



## Managing airports in non-aviation related disasters: A systematic literature review



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### ABSTRACT

The purpose of this review is to present the literature base of airport disaster management (ADM) for non-aviation related events. This study systematically reviews the recent literature to report ADM efforts, identify gaps for future research and determine related research questions to be addressed. In this study, Systematic Literature Review (SLR) approach proposed by Denyer and Tranfield (2009) was used. Transparency, audibility and replicability are the main objectives of this SLR. The studies which were published within the period 2007 and 2017 were reviewed. The papers were screened in the academic databases such as Wiley, Emeraldinsight, ScienceDirect, SpringerLink, Google scholar and Taylor & Francis. However, papers which are related to the research aim were only found in Emeraldinsight, ScienceDirect, SpringerLink and Google Scholar. Twenty-three papers were analyzed including peer reviewed articles and theses. As a result of the review, it was determined that the previous studies mainly focused on five research topics such as stakeholder collaboration, scheduling problems, medical preparedness, infrastructure planning and corporate social responsibility. The study is considered as original in the sense that it is the first systematic research that investigates disaster management for non-aviation related conditions in airport setting.

### 1. Introduction

Since the beginning of the third millennium the number, frequency and scale of disasters have significantly increased. While the number of natural disasters which took place between 1900 and 1909 was 73, this number increased to 2788 within the period of 2000–2005 [1]. According to the Center for Research on the Epidemiology of Disasters (CRED), 8733 people died, and 569.4 million people were affected in 342 natural disasters in 2016. The approximate economic damages caused by natural disasters was USD 154 billion [2]. The investigation of another highly respected institution, Swiss Re, shows that 191 natural and 136 man-made disasters resulted in USD 175 billion economic losses in 2016. In these disasters 11,000 people lost their lives or went missing [3]. The figures for the first half of 2017 presents the fact that 149 natural disasters have occurred in 73 countries and caused 3162 deaths, affected more than 80 million people and caused more than USD 32.4 billion. China, the United States, India, Indonesia and the Philippines were the top five countries that are the most frequently hit by natural disasters over the last decade [2].

The increasing loss of human life and financial resources evoke an enhanced community wide disaster management (DM) capability. DM is defined as “the organization, planning and application of measures preparing for, responding to and recovering from disasters” [4]. The main

phases of DM are mitigation, preparedness, response and recovery [5]. In this sense, DM tries to eliminate potential disruptions, provide immediate assistance to disaster affected zones and restore or improve the conditions of disaster-affected communities or societies [6]. The involvement of multiple actors from the top level of the state, NGOs, private organizations to individual citizen living in and even out of the disaster affected community makes DM operations more sophisticated [7,8]. However, there has been an increase in the tendency to collaborate with multiple stakeholders and establish public-private cooperation in order to manage disasters more effectively [9].

Airport management in an emergency is regarded as a complex process since emergency conditions put pressure on airport resources and require a surge capacity in responding to unexpected demand [10]. Furthermore, DM in the civil aviation industry requires integrating different systems, procedures, mechanisms and exhaustive regulations with the participation of different agencies and jurisdiction [7,11]. Despite the challenges it is strongly recommended that airports should play a proactive role in every step of DM [12,13]. In addition, their involvement in disaster operations is regarded as essential to save the lives of disaster-victims [14]. Airports which are counted as an essential part of the air transport system have a critical role to connect various stakeholders such as individuals, government and private institutions for the purpose of supporting regional and national growth over the

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past quarter century. For instance, Paris CDG, London Heathrow and Frankfurt airports provided sufficient airport capacity in the context of post-war reconstruction as public enterprises [15]. Today, the cyclical nature of the business environment makes airports provide against new challenges and demands of ever-changing needs of the community which they operate in [16–18].

Although airports have a pivotal role in regional economic activities in normal conditions, they have been gaining more importance in accommodating disaster response and recovery operations. The role that Port-au-Prince Airport (2010), Kathmandu Airport (2015), Esenboga Airport (2005), Yamagata Airport (2011), Hanamaki Airport (2008), Fukushima Airport (2008), Bam Airport (2003) and San Juan Airport (2017) played in disaster times has demonstrated the need to consider airports as a critical element of disaster operations in society. Accessibility, open space, large buildings, redundant communications, logistics handling systems, intermodal access and security make airports magnets for many stakeholders [19]. Their facilities are used for different purposes from humanitarian base camp to medical center. For example; New Orleans Airport engaged in military, humanitarian, and rescue operations during the Hurricane Katrina in 2005 [20,21]. These disruptive events have led researchers and practitioners to focus on how to manage airports in disaster times [e.g. 22–24]. As it is mentioned by Walter White “*Airport facilities can substitute for many other things. But nothing can substitute for an airport*” [13].

Although the existing LR have studied different aspects of airport management and made significant contributions to the aviation field, this study focuses on the ADM. Fig. 1 depicts the focal point of the study which is the overlap of DM and Airport Management. Considered as a multidisciplinary research area, DM (A) has been drawing attention over the last twenty years or so.

Airport management is a distinct field of research which is basically grounded on management and operations science. The overlap of disaster management and airport management topics (C) creates ADM which has idiosyncratic characteristics coming from sector specifications. Airport management has been investigated from various aspects. However, the focus of this research is Section C (ADM). Thereby, the papers that have investigated only ADM were selected for this SLR. The motivation to conduct this research is that no ADM literature review study was found in the literature. This is the first systematic research that investigates disaster management for non-aviation related conditions in airport setting. Considering the lack of ADM research in the literature and the increasing importance of airports in disaster operations, it is obvious that there is a strong need to identify and analyze ADM studies in order to show the current situation of the industry and shed light on future researches on managing airports in disaster times. In this sense, the main purpose of this SLR is to present the literature base of airport disaster management for non-aviation related events. In addition, the objectives of this study are to: identify and analyze ADM related papers, research techniques and methodologies which have been used in the papers; summarize the literature of disaster

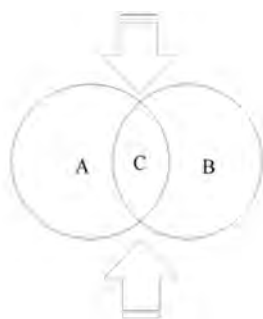
management in airport industry; analyze the literature from thematic and descriptive perspectives; investigate the roles, success factors of airports in disaster operations; identify gaps for future research; increase the awareness of airport disaster management among researchers, airport professionals and their stakeholders.

## 2. Theoretical background

Although the main duty of airports is to carry out passenger and cargo services, they are also expected to fulfill other critical functions in society. Disaster experiences highlight the importance of using airports for different purposes in the immediate disaster response phase and the necessity of further development to expand surge capacity [25]. They are not only involved in disaster response operations to provide logistics support but also they are used as medical treatment areas and base camps [20]. Utilizing New Orleans Airport in military and humanitarian operations; Saudi Airport as a medical center; Kathmandu Airport as a staging area for goods and medical evacuation can be given as successful examples. On the other hand, capacity constraints caused problems in the deployment of emergency items in Port-au-Prince airport in the 2010 Haiti Earthquake [20]. In this sense, airports are considered by communities as essential assets in response to disasters and this role increases their responsibilities.

