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Challenges in airport digital transformation

Sorin Eugen Zaharia[a]*, Casandra Venera Pietreanu[b]

[a]*Politehnica University of Bucharest, Aerospace Engineering Department, Polizu Street 1-7, sector 1, Bucharest 011061, Romania*
[b]*Politehnica University of Bucharest, Aerospace Engineering Department, Polizu Street 1-7, sector 1, Bucharest 011061, Romania*

Abstract

When it comes to digitization, airports face a multitude of challenges including appropriate IT infrastructure for future resource allocation and automated passenger flow forecast tools. Focusing on improving operations and innovation while enhancing passenger experience, airports use different concepts such as: airport collaborative decision making (ACDM), airport operations center (APOC) and total airport management (TAM), which benefit on new technologies and digital tools. The paper outlines airport digitization trends, the structure through which total airport management is implemented and identifies the changes in airport management determined by new implementation schemes. The authors also analyze the technological challenges determined by the required equipments for the digital transformation of Romanian Henri Coandă airport and propose solutions for check-in area, security, customs control, departure control and passenger assistance services. Ultimately, the impact of implementing the proposed technologies, especially on the experience of the passengers will be examined.

Keywords: airport operations center, digitalization, operation terminal prediction, organizational culture, total airport management.

1. Introduction

Airports are constantly launching new digital initiatives. Although safety and security are a priority for airports, in this competitive environment, airport management must also focus on ways to make airport business and operations more efficient (ACI, 2017). Digital-based airport investment will grow by 40% in 2020 with the objective to improve operations and capacity, and to provide a better customer experience (Little, 2015). Digital solutions for airport operations aim improving commercial and technical efficiency and include: flow monitoring and

* Corresponding author. Tel.: +40722341789
E-mail address: sorin.zaharia@upb.ro

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management, process automation, collaborative decision making, predictive & preventive solutions and customer engagement (Gardy, 2016).

The current research is substantiated on a thorough documentation regarding the technologies used on airports and identifies the changes in data application and operational management for innovation development.

Infrastructure modifications, process adaptation to real-time traffic flow through anticipation and better knowledge of the passenger profile or the modalities to strengthen IT management at the airport were considered in the paper. Also, in-situ discussions were carried at airports in different countries, but in particular at Henri Coandă airport, which is the largest and busiest airport in Romania. Questionnaires regarding the identification of existing problems at Bucharest 'Henri Coandă' International Airport (HCIA) and how to address these issues with the digitization process were performed; the survey involved the opinions of airport staff and representatives in airport management. The professional insight of the airport representatives in this matter was relevant as they provided objective information on what could change at the airport in terms of digitization.

After analyzing a wide range of airports that already face capacity problems (such as: London Heathrow, London Gatwick, Frankfurt, Dusseldorf, Milano airports, etc.), reports concerning the new technologies implementation in airports and Eurocontrol's Airport CDM Implementation Manual were reviewed; thus the authors could propose management and operational solutions - which involve the transition from B2B (Business to Business) strategy to B2C (Business to Consumer) and furthermore, to Airport 4.0.

Airports are working towards digitalization, launching dedicated apps (like Changi, Incheon, Schiphol, Heathrow, Frankfurt, Munich, Zurich or Copenhagen Airport) and covering key areas where digitalization has the greatest impact: operations, security, passengers and retail (Gardy, 2016). Thus, digitization has become a different way to do business, generating more than $300 billion profit (Hoffman, 2017).

At Schiphol Airport, the goals of the transformation have targeted cost-efficient operations, proactive coordination and on-time performance for airlines and seamless journey for passengers delivered via mobile app and open APIs for other commercial parties to use the airport's data (The Open Group, 2017). Technology service provider AOE, helps airports like Heathrow, Auckland and Frankfurt to simplify the journey towards a digital and to provide online and offline experience for passengers (Moodie, M., 2018).

Munich Airport is creating new services with its B2B partners, introducing "mobility as a service", which helps passengers compare transport options from/to the airport and provides real wait times at airport checkpoints (Future Travel experience, 2017), while Zurich Airport is applying a central content management, allowing to provide up to date content regarding flight information on all touchpoints (Atos Consulting, 2016).

