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AIRPORT OPERATION DISRUPTIONS

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Abstract

Disruptive events have a very strong potential to create a problem, spreading onwards to different participants in the chain of air travel. To minimize the negative effects, this paper focused on how an airport can deal with disruptive operations effectively. The target of this paper was to come up with a step-by-step method, that airports could follow when coming up with a plan on how to manage their operations during these events. In order to reach this goal, it was essential to understand the principles causing disruptions and furthermore, categorizing them respectively. In addition to that, we had to find out what is the contribution of each category to the overall state of delays. Thanks to interviews with professionals at different international airports, we were able to come up with plans of trainings and exercises as a part of the suggested strategy. At the same time, in the proposed plan, several factors were mentioned, which were considered as an important part of the operations during interruptions that airports should not forget about.

Keywords

disruptive operations, delays, impact, proactive and reactive approach, contribution of disruptions to interruptions, disruptive events, management of disruptive operations.

1. INTRODUCTION

The topic of disruptions can be viewed from many perspectives. These depend on who plays the main character in the whole situation. Disrupting situations represent serious problems that affect many people and organizations. They create significant financial losses and have the potential to spread further down the chain. These are a couple of reasons why they need appropriate attention. There are many papers that discuss the topic of airport disruptions, their origins, and impact. Unfortunately, none of them provide a complex method of solutions, that an airport could use to prepare itself better for these types of situations. Therefore, the purpose of this paper was to develop a better understanding of airport disruptions, in order to create a method an airport could follow to handle these situations better and minimize their negative impact.

2. CURRENT STATE OF THE PROBLEM

Disruptions in general, are very complex situations, just like aviation itself [1]. They interlace a variety of people and events that result in an interruption in the smooth flow of air traffic at an airport. When talking about these situations, we have to consider what is our point of view. This varies, because for example, airlines would deal with disruptions differently than airports or passengers. Since airports play a crucially important role in the air transport process, it is important to focus on them too. If airports manage to handle disruptions better, the impact of such events would decrease [2]. Management of these situations heavily depends on cooperation of all the departments and people that are involved in the process. In addition to that, it incorporates many different aspects, such as the predictability of events, the training of staff or the management of the airport [3]. In order to develop a step-by-step method, which could be used by airports, a deeper understanding of these events is required. Only after consideration of potential situations that cause disruptions and events that affect them, we were able to create a proper picture of this problematics [4].

3. METHODOLOGY PROPOSALS

As it has been mentioned before, disruptions cover a variety of aspects, that had to be considered. To understand this problem better, we had to use different methods and approaches. These mainly consisted of qualitative, statistical, and typological methods [5].

The method that was used the most was qualitative and through it we were able to gather theoretical information about the topic. This meant going through other papers, that discussed the topic of disruptions, their causes and effects [5]. Furthermore, this also included interviews with professionals from different airports, that provided us with valuable insight on the topic. This meant that we were not only able to gather theoretical data, but real-life information as well. The interviews were on a semi-structured level, which means that we had questions prepared, but we were opened for wider talk outside of the scope of our questions.

Another method that was used was the historical point of view on these situations. This was a valuable step, through which we were able to gather information about disruptive events at airports that already happened. This method had to be taken into account since our imagination is limited and we cannot make up scenarios of every possible disrupting event that may happen. Besides that, from this method, we can learn the mistakes that were made and therefore improve our way of approach to these situations. From all of the information assembled, through typological method, we were able to create different categories of disruptions that gather situations that are similar in their nature [5].

Furthermore, statistical research had to be done as well. This mostly focused on the contribution of various categories of disruptions to overall delays in the air transport [5].

Moreover, we used an inductive approach, which means that we first gathered important information, to create something more specific. In our case, that meant the proposed method of solution. In addition to that, it is important to keep the information relevant. This means that we used data from the 21st century, which gave us a wide scale we could work on as well as a high level of precision [5].

4. TYPOLOGY OF DISRUPTIONS

There are many ways how we can look at disruptions. Different papers propose different causes of disruptions as well as their effects on air traffic. In order to understand this problematic better, they all had to be considered. Furthermore, these aspects helped us to reach the goal of this paper.

4.1. Basic categorization

There are different databases that consider disruptions in general. The following table examined American and European databases and therefore was able to create respective categories of disruptions [2].