Airports are exposed to various kinds of disasters. Non-aviation related airport incidents can vary in terms of their time, magnitude, duration and type. They can be classified as natural disasters such as earthquake or tsunami and man-made disasters such as terrorist attacks or hazardous materials spills [26]. Disasters increase the pressure on the availability of airport resources and require capacity increase in order to respond to them effectively [27]. Airport capacity, operations management and flight scheduling are essential elements of airport performance [17]. The demand-capacity incompatibility which is the result of unforeseeable conditions can reduce the level of airport performance [28]. The consequences of the mismatch are congestion in air and airport operations, increasing costs and safety of the air transport system. This leads all stakeholders in the aviation industry to consider airport capacity utilization problems more delicately [29]. Airport capacity is one of the main critical issues in disaster times as well. It is determined by the facilities with the minimum capacity such as airside (runways and aircraft stands) and landside (terminals) [30]. The airport capacity problem considers identifying optimum level of design and expansion capacities for the airport terminal facilities by considering the demand uncertainty [31]. Since their limited resources are utilized by multiple stakeholders to fulfill different functions, disaster response operations face limitations because of inadequate storage for relief items, fuel drums, parking space for airplanes and space for medical care units. In spite of the importance of these facilities, most of the ADM plans do not introduce details of utilizing the limited facilities in the airports [20].

The majority of airports allocate a great deal of their efforts in enhancing their infrastructure for normal conditions. Thus, they ignore the importance of infrastructure resiliency in the face of natural disasters and other catastrophes. Airport resiliency is defined as “*the ability of an airport to cope with or adapt to stress and enable airports to operate at a satisfactory level and restore quickly*” [32]. When a disaster strikes, it creates severe impacts on nearby communities, resulting in an urgent need of relief material. Airports’ role as a recovery agent which has logistical means makes them ideal candidates to store and transport aid materials to the disaster area. Having advanced physical and operational infrastructure can facilitate to achieve logistical efficiency and supplying critical relief items in emergency situations. In addition, providing resilient airport infrastructure will accelerate urban recovery, reduce the time and finance spent in the post disaster phase [21]. All these critical functions lead airports to make more comprehensive disaster management planning in order to reduce the negative effects of disasters. However, this exhaustive and extensive planning requires the



A: Disaster management B: Airport management C: Airport disaster management

Fig. 1. Focus of the research.

integration of multiple stakeholders [33].

Complex entities like airports work with a wide array of corporations and other interest groups named as stakeholders. Stakeholders are important elements to the overall success of business operations. The definition of stakeholder was made by Freeman (2010) as “*any group or individual who can affect or is affected by the achievement of an organization’s purpose*” [34]. Stakeholders can be categorized into two types as internal and external stakeholders [35]. On the other hand, stakeholder groups were categorized by Donaldson and Preston (1995) in a more detailed way as employees, shareholders, government institutions, political groups, customers, investors, communities and trade associations [36,37]. Creating methods to manage the stakeholder groups which have conflicting interests and their relationships in order to achieve the goals of the organization is named as stakeholder management. The focal point of stakeholder management is to create and deliver value by gaining the support of the interest groups [38]. As one of the most conceptualized and applied theory stakeholder management constitutes of understanding and developing stakeholder relationships. Producing economic and social welfare is the ultimate purpose of the theory [39]. Within this scope, managers’ role is to map stakeholders and identify their stakes; to structure organizational processes; to bargain or negotiate transactions so that balance conflicting interests [40].

Stakeholder management is also regarded as an important factor in all phases of disaster management. Disaster stakeholder management focuses on the management and encouragement of stakeholder involvement before, during and after a disaster occurs. According to the study of Horney (2016) et al. the contribution of stakeholders in disaster mitigation plans can reduce the impact of disasters on the affected region [41]. In addition, the involvement of stakeholders can increase the public awareness and motivate the community to take required action. Therefore, disaster stakeholder management has a critical role in enhancing the quality of disaster mitigation plans [42]. Disaster stakeholder management is also a vital part of the disaster reconstruction processes [43].

Airport disaster management is a complex process in which its overall success does not solely depend on airports but also their stakeholders [44]. In lifesaving operations, airports and their stakeholders rely on each other for operational success [45]. Airport relief operations demand the participation of multiple airports, civil aviation authorities, commercial airlines, logistics service providers, agencies, national and international aid organizations [24,29]. Harriman et al. (2009) includes aircraft maintenance, flight operations, ground handling, fueling services, airside services, and air traffic control as airport agencies that have an involvement in emergency conditions [46]. Chang et al. (2003) have a broader approach and lists the airport stakeholders groups which are effected as a result of disaster as air transportation (passenger), air transportation (cargo), businesses at the airport, tourism, agriculture, fisheries, and aquaculture, small businesses, rural communities and health services [47]. The effective utilization of airports in disasters can be achieved only by the integration of these stakeholders, although the involving actors may have different DM perspectives and execution plans. Airports are increasing their territorial integration by establishing new partnerships with all level of public authorities [15]. Cooperation, coordination, and communication among airports, aviation and non-aviation agencies can leverage DM awareness, the protection and promotion of both airport operations and business continuity [19,23,27]. The collaborative efforts can be reinforced through the mutual aid agreements, joint drillings and trainings [33].

Governmental and humanitarian organizations constitute the vast majority of stakeholders that are actively involved in relief operations. But, the increasing number of disasters, the complexity of the humanitarian operations and insufficient capacity of the humanitarian system have made specialization more important and so necessitate the active engagement of private sector organizations into DM processes [48–50]. Private sector organizations can comprise of local, national or international businesses [51]. Their engagement in the humanitarian

operations can be considered within the context of collaborative partnership [52]. The collaborative partnership is to gain benefits from each stakeholder’s capabilities and resources for a specific period of time in order to accomplish both individual and shared objectives [53,54]. The collaborative theory comprises of stakeholders’ recognition of the benefits of working together in a dialogical process [55]. Resource-sharing establishes the basis of stakeholder collaboration [56]. Resources consist of both tangible and intangible assets [57,58]. As one of the important stakeholders private sector’s expertise in the form of operational knowledge, technology and innovation bring additional value for humanitarian operations [48]. For instance, DP-DHL shares its wide range of skills, logistical experiences, competences, knowledge and tangible resources to help airports’ DM processes. The “Get Airports Ready for Disaster” (GARD) training program and GoHelp project are the DP-DHL’s corporate social responsibility (CSR) commitments. Within the scope of these projects, DHL uses its technical resources to help the handling of relief supplies in airports in addition to preparing the airports for disasters.

### 3. Methodology

This study follows Denyer and Tranfield’s (2009) systematic literature review principles that adopt a replicable, scientific and transparent research process [59]. As a LR method, SLR plays a critical role in creating a body of knowledge and guiding practitioners and scholars to inform researchers and practitioners on a given topic [60]. SLR is not solely regarded as the aggregated knowledge of extant studies but also a research project which selects, evaluates, analyzes, synthesizes and reports the existing studies within the scope of formulated questions. It aims to present what is known and not known about the existing studies by improving the transparency, clarity of scholarly communication and internal validity [61].

The method developed by Denyer and Tranfield [59] ensures that LR is transparent, auditable and replicable. In the paper the five steps of this method are as followed:

1. Definition of the research question; (Establish focus)
2. Location of studies; Methods used to find studies (Databases and other searches)
3. Selection and evaluation of studies (Inclusion and exclusion of papers)
4. Analysis and synthesis (Breakdown individual studies into parts and identify associations between parts)
5. Presentation of results (Summary of all studies from data extracted – what is known and not known about the question)

#### 3.1. Question formulation

The main decision in the review preparation is to determine its focus and the scope of the study [61]. In this sense, establishing well-grounded research questions have a critical importance for the following steps of reviews. In this way, researchers can determine inclusion and exclusion criteria and what kind of data will be extracted from the relevant papers [59]. The research questions in this SLR are as follows:

1. What is the current status of research on ADM?
2. What are the main factors that affect positively and negatively the ADM operations?
3. What are the main research interests in the studies?
4. What are the essential elements and managerial practices needed to support ADM capabilities?
5. How the research to date has contributed to our understanding of the ADM?
6. What are the major research opportunities for building ADM?

