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Digitalization and Its Impact on Commercial Aviation

Bachelor's Thesis
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Abstract of bachelor's thesis

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Abstract

The purpose of this thesis was to study the concept of digitalization and to examine its impact on the commercial aviation industry. Digitalization and the numerous developments deriving from it constitutes a comprehensive framework that is consequential for any industry, and especially for the commercial aviation industry. This particular relevance arises primarily from the rapidly evolving nature of the industry, and furthermore components such as the cost structure, security and competition intensity play an important part.

Digitalization has historically been defined in multiple dissimilar ways due to its constantly developing nature. The definition used in this thesis will combine the proliferation of mobile devices and internet-based technologies with other significant innovations such as Big Data, Automation and 3D-printing. This definition will not stand alone, but instead it will be combined to fit the context of the commercial aviation industry.

The findings indicate that investing in significant digital technologies commercial airlines can potentially increase their customer satisfaction as well as their operational efficiency considerably. The specific digital trends contributing to the customer satisfaction are the internet and the Internet of Things (IoT), Big Data and Blockchain, whereas Augmented Reality (AR), Automation and 3D-printing affect the operational flight performance. The successful adaptation of these technologies can potentially lead to improvements in the overall efficiency-, cost-, flexibility- and security related performance of the airline.

However, prior to focusing on the individual trends, it is vital to acknowledge the current capabilities of the firm. Furthermore, the company needs to develop a solid digital strategy and implement that strategy successfully. An ad hoc set of mind is advisable in addition to an approach that promotes trial and failure.

Keywords digitalization, digital, technology, commercial aviation

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1 Introduction and motivation

Digitalization is currently shaping all industries in a manner that is comparable to any other major historical time period that permanently changed the economy (Barnir et al. 2003; Vogelsang, 2009). This new exponentially growing era does not only bring new challenges, but it also poses various potential advantages for industries and companies acknowledging its scope. These advantages include for instance operational agility, the possibility of differentiation and increased revenue and cost savings through increased efficiency (Vogelsang, 2009).

Particularly the aviation industry is under great pressure. This is mainly due to the cost structure, security and competition intensity of the industry (Gillen, Oum, & Tretheway, 1990). Given these factors, it is vital for all commercial airlines, regardless of their market share or position in the industry, to acknowledge their current organizational structure, its suitability to digitally transform and the required tools to accomplish this.

Given these causes, the motivation to combine and study these two components is consequential. An alternative source of motivation that lead to a deeper concern towards this topic was the alarming amount of airlines that do not have a solid digital strategy yet. For instance, Juha Järvinen, chief commercial officer at Finnair, concluded at an aviation festival that Finnair is only half way through the journey to becoming a digital airline. This seemed to be the case also for other major airlines, which certifies the relevance of this research topic (Holmes 2015). Moreover, this absence of the concern towards digitalization emerged from analyzing the search results generated from Scopus, Elsevier's abstract and citation database. When searching the keyword "aviation" 238 250 search results were generated. Of these search results, only 16 661 documents included the keyword "digital", 3 077 included the keywords "digital strategy" and 81 documents included the keyword "digitalization". These portions are portrayed in Figure 1.

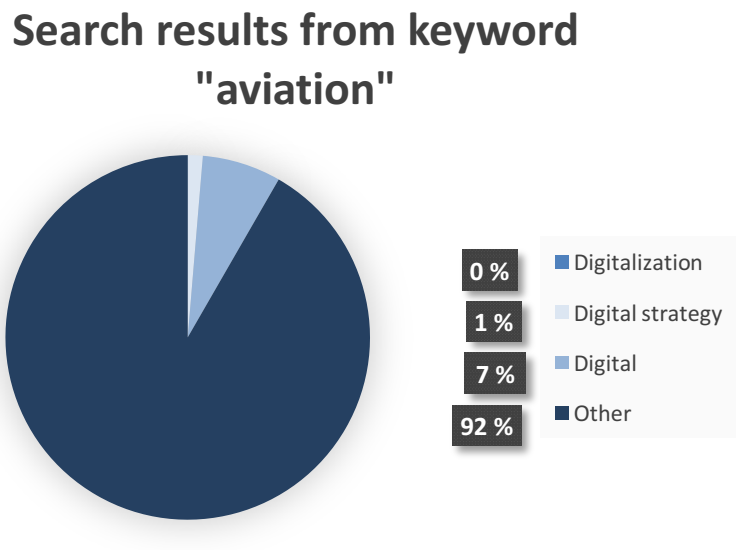

Figure 1

To conclude, this thesis will introduce an interpretation of digitalization in general and furthermore propose different technological solutions to support the implementation of a thorough digital strategy. In the following sections, the purpose and contents of this thesis will be more precisely informed.