Table 1 Ten different categories of disruptions Source: [2].

1.	Cause	Weather						
	Type	Sandstorms	Snow	Wind	Tropical storms	Convective	Fog	Floods
2.	Cause	Other meteorological phenomena						
	Type	Earthquake		Volcanic ash			Tsunami	
3.	Cause	Accidents and incidents						
	Type	Crashes	Maneuvering incidents	Disruption of other types of transport		Grounded aircraft	Road blockage	
4.	Cause	Strikes						
	Type	Airport personnel	Air traffic controllers	Air carrier crew		Transportation		
5.	Cause	Safety and Security						
	Type	Security warnings	Military conflicts	Terrorism		Cyber attacks		
6.	Cause	Technological failures						
	Type	System collapse						
7.	Cause	Illness						
	Type	Pandemic						
8.	Cause	Global occurrences						
	Type	Sport events		Holidays		Religious events		
9.	Cause	Improvements						
	Type	Development of airport infrastructure – runways, taxiways, lights, navigational aids, etc.						
10.	Cause	Economic						
	Type	Air carrier/travel agency economy breakdown						

Table 1 deals with ten categories of disruptions that can arise at an airport. These categories represent a general categorization of disruptions because they may also vary in type.

4.2. Contribution of disruptions to interruuptions

This factor concludes the overall contribution of each category of a disruption to interruption of the normal flow of air traffic.

Figure 1 deals with European data that was based on raw data gathered from Eurocontrol. These are disruptions that cause delays of at least 1 000 minutes, or they affect 100 flights or more. The following categories might differ to the ones mentioned in table one, since their description would not fit their true meaning. Figure 1 shows contribution of these categories to overall delays at European airports from 2015 to 2020 respectively [7][8][9][10][11][12].
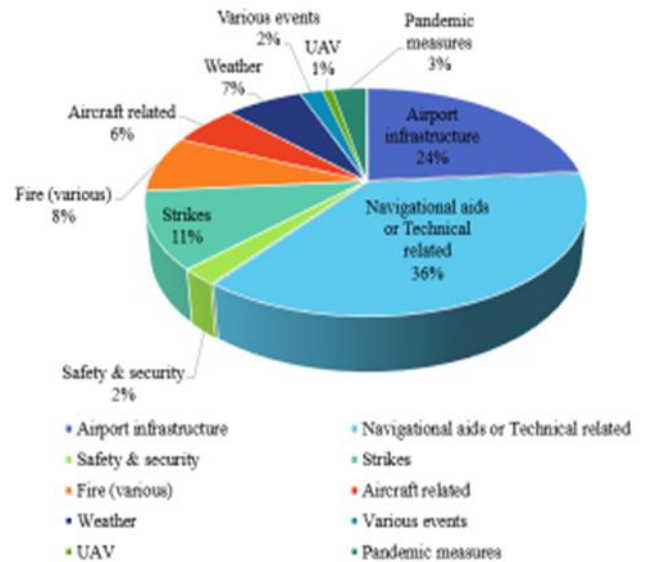

Figure 1 Contribution of various types of disruptions from 2015 to 2020 at European airports. Source: Author

There are different databases that can be used for this step. As it has been mentioned before, figure 1 covers European data. If we were to apply such measure on American airports, we can use database from Bureau of Transportation Statistics. This database uses different categorization of disruptions; therefore, the graph would look different as well [13].

4.3. Parameters affecting disruptions

As it has been mentioned before, in order to fully understand this topic, we had to consider events that affect disruptions as well. These could be narrowed down into seven categories:

- location of an airport
- type of an airport
- predictability
- impact
- duration
- airport's influence
- affecting ground movement

Disruption according to the location of an airport affects this research to a great deal. Certainly, not all airports will have to deal with all types of weather. Airports situated further north will experience different types of weather than airports by the coast of the Mediterranean Sea. This will therefore also affect

the equipment the airport is going to possess and their approach on how to deal with different weather situations [14].

Another important factor that needs to be considered is the type of an airport. In this step, we have to conclude if the airport is acting as a primary or secondary. Primary airports serve traditional air carriers, while their capacity is used almost to its full potential. They also handle passengers that continue on their journey, connecting on another flight with different airline [15][16]. This means that impact of a disruption at this airport would be significant [2]. On the other hand, secondary airports serve low-cost carriers, whose passengers usually do not carry on their journey with another airline [15][16]. These airports are therefore more resistant to disruptions and their impact does not transfer further down the chain as significantly as in the case of primary airports [2].

