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DIGITAL TRANSFORMATION OF REGIONAL AIRPORTS

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Abstract

The digital transformation of airports has become more talked about in recent years. In the case of regional airports, digital transformation represents a challenge due to financing. The goal of this paper is to describe issues connected with digital transformation, especially at a selected group of airports, which are regional airports. Within the first part, there are defined terms as digitalization and digital transformation. There are also presented selected digital technologies used by airports all around the world, and the Smart Airport concept is explained. The second part is focused on terms such as airport, regional airport, and it describes the current level of digital transformation at regional airports. The main goal is to find out the level of digitalization at selected regional airports in the Czech Republic and the Slovak Republic. The output of this paper will be an evaluation of the current digital level of regional airports with regard to the effects of the Covid-19 pandemic.

Keywords

Regional airport, Smart airport, Digital transformation, Digitalization, Digital technologies at airports

1. INTRODUCTION

Air transport is a key infrastructure of modern society. Whether it is due to the transport of passengers or cargo. The speed of air transport plays an important aspect in its competitiveness. But air transport as such could not exist without airports, as it forms the basis of the entire air transport network. Therefore, it is important to develop further not only aircraft and airlines, but also airports. The implementation of new digital technologies is helping modernization in this direction, as is seen in various other sectors.

In the second part of this paper, the differences between the terms as digitalization and digital transformation are explained and a few examples of digital technologies that can be used at airports are mentioned. Of course, the benefits and disadvantages associated with them are mentioned as well. In the second half of this chapter, the concept of "Smart Airport" will be explained and the various levels of digitalization of airports. The third part deals with the current state of digital transformation of regional airports in the Slovak Republic and abroad. It is also important to address the issue of their finances because financing directly affects digital transformation. In the fourth part, the objectives and methodology of work are introduced. Finally, there are evaluated results of the survey, which consists of a sample of regional airports in the Czech Republic and the Slovak Republic. The last part contains a summary of the achieved goals and proposals for further research in the field of digital transformation of regional airports.

2. DIGITAL TRANSFORMATION

Digital transformation represents the integration of digital technologies into established digital ways of operations of companies or state institutions. It is a process where existing methods are changed, or new ones are created from the ground up to streamline working procedures [1].

Digitalization, or also called digitization, is the process of converting information from analogue way to digital way. It is the process by which information from papers began to be stored on hard disks, thus improving, and speeding up data accessibility. But in the real process, change is not always easy and without a failure, so digitization did not go smoothly. At the time when computers began to be used, many people were still not skilled enough to work with them efficiently. This means that operating systems and data storage systems have been designed to make working on them easier for computer users. Making it easier for the user may not immediately mean the most efficient way to store data. This aspect is one of many where digital transformation can help [2].

2.1. Benefits of Digital Transformation

Companies are undergoing a digital transformation mainly due to the economic reason of reducing operating costs while increasing profits. Other reasons include increasing operational efficiency and increasing customer experience [1].

2.1.1. Improved Data Collection and Sharing

Businesses and government institutions collect a lot of data, but the real benefit of them is based on optimizing this data for analyses that can move the business forward. Digital transformation can create a system that selects the most valuable data and processes, which are used in another analysis, and they can be used further and shared between several internal business departments. By processing these various data, it is possible to gain more specific insights into things such as customer needs, system operation, production, financing, or various business opportunities [1].

2.1.2. Unified System

Digitization is also accompanied by how data is being processed. Various applications are used for data processing, and in large corporations this number can be in the hundreds. A study from 2020 found, that businesses use up to 900 applications on average. This is a hassle for new employees who must learn to work in them, and that is a long and difficult process. For already working employees, this represents an inefficient use of working time [1].

The theoretical solution to this problem is to reduce the number of programs used. But these programs are necessary for the operation of the business. So, the real solution is to create a unified system that replaces multiple programs and implements them in its own style under one user interface.

2.1.3. Digital Presence of a Business

For a business to be successful, it needs to have a strong online presence. Have your business on the online stage. People love shopping from the comfort of home. Such visibility takes place through the digital transformation of websites, the development of mobile applications, regular social networking, and the simplification of business-to-customer communication [3].

The digital transformation helps the business's ability to adapt to current trends and take advantage of currently popular social networks easily and quickly. All this leads to greater popularity and awareness of the company among people and to a potential increase in profits [3].