1.1 Research objectives and research questions

The objectives of this thesis are to thoroughly examine the major digital trends currently shaping the commercial aviation industry. Another major focus of this thesis is to study what is presently known of digitalization in general and the factors influencing the successful adaptation to this era. Additionally, the purpose of this thesis is to analyse some potential dangers and challenges associated with the adaptation of digital solutions. Thus, the main research question of this thesis is:

- Why is digitalization important for the commercial aviation industry?

Recognizing the large scope of this research topic and taking into consideration the multiple factors affecting primary research question, this thesis intends to focus the study solely on the most significant causes. These elements are selected based on their acknowledgment in the academic literature amongst their association with the industry in focus. Therefore, the secondary research question of this thesis is:

- What are the major technological trends that commercial airlines shoud adapt in order to gain efficiency and competitive advantage?

To answer these questions, the true nature and concept of digitalization should also be addressed. Thus, this thesis attempts to also propose an unambiguous, although extensive, definition for digitalization and a basis for implementing a digital strategy. However, while primarily focusing on the commercial aviation industry, the foundation of this research as a literature review of digitalization can be applied to other fields of study accordingly, and this will also be taken into account in the concluding section of this thesis.

1.2 Methodology

The methodology used in this thesis is a structured literature review. Hence, this thesis explores previous findings and variables similar to this study in order to fit these definitions and perceptions into the context examined (LoBiondo-Wood et al. 2013). This methodology involves obtaining existing data from various documents such as research papers, journal articles, books and electronic sources. The data collected is acquired from large databases of different kinds of literature based on the relevance of the data and the credibility of the data.

The data was primarily extracted from Scopus and Google Scholar using various keywords. The search used to find the key digital components (Internet, IoT, Big Data, Blockchain technology, AR, Automation, 3D-printing) that shape the commercial aviation industry combined the primary keyword “digital”, with the secondary keyword “airline” that was searched within the search results of “digital”. This search was done by utilizing Scopus and it generated a total of 4 615 document results.

The key digital components (Internet and IoT, Big Data, Blockchain technology, AR, Automation, 3D-printing) were further on searched within the set of documents derived from the keyword “digital” and “airline”. The total share of the documents discussing these components was 43%, which is a significant amount considering the scope of the search and the various definitions associated with the keyword “digital”. This share was calculated by dividing the amount of documents resulting from the individual keyword searches with the total amount of document results, which was 4 615, and eventually summing up the individual percentages.

In addition to this, search word combinations such as “digitalization” and “aviation” or “digital” and “aviation” or “commercial aviation” and “digital” or “commercial aviation” and “digitalization” were used. The term “digitalization” was also infrequently substituted for the keyword “digitalisation”, which commonly resulted in the equivalent amount of search results.

The final amount of documents referred to in this thesis is 51. This share comprises all documents, including the papers discussing the theoretical backround. These documents were chosen based on their relevance to this thesis. So for instance, the material discussing the theoretical backruond was chosen in a manner that fits to the context of this thesis, which is digitalization within the aviation industry in specific and especially the individual digital components that are analysed further.

Additionally, documents were chosen to be looked at based on their title and its similarity to the key search words. The similarity was based on the rank of the documents when organized in the search domain “Scopus” based on their “Relevance”. Also the citation numbers of the documents were looked at. After this, the abstract of the article was read and the article was finally chosen if it discussed the the topic in an appropriate manner in regards of this thesis, and if it offered some valuable insights, for instance concrete benefits that can be attained.

Out of these 51 documents, 29 belong to the previously mentioned 43%, which demonstrated the share of the documents that discussed the digital components of this thesis. Of these 29 documents, 12 were examined in depth and seven of these 12 were analysed more thoroughly. These seven were chosen because they comprehensively analysed the components through variouos points of views, combined the nature of

digitalization with the commercial airline industry, and showed concrete benefits and potential dangers associated with the adoption of these trends. These articles were chosen also because they connected the industry-related components (Cost structure, Security and Competition intensity) to the digital trends.

Table 1 illustrates the 12 documents that form the foundation of this thesis. The Document titles, Authors and Digital components discussed are listed in the table. Additionally, other relevant topics that were discussed in the documents are listed in the final column. These were the relevant topics the highlighted this set of documents of all the 29 documents. The seven documents that were analysed more deeply are shown in bold font. The documents are not pictured in a specific order.