Predictability of disruptions is a very important part of the ability of an airport to react to interrupting situations. If the airport is able to predict a disruption with a timely manner, it is able to prepare itself better. Of course, not all events are easy to predict. The following table shows the minimum time of disruption predictability according to their categories [3].

Table 2 Types of disruptions and their minimum time of predictability. Source: [4].

Type/Predictability	No	Hours	Days	Months	Years
Airport infrastructure					
Maintenance			✓	✓	✓
Upgrades			✓	✓	✓
Blockage on maneuvering area	✓				
Nav Aid/Tech related					
Maintenance			✓	✓	✓
Calibration			✓	✓	
New equip. installation			✓	✓	
System failure	✓				
Safety & Security					
Political conflicts (war)	✓	✓	✓	✓	
Alarms, bombs, threats	✓				
Strikes	✓	✓	✓	✓	
Aircraft related	✓				
Weather & Geology					
Storms		✓			
Local winds			✓	✓	
Icing, precipitation, low visibility, convection, floods		✓	✓		
Volcanic eruptions	✓				
Earthquake	✓	✓			
Events		✓	✓	✓	✓
Pandemic measures	✓	✓	✓		
Economic collapse	✓	✓	✓		

The impact of disruptions does not have to be so severe if the airport handles the situation well. There could be events that only happen at one airport (a bomb) or situations that affect a wider area. Therefore, these affect more airports at once. An example of this could be a storm or pandemics [4].

Duration of disruptions widely depends on the nature of the situation. They can last anything from a couple of hours (navigation aid calibration) to years (disruption caused by war) [4].

Another category that was considered was the influence of airport over the disruptive situations. We can observe three simple groups in this category. Those are events that an airport has no influence over, events an airport has some control over and situations an airport can influence up their full potential. The reason why we have these three groups is the fact that disruptions may vary in their origin [3].

As it has been mentioned before, disruptions are very complex events. The ground movement of aircraft combines many different activities operated by various groups of employees. The interdependence of actions during ground movement of an aircraft makes them vulnerable to disruptions, which can then propagate delays to other areas as well. They gather both the human factor of the process as well as the technical and infrastructural part. If these parts experience any type of malfunction, the delay spreads on. Therefore, looking at disruptions from this point of view, we can observe how different properties of this process are interconnected and have to work reliably [17].

5. AIRPORT DISRUPTION ANALYSIS

5.1. Significant disruptive events

As it has been mentioned before, it is important to focus on disruptions as they have happened. Taking into consideration the location of an airport or its type, an airport can learn from such past events as well. The following events prove just how various these events may be.

• September 11th, 2001 – Hijacking of four commercial aircraft in the United States airspace affected the whole region of North America and have had negative impact on air travel for many years on. This situation required a closure of the US airspace as well as some American airports. On the other hand, Canadian airports were faced with a wave of passengers and flights that had to divert there [18].

• Snowstorm at Heathrow – At the end of 2010, from the 17th to the 23rd of December, the United Kingdom was hit by a severe snowstorm. The cruciality was even multiplied, since this period of the year represents an especially busy time for travel in general. The airport was closed for one full day, while for the following days its operations were limited [19].

• Fire at an air traffic control center – In 2014, a fire at air traffic control center that was responsible for handling the traffic in the area around the city of Chicago, damaged the equipment of the center so much, the traffic had to be diverted. The event caused an emergency situation at Chicago O'Hare, temporarily putting the whole traffic on pause [20].

• Eindhoven luggage drop-off failure – This airport possess a self-drop-off luggage station, where passengers travelling with low-cost carriers can leave their bags, which are automatically handled. In this case, a failure of this mechanism caused that a couple of aircraft had to be delayed [21].

• Power outage in the Netherlands in 2015 – Nationwide power outage affected the whole region around the country's capital.

It not only affected airports, but other types of traffic as well. This event only lasted for about an hour, but it paused operations at Schiphol and the flight were forced to divert [22].

• Change of political system in Afghanistan – This event caused a closure of Kabul International Airport for a couple of days. Its restoration back to normal operations are a complicated topic since it had been severely damaged during the last days of evacuation flights in 2021 [23].