2.2. Disadvantages of Digital Transformation

Just as digital transformation has its advantages, it has one major disadvantage that affects all electronic devices in the world. These are viruses.

2.2.1. Cyber Danger

Opening and connecting a business to the Internet means, that it opens an Internet communication back to it. If the path is not properly secured, just as employees can connect to the world, hackers or cybercriminals can also find a virtual path to the inside of people's electronic devices. With such a breach of business or people's privacy, there is a high risk of data leak such as personal data of customers, or inside information [4].

Fortunately, there are antiviruses and in-house businesses that try to protect their users from Internet threats. There are even companies that specialize in protecting their clients in this way. This is necessary as the speed at which the digital transformation progresses is great. It is an area that changes daily, and a cunning attacker can take advantage of the overlooked weaknesses in the system. The high rate of updates often results in security cracks being overlooked, and subsequently additional security patches must be issued to address this issue. The user, even if protected, must still be vigilant.

2.3. Digital Transformation of Regional Airports

Airport operations are an area where there is always room for an improvement. Operational efficiency seeks to optimize resources and improve processes associated with maintenance, security, and handling services. Air transport and airports have been pioneers of the digital transformation since the very beginning of the massive digitalization of the industry, which began about a quarter of a century ago. They actively participate in the improvement and refinement of services or operational efficiency. Efficiency in air transport must be at the highest level to keep the industry running smoothly. Several systems and technologies help us to do this [5] [6].

2.3.1. A-SMGS

The "Advanced Surface Movement Guidance and Control System" provides a range of ground routes, navigation on them and an overview of aircraft and vehicles at the airport. It seeks to maintain the required speeds of aircraft and vehicles during all possible meteorological conditions, while maintaining the required level of safety [7].

It is a modular system that is implemented in several stages and the air traffic controller has access to the airport map with the locations of individual objects. Such a top-down view of the airport provides a better up-to-date situation overview and thus increasing the situational awareness of the controllers which increases safety [7].

2.3.2. E-ticketing and Online Check-in

In 2004, there were several global crises and IATA decided to introduce 100 percent e-ticketing. Over the course of 4 years, they have succeeded in implementing this at all airports, from large to small regional airports in remote areas. The cost of processing a classic paper ticket was around $10. The cost of processing an electronic ticket is 10 times lower. With this, the aviation industry can save up to $3 billion a year. The passenger has the benefit of eliminating the possibility of a ticket to be completely lost. In the case of a loss, the tickets are simply duplicated [8].

2.3.3. Self-service Check-in Kiosks and Luggage Marking

Most airlines and airports have switched to self-service kiosks. The passenger must register for the flight with his luggage, which he will later hand over at the appropriate place. Although staff are still available to assist passengers in case of a problem. Self-service kiosks have lower operating costs than employees used at check-in positions. The initial investment is large, but in the long run there is a financial return. Employees can be relocated from their check-in positions to another work positions where they are needed the most. The advantage for passengers lies in not having to wait in long lines and increasing the speed of check-ins [9] [10].

2.3.4. Identification of Luggage Using Radio Waves

RFID technology is used at airports to mark passengers' luggage. This system works on the basis of electromagnetic fields, which transmits data of unique codes assigned to luggage. This method is much more efficient as it is much faster than using standard barcodes. Bar codes require that they be scanned individually, and direct visibility must be maintained. One RFID scanner can scan up to 1,000 individual tags per second and does not require

direct visibility. It works by using radio waves and thus can take more luggage at once [11] [12].

2.3.5. A-CDM

"Airport Collaborative Decision-Making" improves the efficiency and resilience of airport operations by optimizing the use of different resources and improving air traffic forecasting. It is achieved by enabling cooperation between airports, aircraft, and ground operators. Transparency is promoted by exchanging accurate and up-to-date information and as well a more accurate departure information and scheduled take-offs in Europe is provided for the European ATFCM network [13].

2.3.6. Biometrics

This technology can provide a higher degree of identity verification than other methods. In the case of the use of staff in security checks, the failure of human factor must also be considered, which leads to errors. The machines eliminate this factor, which increases the safety and speed of passenger equipment. Standards for digital identity documents are being developed internationally, e.g., digital passport, thus eliminating the need to carry physical documents [14] [15] [16].