Document title	Author(s)	Digital component discussed in detail	Other relevant topics discussed
Best and worst airlines for lost luggage (2014)	**Yogerst**	**Internet of Things**	**Digitalization within airline industry, Customer satisfaction, Cost reduction**
Online airline ticket purchasing: Influence of online sales promotion type and Internet experience (2016)	Crespo-Almendros & Del Barrio-Garcia	Internet	Cost structure, Competition intensity
Gaining customer knowledge in low cost airlines through text mining (2014)	**Yee Liau & Pei Tan**	**Internet, Big Data**	**Digitalization, Customer knowledge, Customer satisfaction, Competitive advantage**
Impact Of Blockchain Technology In Enhancing Customer Loyalty Programs In Airline Business (2017)	**Ebarefimia**	**Blockchain**	**Digitalization, Customer loyalty program, Security, Competitive advantage**
Automated driving: Safety blind spots (2018)	**Noy et al.**	**Automation**	**Digitalization, Security , Efficiency**
Airline cost structure and policy implications: a multi-product approach for Canadian airlines (1990)	**Gillen et al.**	**3D-printing**	**Digitalization, Cost reduction, Competitive advantage**
21st Century Airlines: Connecting the Dots (2017)	**Taneja**	**3D-printing**	**Digitalization within airline industry, Industry-related components, Benefits of digitalization**
Driving the digital enterprise in the aerospace industry (2016)	Ludwig & Orhcard	Internet of Things, Big Data, Automation	Digitalization within airline industry
The implementation of digital technologies for operations management: a case study for manufacturing apps (2017)	Zangiacomi et al.	Internet of Things, Big Data, Automation, 3D-printing	Digitalization within all industries
How blockchain will change organizations (2017)	Tapscott & Tapscott	Blockchain	Security, Efficiency, Customer satisfaction
A Bayesian approach to system safety assessment and compliance assessment for Unmanned Aircraft Systems (2017)	Washington et al.	Automation	Security, Cost reduction
Augmented Reality for Aircraft Maintenance Training and Operations Support (2011)	**De Crescenzio et al.**	**Augmented reality**	**Security, Competitive advantage**

Table 1

1.4 Structure of research

The rest of the thesis is structured as follows. Chapter two provides the theoretical framework referred to in this thesis. It will introduce various definitions for the concept of digitalization and determine the context in which it will be used in this thesis. Chapter two will also propose theories that influence the development and implementation of a digital strategy.

Chapter three will present the notion of digitalization within the context of the commercial airline industry. This chapter also validates the relevance of digitalization for the commercial airline industry and supports the adaptation of the technological advancements introduced in the following chapter.

Chapter four will look more closely into the specific digital trends shaping the commercial airline industry. These trends will be analyzed through two different perspectives: the customer point of view and the operational flight performance point of view.

Finally, the thesis will finish with conclusions and discussions followed by limitations and further research suggestions. These chapters will conclude the findings of the thesis and analyze their theoretical and practical relevance. The thesis will also include a list of references at the very end.

2 Theoretical backround

2.1 Defining digitalization

Digitalization in its traditional meaning is considered to have been introduced by Gottfried Wilhelm Leibniz, who was the lead developer of the transformation of Arabic numbers to binary strings. Further on this definition of digitalization was extended to cover the conversion of a broader range of analog actions and systems into digital entities. However, these processes of digitalization were not considerably apparent to the conventional consumer until the introduction of the first personal computers took place in 1981. This triggered a new digital era, which continued to grow with prominent velocity. Along with the accelerated growth and progress of digitalization also new definitions for the concepts of a digitalizing world began to unfold. (Barnir et al. 2003; Vogelsang 2009)

Milkau and Bott (2015) gave a more modern and up to date definition for digitalization. They defined it as a "combination of proliferation of mobile devices, use of internet-based technologies and leverage of data analytics in the interaction between market agents". These market agents were further on construed as various kinds of buyers and merchants or consumers and producers. This definition is more appropriate considering the themes that are being closer examined in this thesis. This approach also endorses the context in which digitalization is studied in this thesis, but still lacks some aspects that need to be taken notice of.

In this thesis when referring to digitalization, I will use a more comprehensive definition than proposed by Milkau and Bott. I will exploit the fundamental idea behind it, and highlight its role as an an interactive relation between market agents, yet I will extend the repertoire of different features connected to it. In addition to mobile devices, internet-based technologies and data analytics, I will define digitalization also as a collective umbrella for these technological innovations: Blockchain technology, Augmented Reality, Automation and 3-D printing. Specifically these digital trends were chosen because they were highlighted within the set of document results derived from the search combination ”digital” and ”airline” as mentioned earlier in the section 1.2. These technologies additionally stood out when searching the keyword ”digitalization” and

”aviation” and limiting the search results to the business, management and accounting field (see, for example Yogerst 2013; Yee Liau & Pei Tan 2014; Ebarefimia 2017; Noy et al. 2018; Gillen et al. 1990; Taneja 2017 & De Crescenzio et al. 2011).

Ludwig and Orchard (2016) also emphasize the relevance of these trends for the commercial aviation industry and according to Jasimuddin et al. (2017) and Zangiacomi et al. (2017) these technologies are widely recognized in the current economy in general. By extending the definition of digitalization, the term itself will perhaps obtain a subtly modified meaning, but will better serve the objectives behind this research to analyze the digital trends shaping the airline industry.

2.2 Developing a digitalized strategy

To prosper in this digitalizing and rapidly transforming era, companies need to incorporate a digital strategy that exploits the technological instruments in manner that is difficult for competitors to replicate. Prior to examining all the conceivable options, a solid digital strategy should be determined. In the following sections I will propose a general conception of a convenient digital strategy and moreover specify two different principles that commercial airlines should consider: the customer point of view and the operational flight performance point of view.

