-reviewed articles, book chapters, news articles, editorials, personal comments and opinions were excluded.

Search terms were carefully chosen to capture and filter relevant papers and were consistently used across the databases. The aggregated data in the MS Excel Spreadsheet had many headers such as 'Item Type', 'Publication Year', 'Author(s)', 'Title', 'Publication Title', 'DOI', 'Abstract', 'Date', 'Issue', 'Volume' etc. In the first round of screening, the data was sorted based on paper titles of all 585 results, however, 216 of these papers were duplicates. Most duplicate papers appeared in more than two databases. Although we intended to exclude non-peer-reviewed articles, some of the databases we used did not specify this in the search process. Therefore, in the second round of screening, any articles which were not peer reviewed in journals or book chapters were removed manually. There were 42 articles in that category as shown in the figure below.

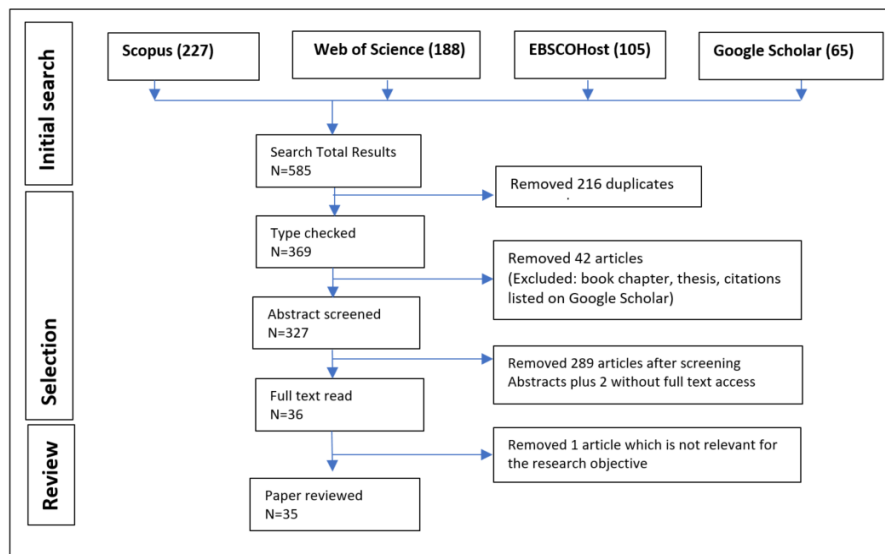


Figure 1. PRISMA Flow Diagram – Literature search and selection process.

If an article appeared in both Google Scholar and any other databases, the record extracted from Google Scholar was removed (abstract are missing at first glance in Google Scholar, without downloading the paper). For the remaining articles found in Google Scholar, each link was manually checked to extract abstracts to populate our spreadsheet for the third round of screening.

The first two authors screened abstracts of all 327 articles separately in the Excel spreadsheet. Author 1 and Author 2 selected 34 and 37 papers respectively for the next round of analysis, as most of the articles were not relevant to the research topic. There was a high degree of similarity between two authors' selections, except three. The inter-rater reliability was more than 95%. Papers which were mismatched between two authors were screened again (collaboratively) and a consensus was reached to remove these papers. 289 articles had been removed in this stage, as they were not related to the topic of investigation i.e., using ICT for disaster management in tourism. The majority of rejected papers did not address the use of ICT or disaster management in tourism primarily but included ICT or digital in their abstracts. Additionally, 2 articles were also removed as their full-text versions were not publicly available.

Review

The remaining 36 papers were distributed between two of the research team and the content was analysed through close reading. By mutual agreement we removed one paper as it was not totally relevant to the topic under investigation. The remaining 35 papers were discussed in detail by the research team to identify, categorise and code topics related to disaster management themes in the tourism industry. The list of selected papers is shown in Appendix A. A Google Spreadsheet was created, shared and populated collaboratively with identified themes as the review and analysis of papers progressed. Theme codes changed minimally over the course of the analysis, as inter-rater agreement and reliability increased over time.

RESULTS

Across the selected databases, initially a total of 585 articles were identified using our search criteria. After several rounds of screening, we identified 35 research articles to review closely. Table 1 below shows the comparison of the number of research articles initially found and finally selected across the four databases.