### 3.2. Locating studies

The scoping study reveals that the topic is not discussed in specific journals. The topic is addressed in various journals such as business management journals, health care management journals and social sciences journals. For this reason, this study does not select papers based on journal titles. A structured keyword search was conducted on four major management science publishers such as Wiley, Emeraldinsight, ScienceDirect, SpringerLink, Google scholar and Taylor & Francis. However, papers which are related to the research aim were only found in Emeraldinsight, ScienceDirect, SpringerLink and Google scholar.

Although “disaster” is commonly used within the scope of the research, there are other synonymous terms used in different studies. These include; emergency, humanitarian, relief, epidemic, pandemic and terrorist attack. Therefore, a broad range of search terms were included in order to complete the paper selection process. Hence, the following keywords were used: “disaster” OR “emergency” OR “relief” OR “crisis” OR “disruption” OR “disaster management” OR “humanitarian” OR “surge capacity” OR “resilience” AND “airport” OR “aviation”. The search was based on all possible combinations of the above-mentioned groups of keywords, using the “Titles, Abstracts, Keywords and All text” field to search. (Table 1)

### 3.3. Study selection and evaluation

The transparency in each step of this SLR is a principle in order to assess the suitability of the academic researches for answering the research questions [59,62]. All relevant publications (journal papers and thesis) regarding ADM activities were reviewed. There is a not time limit set on date range. However, no paper was found before 2007. Article selection was finalized in December 2017, therefore researches published after this date were not included. Since the English language is regarded as a dominant language in business research, only English papers were selected. In addition to these criteria, this study included qualitative and quantitative methods together in order to evaluate literature from a broader perspective. After the initial screening by using the keywords determined in the previous section, 86 papers were collected and related information about the articles were entered into an electronic spreadsheet. Secondly, title, abstract and keywords were analyzed based on the following criteria: Do the papers investigate disaster management in airport industry? At this point, there was an issue that needed to be decided. The issue was to determine the scope of the disaster term. Disasters are considered as intractable problems that deteriorate the operations management capability of disaster effected systems [63]. The subjectivity issue in determining an event as a disaster was discussed in Galindo and Batta (2013). In order to minimize the subjectivity, the following conditions were also taken into consideration: The event’s level of effect on a community; adequacy of resources to respond to the event and the number of agencies involved in coping with the consequences of the event [64]. The above-mentioned understanding of disaster establishes the scope of the SLR. Having determined the scope of the SLR, papers which fit into the scope of the research were determined. The papers that were not relevant to our research question were excluded and 32 papers were selected as

**Table 1**  
Keywords.

Search terms	
Airport	Aviation
+	+
Disaster; Emergency Relief; Crisis; Disruption; Disaster management; Humanitarian; Surge capacity; Resilience	Disaster; Emergency Relief; Crisis; Disruption; Disaster management; Humanitarian; Surge capacity; Resilience

**Table 2**  
Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
– English language	– Not related to airport disaster
– Qualitative or quantitative data	– Not related to healthcare and prevention in disaster
– Outcome measure is related to preparedness and responsiveness against disaster in airport industry	– Related to aviation related disasters
	– Not original research (editorial or commentary)

potential candidates for the full document screening process. Finally, the remaining papers were exhaustively and fully analyzed and the papers which were related to the research questions were included. Ultimately, 23 articles published between 2007 and 2017 were included in this review. (Table 2)

### 3.4. Analysis and synthesis

After selecting the relevant literature, the first objective of this step is to break down each included paper into constituent parts. In the first step, data extraction form was created, and papers were categorized according to criteria shown in Table 3.

The synthesizing of findings constitutes the second phase. The synthesis process groups the results of each paper and creates context specific arrangement which is appropriate to the main aim of the study so that it gives a holistic and different view to the readers [65].

## 4. Descriptive and ADM focused results

### 4.1. Distributions of the papers by year

Fig. 2 represents the distribution of papers on yearly basis. 2012 and 2017 are the years of the most airport disaster-oriented papers published. The papers published in 2012 vary in terms of research interests. The studies investigated scheduling problems, stakeholder collaboration, evacuation process infrastructure planning and medical preparedness. In 2017, the case-study method was the only method which was applied in order to investigate the topic. Choi, S. and Hanaoka, S. (2017) studying the impact of natural disaster on airports in Japan published two papers [20,33].

### 4.2. Publication source

As a result of SLR we found 23 papers related to ADM in 23 different journals. That means that each journal published only one paper concerning this study’s research question. Seven of these journals are disaster, health care or humanitarian focused; seven of them are aviation

**Table 3**  
Criteria for quantitative analysis of the articles.

Category	Information
Year	Year of publication
Publication source	Journals in which the papers published
Database name	Collections of online journals that publish ADM related studies
Location	The geographical dispersion of the disaster effected countries and regions
Research method	Classification of methods used (mathematical modeling, survey, case studies, literature review)
Data type	Classification of data type (qualitative and quantitative)
Research interest	The main focus of the study
Disaster type	The type of disaster(s) investigated
Research aim	The intention of the paper

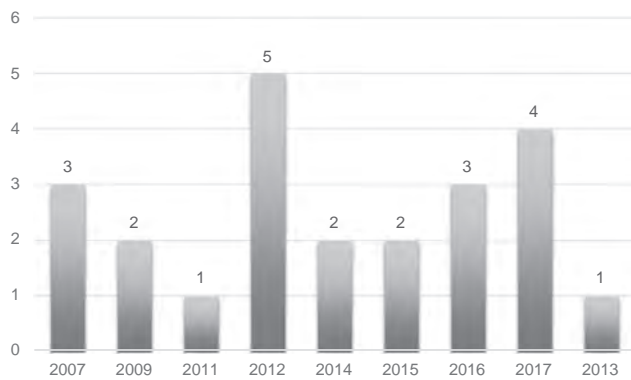


Fig. 2. Distributions of the papers by year.

Table 4  
Number of papers published in each journal.

No.	Journal	Frequency
1	Advances in Distributed Computing and Artificial Intelligence Journal	1
2	American Public University System	1
3	Disaster Manage Response	1
4	European Journal of Operational Research	1
5	IEEE-Industrial Informatics - Computing Technology, Intelligent Technology, Industrial Information Integration	1
6	IEEE-Networking, Sensing and Control (ICNSC)	1
7	IOSR Journal Of Humanities and Social Science	1
8	Japan science and technology information aggregator	1
9	Journal of Air Transport Management	1
10	Journal of Business Ethics	1
11	Journal of Hazardous Materials	1
12	Journal of Homeland Security and Emergency Management	1
13	Journal of Humanitarian Logistics and Supply Chain Management	1
14	Lunds universitet (Master Thesis)	1
15	Michigan State University (Master Thesis)	1
16	MOJ Public Health	1
17	Proceedings of 5th International Global Disaster and Risk Conference IDRC	1
18	Promet – Traffic and Transportation	1
19	Research in Transportation Business & Management	1
20	Transportation Research Part A	1
21	Transportation Research Record Journal of the Transportation Research Board	1
22	Travel Medicine and Infectious Disease	1
23	World Academy of Science, Engineering and Technology International Journal of Aerospace and Mechanical Engineering	1

and transportation focused; two of them are thesis and rest of the journals is either operational oriented or business-management oriented. (Table 4)

4.3. Data type

Qualitative research is in-line with the positivist paradigm, while quantitative research has a close relationship with the naturalistic paradigm. Qualitative research generally provides a micro view of the research focus and uses small sample size. On the other hand, quantitative research has a macro view and uses larger data sets. Other significant difference between these research methods is that the quantitative research applies statistically rigorous techniques, but the qualitative method is more subjective in problem analysis processes. Even though both methods are suitable for conducting research, the qualitative method is recently gaining more attention by researchers. The research question is the determinant to decide which method to apply in the study. The third method is using triangulated data. Triangulation is the combination of different data and methodologies

Table 5  
Qualitative, quantitative and triangulated data.