The most convenient digital strategy is one that assigns direction, enabling the management to lead these digital initiatives, measure their development and then redirect those attempts if necessary (Ross et al. 2017). An advisable approach to choosing a profitable strategy is to narrow the potential perspectives to one or two strategies and to focus on them (Barnir et al. 2003). Ross et al. (2017) advise digitally transforming companies to choose from two possible strategies: a customer engagement strategy or a digitized solutions strategy. The aim of a customer engagement strategy is to rapidly and seamlessly respond to new customer demands and to generate personalized experiences that enhance customer loyalty. A digitized solutions strategy targets at creating new value for customers using different digital instruments and integrating products and services into solutions. (Ross et al. 2017)

This theory introduced by Ross et al. (2017) was furthermore examined and questioned by various researchers and even executives from multinational corporations. The primary critique that emerged was the the insularity of the theory (Posner 2017). Why should managers select one strategy over another instead of operating multiple strategies simultaneously? Ross et al. (2017) responded to this critique by stating that the underlying purpose behind choosing only one digital strategy is to avoid a situation where the senior management would constantly have to weigh the trade-offs between multiple strategies when allocating a firm's resources.

In this thesis, I will use the foundation of the theory presented by Ross et al. (2017), however, I will modify it in a manner to suit my objectives. I will further on propose two different types of digital strategies which both contain different technologies that should be incorporated. These strategies are a digital customer experience strategy and a digital flight performance strategy. These two potential perspectives are not exclusive and can be implemented concurrently, but in different business units.

2.3 Implementing a digitalized strategy

After determining the applicable strategy to focus on, the strategically liable executives must ensure the selected strategy is properly implemented within the organization's business units and processes. A great emphasis on the implementation process of the digital strategy is required, since too often the strategic renewal process ceases after the strategy has been communicated to lower levels of the organization (Beer & Eisenstat 2000). Thus it is not sufficient to solely communicate the strategy onward, but concrete actions are needed. The following paragraphs introduce the four stages of the implementation process of a new digital strategy. These stages are based on an extensive survey carried out by Beer and Eisenstat (2000) as well as an executive study and research project report conducted by Kane et al. (2015).

The first priority is to formulate the strategy in a way that is clear, coherent and easy for the members of the organization to understand. The top management should formulate the strategy as a group and spend significant amounts of time to discuss it with lower

levels of the organization to gain a clear mutual understanding of the objectives and desired actions (Beer & Eisenstat 2000). In addition to this, the organization needs to be equipped with extensive vertical communication skills and solid coordination across all functions and departments, in order to implement the strategy effectively (Beer & Eisenstat 2000).

The following step in implementing a digital strategy is to build the requisite skills. Primarily, the responsible executives should be equipped with adequate down-the-line leadership skills (Beer & Eisenstat 2000). These skills include turning top-down management into engaging leadership, increasing trust towards lower-level leaders and intensifying teamwork as whole (Beer & Eisenstat 2000; Kane et al. 2015). Thereafter the management is capable to enable the rest of the organization to adjust to the new strategical approach.

When the top executives are competent to lead the novel strategical initiatives, they need to lead these initiatives and help build the necessary skills for the other employees (Ross, et al. 2017). The capability to conceptualize how the different digital technologies can influence the business is often a skill that is lacking in many organizations at the early phases of digital maturity, which is why this is a relevant priority to focus on initially (Kane et al. 2015). Given the reasons presented in Chapter 1, this seems to be the case also for commercial airlines, which further on justifies the importance of this step. In addition to this, the capability to adapt quickly to any new alterations is a major skill. This type of agility should be rapidly immersed in the organizational culture if it is currently lacking, and this trait should also be sought after in future recruitments. In conclusion, the top management ought to provide the employees with the necessary skills and encourage them to pursue these abilities.

Finally, in order to successfully implement a digital strategy, organizations are advised to take audacious actions. This requires embracing multiple trials and failures as a prerequisite for prosperity (Kane et al. 2015). This needs to be incorporated in the training of both executives and their employees. Applying an ad hoc mindset will most likely be the optimal solution for a digitalizing organization. (Kane et al 2015).

3 The relevance of digitalization for the airline industry

3.1 An industry analysis

The commercial airline industry is undergoing its greatest shift since deregulation. Digital transformation and other major economic evolutions, for instance the quickly growing competition from new low-cost airlines, are pushing the major airlines to increase their efficiency (Gillen et al. 1990). Since the adaptation of various digital trends can potentially increase efficiency, digitalization is particularly relevant for the commercial airline industry. In the following section I will examine three other factors that suggest that obtaining a competitive digital strategy that exploits several different technological trends is of importance for companies operating in the airline industry. These three factors are the cost structure, security dependence and the competition intensity of the industry. These factors distinguish the aviation industry from other rapidly growing industries and determine the long-term potential of any commercial airline (Cento 2009).