Table 1. Comparison of research articles found and selected

Databases	URL	Initial Search Results	Final Selection
Scopus	scopus.com	227 (39%)	9 (26%)
Web of Science	apps.webofknowledge.com	188 (32%)	16 (46%)
EBSCOHost	ebscohost.com	105 (18%)	7 (20%)
Google Scholar	scholar.google.com	65 (11%)	3 (8%)

Academic studies on how ICTs have been adopted for disaster and crisis management in tourism only commenced less than 2 decades ago. From the selected papers, the oldest article published was in 2009. The number of publications on this topic only grew in the last 5 years from 2017. More than 90% of the selected papers were published in the last 5 years (2017 to 2021). The number significantly increased due to the impact of the COVID-19 pandemic. Figure 2 shows the summary of research paper distribution over the last 12 years.

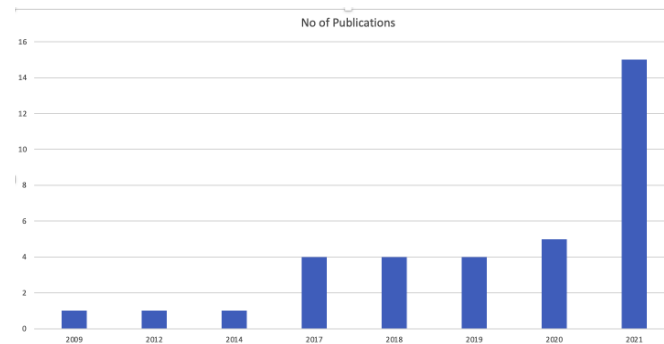


Figure 2. Distribution of selected research articles across last 12 years.

The selected papers were from research studies in many different countries but were mostly focused on Asia. For example, 5 studies were conducted in Japan, 3 in Indonesia, 2 in China and 1 in India, Nepal and Phillipines. Others were from other countries including Australia, Fiji, Spain, Sweden, and USA.

About two thirds of the selected papers were published in journals and the rest in international conferences. The Tourism Management journal published three of these papers, the Journal of Sustainable Tourism published two and the rest of the selected papers were published in different journals and conferences.

We have also analysed research methods used by the selected papers. Table 2 (below) shows the distribution of research methods used. Less than 40% of the selected papers (13 out of 35) conducted empirical studies, out of which only nine had collected primary data with tourism stakeholders.

Table 2. Distribution of selected articles based on research methods

Research Methods	No. of Studies	Percentage
Mixed (Quant and Qual)	5	14%
Quantitative	4	11%
Review and content analysis	12	34%
Qualitative	4	11%
System development	10	29%

Papers were also divided into several broad categories based on the type of ICT applications for disaster management in the tourism context. Table 3 below shows the top five ICT tools that have been researched in selected articles. Most of the selected papers (15 out of 35) conducted their studies on social media. Other ICT tools such as IoTs, AI, GIS, VR and web applications have also been used for disaster management in tourism.

Table 3. Top five ICT related applications in selected articles

ICT Applications	No. of Studies	Percentage
Social Media	15	43%
Internet of Things (IoTs) / AI / sensors	4	11%
Web applications	4	11%
Geographical Information Systems (GIS)	3	9%
Virtual Reality	3	9%

12 out of 35 papers were relevant to the COVID-19 pandemic and other good proportion of papers were related to other natural disasters such as earthquake, hurricane, tsunami, flooding, and landslides. Five papers were related to human induced crises such as crime, political unrest, or terrorism. There were six, which were general papers in tourism disasters.

DISCUSSION

The tourism industry is susceptible to various disasters i.e., both natural and human induced crisis. Some disasters have a longer lasting impact on tourism enterprises with a potential to cause tremendous loss to global and local economies for decades, changing the attributes and attractiveness of tourist destinations. Most disasters which impact locally cause serious impacts to local people, communities, and their tourism industries, while others have a global impact in many countries in the world. The recent COVID-19 pandemic is a humanitarian crisis of epic proportions, and it has already caused havoc for the global tourism sector that is continuing. Although there is scant empirical research that shows the relationship between adoption of disaster informatics and its implications for tourism, a few studies have shown how various ICT applications have been adopted for all three stages: pre-disaster, during and post-disaster.