5.2. Solutions to disruptions

While dealing with disruptive situations, airports can take different approaches. Some are more complex than others. The following list describes what an airport can do during these situations.

• Cancel or divert flights

• Traffic holding in the air or on the ground

• Delay of departure

• Switching to other types of traffic

• Command and control – Stating the leading departments that is going to guide the management of operations and responsibilities of others [3].

• Cooperative preparation – Departments involved in operations during disruptive events work closely together. The airport communicates with airlines and other stakeholders [3].

• Passenger well-being – Focusing on the needs of passengers. This includes provision of internet spots, information centers, accommodation arrangements (beds, blankets, sources of power) [3].

• Prepared reserves and facilities – Having third party agreements with organizations that would provide additional help (staff, equipment) when an airport faces a significant disruptive event [3].

• Collaborative decision making – Implementation of overall changes to the culture of an airport. Communication is key and its execution takes time, but it supports general improvement of airport's performance [3].

• Emergency and contingency plans – According to Annex 17, this step is mandatory for certain events. These plans enable to follow particular set of steps, minimizing the risk of an error. It should cover everything from the preparation for such events, trough initial reaction of an airport, to the communication with other involved departments [24].

• Monitoring disruption related indicators – Active approach towards following values indicating an approach of a disruption. This may include meteorological indicators, status of neighboring airports or airlines [25]. Another example of this is monitoring data of terrorist attack probability [26]. An airport needs to have agreements with organizations that would provide these information.

• Airport minimum operating list – Prioritising of certain parts of infrastructure and subsequent recovery of airport's infrastructure [25].

• Exercises and trainings – Airport's prompt response is based on the preparedness of its staff too. Therefore, creating plans, trainings, theoretical materials that would prepare the staff and the management for disruptive situations [25].

6. ACTION PROPOSAL

The goal of this paper was to propose a complex plan considering all the above-mentioned factors. This method would consist of a couple of important steps.

6.1. Selecting key parameters

A Considering all the discussed parameters that affect disruptions, only a couple of them could be used for our research. Therefore, we have considered the type of an airport, location of an airport, predictability, impact, and duration as key parameters. Although we believe that they all represent an equally important fragments of disruptions.

6.2. Development of a disruption calendar and impact matrix

Based on the already selected factors we created a calendar of what types of disruption an airport can expect. With the support of additional information, specific for the location of the airport, we proposed that it would be possible to depict months distinctive for each category of a disruption.

Table 3 Calendar of annual expectation of disruptions. Source: Author

Economic factors	Improvements: maintenance	Global occurrences		Illness	Technological failure	Safety and security	Strikes	Accidents and incidents	Amount of traffic	Other meteorological phenomena	Weather								Cause
		Religious & sports events	Christmas								Floods	Fog	Convective	Tropical storms	Local winds	Snow	Sandstorms		Type/Month
G	G	X	R	G	G	G	G	R	R	G	O	O	G	G	G	R	G		1.
G	G	X	G	G	G	G	G	R	R	O	O	O	G	G	G	R	G		2.
G	G	X	G	G	G	G	G	G	G	G	G	G	G	G	O	G	G		3.
G	G	X	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G		4.
G	G	X	G	G	G	G	G	G	G	G	O	O	O	G	G	G	G		5.
G	G	X	G	G	G	G	G	O	G	G	G	O	R	O	G	G	G		6.
G	G	X	G	G	G	G	G	R	G	G	G	O	O	G	G	G	G		7.
G	G	X	G	G	G	G	G	R	G	G	G	O	R	O	G	G	G		8.
G	G	X	G	G	G	G	G	G	G	O	G	O	O	G	G	G	G		9.
G	G	X	G	G	G	G	G	G	G	O	G	G	G	G	G	G	G		10.
G	O	X	G	G	G	G	G	G	G	O	G	O	G	G	O	G	G		11.
G	G	X	R	G	G	G	G	G	G	G	G	G	G	G	R	G	G		12.