Data Type	Frequency
Quantitative	8
Qualitative	11
Quantitative and Qualitative	4

with the objective to validate the evaluation and research findings. The SLR findings show that 48 per cent of the papers used the qualitative method, 35 per cent the quantitative method and 17 per cent the triangulation method. (Table 5)

4.4. Methodological categorization

The research process is a systematic way of defining the research objective, evaluating the data and interpreting the results within a pre-determined framework. The framework guides researchers to decide how to perform the project. Research methods are the methods or techniques that are applied to conduct research. In this sense, selecting the most suitable research method is a critical element of accomplishing a research project successfully. As a result of the SLR, it is observed that the case study method was used in 16 papers. In these investigations, interviews, observations, workshops, focused group discussions, diagramming techniques were applied. Modeling technique was used in six papers. In these studies; mixed integer programming, meta-heuristic, two-stage flexible reentrant flow shop (TSFRFS), SEIR modeling, constraints permutation problem, GRASP algorithm and UML modeling were applied. There is only one simulation-based study. In this study multi-agent framework, multi-agent crowd simulation system, Net-Logo, BDI model and multi-Agent Simulation system prototype for Egress analysis (MASSEgress) were used in order to find answers to the research question. (Table 6)

4.5. Database categorization

Papers which are related to the research aim were only found in Emeraldinsight, ScienceDirect, SpringerLink and Google Scholar databases. As it can be seen in Table 7, the majority of papers was published in Google Scholar. Twenty-six percent of the papers has been published in ScienceDirect. SpringerLink and the journals published in Emeraldinsight contributed to the field with only one paper each.

4.6. Disaster types

According to the SLR results it was observed that disaster types studied in the papers can be categorized into three groups as bioterror attack, earthquake and weather-related disasters such as hurricanes and floods. The research investigated bioterror attacks by using the SEIR model [66] and observations and interviews [67] methods in order to measure the medical preparedness in airports. Earthquakes were research focus of the four studies. The modeling and interview methods were applied for the purpose of examining the Asian earthquakes within the scope of stakeholder management. Fourteen papers did not

Table 6  
Research methods.

Research methods	Frequency
Diagramming	1
Interview	6
Interview and Survey	3
Modeling	6
Observation	3
Survey	2
Theoretical research	2

**Table 7**  
Databases.

Databases	Frequency
Sciencedirect	6
Emeraldinsight	1
Google Scholar	15
Springer	1

**Table 8**  
Disaster Types.

Disaster Type	Frequency
Bioterror attack	2
Earthquake	4
General	14
Weather-related disasters	4

specify any kind of disaster and offered their solution to airports for all kinds of disasters. Smith (2009) is the person who did the most work on disasters with three articles. The studies related to weather conditions (hurricane) mainly analyzed airport medical preparedness, evacuation planning and infrastructure planning. Two of these studies especially focused on the impact of the hurricane on New Orleans Airport. (Table 8)

4.7. Locational categorization

This section examines the disaster effected countries and regions that the selected articles examined. In other words, the region of the author’s institution is not the interest of the analysis. N/A refers to the papers that the research did not mention any region within the paper. The Asian continent is the most studied region with eight papers. The number of papers which focused on disaster affected airports in China is 2, Japan is 4, Taiwan is 1 and Saudi Arabia is 1. The papers are related to the impact of Chinese and Japanese earthquakes on airport operations. The airports investigated in Europe are located in Turkey, Croatia and Czech Republic. While academic and managerial implications were given to the Croatian and Czech Republic airports regarding general disasters, bio-terror attack was the focus point of the Turkish airport. The papers which examined the USA airports are mainly related to weather and bio-terror related disasters. (Table 9)

4.8. Research interest

Airports disaster management is a complex process and requires different actors contributing to a response to unexpected events and to continue operations effectively. At this point, stakeholder collaboration plays a critical role to bring a holistic view to the emergent conditions. The SLR shows that eight of the articles focused on stakeholder collaboration. While the other papers touched on topics such as private

**Table 9**  
Disaster occurred countries and regions investigated in the papers.

Regions	Countries	Number of Papers
Asia	China	8
	Japan	
	Taiwan	
	Saudi Arabia	
Africa	Kenya	1
Europe	Croatia	3
	Turkey	
	Czech Republic	
North America	USA	7
Not available (N/A)		4

**Table 10**  
Research interest.

Research interest	Frequency
Capacity utilization	4
Scheduling problem	1
Stakeholder collaboration	8
Medical preparedness	5
Corporate social responsibility	1
General preparedness	4

sector involvement, coordination among airports and partners, business continuity, surge capacity and cross-sector partnership. Secondly, medical preparation for the disasters is another important issue. Researchers mainly analyzed it within the scope of infrastructure planning, resource allocation and operational planning. The solutions are offered both from a specific point of view and from a general approach in the researchers’ studies. Four papers addressed issues from a general airport preparedness level or general disaster competency perspective. The number of papers related to capacity utilization is four. The main topics discussed are: humanitarian logistics bases, space utilization, base camps and staging areas, physical infrastructure, operational performance, community shelters and humanitarian logistics bases. (Table 10)

5. Discussion of ADM literature

5.1. Airport capacity utilization

As an essential part of the air transport system, airports are used by a variety of stakeholders. They are expected to be resilient to the changing conditions for the purpose of being available when the community needs them. Even though it is regarded as a complex process due to the involvement of various factors, airport resources should be planned meticulously to fulfill both commercial and non-commercial activities [68]. Airport planning consists of determining the locations and layout plans of airport facilities, runways, storage and parking space within the airport capacity constraints. Airport capacity is defined as “the maximum number of operations (arrivals and departures) that can be performed during a fixed time interval at a given airport under given conditions such as runway configuration, and weather conditions” [69]. Determining the airport capacity is complicated. Factors such as meteorological conditions, airspace factors, runway configurations, human factors, arrival departure ratio and fleet mix affect the airport capacity utilization decisions [70].