Social Media

One of the ICT applications, which has been widely used in tourism, is social media. Many aspects of tourism business have been influenced by social media such as searching and finding information related to tourism destinations, tourism promotions, interaction between tourism providers and tourists [Schroeder & Pennington-Gra, 2015, Zeng & Gerritsen, 2014] to name a few. Likewise, social media has changed the communication processes and interactions among stakeholders at the time of disaster from what used to be a top-down direction of information flow (Luo & Zhai, 2017) to bottom-up communications as information is sourced from users and the communication is now dynamic and multi-dimensional. Moreover, individual users can gain insider information quickly (Schroeder & Pennington-Gra, 2015). This has significant repercussions in tourism businesses both positively and negatively (Zeng & Gerritsen, 2014). For example, volunteer tourism is promoted to disaster zones via social media for recovery work or to boost the local economy (Fukui & Ohe, 2020; Wearing et al., 2020). However, an Indonesian study (Erdiana et al., 2019) highlights the negative impact, whereby images of a localized incident affected and limit tourist activity in that region. Moreover, social media is also seen to facilitate discussions of local events like recent bushfires in Australia to highlight the complex linkage of climate change to tourism (Schweinsberg et al., 2020).

Besides so many different ICT applications, social media has a potential to shape social discourse globally and dramatically re-frame the landscape through the accessibility of information, in both text and image (Fukui & Ohe, 2020). Social media users can also trigger a series of positive or negative connotations to a crisis by commenting, sharing, or forwarding posts, commonly known as secondary crisis communication. For example, a Hong Kong study shows how the secondary crisis communication of 'Occupy Central', which started as a political topic on Weibo (social media platform - Chinese version of Twitter), morphed to a tourism boycott, causing a new crisis (Luo & Zhai, 2017). Similarly, another study Zhai et al. (2020) illustrated that social media also facilitates the evolution of a personal incident into online collective action and influences offline behavioral intentions of other users of the platform. Thus, the behavioral pattern of netizens on social media linked with emotions can develop into new challenges for crisis management in tourism destinations (Park et al., 2019; Huertas & Oliveira, 2019; Luo & Zhai, 2017; Zhai et al, 2020). In contrast, secondary crisis communication in social media can also be a blessing in disguise with an ability to empower and inform tourists during emergency, disaster, and crisis situations (Rucińska, 2014, Möller et al., 2018). Social media can sometimes embody a crucial role in building resilience and increasing awareness (Möller et al., 2018) by bringing together both local and virtual communities during different stages of a disaster. A sense of belonging to a broader global community inspires people to contribute either directly or indirectly through volunteer tourism and funding or donations (Fukui & Ohe, 2020).

Geographical Information Systems (GIS)

Another ICT application that is widely used for the context of disaster management for tourism is Geographical Information Systems (GIS). Most of the applications related to GIS have been used for disaster planning and mitigation: pre-event and prodromal phases (Faulkner, 2001). Several opportunities have been developed for tourism planning such as visitor flow management, tourism resources investigation and prediction of impacts from tourism (Ting & Qiao, 2010). Two Indonesian studies utilised a GIS application to map earthquake-hit areas in Padang (Marizka & Afnarius, 2019) and a tsunami evacuation route for tourists in Lebak (Handawati et al., 2020). Similarly, geotagged social metadata was used in the Bohol earthquake and Haiyan typhoon in the Philippines (Yan et al., 2017) to monitor and assess post-disaster tourism. Whereas in India, pilgrim tourist flow is managed by integrating RFID with GIS in vulnerable disaster areas (Pal & Jain, 2014). Web applications were developed by integrating Web-GIS, disaster risk evaluation technology and host identity protocols to effectively evaluate and manage risk for tourism disasters (Tsai, 2017). Thus, GIS applications are widely used in various types of tourism platforms to plan, manage, and mitigate potential risks for tourists in real-time.