3.1.1 Cost structure

Despite the rapidly growing intensity of competition originating mainly from low-fare airlines and the lack of a variety of aircraft suppliers, the cost structure of the commercial airlines is a major reason behind the significance of applying a solid digital strategy. A pivotal characteristic of most oligopolies like the airline industry is the demand of high capital investments to acquire capacity. This in turn results in large fixed costs, which is why it is vital to consider the possible cost reductions that could be achieved by exploiting different digital solutions in the early stages of investing prominent amounts of capital, since these costs will be difficult to alter in the near future (Gillen et al. 1990; Air Transport Association 2002; Finnair 2016). Also when operating with large volumes to attain scale advantages, every minor cost reduction that could be achieved by employing digital technologies in any cost factor could enable large improvements in profitability (Taneja 2017).

The digital technologies that have potential in influencing the cost components of commercial airlines are 3D-printing, internet-based solutions and the Internet of Things (IoT). These technologies have the potential to offer consequential cost reductions, which further on lead to increased gross margins. These digital trends will be analyzed more thoroughly in Chapter 4.

3.1.2 Security

Another reason why this industry is particularly vulnerable to digitalization and its future potential is due to its security-intensive nature. With digitalization and the accelerated rate of globalization the boundaries between airlines and any outside parties are slowly beginning to fade. This raises a new concern for any contingent risks that may emerge.

Especially interdependent security risks, which are risks that not only depend on the security investments of airlines, but also on the actions of other individuals, are a severe concern to any company operating in the commercial airline industry (Heal & Kunreuther, 2005). An interdependent security risk could be for instance a terrorist interference or a dangerous article placed inside an aircraft. Heal and Kunreuther (2005) introduced a game-theoretic method as a way of investigating the influence of interdependence of choices related to the investments on various security-related components. This paradigm of investing large amounts of capital into an issue widely affected by the decisions of other companies was formulated into a payoff matrix incorporating the Nash equilibrium. According to this model, to maximize expected profits, commercial airlines should choose to invest in security. This not only helps the airlines to adapt to the digital era in a safe manner, but it also enables cost savings that originate from a solid risk-avoidance strategy. (Heal & Kunreuther 2005).

The digital trends that are considered to have the potential to reinforce the security-related components of commercial airlines are Automation in the flight deck, Blockchain technology and Augmented Reality (AR). Through increased security, commercial airlines can obtain increased customer satisfaction and also potential cost reductions resulting from decrease of security-related errors. These trends will be profoundly analyzed in Chapter 4.

3.1.3 Competition intensity

The final cause behind the importance of digitalization for the airline industry is the nature of the intensified competition. As digitalization is proven to lower the entrance costs to any market, the effects are also evident in the airline industry (Ludwig & Orchard 2016). In addition to this, the increased availability of starting capital and the deregulation of the commercial airline industry in various parts of the world tightens the competition even further.

Due to the accelerated competition in the industry, it is now more urgent than ever to pursue a digital strategy that utilizes the firm's resources in a way that is difficult for competitors to imitate. Furthermore, to gain sustained competitive advantage (SCA), the firm's resources should be also valuable, non-substituable and rare (Wernerfelt, 1984; Hanningan et al. 2015).

Mastering all the six most significant digital components (The internet and IoT, Big Data, Blockchain technology, Automation, Augmented Reality and 3D-printing) in a way that is difficult for competitors to imitate, commercial airlines can address the challenging competition intensity of the industry. Especially Big Data and various internet-based solutions offer commercial airlines insight into their competitive environment, as well as their customers' needs. In the subsequent sections I will introduce these resources that airlines operating in the competition-intensive industry could utilize to gain vantage in the rivalry of becoming a digital master.

4. Defining relevant components of digitalization for the airline industry

4.1 Digitalized customer experience

4.1.1 The internet and the internet of things

Gubbi et al. (2013) define the Internet of Things (IoT) as an "interconnection of sensing and actuating devices providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications". This approach can furthermore be divided into two divergent perspectives: object-centric and internet-centric. The object-centric view accents the role of intelligent devices whereas the internet-centric view focuses primarily on different internet services (Gubbi et al. 2013). The following section will thoroughly extend the thing-centric perspective, since it produces a notable improvement that could enhance the digital customer experience. Additionally, the internet in general will further on be introduced as an online platform to provide digital solutions for the customer.

One of the primary applications of the Internet of Things could potentially address the issue of the significant amount of lost and mishandled luggage. In the year 2012, 25.8 million pieces of luggage were mishandled, of which approximately 85% were delayed and the remaining percentage was lost, which demonstrates the magnitude of this issue (Yogerst 2013). Thus, commercial airlines are now pushed to develop their processes to better respond to this problem.