Airports have a vital importance in the immediate disaster response phase especially when the alternative transportation modes are paralyzed [21]. Airports are referred to as a base to fulfill different humanitarian activities such as providing emergency medical care, carrying evacuees, aid goods, and other cargo. These activities are carried out in temporary or permanent airport facilities which are used as base camps, medical treatment areas, logistics centers and staging areas [13,20,26]. But, the insufficient airport capacity may cause problems in the utilization of airport facilities. The research findings of Wu and Ren (2016) show that emergency equipment and facilities are the major problems for airports in China [11]. The disaster experiences point out the significance of airport capacity utilization in the immediate disaster response phase. The utilization of New Orleans Airport for medical, military, rescue and humanitarian operations can be considered partially successful. On the other hand, Port-au-Prince Airport (Haiti) and Yamagata Airport (Japan) failed to respond to the overwhelming flow of items, people, and aircraft because of limited runway capacity [20]. For this reason, airport space planning and capacity utilization are gaining more importance. Space planning aims to find solutions to the logistical problems by considering users’ priorities, layout constraints, organizational structure and security issues. Airport planners should

take into consideration the amount of available area, the number of emergency workers and disaster victims and the operation cost in order to analyze the airport capacity [71]. So, the available space can be utilized more efficiently and effectively in line with the goals of various stakeholders. The space constraint forces airport managers to establish temporary structures such as tents, trailer units and grass landing areas. This indicates that the airport humanitarian logistics base planning should not be rigid. If the space is insufficient for all activities, priorities are to be assigned to functional areas in each facility in the base. The priorities of airport facilities depend on the existing capacity of the airport and the impact of the disaster.

In addition to the main facilities in airports, support facilities such as fueling, drainage, fencing, lightning and airport maintenance have a critical role in emergency conditions. These facilities affect the number of victims and active aircraft that an airport serves in disaster times [26]. Another finding of the review indicates that there is a correlation between airport infrastructure protection and operational capacity. Airport infrastructure protection can enhance the operational capacity to manage aid items such as medicine, food, construction materials and acting as a shelter [21].

### 5.2. Airport scheduling problem

The dramatic growth in air transportation increases the competition and passenger demand for higher standards in the airport services. This leads to new models and techniques to overcome the complex planning issues in airports. One of the problems experienced in airports is the scheduling problem. There is an intense competition for airport resources particularly for the departures and arrivals. Airport users have to share the same space and technical services to accomplish their operations. The increasing demand on the limited airport resources by highly interdependent stakeholders makes airport capacity allocation more complicated [72].

Demand management deals with the capacity limitations and delays in transportation system. Slot scheduling is one of the approaches to operationalize demand management [73]. The scheduling problem organizes the sequence of aircraft operations with the aim of minimizing the total makespan with indefinite aircraft presence on the runway [74]. The air transport scheduling concerns the apportionment of limited airport resources into a determined date and time by airline companies. The planning process helps in; finding routes for operations with minimum delays, an efficient management of airport ground traffic, reducing the operational delays through a suitable assignment of resources and finding a sequence of operations and time schedules to achieve optimal use of capacity [75]. Scheduling in tactical and operational level facilitates to follow real time aircraft flows in response to current operational conditions and to allocate ATM resources appropriately. Wrong decisions can cause long queues on the runways so that aircraft delays and energy consumption increase [76]. Furthermore, schedule disruptions can lead to further problems into the airport network.

The result of the SLR shows that the paper produced by Yang et al. (2012) is the only study which is related to airport scheduling in disaster times [77]. They investigated the relationship between runway capacity constraints and airport scheduling problem in disaster relief operations by applying GRASP algorithm. For the purpose of calculating the minimum schedule length, factors such as landing time of an airplane, assignment of stands to discharge relief supplies and airplane departure time were selected. Considering the importance of scheduling problem in airport disaster operations, especially in small airports which have limited runway capacity, more studies are needed to address the issues from different perspectives and methods.

### 5.3. Airport stakeholder collaboration

The connected and nested subsystems create a total complex system. Subsystems which are considered as autonomous operate according to

their logical structure. Their autonomous nature makes them flexible in designing rules of the relationship and eases the decision of continuing the partnership or withdrawing from the partnership. Another characteristic of the complex systems is the unpredictability of the consequences. The ever-changing operational environment, interventions and unexpected externalities can change the intended outcomes that the system planned in the beginning. In this constantly flux system the actors involved have a self-organizing capacity which means that no actor is fully 'in charge' and controls the complex system [78]. Multi-stakeholder collaboration (multi-organizational, intergovernmental, cross-sector) is critical in disaster management processes [79]. The stakeholders which are involved in DM generally are categorized as host governments, military, local enterprises, regional aid agencies and international actors such as the UN, larger aid agencies, extra-regional NGOs and logistics service providers. Although partnership is valued as an important asset in effective disaster response, the involvement of various actors create a complex and dynamic environment which requires an advanced set of skills and experiences [80,81].

Airports, as public facilities, serve the community not only in normal times but also in disaster conditions. While the airports fulfill their responsibilities with a great number of stakeholders in their normal operations, the number of responsibilities and so stakeholders multiply in disaster operations. Their vital role in transporting relief items, aid personnel and victims attract different stakeholder groups. The unexpected increase in demand and the existence of various actors such as multiple aircraft operators, aviation and non-aviation organizations create bottlenecks in the airport operations [24]. This necessitates airports to implement collaborative DM in their region to reduce congestion and response time. Airports essentially operate as delivery points for cargo and passenger with pre-determined amount in normal conditions. However, disasters create surge and require more agility and resiliency in airport operations. In order to overcome surge-capacity problem, airports collaborate with logistics service providers, other airports, airline companies, local business and other governmental institutions [19,23,27,44]. Coordination of airport stakeholders in operational decision-making processes is vital in the initial response to disasters. In this respect, disaster drills, staff trainings, using advanced information technologies, pre-established cooperation agreements between airports and their stakeholders are the most highlighted points in the literature.

The increasing number of disasters has advanced the skills and knowledge required for disaster management operations. As Kovács and Spens (2007) states the 2004 Asian Tsunami created logistics management awareness [82]. Today, given logistics service providers' (LSP) capacity, knowledge, geographical coverage and experience, it is commonly believed that they have a vital role in life saving operations [83]. That is to say, in addition to their capability in distributing relief items, the tacit knowledge, technical expertise and cost efficiency capabilities that they possess make them important players in humanitarian aid [84]. Commercial logistics aim to minimize costs and satisfy demand, whereas the objective of humanitarian logistics is to deliver critical aid items for the purpose of society's benefit [85]. The Get Airports Ready Disaster (GARD) and GoHelp projects of Deutsche Post DHL can be given as an example of the stakeholder collaboration in airport industry [48,86]. The projects include airport disaster preparation (e.g. airport infrastructure and key personnel), developing an Airport Surge Capacity Assessment (ASCA-report), organizing workshops, train-the-trainer program and also providing the company's core competencies in logistics through expertise and staff time and follow-up activities in airports [87]. The results of the company's analysis reveal that airports are not adequately prepared for the sudden pressure when a disaster strikes, especially in the issues of airport operations, cargo operations, passenger operations and facility management. The results also show that the deficiency in airport capacity and logistics operations can hinder resource allocation. Even though the collaboration with external stakeholders can bring benefits to airports in disaster

operations, finding correct partners and establishing a legitimate framework is important in order to have transparent operations in terms of perceived relationship. Given the fact that external partners' involvement is often considered suspicious and questions like "Why are you doing it? What's in it for you?" are encountered in the community, airports have to be more careful in this process [88].