Providing automating services and using big data, Copenhagen Airport has enhanced efficiency, becoming this way one of the airports in the world that applies most self-service solutions, or utilizing technologies to reduce waiting times in the baggage reclaim or speed up boarding times (Kobenhavns Lufthavne, 2016). However, the winner of the digital transformation award in 2017, Singapore Changi Airport has managed to create a unified airport identity by digitalizing core processes and operations and using data platforms for problem-solving and collaboration between business partners (Jimenez, D. Z., et al., 2017). From a total airport management perspective, Changi has reached better operational anticipation and reaction; and has improved resource planning, acquiring a unified digital identity (Jimenez, D. Z., et al., 2017).

2. Digitization - an important component of 4.0 airport management

2.1. Objectives

The following levels of airport digitalization mirror the objectives regarding operational efficiency and passenger experience enhancement.

- **Airport operations.** The efficiency of overall airport operations aims to optimize resources and improve processes related to maintenance, handling operations, security services, thus eliminating delays or other operational risks.
- **Passenger journey.** Targets to improve passenger perception and experience by handling congestion, ensuring a continuous flow, thus minimizing queues and maximizing passenger's time spent in retail areas.

- **Ancillary revenues.** Non-aviation revenues can be increased by amending retail area attractiveness, provide commercial information through mobile apps or digital walls and use digital capabilities to perform online orders.

2.2. Airport 4.0

Digital transformation is mainly about the use of technologies in process automation and passenger engagement, which involve mobile CRM, cloud, block-chain technologies, big data, Internet of Things (IoT) or robotics. Another important aspect refers to flow monitoring which applies predictive/preventive solutions refers to airport indoor geo-location, identity management, flow management or radio frequency identification (RFID). In respect to the efficiency of airport operations, a harmonized approach between different actors is important. It involves cognitive systems based on analysis of the integrated data from the appropriate process monitors, with the purpose to predict and improve processes (Fig. 1).

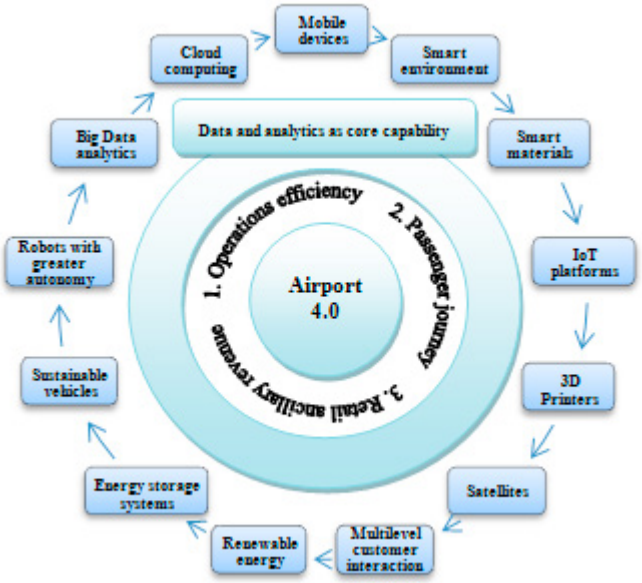

Fig. 1. Airport 4.0

However, an efficient digital transformation comes not from implementing the latest technologies, but from transforming the organizations in order to leverage the potential that digital solutions bring (ACI, 2017). This approach involves the development of new business models, reshaping the organizations boundaries through digital and to rethinking the all management of airport.

Also, for digitalization process implementation, an important action is the human resource education and training. It is necessary to understand the objectives and the benefits of digitalization by each employee and to create an organizational culture of digitalization. It is necessary the anticipation of knowledge and skills needed for the large enhancement of this process and to ensure new interdisciplinary qualifications.