Wong & Wong (2017) propose a framework that employs IoT and Radio Frequency Identification (RFID) to develop a reusable luggage tag to facilitate the handling of travel baggage, the tracking process and also to conserve the environment as disposable luggage tags would not be required any longer. In addition to operating the technology of IoT and RFID, the reusable luggage tag would also require an extensive database management system (DMS), a point-of sale system (POS) and a mobile application. In practice, the system would involve numerous amounts of RFID readers that continuously collect data from passive RFID ports in retail stores, airports, aircrafts and hotels. The personal RFID tag, with its identification number and radio frequency, transmits signals to the RFID readers, which then forward the signals to a DMS via the network. This data is then

transmitted to the mobile application, where the user can easily locate the luggage. (Wong & Wong 2017).

By applying this digital technology, commercial airlines could obtain an increase in customer satisfaction as well as a competitive advantage. In addition to this, cost savings could be attained since the compensation of lost or mishandled luggage could be decreased notably. To integrate this type of IoT technology however obliges the airline to cooperate with multiple parties provided that an extensive DMS is already in place (Wong & Wong 2017 & Yogerst 2013).

This section will furthermore introduce an internet-based solution, that could be applied to multiple different customer interfaces. This perspective will be examined by using the online ticket sales platform as a convenient starting point, due to its dominating role in delivering a digital customer experience. Most commercial airlines have already adopted an online channel for ticket purchasing, since it is considerably cheaper and more efficient than selling a ticket through a travel agency (Crespo-Almendros & Del Barrio-García 2016). As it is obvious that a consumer-friendly online platform for airline ticket sales should be established, the bigger question remains as to what extent should different airlines integrate their marketing and additional sales to the ticket purchasing process to utilize the full potential of the online platform.

This question is thoroughly analyzed by Crespo-Almendros & Del Barrio-García (2016). Their research is based on data derived from monetary, non-monetary utilitarian and non-monetary hedonic online sales promotion levels. Their findings indicate that different online sales promotions should be utilized for different internet users based on their level of experience in the usage of internet. For instance, discounts should be offered to novice internet users whereas expert internet users prefer free hotel accommodations associated with the purchase of an airline ticket (Crespo-Almendros & Del Barrio-García 2016). Taking this into account, airlines should combine a thorough customer analysis, which will be further examined in the following sections, with an appropriate online promotional incentive to acquire maximum profits from additional sales (Crespo-Almendros & Del Barrio-García 2016; Yee Liau & Pei Tan 2014).

4.1.2. Big data

Big data is generally defined as data sets that are so large or complex that they can not be managed, captured or processed by traditional data processing software within an approvable extent (Chen, Mao, & Liu 2014; Yee Liau & Pei Tan 2014). This definition proposes two features that distinguish big data from the conventional data: its magnitude and complexity. Chen et al. (2014) also highlight big data's role as a driver for innovation, productivity and competition, which implies that its full potential is still indistinct.

Yee Liau & Pei Tan (2014) conducted a research on big data's and its examination's effects on gaining customer knowledge in low cost airlines by utilizing various data mining tools. This study examined customer knowledge through four main principles: customer service, flight cancellations and delays, ticket promotion and post-booking management. The results of the study propose that applying K-means clustering, a method of vector quantization that clusters data to permit further analysis (Kanungo et al. 2002), can evidently facilitate gaining knowledge about the customers of the low cost airlines. This knowledge on customer sentiments assists on attracting new customers in addition to improving the identified problem areas. In the long run, applying these methods to systematically analyzing the customer needs can prominently increase profits. (Yee Liau, & Pei Tan 2014).

Also Alt & Zimmermann (2017) acknowledged the potential of big data in analyzing airline customers. For instance, computer reservation systems (CRS) in the aviation industry store large quantities of passenger data in passenger name records (PNR), which allows airlines to attain important knowledge on the characteristics of their customers. As this technology developed further to multiple platforms in all marketplaces, airlines could gain a deeper understanding on the demand also through the transaction data of competitors. This improvement in the technological and analytical techniques enabled airlines to not only understand their customers better, but also to gain valuable insight into their competitive environment (Alt & Zimmermann 2017). By understanding the customers and the competitive environment better, airlines can increase their customer satisfaction and gain a better understanding on their competitors' actions as well. By evaluating and comparing the current state of the company's digital transformation to other rivals positions, commercial airlines can also evaluate their own strengths and

weaknesses in the digitalization process and improve their digital strategy discussed in chapter 2.2 and 2.3.

4.1.3 Blockchain technology

Blockchain is defined as a public ledger with a growing list of records, or blocks, which are secured and linked by utilizing cryptogrpahy (Swan 2015; Tapscott & Tapscott 2017). Blockchain technology can potentially serve as the technological foundation for payments, exchange, token earning and spending, digital resource transmission and smart contract assignment and implementation (Swan 2015).