#### 5.4. Airport medical preparedness

Despite airports having commercial interests, they also function as public facilities especially in disaster times. One of the functions among them is using airports as medical centers when the hospitals are damaged or inoperable. The findings of the SLR show that the investigated airports could not function appropriately in the immediate response phase of the disasters and offered limited number of services as temporary medical facilities. One of the most significant examples is New Orleans International Airport where victims were evacuated and treated once the hurricane had destroyed the community as a whole. The airport witnessed the largest medical evacuation in recent history with approximately 24,000 people arriving by helicopter [89]. The observations of the Disaster Medical Assistance Team revealed the fact that the airport was not suitable for the medical treatment. The scarce electrical power was adequate for providing light, but it was not enough for air conditioning. The airport was hot and musty, smelled of mold, and was devoid of any potable water. Medical tents were set up inside the airport terminal because the only space for them was the helicopter landing space and it was occupied and outside was very cold to accommodate the victims. In addition, the number of trained airport staff was not enough to provide medical services to the victims [22]. These findings indicate the importance of airport facilities conformance and availability of airport staff who have medical training in order to provide emergency medical services to the disaster affected population.

Airports do not only experience natural disasters but also man-made disasters as well. Bio-terror attacks or chemical release events pose a threat to airport workers and passengers. In this case, the main aim of an airport is to minimize the number of deaths from a bio-terror attack in an airport. For this purpose, the proper decontamination of victims at the incident scene is important to prevent other people in the airport getting infected [67]. In order to have a flexible and effective operation against airport chemical attacks, operations need to be fulfilled with a multidisciplinary approach among emergency medical services and airport authorities and exhaustive coordination plans should be prepared [66]. Supplying sufficient numbers of detection equipment and personal protective equipment for the first responders is another critical suggestion gained as a result of the literature findings.

#### 5.5. Airport corporate social responsibility

As Frolova and Lapina (2015) state, the survival of the organizations depends upon how much they allocate their resources to corporate social responsibility (CSR) activities [90]. CSR adds value through providing competitive advantages, establishing a company's reputation and brings mutual benefits. Today, successful organizations put social issues at the center of their operations [91]. Based on this literature review, airports are expected to have a balance between making profits and considering their stakeholders' interests [92]. Having a significant level of CSR understanding and implementation would provide airports sustainable development [93]. In this sense, providing airport safety, emergency services, community caring, and society participation are counted as important elements to fulfill CSR activities of an airport.

Logistics service providers' (LSPs) CSR efforts, by sharing their expertise, aim to help the disaster affected communities [94]. Logistics functions that have cross-functional nature are considered as a critical element for the environmental and social sustainability of operations. The awareness of logistics social responsibility (LSR) has been increasing in academic and industrial arenas. LSR consists of employee

training, philanthropic activity, community involvement, ethics, safety and community issues [95]. Logistics companies communicate their CSR activities by issuing periodicals and reports for the purpose of implying their existence as a good corporate citizen. While the literature which investigates the relationship between the CSR activities and logistics function exists, LSPs' involvement in humanitarian CSR activities is scarce [96]. One of the most significant LSR activities belongs to the German mail and logistics company, Deutsche Post DHL. The company has launched "Corporate citizenship projects" called GoHelp and GARD in a partnership with the United Nations. The CSR activities bring mutual benefits to the involving actors. The social commitment projects lead stakeholders to learn from each other and to develop their skills and knowledge [51]. In addition to these findings, the study also reveals that the company only gives assistance to small scale airports that really need training and operational help in pre- and post-disaster times. This is regarded as an evidence that DHL separates its CSR activities from business ones. The CSR project makes a significant contribution to society as well as increasing employee motivation and learning. The employees do not only consider the DHL as a company that only focused on its own business interests but also has a sense of social responsibility [48]. Furthermore, this kind of initiatives facilitates airport disaster operations, resulting in accomplishing airports' roles to help disaster affected society by offering their facilities and logistical capabilities.

## 6. Conclusions, limitations and recommendations for further research

### 6.1. Conclusions

This SLR meticulously analyzed 23 papers with the purpose of understanding how airports reacted to disasters, what kind of methods they used to mitigate, prepare, respond to disasters and what lessons can be learned from their success or failures. The study is considered as original in the sense that it is the first SLR that investigates disaster management for non-aviation related conditions in airport settings. As a result of the SLR, we categorized the main research topics as (1) airport capacity utilization, (2) airport scheduling problem, (3) airport stakeholder collaboration, (4) airport medical preparedness and (5) airport corporate social responsibility. The descriptive analysis of the SLR shows that qualitative research methods were used in the majority of the papers. In order to investigate airports' roles in disasters, the interview and modeling methods were mainly applied in the studies. In addition, most of the researchers have provided solutions to airports for all kinds of disasters rather than focusing on disaster-specific conditions.

The insights which were derived from this SLR highlight some important factors to be considered in airports disaster operations. The findings indicate that establishing an integrated action program with stakeholders increases the airport resiliency and success rate of disaster operations to a measurably higher level. Because of this reason, convincing all stakeholders about the life-saving role of airports in every stage of disaster operations is necessary not only to increase coordination in disaster times but also to receive government support to prepare airports for future disasters. Creating a realistic emergency plan is considered another important factor especially for the immediate response phase. If the preparation plans are made seriously by a group of experts, airports and their stakeholders can respond to disasters successfully. The review findings refer to a sense of transport responsibility, distribution of simplified information and minimizing official formalities as the success factors in the collaborative management of regional air transport systems in disasters. Another issue to be considered is that every airport has unique characteristics. Therefore, an airport emergency plan should not be the copy of other airports' since every airport has different local conditions, infrastructural characteristics and purposes. In addition to these issues, road conditions and



lifeline networks between the disaster base and airport should be reflected in the airport disaster planning. An airport's physical condition in responding to a disaster is also important. The immediate and convenient proximity of the functional areas should be determined in advance of an emergency situation. The development of a mathematical model for the measurement of the space and the location of functional areas would allow decision makers to choose the best-fitting design from different alternatives. The location of the airport is regarded as its primary advantage. Geographical location of an airport would enable an airport to serve the community without being affected by natural disasters such as floods. Furthermore, the SLR indicates some barriers to having resilient airport operations. These barriers are; lack of perceived need, expected cost, lack of motivation, and lack of guidance [32].

The review concludes that airport disaster management is still in its infancy in academic and also sectorial terms. Although there have been attempts to get airports ready for disasters, they are not sufficient. This paper supports the literature by identifying and categorizing the main research topics. Furthermore, this study presents the methodological approaches applied in the studies. Lastly, the SLR provides future research directions to researchers. In addition to presenting the literature related to airports disaster management, the study gives valuable insights to practitioners as it identifies above-mentioned critical success factors affecting airports in disaster times. It will be useful for managers to take these factors into account to use their resources for the sake of community benefit and also the continuity of their businesses. In addition, this study is believed to increase the airport managers' awareness and encourage them to take correct steps in actual disaster relief efforts.

6.2. Limitations and recommendations for further research

Although the SLR approach was used and analysis was conducted and presented rigorously, this study has certain limitations. Firstly, some studies could not be included in this paper because the university where the author works does not have access to the relevant databases through the university's network. Secondly, only researches which were published in English were considered in this SLR. For this reason, not all relevant information and research results could be included. Thirdly, the SLR is based on a limited number of papers which assess the airport disaster management. The fourth limitation is regarding the subjectivity of the research interest categorization. Although the classification of papers was carried out with great care, it should be mentioned that the author's judgment is a factor in selecting and categorizing the papers.

Airport management is a growing field of research in which various research opportunities are available. Despite the current research having made valuable contributions there is an important gap identified in the literature. The previous papers mainly focused on five research topics such as stakeholder collaboration, scheduling problems, medical preparedness, infrastructure planning and corporate social responsibility. However, airport disaster management can also be investigated by considering hundreds of operational management and business management topics. For instance, logistics management, supply chain management, warehouse management, organizational management and surge capacity. The literature needs more rigorous empirical research which uses various methods such as survey, modeling and simulation so that airports' resiliency to disasters can be determined more accurately. Airports operate in a highly regulated industry and every step they take are seriously controlled. However, as the communities' backbone airports do not have detailed performance standards in preparing and responding to any kind of non-aviation disasters. Future research could investigate disaster management processes of airports by considering the findings this study reveals.