Biometrics can be used across multiple airport transfer segments. The speed of this technology is in seconds, if not milliseconds. Another great advantage of it, which was initiated by the current world situation, is the possibility of reducing human contact between several people, in order to protect against the spread of viruses and similar pathogens. The number of areas touched by travellers also decreases, thus reducing the chances of transmitting more types of diseases between people [14] [15] [16].

2.4. Smart Airport Concept

The digital transformation has taken place in several stages as different technologies have been introduced. Based on digital sophistication, which represents the level of adaptation of digital technologies, airports can be divided into individual categories. Currently, 4 stages of airport digitization are distinguished. The transitions between stages are driven by the various challenges the airport currently faces [17].

2.4.1. Airport 1.0

The first category of the airport is a classic, traditional airport, which still operates on the basis of analogue processes. Automated systems are not integrated and overall, no emphasis is placed on passenger experience and satisfaction. In the case of small airports, e.g., regional, which will serve fewer passengers, the traditional operating system is not a problem. However, if it were an airport where the number of passengers carried was in millions, the traditional airport concept would be absolutely unsatisfactory [18].

The integration of digital processes is very limited in this case. The most what can be found at an airport of the first category is CUTE. "Common Use Terminal Equipment" is digital transformation, which is a technological solution that allows multiple airlines to use existing airport infrastructure to equip passengers through their own servers [18] [19].

2.4.2. Airport 2.0

Important feature of this stage is the full deployment of CUTE, but the main factor that defines the second level of airports is self-service. CUSS technology is therefore added to CUTE, but not to such an extent and only for some airlines. "Common Use Self-Service" is an airline platform at airports that uses electronic self-service kiosks to handle passengers and eliminates the need for staffing. Kiosks are mainly used in check-in processes. Construction of a Wi-Fi network at the airport can be observed. In this case, it is a fundamental digital transformation if the airport wants to operate simpler and more efficiently [18] [19].

2.4.3. Airport 3.0

The penultimate level is trying to maximize its space capacity. Self-service kiosks can be found in all parts of the airport. Operational management is automated and portable intelligent devices such as tablets are used. A-CDM is also being used for this category, as digital maturity is at such a level that this system can be fully integrated and used. The airport's website is usually supplemented with 3D maps, and it also contains elements of online stores [18].

The first B2C models can also be seen. This means that airports try to get to know their passengers and find out their needs and preferences. In practice, airports often try to obtain information through various ways like "Passenger Name Record" of airlines, mobile applications, or providing free Wi-Fi and using cookies. Subsequently, they can create targeted advertising through which profits may increase.

2.4.4. Airport 4.0

Level 4 is considered to be the latest stage of development as it is a full-fledged smart airport that uses almost all the latest available digital technologies with the maximum possible efficiency. In the fourth level, analyses are created and processed in order to create maximum innovation. The airport seeks to generate valuable data from this information by tracking passenger flows, anticipating, and knowing customer needs. A clear shift of the business model from B2B to B2C is visible. The systems are fully integrated and can share a wealthy amount of data. The use of artificial intelligence and various automated machines can also be seen. Smart Airports 4.0 are located mainly in the areas of Europe, the Middle East and the region between Asia and the Pacific Ocean. These are mainly major hub airports. Air traffic in these places is very dense, which is why there are many delays at the airports. This problem is driving digital transformation forward very fast [18] [20].

3. CURRENT STATE OF THIS PROBLEMATIC IN SLOVAK REPUBLIC AND ABROAD

In this paper, digital transformation of regional airports is the main focus. Regional airports are a special group of airports that is very important in the air transport network. On the other hand, this group of airports is very specific. It is primarily a view of their operation, which is extremely costly. No matter how hard they try to prosper, their financial problems are deepening every year, which has a direct impact on their digital transformation, development, modernization, and overall operation. Of course, the regional airports can apply for financial

support in the form of various subsidies and state grants, specifically investment and operating aid. However, in many cases, state aid is insufficient and regional airports fail to be profitable [21]. Therefore, they have to adapt to their local conditions and properly solve their financial situation and thus their own development.

3.1. Airports

The airport can be defined according to the L14 regulation. An airport is "a defined area on land or water (including buildings, facilities and equipment) intended either wholly or partly for departures, arrivals and ground movements of aircraft" [22].