2.3. Promoting organizational culture by means of digitalization

The digital initiatives do not involve only the technological and organizational aspects on airport and its processes, but impact all the actors in aviation. Forced by the need to adapt to the standards set by the industry, all market players in aviation are introducing the newest information technologies and digital tools in order to position themselves in the competition for customers. In this respect, airports, airlines, ground handling, air navigation service providers and new market players are positioned differently in the digital competition. Managing an airport

requires the use of various means to support airport operations from landside to airside. This means that it also implies a close collaboration of all actors for the optimal allocation of resources via digital means (Eurocontrol, 2018). The influence of organizational culture in modern aeronautical organizations may represent a key to the success of digital transformation. It is important to promote a new way of working and managing processes by developing a digital culture across the organization. A digital culture will promote transparency, will encourage decision making and improve the collaboration of all market players, stimulating them to experience and take risks. Thus, digital culture will influence substantially the effectiveness of operations and the development of the airport, changing the perception of societal responsibility which includes sustainable development-as an important target.

In this respect, the management must make staff understand that the digital transformation of the airport is assigned to the entire team, which will create and support an organizational culture that promotes performance and development. For example, at Munich Airport, for enhancing the process of digitalization, a vice-president for digitalization was appointed.

2.4. Societal responsibility

Societal responsibility is one of the important components of airport management and involves an interdisciplinary approach. This means to create a system culture for the interaction between airport and local community, between air transport employees and the society. In other words, it implies having staff with special skills for developing societal responsibility: IT, environment, sociology, geopolitics, etc. Furthermore, airports must integrate in the organizational culture compartment, able to manage this societal responsibility. The IT component is also essential as a support tool of societal responsibility, by his role in optimization of airport operations and energy, contributing to the reduction of negative impact on environment.

For the airport Bucharest Henri Coandă International Airport (HCIA), societal responsibility represents a long term business strategy, which will consider its economic and environmental impact. Taking into account both internal and external dimensions of societal responsibility (European Commission , 2001), a major challenge for the airport is to attract skilled personnel. The airport staff responsible for the implementation of societal responsibility actions will require specific skills and knowledge, such as environmental management, ethical finance, IT, marketing and HR, etc.

Societal responsibility is a very complex issue for the airport and for this reason, it is highly recommended to have qualified and well-trained employees leading these actions. Furthermore, the strategy of HCIA must be centred around the passenger experience, on its employees, on local development and on protecting the environment.

3. International Henri Coandă Airport toward Airport 4.0

Henri Coandă International Airport (HCIA) is the largest and most important airport in Romania, having a declared maximum annual capacity of 6 mil passengers and 2300 passengers/flow/peak hour, reaching 12.8 million passengers in 2017 (http://www.bucharestairports.ro, 2018), with a very high increase in passenger number (Fig. 2).

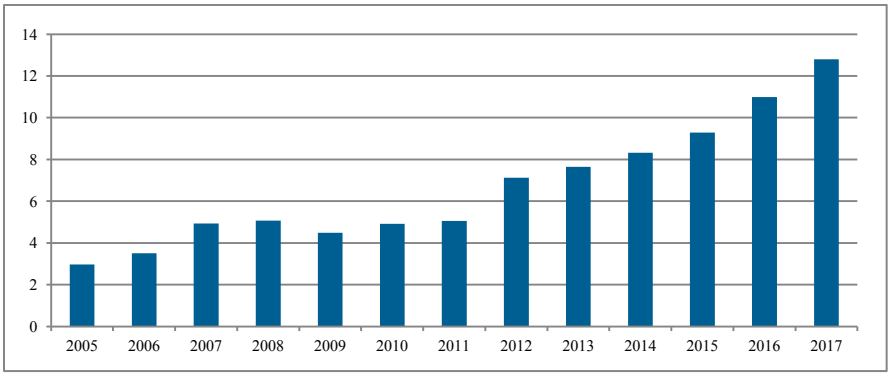

Fig. 2. Annual passenger traffic on Henri Coandă International Airport (in million passengers)

Since the airport has the potential to become an important HUB for the South-East region of Europe, being the only airport in the area opened 24 hours a day (other nearby airports such as Budapest, Warsaw or Sofia have night restrictions) and taking into account that the airport is already operating well above its maximum capacity, it is necessary to find solutions to increase the airport's processing capacity in order to optimize operational efficiency.