Internet of Things (IoT)

Furthermore, other emerging technologies such as IoTs are also gradually making their presence felt in e-tourism and smart tourism developments. Takahashi et al. (2019) proposed an IoT surveillance system to assure safety and wellbeing of vulnerable residents and tourists after the tsunami in Japan. In South Korea, cultural heritage sites such as temples are protected from fire danger using a ubiquitous sensor network (Joo et al., 2009). There are many other areas IoTs can be used for assisting tourism operators during disasters, for example tracking tourists' location, relaying traffic congestion information, suggesting alternate routes etc. The omnipresence of mobile phones with cameras, video, microphones, and sensors (Kaur & Kaur, 2016) together with the ability to connect to the internet has provided access to information and advice for many tourists. The convenience and quick access to social media platforms has enabled speedy sharing of information about local incidents, crises etc. making mobile devices an unconventional form of disaster sensing and situational awareness (Harrison et al., 2010). Sensors have been used with mobile devices to capture images and aid maintenance, repair processes and rescue operations. In pre-disaster scenarios, sensors can be used to limit the number of visitors, track location of tour buses (in case of disaster-prone areas) etc. Similarly, adoption of interactive help desks, kiosks, and social networks can be used as tools to assist tourists at the time of a disaster or crisis. Tourism organisations can benefit from virtual tours and augmented reality (AR) to enable tourists to experience the characteristics of the tourism destination / history, even after a disaster (Gutiérrez et al, 2013).

Digital Tours

The studies on ICT use for challenges within tourism disaster management highlight that ICT plays an essential and positive role in investigating existing issues and potential benefits to help the revival of the tourism industry. It is expected that a positive trend of interest in digital tours in the post-COVID era will be seen, and interactive digital experiences may have comparable tourism recovery impacts to physical experiences (Sorooshian, 2021). The virtual ICT tool adoption such as virtual tours and the use of digital avatars provide enhanced interaction and personalisation (Viñals et al., 2021), for online services to increase tourists' engagement and enhance brand competitiveness (Buhalis and Sinarta, 2019; Viñals et al., 2021). Virtual personalised immersive tourism experiences have also created opportunities to develop new tourism services or products and provide a new form of promotion (Sánchez & Palos-Sanchez, 2021). The virtual tours are not only enabling interactive and personalised tours which are comparable to conventional tours in generating more visits during pandemic, but they also enable people who are unable to travel due to infirmity or illness to visit and enjoy the experience of tourist sites. Increasing ICT capabilities for tourism service providers and tourists are enabling such interactions and are better connecting the people and tourism settings (Fennell, 2021). Using ICT in disaster management also supports tourism rehabilitation enabling tourists, service providers and policymakers with better decision making over reopening destinations (Yan et al., 2017) and helps investigate changing traveller behaviour and needs considering a disruption created by a disaster. Lemy et al. (2021) argue that consumer behaviour during COVID-19 has changed and modified the use of ICT for tourism services.

Artificial Intelligence (AI)

AI tools can also help to explore tourists' intention or readiness to use tourism services post-pandemic considering things like safety-related concerns (Perić & Vitezić, 2021). Similarly, social photography sites such as Flickr and Instagram enable visual storytelling at a relatively lower cost to help in destination brand promotion and awareness, increasing tourist visits during the pandemic or in the current tourism revival process (Mardhiyani et al., 2021) (Yan et al., 2017). Such visualisation also enables monitoring and assessment of post-disaster recovery for tourism stakeholders (Yan et al., 2017). Such platforms are also being used to examine visitor/tourist perceptions and sentiments of a return to a destination, which plays an important role in a revival of tourism (Martínez-Hernández et al., 2021; Obembe et al., 2021).

ICT Adoption for Tourism Disaster Management

Consumer behaviour during the pandemic has changed (Lemy et al., 2021). Considering the present context and volatile post-pandemic situation, more studies on this topic are necessary to better understand how to effectively adopt ICT for disaster management in tourism under a variety of contexts. Despite increased ICT adoption and studies investigating technology use during the pandemic, Sorooshian (2021) asserts the need for assessing digitalisation readiness and preparedness for digital transformation of various sectors and stakeholders. ICT is expected to play an important role in tourism not just during the crisis when tourism is adversely impacted, but also in the post-crisis phase for local and global economic revival (Sorooshian, 2021).

Although the travel and tourism industry has been challenged on numerous occasions by disaster and crisis, the COVID-19 pandemic has brought an unprecedented impact and global halt to the industry. With travel restrictions placed across borders both nationally and internationally and the prevailing uncertainty of the pandemic, there has been a major restructuring of many tourism sectors such as airline business. Deep job cuts and/or reduced work patterns were seen across almost all European airlines (Albers & Rundshagen, 2020) and the second biggest airline in Australia, Virgin Australia was forced into voluntary administration (Gao & Ren 2020). Similarly, with the enforcement of social distancing measures, lockdown and shutdowns, the hospitality industry has had substantial impact with changes to their operations, staff lay-offs and closures (Gössling, et al., 2020). Despite the multitude of crisis response strategies being used globally, the uncertainty of the pandemic still persists, and it is difficult to ascertain the damage and time it will take for economies to heal and recover. As demonstrated in the examples outlined previously, ICT tools can be used to minimise impacts on the tourism industry brought about by this exceptional pandemic situation (Viñals et al., 2021).