Airports can be divided according to several criteria. They can be, for example, public or non-public, international, or national. However, in our case, we are interested in a group that considers the number of passengers transported per year:

- **Main airport** (carries more than 25 million passengers a year).

- **National Airport** (carries between 10 and 25 million passengers per year).

- **Large regional airport** (carries from 5 to 10 million passengers per year).

- **Small regional airport** (carries from 1 to 5 million passengers per year).

- **Small airport** (transports more than 200,000 per year) [23].

3.2. Regional Airport

According to the Commission Regulation of EU 2017/1084, a regional airport is defined as "an airport with up to of 3 million transported passengers annually in average" [45].

3.2.1. The Importance of Regional Airports

Regional airports are an important part of the European Union's aviation infrastructure. They provide access to certain areas that are remote from civilization and difficult to access for other types of transport. Regional airports ensure the economic development of the regions in which they are located, but also in the surrounding cities. From another point of view, they are able to attract various investors to the regions, who are building their industrial companies in these areas or investing in local businesses. Lastly, they help primary hub airports to regulate the overall influx of passengers, especially on busy days [24]. The importance of regional airports has also been confirmed by several studies. For example, Carballo-Cruz and Costa (2014) explained the success of Oporto Regional Airport in Portugal. According to the authors, the main advantage of this airport is its attractive geographical position. The expansion of airlines, expansion and improvement of airport facilities were able to attract more passengers, especially in the period from 2007 to 2011. The number of overnight stays of tourists in this region also increased by 16.5%. This is a clear evidence that a regional airport has positive effects on the economic development of the region in which it is located [25].

3.2.2. The Expansion and Problems of Regional Airports

The liberalization of the air transport market prompted the expansion of these airports. The original goal of liberalization was to increase competition, which led to greater demand for take-off and landing slots. National and major airports have failed to offer more of these slots, and thus the expansion of regional airports has been observed. Between 2005 and 2017, an increase of 39% in direct flights between regional airports was observed, and by less than 20% at larger airports. Low-cost airlines have started to use regional airports as their main airports. The expansion of low-cost airlines has brought changes in the form of cheaper flights, increased frequency, and a greater offer of destinations. In this way, air transport has become more popular and beneficial. The gates to economic growth have opened up, tourism has improved, and the regions have risen economically overall [24].

It can be said that regional airports are very beneficial for their regions. Unfortunately, their operation is not easy and brings several problems. Regional airports often experience financial problems, precisely because of the lack of passengers. Many regional airports have difficulties providing their services not only to passengers but also to airlines. Any airport without passengers and airlines will not survive financially. Without airlines, there will be no passengers, and without passengers, there is no income. Huderek-Glapska and Nowak (2016) dealt with the relationship between regional airports and low-cost airlines. According to the authors, the operation of the regional airport is significantly affected by the presence of low-cost airlines. Maintaining a long-term relationship with low-cost airlines brings several benefits to the airport. [26]. Lin et al. (2013) examined the business relationship between low-cost airlines and airports in Southeast Asia. The results showed that the more the airport's survival depends on the airline, the more compromises it makes. However, this may not be beneficial for the airport, as low-cost airlines are in a better position to negotiate lower airport charges [24] [27].

Regional airports are mostly loss-making and difficult to maintain economically. In this case, too, several studies are enclosed here that confirm this fact. In his study, Červinka (2019) looked at whether a regional airport is a business that can generate profit. According to the author, regional airports can profit, but the most unprofitable are the airports that carry under 3 million passengers a year. Low-cost companies complicate the situation. As a solution, the author proposes to provide airport services to several airlines to generate more profit from airline activities. He also introduced another option, where he proposes to make a profit from non-aviation activities. However, many regional airports do not have the potential to build significant infrastructure to generate profit from non-aviation activities. But if such possibility exists, it must be used. An example of this is the Ostrava regional airport, which has built an aircraft repair shop and a cargo terminal. As a result, the long-term loss of Ostrava Airport may not be permanent. Zuidberg (2017) focused on the financial performance and profitability of regional airports in the EU. The economic performance of the local region contributes in particular to the local regional airport profits [28] [29].