The analysis of the airport's existing problems in means of operations and passenger processing capacity, aims at proposing solutions to increase operational efficiency and offer digitization solutions to operate in an optimal regime. Digital solutions for HC airport will assure an increase in efficiency, offering possibilities and perspectives regarding the operations and passenger experience.

Romania is ranked last at the level of general digital development, with a digitization process of only 33%, which is a very low percentage, compared to the first ranked, Denmark, where digitization reached 71% (ec.europa.eu/eurostat, 2018). This condition is also mirrored at Henri Coandă airport, which has a very low digitization degree, with fundamental infrastructure and cyber resilience. Most of the processes are carried out manually and there are only 12 self-check-in machines, but not connected to conveyor belts luggage, thus passengers still need to check at check-in counters for baggage handover.

Digital transformation has an impact on all aspects of the airport; therefore it was critical to identify the key areas on HC airport where digital strategy should be focused on improving processes and services.

The main categories of problems that were identified and can be solved by digitization methods are as following:

- The high volume of passengers vs. the airport capacity
- Outdated infrastructure in the old departure terminal
- Airport congestion

Regarding the benefits of applying the digitization methods at Henri Coandă airport, these were divided into 3 categories:

- Airport operation management
- Passengers flow optimization
- Relation of the airport with stakeholders

In the light of the above mentioned, the challenges faced by HCIA involve reinventing the business model which means adapting its services to the plans and requirements of each individual passenger. In order to become a full digital airport, it must optimize its facilities and enhance the passenger satisfaction. Actual competitive strategies don't only refer to price and product features, but a dynamic adaptation to the next digital generation which means personalized and context aware services for customers (ACI, 2017).

3.1. Airport operations management

Henri Coandă operations management should be based on a modern approach on information and communication technology and the total airport management (TAM) concept. The implementation of an operations center (APOC) can improve services including ground activities and can help the airport develop collaborative decision making and optimize its resources. More so, digital tools will provide a solid foundation for the relations between different parties, establishing a better collaboration between the airport and airlines, ground handling, ATC, but also employees, passengers or investors.

The airport must be organized in order to monitor operations in real time and automate ground activities (Gardy, 2016). This means HCIA will be able to reduce delays, operational risks and have a preventive approach on incidents. The airport management strategy for hazard assessment must be based on a systematic review of all activities, establishing safety measures and reducing operational risk.

Bucharest Henri Coandă airport already uses technologies such as Bluetooth and Wi-Fi, so these can be further used for indoor geo-localization and flow monitoring. Also, in the near future HCIA might use analytics based on real-time data inputs to visualize airport operations, or artificial intelligence for decision making to improve its efficiency. So, the airport must have a holistic approach towards optimizing its processes and activities, monitoring airside and landside operations (AT-One, 2018).

3.2. Flow monitoring and capacity management

Customer engagement involves the use of digital and interactive displays. Also, the increase level of self-services is meant to save time and avoid queues. Regarding the processing difficulties on HC airport, the authors identified the poor operation of luggage conveyor belts which are constantly blocking and the lack of a high number of filters in security control.

3.2.1. Departure control system analysis

- **Self-services. Implementation of automatic baggage handlers**

Enabling technologies and implementing automated passenger flow solutions such as imaging based flow monitoring will provide ideal capacity process through the airport. Currently, HC airport has a total of 104 counters in the check-in area, divided into 4 islands, each island with 26 counters (http://www.bucharestairports.ro, 2018).

Taking into account that in the northern part of island A, the counters 14 to 26 are used quite a bit, we can propose the implementation of automatic baggage handlers using self-service kiosks. An airport which sets a good example for our study is London Gatwick which opened in 2016 the largest automated bag drop-off area in the North Terminal, with 48 counters.

In the case of Henri Coandă airport, since not all 104 counters are opened at the same time, not even at peak hours, we will consider the following hypothesis: at the peak hour, 13 self-service counters and another 80 traditional counters should be opened at the same time.

For a traditional counter, the present processing time is 2 min/pax, this means 30 pax/hour/counter, or 2400 processed passengers for all 80 counters considered in our hypothesis (Table 1).