IMPLICATIONS AND RESEARCH DIRECTION

Our review has also identified several research gaps. Studies related to ICT tools adoption in this research area are still at an early stage. With the advancement in technology, ICT applications have been increasingly adopted for planning, managing and recovery of tourism disasters, yet there are only a handful of research studies which document these efforts. Clearly more research can be conducted to better understand the ICT adoption barriers, processes, outcomes and lessons learned in tourism disaster management.

It is also evident that there are minimal studies on ICT adoption of the latest technologies like big data analysis and AI. The impacts to both tourism providers and tourists should be studied on a large scale to identify ways to help both parties to these ICT applications. Another future research direction could be in developing monitoring or evaluation systems for the adoption and use of ICT for tourism disaster management. This would assist us to better understand current success or failure of these systems to better deploy them in the future.

Our review of the current research literature shows that many researchers are investigating the potential adoption of ICT for COVID-19 disaster management related to tourism industry. Most of these studies, however, focused on social media. Future research should consider adoption studies of more diverse ICT tool sets covering the use of other innovative tools, in various geographic locations using different research methods. With the increasing adoption of ICTs during the COVID-19 pandemic, future researchers focusing on tourism disaster management can also investigate the market and consumer's readiness and security-privacy concerns for the tourism industry through the adoption of such tools.

CONCLUSION

Both natural and human induced disasters have a serious impact on the tourism industry. Adoption of ICTs have a significant role to play for assisting tourism operators and tourists both before and in the aftermath of any disasters or crises. This review highlights the very few studies conducted on the adoption of ICT applications in planning, managing and recovery operations both during and post disaster. This review clearly highlights that there is a lack of research which needs to be increased to better understand and strengthen the adoption of ICT for tourism disaster management. This review also highlights the opportunity to utilise a crisis, such as the current COVID-19 pandemic, to develop, adopt and study foundational and critical ICT systems for the tourism industry.

One of the limitations of our study is that the data for this review was extracted from four selected databases and then filtered to only peer-reviewed papers from journals and conferences. During the search, only research articles having *touris** in titles and any study which did not mention tourism or tourist(s) in its title was eliminated. The resulting papers that were reviewed were relatively low in number because of the topic of focus i.e., ICT adoption strictly within a tourism disaster or crisis. Furthermore, we were not able to retrieve the full text of some articles in the list from the selected databases for this review. Most of the articles reviewed were country specific and so may lack generalisability to other contexts. This provides another opportunity to conduct

further research to expand studies to other geographical locations. Similarly, for the information intensive nature of a tourism operation, it is apparent that the collection, retention, and curation of data will become more prevalent over time and there will be a growing need to consider potential risks to tourism stakeholders, especially the need to address data security, privacy, consent, access and cloud-based storage systems. Such studies will enhance the awareness of government and sector policymakers to incorporate ICT tools for strategic planning, maintenance, and management of the sector.