Tapscott & Tapscott (2017) and Underwood (2016) indicate the major advantages resulting from the key characteristics of blockchain. These benefits are related to the distribution, publicity and the real time nature of blockchain. Firstly, since blockchain is scattered across multiple locations, because it runs on computers provided by volunteers all around the globe, there is no one central database. This implies that most of the major risks that derive from data being retained centrally can be eliminated or at least diminished, which is significant for a security-intensive industry. Secondly, the publicity and transparency of the blockchain provides increased auditability and confidence as all of the occurred transactions are observable and irretrievable. This also decreases the risk of fraud and treachery. Finally, blockchain permits a practically real-time clearance of the recorded transactions, which reduces the transfer time of funds. (Tapscott & Tapscott 2017; Underwood 2016).

Due to these significant benefits of adapting blockchain in an organization, the potential to transform wholly the way an organization is structured and managed is eminent (Tapscott & Tapscott 2017). Relevant components such as transaction times and costs could be deducted to a minority (Underwood 2016), which enables the organization to utilize resources on the outside as readily as on the inside (Vranken 2017). This in turn facilitates risky or impossible transactions due to the disappeared cost of acquiring trust (Vranken 2017; Tapscott & Tapscott 2017).

In conclusion, applying this technology to enhance the digital customer experience, commercial airlines can evidently gain increased cost savings, strengthened security and an option to allocate its resources more efficiently. This technoloy addresses mainly the security-related challenge of the industry, but also has a significant effect on the costs of the airline industry. Also adopting this technology rapidly before the competitors can pose a major competitive advantage.

However, probably the most notable outcome from adopting blockchain is its ability to increase customer satisfaction through an improved customer loyalty program, which further enhances the brand recognition and brand loyalty of the airline (Ebarefimia 2017). This finding was based on an extensive survey that examined the effects of the usage of blockchain technology in the customer loyalty program and the customer satisfaction as a whole. An unambiguous positive correlation was found between adopting blockchain technology and achieving the objectives and ambitions of a customer loyalty program (Ebarefimia 2017). Thus, the blockchain technology benefits both the commercial airline and its customers, who have a consequential lifetime value.

4.2 Digitalized flight performance

4.2.1 Augmented reality

Augmented reality (AR) is defined as a practice that "augments" or enhances the actual world with virtual articles exploiting computer vision and object identification (Milgramt & Kishinott 1994). Azuma et al. (2001) added to this definition the characteristic of combining actual and virtual articles in a real life environment and the capability to run interactively and in real time. With the assistance of sophisticated AR technology, the knowledge of the surrounding environment of the operator transforms into an interactive and digitally manipulable setting (Azuma 1997).

The application of AR technology in the maintenance field has proven to have had multiple advantages (Palmarini et al. 2017; De Crescenzio et al. 2011). Especially in the aircraft industry, which is considered to have exceedingly strict security standards, and where maintenance is a crucial component of the daily operations, incorporating AR

technology could have a remarkable impact (Haritos & Macchiarella 2005). AR technology in the aviation industry specifically is designed to construct unconventional interfaces utilizing wearable and communicative visualization techniques to accomplish new practices to present documentation as digital data as well as graphical databases (De Crescenzio et al. 2011).

According to Haritos and Macchiarella (2005), traditional training techniques can no longer be applied to the modern aircraft maintenance and have to be updated to cope with the complex systems and avionics. By incorporating AR technologies, maintenance employees could be able to carry out complex assembly tasks without having to follow inconvenient manuals or handbooks, which often leads to frustration and thus human error (Palmarini et al. 2017). Additionally, the total training required to be a skillful aviation maintenance auditor is approximately 2000 hours, and the skills obtained are seldom transferable to another maintainer. AR could potentially propose a solution to this obligation as well, since it has been proven to reduce the required manual maintenance tasks, which in turn reduces the amount of needed training. In addition, by applying AR technologies, knowledge on the maintenance operations could be virtually transferred between the different augmented platforms removing the inability to transfer knowledge between workers (Palmarini et al. 2017; Haritos & Macchiarella 2005).

By enhancing human performance in executing maintenance functions and improving the administration of maintenance operations, airlines can obtain major advantages related mainly to increased security, but also advantages related to cost reductions and improved efficiency are possible (De Crescenzio et al. 2011). Also the quality of the maintenance tasks could increase in the long run, which would lead to an improvement in the flight performance as well (Palmarini et al. 2017 Haritos & Macchiarella 2005). A safe flight with uniform quality is also in the interest of an airline customer, therefore AR also has an impact on overall customer satisfaction.

4.2.2 Automation

According to Parasuraman & Sheridan (2000), automation is defined as the machine execution of functions once performed by humans. Parasuraman & Sheridan also specify

that the intention of automation is not to entirely supersede the function of a human in regards of the task to be performed, but to modify in a manner that poses new synchronization demands on the human operator. This produces that the definition of automation varies across a continuum of levels ranging from fully automated operations to completely manually performed tasks (Parasuraman & Sheridan 2000; Kongoli 2012). The following sections will examine automation from the flight deck point of view, since it is one of the most frequently recognized application in the commercial aviation industry (Wiener & Curry 1980; Sweet 1995). In addition to this, airlines could employ automation also for instance in ticket sales, seat reservations and duty rosters of the cabin crew.