Due to the problems mentioned above, regional airports can apply for state aid and various subsidies for the operation and construction of infrastructure. However, this is not a long-term solution to the problem and is not always enough. The study

Sedláčková and Švecová (2018) examined the problems of regional airports in the Slovak Republic. The study notes that the problems of airports are demonstrably mainly due to insufficient subsidies. Airports with less than 200,000 passengers a year have been shown to be unable to cope with their operating costs. Financing of small regional airports is not only a problem in the Slovak Republic, but also a nationwide problem within the EU [30] [31].

3.2.3. *Digital Transformation of Regional Airports*

The pandemic has accelerated the development and application of many technologies. Therefore, several experts address this issue. Kováčiková et al. (2021) dealt with the current level of digital transformation of airports in the Slovak Republic and in the European Union. Within the results, they found that the airports in the Slovak Republic are below the EU average. However, these figures are based on 2019. Airports in the Slovak Republic have at most online check-in or websites that have sections for business partners and passengers. Košice airport, e.g., is currently preparing an application for passengers [32].

The DESI index shows the level of digitization in EU countries, which is also reflected in the aviation industry. The data of index 2021 shows that Slovakia is currently ranked 22nd. Denmark, Finland, and Sweden lead in digital maturity [33] [34].

For regional airports that are not successful in their business, it is difficult to allocate money for digital transformation. On the other hand, it is necessary if they want their operation to be more efficient and if they care about customer experience from using their services. Passenger experience is a very important factor in this case. Halpern et al. (2021) in their study addressed passenger preferences regarding the use of digital technologies at Norwegian airports. The results showed that a large proportion of passengers want to have more control over their travel through the use of kiosks and personalized options. Specific examples include interest in boarding passes, mobile payments and services, permanent digital baggage tags and the use of biometrics at checkpoints. They are less concerned about their privacy and the impact on human pride in the use of digital technologies. The study concludes that the public is interested in using digital technologies [35]. The study done by Remencová and Sedláčková (2021) also took a look at the digital transformation of regional airports in Slovakia. Introducing new digital technologies at regional airports is more complex, slower, and costly than at a larger airport. For example, investing in self-check-in kiosks may seem costly at first glance, but on the other hand it can speed up the movement of passengers through the airport. At the same time, it can reduce daily operating costs, which in the long run brings a return on investment [36]. Stark (2020) focused on the digital transformation of Springfield Regional Airport, one of the first airports to introduce e-ticketing, automatic baggage sorting and websites. The reason behind the digital transformation of this airport was to increase capacity, safety, operational efficiency and at the same time reduce emissions with lower financial costs and achieve the maximum possible passenger satisfaction. Given the airport's experience with several innovations, a few basic rules are recommended by the management for a successful implementation of new technologies. There is a need to work more closely and address the issue with all stakeholders, such as key airport partners (airlines, airport shops). It is also very important to determine what the airport management wants to achieve with its digital transformation. As soon as strategic goals are defined by the airport, it can gradually start working on digital transformation. Without good management and proper planning, the process will not be possible [37].

3.3. *Current State of Air Transport*

The year 2020 can be considered as one of the most difficult in air transport. The Covid-19 pandemic and related anti-pandemic measures have taken their toll in the form of an overall decline in air transport demand. Travel restrictions have left some airports with almost no passengers, which in some cases has led to the closure of airports. Many airlines have announced their closure. The financial implications of the pandemic are also huge. ACI Europe said that European airports lost a total of 1.72 billion passengers in 2020, a decrease of 70.4% from the previous year. Some small regional airports, which depend on local tourism, have seen an even steeper drop in passenger numbers. In the case of the Dubrovnik regional airport, in Croatia, this represented a drop of up to 88.6%. However, not all segments of air transport have been affected by such a significant drop in flights. Freight transport fell in Europe, by only 12.1% [24].

The beginning of 2021 was also in a similar vein to the previous one, with continuing restrictions on travel. Today is the year 2022 and the air transport sector is opening up to the public again. Many measures have been phased out, as well as travel restrictions, and air traffic is slowly recovering. The overall recovery of air transport takes time, but the results will gradually show [38] [39].