Appendix A

See Tables A1–A3

Table A1 Descriptive information of the reviewed papers.

First Author	Year	Journal Name	Database	Disaster Type	Disaster Type	Country	Region	Sample Organization
Chang, Y.	2016	TRPA	Sciencedirect	General	Non-Aviation	Taiwan	Asia	Taoyuan International Airport
Link, D.	2014	IDRC	Googlescholar	General	Non-Aviation	NA	NA	NA
Wu, Qian	2016	ICIICII	Googlescholar	General	Aviation and Non-Aviation	China	Asia	Heilongjiang, Jilin, and Liaoning
Smith, J. F.	2012	JHSEM	Googlescholar	General	Non-Aviation	USA	North America	331 airport survey; 20 GA airports interview
Kraus, J.	2014	WASET	Googlescholar	General	Non-Aviation	Czech Republic	Europe	NA
Choi, S.	2017	JHLSJM	Emeraldinsight	General	Non-Aviation	Japan	Asia	Shizuoka prefecture (Airport)
Vertalka, J.	2012	MSU	Googlescholar	Weather conditions	Non-Aviation	USA	North America	NA
Kanyi, P. M.	2016	IOSR-JHSS	Googlescholar	General	Aviation and Non-Aviation	Kenya	Africa	Wilson Airport
Bicharra, A. C.	2012	ADCALJ	Googlescholar	General	Non-Aviation	NA	NA	NA
Kenar, L.	2007	JHM	Sciencedirect	Bioteor attack	Non-Aviation	Turkey	Europe	Esenboga Airport
Klein, K. R.	2007	DMR	Googlescholar	Weather conditions	Non-Aviation	USA	North America	New Orleans Airport
Ezrekat, S. A.	2017	MOHPH	Googlescholar	General	Aviation and Non-Aviation	Saudi Arabia	Asia	NA
Berman, O.	2012	EJOR	Sciencedirect	Bioteor attack	Non-Aviation	USA	North America	California; Long Beach Airport
Sanford, C.	2007	TMID	Sciencedirect	Weather conditions	Non-Aviation	USA	North America	New Orleans, Louis Armstrong Airport
Yang, Z.	2012	ICNSC	Googlescholar	Earthquake	Non-Aviation	China	Asia	Wenchuan County and Yushu City Airports
Choi, S.	2017	JATM	Sciencedirect	Earthquake	Non-Aviation	Japan	Asia	Yamagata Airport
Smith, J. F.	2009	APUS	Googlescholar	General	Non-Aviation	USA	North America	37 U.S. airports
Minato, N.	2012	RTBM	Sciencedirect	Earthquake and tsunami	Non-Aviation	Japan	Asia	Yamagata airport
Smith, J. F.	2009	TRRJTRB	Googlescholar	General	Non-Aviation	USA	North America	20 U.S. airports
Bautić, M.	2015	Promet	Googlescholar	General	Non-Aviation	Croatia	Europe	Split Airport
Ruede, D.	2015	JBE	Springer	General	Non-Aviation	NA	NA	36 Interviews airport with stakeholders
Hult, A.	2017	LU	Googlescholar	General	Non-Aviation	NA	NA	NA
Hanaoka, S.	2013	JSCE	Googlescholar	Earthquake	Non-Aviation	Japan	Asia	Iwate Hanamaki, Yamagata and Fukushima Airports

**Table A2**  
Research focus and methods.

First Author	Research focus			Research methods and techniques			Type Of Data
	Main Topic	Sub-topics	Main Method	Techniques			
Chang, Y.	Corporate social responsibility	Disaster preparedness	Case-study	Modeling; Analytic hierarchy process; Pairwise comparison method; Decision-making trial; Evaluation laboratory method	Quantitative		
Link, D.	General preparedness	Airport resiliency certification program	Theoretical research	Theoretical research	Qualitative		
Wu, Q.	General preparedness	Emergency response efficiency, Evaluation index system	Case-study	Interview and Survey	Qualitative and Quantitative		
Smith, J. F. Kraus, J.	General preparedness		Survey Theoretical research	Interview and Survey Theoretical research	Qualitative Quantitative		
Choi, S.	Infrastructure planning	Humanitarian logistics base; space utilization; space constraints	Case-study	Diagramming; Adjacency matrix diagram and Bubble diagram; space planning models, interview; Area estimation model; schematic plan	Quantitative		
Vertalka, J.	Infrastructure planning	Operational performance; Community shelter, Humanitarian logistics base	Interview	Interview	Qualitative		
Kanyi, P. M.	Infrastructure planning	Physical infrastructure	Case-study	Survey; Interview; Secondary data / Statistical data; Focused Group Discussions	Qualitative and Quantitative		
Bicharra, A. C.	Infrastructure planning		Modeling	Modeling; Simulation modeling; Multi-agent framework, multi-agent crowd simulation system, Net- Logo; BDI model; Multi-Agent Simulation System prototype for Egress analysis (MASSEgress)	Quantitative		
Kenar, L. Klein, K. R. Ezraqat, S. A.	Medical preparedness Medical preparedness Medical preparedness	Chemical spill response; Chemical attack Infrastructure planning MCIs preparedness	Case-study Case-study Case-study	Observation; Interview Observation; Interview Interview; Survey	Qualitative Qualitative Qualitative and Quantitative		
Berman, O. Sanford, C.	Medical preparedness Medical preparedness	Resource allocation; Bioterror Medical and operational planning; Resource allocation; Evacuation process	Case-study Case-study	Modeling; SEIR model Observation; Interview	Quantitative Qualitative		
Yang, Z.	Scheduling problem	Airplane minimum schedule length	Modeling	Modeling; Mathematical modeling; Mixed integer programming, Meta-heuristic; Two-stage flexible reentrant flow shop (TSFRFS) constraints permutation problem; GRASP algorithm	Quantitative		
Choi, S.	Stakeholder Collaboration	Airport waiting time; Cooperative disaster response operations; Operational bottlenecks	Case-study	Modeling; Jackson network model	Quantitative		
Smith, J. F.	Stakeholder Collaboration	Business continuity; Surge capacity	Survey	Survey	Quantitative		
Minato, N.	Stakeholder Collaboration	Collaborative management; Inter-stakeholder management	Case-study	Interview; Historical data analysis; Graph	Qualitative and Quantitative		
Smith, J. F.	Stakeholder Collaboration	Coordination among airports and partners; Business continuity; Airport disaster preparedness	Case-study	Interview; Workshops	Qualitative		
Baučić, M.	Stakeholder Collaboration	Geographic Information Systems; Airport emergency response; Communication and coordination of rescue teams; Shorter response time	Case-study	Modeling; UML modeling; Interview; Diagramming	Qualitative		
Ruede, D.	Stakeholder Collaboration	Legitimation processes; Cross-sector social partnership	Case-study	Interview; Documents; Observations	Qualitative		
Hult, A.	Stakeholder Collaboration	Private sector involvement in disaster operations; General preparedness level; Resiliency; Preparedness; Awareness; Disaster competency	Case-study	Interview	Qualitative		
Hanaoka, S.	Stakeholder Collaboration	Resource allocation; Disaster preparation and training	Case-study	Interview	Qualitative		