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Appendix A

S. No.	Selected Articles
1	An, T. T., Hanh, L. N., Izuru, S., Minh, T. P., Minh, V. V., Thoa, N. T. K., and Long, N. V. (2021). GIS-based Assessment of Coastal Tourism Vulnerability to Climate Change-Case Study in Danang City, Vietnam. <i>42nd Asian Conference on Remote Sensing, ACRS 2021</i> .
2	Fennell, D. A. (2021). Technology and the sustainable tourist in the new age of disruption. <i>Journal of Sustainable Tourism</i> , 29(5), 767–773.
3	Fitriyah, P., and Nurhaeni, I. D. A. (2021). Netnography and Social Network Analysis: Centrality Actors Reopening Indonesia's Tourism Industry in a Transitional Era. <i>Jurnal Komunikasi-Malaysian Journal of Communication</i> , 37(3), 257–273.
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6	Hasan, R., Koles, B., Zaman, M., and Paul, J. (2021). The potential of chatbots in travel and tourism services in the context of social distancing. <i>International Journal of Technology Intelligence and Planning</i> , 13(1), 63–83.
7	Huertas, A., and Oliveira, A. (2019). How tourism deals with terrorism from a public relations perspective: A content analysis of communication by destination management organizations in the aftermath of the 2017 terrorist attacks in Catalonia. <i>Catalan Journal of Communication & Cultural Studies</i> , 11(1), 39–58.
8	Ide, A. (2021). Tourism and ICT Solutions in the COVID-19 Era: A Comparison Between Japan and Sweden. <i>Review of Socionetwork Strategies</i> , 15(1), 195–211. https://doi.org/10.1007/s12626-021-00072-x
9	Ide, A. (2021). Use of Contact Tracing Apps to Promote Tourism Under Covid-19. <i>International Conference E-Society</i> , 250–254.
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12	Joo, J., Yim, J., and Lee, C.-K. (2009). Protecting cultural heritage tourism sites with the ubiquitous sensor network. <i>Journal of Sustainable Tourism</i> , 17(3), 397–406.
13	Lama, S. and Pradhan, S. (2018). ICT Usage for the post-disaster recovery in tourism: The 2015 Nepal Earthquake. . <i>Information Systems for Crisis Response and Management (ISCRAM) Asia Pacific</i> , 5-7 November, 2018, Wellington, New Zealand.
14	Lemy, D. M., Pramezwar, A., Juliana, Pramono, R., and Qurotadini, L. N. (2021). Explorative Study of Tourist Behavior in Seeking Information to Travel Planning. <i>International Journal of Sustainable Development and Planning</i> , 16(8), 1583–1589. Scopus. Retrieved from Scopus.
15	Luo, Q., and Zhai, X. (2017). "I will never go to Hong Kong again!" How the secondary crisis communication of "Occupy Central" on Weibo shifted to a tourism boycott. <i>Tourism Management</i> , 62(1), 159–172.
16	Mardhiyani, N. L., Budiastuti, L., Mardhiyani, N. L., and Budiastuti, L. (2021). Implementing The Visual Storytelling Model as a Branding Strategy of Kandri Tourism Village on Instagram @desawisatakandri. <i>E3S Web of Conferences</i> , 317(1).
17	Marizka, M., and Afnarius, S. (2019). Development of Web and mobile GIS application of disaster in Padang to support tourism of West Sumatra Province. Proceeding of the 1 st international conference on ASEAN (IC-ASEAN), 344.
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19	Möller, C., Wang, J., and Nguyen, H. T. (2018). #Strongerthanwinston: Tourism and crisis communication through Facebook following tropical cyclones in Fiji. <i>Tourism Management</i> , 69, 272–284. https://doi.org/10.1016/j.tourman.2018.05.014
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21	Obembe, D., Kolade, O., Obembe, F., Owoseni, A., and Mafimisebi, O. (2021). Covid-19 and the tourism industry: An early stage sentiment analysis of the impact of social media and stakeholder communication. <i>International Journal of Information Management Data Insights</i> , 1(2).
22	Pal, I., and Jain, S. (2014). Disaster Risk Reduction and ICT Applications â€“a Conceptual Framework for Tourism Management in Uttarakhand, INDIA. <i>International Journal of Modern Communication Technologies and Research</i> , 2(4), 265812.
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27	Sorooshian, S., Azizan, N. A., and Ismail, M. Y. (2021). Influence of readiness measures on planning tourism digital shift. <i>Academy of Strategic Management Journal</i> , 20(SpecialIssue2), 1–6. Scopus. Retrieved from Scopus
28	Sorooshian, Shahryar. (2021). Implementation of an Expanded Decision-Making Technique to Comment on Sweden Readiness for Digital Tourism. <i>Systems</i> , 9(3), 50. https://doi.org/10.3390/systems9030050
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33	Yan, Y., Chen, J., and Wang, Z. (2020). Mining public sentiments and perspectives from geotagged social media data for appraising the post-earthquake recovery of tourism destinations. <i>Applied Geography</i> , 123(1).
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35	Zhai, X., Luo, Q., and Wang, L. (2020). Why tourists engage in online collective actions in times of crisis: Exploring the role of group relative deprivation. <i>Journal of Destination Marketing & Management</i> , 16(1).