In addition to the decrease in passengers, there was, of course, an overall decrease in flights. Fig. 1 shows EUROCONTROL forecast of the number of IFR flights over Europe until 2027, compared to 2019. The figures are in millions, and a decrease in air traffic in 2020 of 55% is visible. In 2021, traffic over Europe reached 56% of total capacity compared to 2019. From there, a forecast with a continuous increase in the number of flights can be seen. Achieving pre-pandemic levels is expected as early as 2024 [40].
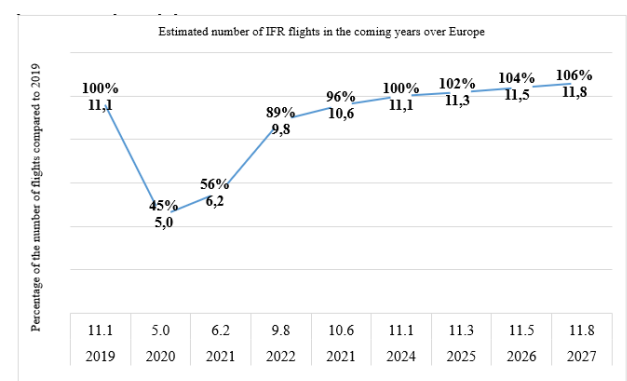

Figure 1: Estimated number of IFR flights over Europe in the following years from October 2021. [40]

In the beginning of 2022, air traffic over Europe was expected to decline by 21% over the same period in 2019, based on more recent calculation models. However, real figures showed that air transport reached only 68% compared to the overall level of 3 years ago in the same period. An increase to 71% in February has been seen, but on the 24th of February an armed conflict

broke out in Ukraine. This war closed the airspace between the EU and Russia on the 28th of February, which led to the cancellation of numerous flights or a change in flight paths. It is too early to say what impact this war will have on Europe in the long term, but it is more than certain that it will slow down the resurgence of air transport [41].

The total number of flights fell by more than half in 2020 [42]. This means that fewer aircraft were handled each year than usual, resulting in a surplus of staff in the air transport sector. This fact of staff surplus was reflected in the redundancies of airport staff as well as airline staff due to cost reductions. This, of course, has a negative impact on the regeneration of the aviation sector. From another point of view, the loss of professionals has put pressure on even faster digital transformation and modernization of airports in general. The digital transformation should result in increased work efficiency as well as automation of airport processes [38]. Therefore, it could be said that the pandemic has pushed regional airports into the corner, and it can be expected that these airports will have to be digitized in the future. It is mainly about passenger protection and cleanliness in the airport. The introduction of new digital technologies can eliminate the spread of viruses and various diseases. This issue was addressed by Amankwah-Amoah (2021), who examined innovations in air transport that were to act as countermeasures against the spread of Covid-19. He also noted an acceleration in the adaptation of contactless technologies at airports to minimize the number of areas that passengers have to touch [43]. A good example is the use of facial biometrics or solutions and processes used in hospitals, laboratories, and other health centres. For example, an intelligent air filtration and purification system, where this properly applied system can help reduce pathogens, allergens, and other air pollutants [44]. In the future, it can be expected regional airports to adapt to the digitalization trend. However, the question remains as to how these digital changes will be financed given the unfavourable economic situation of these entities. The EU could be interested in this issue and offer regional airports solutions on how to finance this modernization.

4. GOALS AND METHODOLOGY OF OUR REASEARCH

This paper is focused on the digital transformation of regional airports. As it was clarified in the previous section, these airports represent a specific group of airports that need to be addressed separately. Therefore, the main goal of this paper is to determine the level of digitization of regional airports in the Czech and the Slovak Republic, which often have a low level of digitization. In their case, it is most often the use of self-service check-in kiosks, and that is all. So, a survey was decided to be made, that was targeted at regional airports in the Czech and Slovak Republics, because there was a need to clarify the current state of their digital level. A very widespread method of "questioning" was used, which consists in obtaining information from respondents by asking questions. In our case, a form in Google Forms was created, and it was distributed electronically to selected regional airports to find out the current level of digitization. This form contained several questions focusing on the technologies already in use and the potential benefits or challenges of digital transformation. We also asked about the digital technologies that airports plan to implement in the near future. At the same time, it is considered important to find out

how the Covid-19 pandemic has affected the implementation of digital technologies at these regional airports.

4.1. Sample

The sample consisted of 9 regional airports in Czechia and Slovakia. The Prague Airport was not included, since it has more than 3 million transported passengers a year, and the airport Sliač was also not included, considering it was closed for civil aviation and is open only for the military.