**Table A3**  
Research aims and findings.

Main focus	References	Aim (respectively)	Key findings
Corporate social responsibility	Chang et al. [93], Hult et al. [48], Ruede et al. [88]	<ul style="list-style-type: none"> <li>To analyze, categorize and prioritize airport corporate social responsibility (CSR) activities.</li> <li>To investigate the airport disaster management related CSR program of DP-DHL as a private logistics service provider.</li> <li>To examine the criteria used by DP-DHL before starting an airport disaster management related CSR program.</li> </ul>	<ul style="list-style-type: none"> <li>CSR strategies are important for airport sustainable development.</li> <li>The most significant CSR project is related to risk management and emergency response ability.</li> <li>The CSR projects conducted by LSPs increase employee motivation and learning.</li> <li>Cooperation among stakeholders is critical enabling maximum impact of the project in CSR projects which conducted by LSPs.</li> <li>Legitimization is a critical issue for airports when they engage with a private company to help their disaster management processes.</li> <li>Airports face limitation in space allocation in disaster times.</li> <li>The sources of limitations are insufficient parking space for aircraft, limited space for the temporary storage of fuel drums, and shortages in the prepared space for temporary lighting facilities, storerooms for storing relief goods, and space for setting up staging care units, runway orientation, length, width, and pavement strength.</li> <li>The base camp plans should be flexible.</li> <li>The airport area can be divided by tents, trailer units considering the changing needs.</li> <li>If the airport does not have enough capacity the required activities should be prioritized for each facility.</li> <li>The planning should consider the facilities within and around airports.</li> <li>Infrastructure plans should be created with the participation of related stakeholders.</li> <li>There is a positive correlation between the disaster preparedness and appropriateness and adequacy of the existing infrastructure.</li> <li>When to land an airplane, which aircraft stand it is assigned to discharge relief supplies and its departure time for leaving airport are the main issues to solve airport scheduling problem.</li> <li>The capacity constraints affect minimization of scheduling length.</li> <li>The waiting time does not always decrease when the number of airports increases. Adapting a balanced role assignment is more preferable.</li> <li>The disaster management planning phase airport administrators and other stakeholders should analyze the strengths and weaknesses of each airport to identify each airport's role in immediate disaster responses.</li> <li>The continuity of relationship depends on the succession planning.</li> <li>The appropriate mutual aid agreements can increase the surge capacity during disaster response.</li> <li>The coordination among airports and emergency management agencies is a strong and efficient disaster mitigation approach.</li> <li>Establishing parallel information flows in disasters times is vital.</li> <li>Reduce official formalities to minimum, increase personal relationships, exchange knowledge, skills with the stakeholders.</li> <li>The sense of transport responsibility and distribution of simplified information increases the effectiveness.</li> <li>The coordination between the regional airports provides continuous logistics operations in after disaster.</li> <li>Airport emergency management planning should include: types of emergencies planned for, agencies involved in the plan, responsibility and role of each agency, stakeholders' contact information, a grid map of the aerodrome and its immediate vicinity.</li> <li>WEB GIS; provides the most appropriate information to all airport emergency management participants, improves communication and coordination of rescue teams; makes response time shorter and emergency operations more efficient.</li> <li>The involvement of private sector in airport disaster management has a significant contribution since they provide their core expertise into humanitarian operations.</li> <li>Regular training is essential for successful cooperation of organizations within and without the airport.</li> </ul>
Infrastructure planning	Choi et al. [20], Vertalka [21], Kanyi et al. [26], Bicharra et al. [97]	<ul style="list-style-type: none"> <li>To create a method to diagram a base camp in airports in disaster times.</li> <li>To explore how airports prepare their infrastructure and operations that protect themselves from hazardous events.</li> <li>To evaluate the airport physical infrastructure in responding disasters.</li> <li>To evaluate airport building layout constraints by considering collective behaviors during emergency evacuations.</li> </ul>	
Scheduling problem	Yang et al. [77]	<ul style="list-style-type: none"> <li>To create minimum airport schedule length for airplanes in the process of landing, departure and discharging relief items.</li> </ul>	
Stakeholder management	Choi et al. [33], Smith [19,27], Minato et al. [23], Baučić et al. [44], Ruede et al. [88], Hult et al. [48], Hanaoka et al. [24]	<ul style="list-style-type: none"> <li>To estimate the mean waiting time in airports with the involvement of multiple stakeholders.</li> <li>To summarize strategies for coordination among airports and other agencies during disasters.</li> <li>To discuss regional air transport collaboration affects disaster response effectiveness.</li> <li>To examine the impact of the cooperation among regional airports and other actors on in each step of airport disaster management.</li> <li>To present the benefits of WEB GIS services to airport stakeholders in collective decision making during disaster conditions.</li> <li>To explain how a cross-sector social partnership (CCSP) legitimizes itself toward multiple internal and external stakeholders.</li> <li>To understand the function of private sector in getting airports ready for humanitarian operations.</li> <li>To investigate the role of airport and surrounding stakeholders in responding to a disaster.</li> </ul>	

(continued on next page)

Table A3 (continued)

Main focus	References	Aim (respectively)	Key findings
Medical preparedness	Kenar et al. [67], Klein et al. [22], Ezeqat et al. [14], Berman et al. [66], Sanford et al. [89]	<ul style="list-style-type: none"> <li>To assess a chemical release event, the medical response efforts and share the experiences for future exposures in airports.</li> <li>To describe the experiences and solutions of medical staff in using an airport as a medical center.</li> <li>To investigate the level of medical preparedness for mass casualty incidents in airports.</li> <li>To discuss a one-time resource allocation decision in a bioterror attack on an airport.</li> <li>To analyze medical and operational planning.</li> </ul>	<ul style="list-style-type: none"> <li>A successful airport medical response can be fulfilled with a multidisciplinary approach among emergency medical services.</li> <li>Airport personnel should be educated how to approach a chemical attack.</li> <li>Integrated medical preparedness programs should be developed.</li> <li>The resource shortages are the major obstacle to provide medical services in airports.</li> <li>Airports have to make sure that not only emergency medical services take the responsibility but all airport employees.</li> <li>Airports should create detailed plans to respond different kinds of medical requirements.</li> <li>Finding optimal allocation of resources is vital to minimize the number of casualties.</li> <li>Organizational deficiencies such as insufficient medical and operational planning, staff allocation problem cause the failure of medical operations in airports.</li> <li>Unawareness of the need to resiliency program, the costs to be borne, lack of motivation, and guidance are considered as major barriers to improve airport resiliency.</li> <li>The capability evaluation system consists of emergency management organization, risk management, publicity and education, emergency response plan, emergency personnel, emergency equipment and facilities, training and exercises, communication and information, decision making support, financial support and response in the later stage.</li> <li>Location determines the role of airport in disaster response.</li> <li>Airport users can apply their business capabilities to disaster management operations.</li> <li>An airport's unique characteristics should be borne in mind when disaster management planning is made.</li> </ul>
General preparedness (Multiple)	Link et al. [32], Wu et al. [11], Smith [98], Kraus et al. [12]	<ul style="list-style-type: none"> <li>To propose airport resiliency certification program for the purpose of increasing airport administration and other users' motivation to support airport resiliency efforts.</li> <li>To propose capability evaluation system in order to measure the emergency response efficiency.</li> <li>To present concepts related to the position of general aviation airports in disaster planning.</li> <li>To develop basic document and manuals for airport emergency planning.</li> </ul>	

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