Table 1. Passenger processing analysis

Passenger processing	Present processing time	Optimistic approach
Processing time/pax	2 min/pax	30 sec/pax

At the same time, having 13 self-service counters, 120 passengers will be processed in one hour at one counter, this means 1560 pax/hour for the 13 self-service counters.

Table 2. Analysis of the baggage handling system hypothesis

Passenger processing	Current processing	Optimistic processing
93 counters considered	2790 pax/peak hour/flow	3960 pax/peak hour/flow

The optimistic approach on passenger processing time indicates a 41.9% increase in processing capacity in the check-in area following technology deployment (from 2790 to 3960 pax/peak hour/flow) (Table 2).

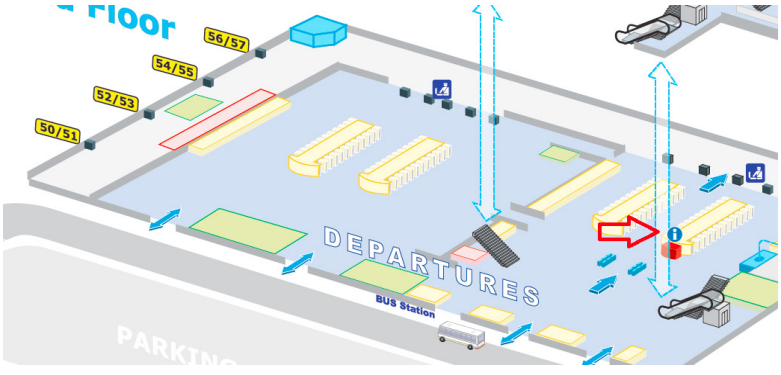

Fig. 3. Implementation of automated baggage handlers in DCS zone-HC Airport

The Figure 3. above shows the authors' proposal for the implementation of automated baggage handlers in the departure control zone. The area which will contain 13 self-service counters is indicated by a red arrow.

- **Security control**

At Bucharest Henri Coandă International Airport, security checkpoints can be considered the most problematic areas in means of airport congestion. It is thus crucial for the management to find solutions to increase processing capacity, ensuring the optimization of airport facilities. HCIA must keep its advantage over other nearby airports which are developing faster and more efficient (this beeing already the case of Warsaw Airport).

Automatic security control systems which exist in several airports could be a good solution. Since each airport has a specific configuration, a flexible and customer-orientated automatic tray-return system can be succesfully used since it enables different configurations, allowing maximum use of the available space inside the terminal (www.alfyma-airport.com, 2018).

According to an article published in 2017, the capacity of an airport may increase by up to 30% following the deployment of security systems (US Transportation Security Administration, 2017). For example, Los Angeles Airport (LAX) can process up to 3220 passengers in one hour, using 16 control points. Comparing this data to utilizing standard equipments, 1000 more passengers are processed. This means 201.25 pax/hour/control point compared to 138.75 pax/hour/control point.

If we translate these figures into what exists on HC Airport, by having 9 automatic security control gates with modules for curves or straight sections which will enssure optimum flow rate-interface, we will achieve 1811 pax/hour/control point (Table 3):

Table 3. Analysis of the security control checkpoint hypothesis

Passenger processing	Current processing	Optimistic processing
9 security checkpoint considered	1249 pax/ hour/control point	1811 pax/hour/control point

- **Border control**

According to the Bucharest National Airport Company (CNAB), Henri Coandă International Airport has in the border control area 13 counters, each one with 2 checkpoints. In order to increase the passenger processing capacity at the airport, it is possible to propose the replacement of half of these control points with biometric passage gates. We chose to replace only half of these checkpoints as they would only be available to EU passengers holding a biometric passport. Using this system, the process can take between 10 and 20 seconds per passenger (swissinfo.ch, 2017).

Considering 20 seconds per process, the calculations indicate 180 pax/hour/check point, or 2340 pax/hour for all 13 counters, which represents an important improvement from the existing document control average processing time, which can take on an average 45 seconds per passenger. Thus, at present 80 passengers are processed during an hour at a control point (i.e. 1040 pax for 13 counters, or 2080 for all existing check-points) (Table 4).