In this calendar, various categories of disruptions are represented in different colours depending on their month of occurrence. This is because certain disruptions occur more in different seasons. The colours in the table represent severance of the disruption. In this case, a severe disruption (red) represents a situation that is very likely to occur, requiring a considerable preparation of the airport and creates a significant

impact on the traffic. The group of disruptions in orange are disruptions that do not happen as often, but usually come after or before the severe ones. An example of this could be the Christmas season. During months such as November or February, we might expect a small increase of passengers, who are travelling due to holidays. This would be represented with colour orange. Although, we know that we can expect a significantly higher number of passengers in December and January. This would be represented with colour red, as it puts the airport's infrastructure under even more pressure. The ones in green do not create significant events and do not happen as often. Further explanation of these events is clarified in the following tables, which also take the parameter of impact into consideration. We recommend this calendar would be prepared before a significant season (winter or summer operations) and should be updated monthly and weekly in order to stay accurate. Although this calendar provides a general proposal, an airport can easily use its database as the input values. The only category that is not coloured is the global occurrence of religious and other events, since they vary from year to year.

The following table considers the impact of disruptions as well and it identifies what the airport should do when respective groups of disruptions arise.

Table 4 Assesment matrix. Source: Author

Possibility of occurrence	Impact		
High	🟥	🟧	🟩
Medium	🟧	🟧	🟩
Low	🟩	🟩	🟩

We can observe that events with high levels of impact and high levels of occurrence are the ones that are going to cause the most difficulties. Therefore, we strongly advise an airport creates specific methods of solutions for these events, that would include ways of how to reduce their significance. After their application, the matrix should look as the following.

Table 5. Assesment matrix after applying specific precautions. Source: Author

Possibility of occurrence	Impact		
High	🟧	🟩	🟩
Medium	🟩	🟩	🟩
Low	🟩	🟩	🟩

Table 5 represents what would be the colour distribution of the same disruptive events after developing specific preparations for them and their consequential application. We can clearly observe that the most hazardous situations, which were colour coded by red, would now represent a lower level of hazard. Level downgradient would be also experienced by category that was in table 4 shown as orange. With application of further

preparations, we could lower the level of these situations as well.

6.3. Method of solutions

Methods of solution can be divided into two groups, based on when they take place. There are processes that start way before a disruption occurs (proactive), which have a wider area of impact. The other group is a set of reactive solutions, that implement the previously prepared plans or simple actions as holding of traffic or its cancelation. The following table describes which approaches an airport can take, according to time. It considers the previously mentioned methods of solutions.

Table 6. Potential actions an airport can do prior and during disruptions. Source: Author

Approach	Proactive	Reactive
	CDM	Command and control
	Developing a contingency plan	Cooperation of stakeholders
Action	Third party agreements	Cancellations, diversions, delays, holdings
	-	Following a contingency plan steps

6.4. Testing and exercises

Since disruptions do not happen on daily basis, it is important to provide ways how, not only the management of the airport, but also the ground personnel, can prepare themselves. As stated in Annex 14, Volume I, Aerodromes, these exercises must take place not more than once in two years. We recommend that exercises, including the whole airport and other additional services, should take place at this rate. Although we also propose that a smaller scale training, specifically focused on one type of operations, should take place, depending on climatic conditions of particular airport, before winter operations. Besides maintenance and a winter theoretical training, an airport practical exercise should happen as well. These trainings can take an appearance of tests, workshops, lectures or study materials.

6.5. Correct time management

This step is important to minimize the impact of a closure of a certain part of an airport. Therefore, an airport has to consider the timing of its actions. The more time it has to prepare for disruptions, the better its response is going to be. Moreover, contingency plans and other proactive approaches can be used in this step as well.

6.6. Communication

Proper communication on all levels affects how the whole situation is handled. One might think that this aspect only affects the staff and management of an airport, when in reality, it represents a lot more. It could be divided into internal communication, that includes direct employees of an airport, to external, which covers all the outsiders. The group of externals could be represented by the government, media, or families.

6.7. Proposal for further action

It is almost impossible to create a specific step by step method that would be suitable for more than one airport. This is due to the fact, that each airport is unique. Although we believe our proposal could serve as a template airports in general could follow.

CONCLUSION

The topic of disruptions covers a variety of areas. They affect many stakeholders, airlines and passengers. Therefore, they require adequate amount of our attention. In order to master this topic, we had to dig deeper into the topic and understand what are the causes of these events and what are the factors that affect them. After this process, we were able to propose a method that would deal with these situations and provide a guidance for airports to minimize the impact of disruptions.

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