- Slovak Republic
    a. Bratislava Airport
    b. Piešťany Airport
    c. Žilina Airport
    d. Poprad Airport
    e. Košice Airport
- Czech Republic
    a. Brno Airport
    b. Karlove Vary Airport
    c. Ostrava Airport
    d. Pardubice Airport

5. RESEARCH RESULTS

In this part, the results that were received in our survey are analysed. We managed to obtain only 5 responses out of the 9 regional airports we contacted.

5.1. Žilina Airport

The airport is not currently digitalized and does not use any digital technology to operate. It was added that they plan to introduce self-service check-in kiosks, self-service baggage marking, e-ticketing, online check-in, and mobile application for passengers.

The reason for the implementation of digital technologies is mainly to increase operational efficiency and reduction of current operating costs. It has already been mentioned that the biggest barrier to starting a digital transformation is the initial cost. The airport confirmed this and stated, that their biggest obstacles were the initial investment and current technical equipment.

As can be seen from the previous answers above, the airport has not implemented any digital technology due to the pandemic. However, Covid-19 launched its digital transformation, and they consider it beneficial in the digital development of the airport. This regional airport can be considered as level 1.0 airport from the answers provided, and after the planned digital transformation it will gain the Airport 2.0 status. But it all depends just on the initial investment and also on whether this airport will operate flights.

5.2. Bratislava Airport

According to the results, the airport only uses e-ticketing and the online check-in. They do not plan to implement any new digital technologies in the near future. However, the study by Kováčiková et al. (2021), found that the Bratislava Airport had plans to implement mobile application for passengers. In the current situation, it can be seen that this airport has already given up the implementation of the mobile application. We can only assume that the plan was disrupted by the pandemic, as the survey found that the pandemic was seen as an obstacle to their digital development. This claim is also supported by the fact that they did not implement any technology due to the pandemic.

One of the main reasons for implementing new digital technologies is to increase the speed of passenger check-in. The initial investment represents the biggest challenge for the airport.

As the airport has undergone a minor digital transformation in the past, they provide e-ticketing and online check-in, they have also been able to respond to whether they have seen positive changes in their airport operations. They answered yes to this question, arguing that they had seen positive changes, especially in increasing passenger satisfaction. This airport can be classified as the airport in level 1.0 for now.

5.3. Brno Airport

The regional airport Brno currently uses only e-ticketing and online check-in, as it is in the case of Bratislava Airport. In the near future, the airport plans to implement self-service check-in kiosks, RFID bag tags and self-service baggage tagging. For now, this airport is defined as Airport 1.0. After the implementation of these digital technologies, it will be possible to move this regional airport to level 2.0.

In this case, new technologies are implemented for several reasons, namely: increasing passenger satisfaction, increasing passenger handling speed, increasing operational efficiency, and reducing operating costs. The biggest challenge for Brno Airport in the implementation of new digital technologies is the initial investment.

As part of the fact that they had implemented e-ticketing and online check-in in the past, they answered yes to the question whether they observed changes in their operation. There were positive changes in all 3 mentioned categories: increased passenger satisfaction, increase operational efficiency, and increase staff satisfaction.

When asked if they considered the Covid-19 pandemic to be a benefit or an obstacle, the airport services manager answered following "Definitely not. The reduction in operations and thus in revenues has delayed the implementation of new technologies due to a lack of funds."

For this reason, they did not even implement any digital technology due to the pandemic.

5.4. Ostrava Airport

Based on the results, the airport Ostrava uses, as in the case of Brno Airport, only e-ticketing, and the online check-in. In the

next years, they plan to implement self-service check-in kiosks and biometrics of the face and fingers. For this reason, the airport can only be defined as Airport 1.0 for now.

The reason for implementation is first and foremost to increase passenger satisfaction, then to increase passenger handling speed, increase operational efficiency and improve safety and security. However, in this case, they answered, that they do not do so due to a reduction in operating costs. In the case of the challenges of implementing digital technologies, they gave the following reasons: initial investment, technical equipment, and the necessary trained staff.

As for whether they were able to observe positive changes at the airport-related to the previous digital transformation, they answered yes, stating that they observed these positive changes in increased operational efficiency. However, they did not observe changes in the satisfaction of staff and passengers.