The authors hypothesis considers a bording control area consisting of 13 traditional checkpoints and 13 biometric passage gates. In this case, an increase of approximately 62.5% (i.e. 3380 pax/hour) of processing capacity will be obtained by implementing biometric technologies based on facial recognition (Table 4).

Table 4. Analysis of the border control processing time

Passenger processing	Current processing	Optimistic processing
Considered hypothesis	2080 pax/hour	3380 pax/hour

- **Boarding**

The authors' research revealed that the greatest inconveniences passengers experience in the boarding area is represented by the long waiting time, poor internet connection, and the fact that they want to kept up to date regarding boarding times or possible gate change. On an average, passengers spend about 30 minutes at the

embarkation area. From a digital point of view, solutions for enhancing the passengers experience in this area are associated to entertainment options, digital platforms for food ordering, as well as self-service boarding systems (Boutin, 2016).

By implementing an automatic boarding system, boarding time can be reduced by half. For this case study, we will take as a reference the most common types of aircraft on Henri Coandă Airport (i.e. Airbus 320 or Boeing 737), which have an average of 150 passengers/flight at HCIA.

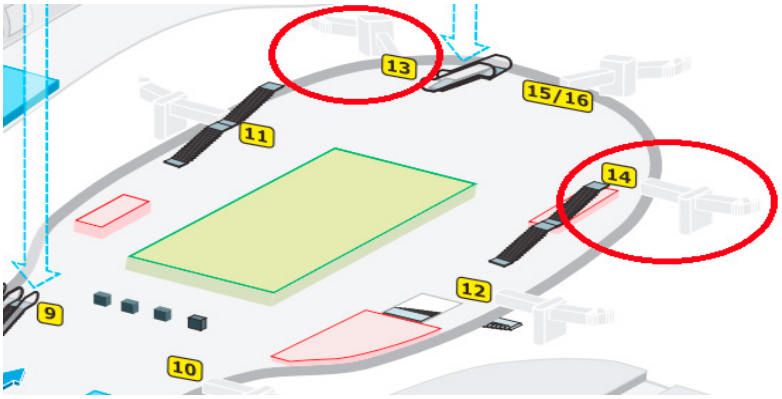

Fig. 4. Boarding area at HC Airport

The optimistic approach is inspired by Los Angeles Airport, where by using such a system, 400 passengers can be embarked on a flight, meaning 3.3 seconds per passenger, or 22 minutes for a flight. At HC airport, for automated boarding of 150 passengers, according to calculations, we can get the figures presented in Table 5:

Table 5. Analysis of automated boarding system on HCIA

Passenger processing at boarding	Number of passengers/flight	Optimistic processing time/pax	Optimistic processing time/flight
	150 pax	3.3 sec	8.25 min

According to this results, boarding time will be significantly reduced by implementing this systems at embarkation gates. The automatic gates have a higher rate of throughput and will become the norm in HCIA in the near future, this will also result in the reduction of aircraft stopovers, thus allowing an increase of the number of aircraft movements. Nevertheless, at the moment, this system would be useful at just one or two of the boarding gates in the terminal. Since there are boarding gates destined for bigger airplanes (for example Airbus 330), the authors suggest that the implementation of automated boarding gated can be valid for the gates 13 and 14 (as shown in Fig. 4.).

3.3. Predictive and preventive solutions

Digital tools for predictive solutions for the studied airport consider automated planning management and preventive actions for security matters. The analysis of passenger name record and advanced passenger information will provide suspect passenger identifications (ACI, 2017).

In the light of the above mentioned, HCIA must define its objectives on using digital technologies for airport operation optimization, obtaining a decrease of congestion and delays, reducing costs, delivering synergies amongst stakeholders and building a better business model. Exploring the potential of digitization on passengers can be used by Henri Coandă airport for predictive analyzes and decision making. On the other hand, flight optimization can be achieved by identifying efficient flight routes, while protecting the environment.