In the last part of the form, they stated that they considered the Covid-19 pandemic to be an obstacle and therefore did not implement any new digital technologies.

5.5. Piešťany Airport

This airport did not respond to our form. Instead, they issued a statement made through an e-mail. A Member of the Board said: "I have no doubt about the need for gradual (reasonable) digitization, which in most cases will make operations more efficient and increase the level of security."

Unfortunately, he added that he would only be able to answer our questions satisfactorily to a very limited extent, as most of the questions are related to the airport's investment plan. For this reason, he provided us with a contact to the CEO, and we subsequently received a reply again through an e-mail. The airport does not currently use any digital technologies, and the director stated: "We will start thinking about them only at a time when we would have regular flights and the number of transported passengers will increase. High financial investment in the systems must have a meaningful return in time, but at the same time, we know that we will have to invest in the systems if regular flights will be operated."

From the answers he provided, we can conclude that they would like to implement new digital technologies to increase operational efficiency, but the current situation does not allow them to do so. In an e-mail communication, a board member also mentioned how the Covid-19 pandemic had negatively affected the situation at the airport. It also takes note of the current Russo-Ukrainian war, which has incredible implications for the economy, respectively crushing impact on their finances.

5.6. Summary of the Results

The survey shows that regional airports in the Czech Republic and Slovakia are not well digitized. E-ticketing and online check-in are more a matter of airlines, but also airports that allow you to work with these services. The digital transformation that involves technologies such as self-service kiosks or biometrics, which are implemented mainly to improve airport operations, are not located at any of our requested regional airports. However, in the near future, these regional airports are going to implement these technologies, but everything requires time and investment. Therefore, we think that after a while, it will be

possible to contact them again and find out if they have noticed the benefits of digital transformation.

Table 1 shows a summary of used and prepared digital technologies at regional airports in our region, namely in Žilina, Bratislava, Brno, and Ostrava.

Table 1: Used and prepared digital technologies at selected regional airports in the Czech and Slovak Republic. [authors]

Digital Technologies	Žilina	Bratislava	Brno	Ostrava
A-SMGC	X	X	X	X
A-CDM	X	X	X	X
Self-service check-in kiosk	Preparing	X	Preparing	Preparing
Self-service baggage handling	Preparing	X	Preparing	X
RFID bag tags	X	X	Preparing	X
Biometrics	X	X	X	Preparing
Artificial Intelligence	X	X	X	X
Automated robots	X	X	X	X
E-ticketing	Preparing	Using	Using	Using
Online check-in	Preparing	Using	Using	Using
Mobile application for passengers	Preparing	X	X	X

6. CONCLUSION

The digital transformation of airports has more advantages than disadvantages. In particular, it brings benefits in the form of more efficient operations, reduced operating costs, and increased passenger satisfaction. In the current situation, it can be confirmed by several studies that the existence of such airports has a positive impact on the local economy, and the larger the airports, the greater the effect itself. However, if there are not enough passengers, the regional airports are not able to cover their high operating costs. If there is only one low-cost airline operating at a regional airport, these problems only get worse. However, there are several ways to solve the problems. The first is, e.g., construction of cargo terminals, but only if they are usable for the regional airport region. The second is the already mentioned digital transformation, which reduces the airport's operating costs, increases passenger satisfaction and, of course, increases the airport's cleanliness from pathogens. Some studies showed that passengers are willing to take advantage of the new digital technologies, but the initial investment in these changes is too large in many cases and regional airports are unable to finance this development on their own.

As for the goals, it can be said, that they were only partially achieved. The cooperation from the side of regional airports was limited because a lot of airports did not respond. Despite the smaller number of responses, we were able to find out the current situation at 5 regional airports. Regional airports in the Czech Republic and the Slovak Republic are minimally digitized and do not reach higher levels of maturity than Airport 1.0. In the future, it would be appropriate to repeat a similar survey, in order to get a more up-to-date and better overview of the digitization of regional airports in our region. As part of the survey, it is possible to expand the sample of regional airports with a focus on other Central European countries. This will make it possible to compare individual regional airports and analyse differences in the use of digital technologies.

To conclude, the digital transformation makes sense in terms of increasing operational efficiency, reducing operating costs and increasing passenger satisfaction. Regional airports see a sense of moving forward in digital development, but they have a funding problem that only prolongs the whole digital transformation.

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