3.3.1. Human resource education and training

New qualifications and jobs related to the digitization of airport are needed. Digital transformation requires a coherent professional pathway founded on a set of demands and skills that don't follow the general education and training process in aviation (Zaharia, 2018). Specific demands and competences need to be tackled collaboratively by the industry and regulatory authorities (World Economic Forum, 2017), implying the ability to deal with complex knowledge and problem solving in ICT. The challenge of creating new types of jobs demanded by digital transformation is to anticipate and prepare for future skills requirements (International Air Transport Association, 2018), to share a common expertise and create a safety net for employees. The research on new skills for smart occupations must consider the opinions of experts from both academia and aviation organizations (International Air Transport Association, 2018) and outline the need for interdisciplinary qualifications. Thus, study programs must focus on interdisciplinarity (for example IT & Aviation) since the industry predicts more smart technologies and smarter operations. In this respect, education and training strategies must be applied by universities and training institutions for preparing the next generation of aviation employees.

3.4. Airport digitization costs and benefits

Worldwide, airport IT costs are increasing considerably, reaching $8.43bn in 2017 (Garcia, 2017). These figures are showing airports' interest in introducing smart technologies. In 2016, a study on introducing new technologies in Barcelona El Prat airport considered an initial budget of $32-36mil only for baggage self service, having as a reference Gatwik Airport; and a $500.000 for the implementation of 5 border control systems (Guiu, 2016). In the report, border control system implementation estimated costs were similar to those necessary for JFK airport (Guiu, 2016). Although these airports are not comparable to HCIA, since the price of each border control machine is estimated at approx. $100.000, the authors' hypothesis of implementing 13 biometric passage gates, will thus imply an initial investment of $1.300.000 only for border control check-points.

The HC airport management strategy regarding areas of investment previously detailed in this paper considers a feasibility study which will provide concluding aspects of estimating the costs of the modernization and development of terminal infrastructure. Although the objectives of the airport digital transformation have been defined on different levels, the airport's detailed investment plan will require a study on request funding opportunity. At the same time, technological breakdowns and cybersecurity issues, their implications and their costs need to be considered by the managers in dealing with airport digital transformation. One example in this regard is Gatwick Airport, who recently faced over four hours of tech failure until fixing problems in display flight information which caused chaos (International Airport Review, 2018).

Digitization impacts the airport, its business partners and customers on different levels, and the benefits regard operations efficiency, automating activities, monitoring processes in real time and providing self-services, guidance and real-time travel information to passengers (Gardy, 2016). Applying the previously analyzed digital initiatives will help reduce waiting times and minimize queues, thereby ensuring a continuous flow and improving passenger perception while giving them more time to spend in restaurants, shops, etc., which will lead to higher earnings for the airport from non-aviation revenues. However, it is important to point that the obstacles to airport digital transformation success imply insufficient investments to capture the opportunities digital initiatives present.

4. Conclusions

The paper presents a general trend on operational management on airport and particularly on HCIA and considers the changes in ITC, education, training and marketing management, having the societal responsibility management as a strong pillar. The demand on the air transport market in Romania forces the studied airport to identify and put into practice solutions for accommodating the growing number of passengers. For HCIA, the construction of a new terminal is an alternative taken into account, but the directorates proposed in the paper involve embracing new technologies for the automation of specific air transport processes.

Considering the study of HCIA, the authors revealed a gap between management and technology, indicating a very low digitization degree and demonstrating that the staff is not trained to face the challenges of new

technologies. Also, the considerations regarding the organizational culture for all market players considered in the study (i.e. airports, airlines, ground handlers, ATC, etc.), showed a substantial influence on the effectiveness of operations; affecting progress and conditioning the level of digitization.

Since technological progress in aviation assures an increase in efficiency, the authors consider imperious for HCIA to have a digitization department, thus offering new perspectives regarding the nature of operations management. The development of the managerial directions proposed in the current paper is designed to optimize operations at the airport and adapt them to technological and air traffic trends.

One of the challenges HC airport managers have to face is finding the best solution to provide a common platform for mobile application, whereas the passengers are not willing to use more than one app for their travel information needs. In this respect, a mobile app for passengers providing information about airport facilities and layout, directions in the terminal indicating points of interest or recommendations, real time notification of flights and airlines' policies, parking guide and information about fees, but also intermodal connections and transportation should be considered by HCIA managers in the near future.

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