Automation has been a revolutionary technological development particularly in the aviation industry for numerous years now, since it considerably enhances the operational efficiency and safety of the flight (Noy, Shinar, & Horey 2018). The advancements originate from reducing the probability of human error as well as decreasing operational costs by improving efficiency (Kongoli 2012). To concretize the magnitude of decreasing for instance fuel costs by a minority is stated by ICAO as follows: a one percent reduction in fuel consumption translates into annual savings of approximately 100,000,000 dollars a year (ICAO 1998). In addition to potentially lowering fuel and other significant operational costs, automation has proven to have a positive impact also on reducing workload and increasing overall job satisfaction (Kongoli 2012).

As the positive impacts of automation are highly recognized, much attention needs to be focused on the potential dangers of adopting automated functions in the flight deck. One of the major problems in commercial aviation that invalidate a portion of the benefits is the behavioral dependence on automated systems (Noy et al. 2018; Parasuraman & Wickens 2008). This dependence primarily derives from the inappropriate amount of trust based upon the automated systems, which leads to pilots operating the systems under circumstances that they are not designed for (Noy et al. 2018). In addition, relying solely on automated systems furthermore leads to failure to adequately monitor the surrounding environment which can lead to dramatic adversities under critical circumstances (Hampton 2016).

Unmanned Aircraft Systems (UAS), a further application of automation, is considered to be one of the most rapidly growing digital innovations in the aviation industry

(Washington et al. 2017). However, also this sector of development contains several challenges, especially deriving from various safety regulations. These regulations restrain the operation of UAS to unpopulated areas (Washington et al. 2017). According to Washington et al. the solution to the relaxation and partial elimination of these restrictions is the precondition of assuring greater airworthiness of the UAS systems and the comprehensive awareness of the limitations that the systems pose.

To conclude, automation in the flight deck is proven to decrease human error. This directly affects the operative security of the aircraft. Additionally, automation could be applied to other sections of the airline as well, which could potentially decrease costs. Therefore, automation is a significant technology for a company operating in an industry with a stiff cost structure and extreme security precautions.

4.2.3 3D printing

Another factor significantly contributing to increased aircraft performance is lightweight design and technology, which can be applied both in the cabin interior, and also to other frequently manufactured and maintained components of the aircraft. One of the primary innovations in this domain is Additive Layer Manufacturing, universally recognized as 3D printing. This development enables the generation of a physical piece derived from digital 3D data. The piece itself is constructed on a layer-by-layer foundation across multiple cross-sectional portions. To determine the exact formation of each layer, the 3D printer uses computer-aided design and drafting (CADD) software that envisages models through photorealistic transcriptions and simulates how a certain prototype will perform in realistic settings. (Berman 2012; Richter & Walther 2017).

Besides 3D printing offering a new proficient way of manufacturing aircraft parts, the key potential is affiliated with its capability to engender comprehensive weight savings due to its bionical structures (Berman 2012). These prominent weight reductions arise from the exclusive hollow shapes and textures that the 3D printer is able to offer, which can not be fabricated in any other manner, at least not in an industrial layout (Berman 2012; Richter & Walther 2017). Applying these new manufacturing methods in the production and maintenance of aircraft elements could result in considerable cost savings

since a large portion of the total costs of commercial airlines result from fuel and oil expenditures, which in turn result partly from the total weight of the aircraft (Gillen et al. 1990 & Taneja 2017). Thus, also 3D printing offers a solution to address the large amounts of fixed costs related to this industry. However, Berman (2012) proposes that new calculation and simulation methods will additionally need to be incorporated to fully utilize the potentials of 3D printing. Haritos & Macchiarella 2005).

5. Discussions and conclusions

The two principal research questions of this thesis were:

- Why is digitalization important for the commercial aviation industry?
- What are the major technological trends that commercial airlines shoud adapt in order to gain efficiency and competitive advantage?

The primary research question was solved by looking into digitalization in general and its relevance for any industry existing in this current era. Furthermore, this thesis took into consideration industry-specifical features, which were the cost structure, security and competition intensity of the industry, which moreover demonstrated the importance.

The secondary research question was answered by analysing the documents discussing digitalization in the context of commercial aviation. This analysis incorporated with various research results (see, for example Ludwig and Orchard 2016; Jasimuddin et al. 2017 and Zangiacomi et al. 2017) lead to a more thorough analysis of six specific digital trends, which were the Internet and the Internet of Things, Big Data and Blockchain, Augmented Reality, Automation and 3D-printing.

To conclude, digitalization is currently modifying all industries and providing significant benefits for those companies that manage in developing a competitive digital strategy that can be successfully implemented (Barnir et al. 2003; Vogelsang 2009). Especially highly saturated, security-intensive industries with an inflexible cost structure, like the commercial aviation industry, are under tension regarding this current era and the technology accompanying it (Gillen et al. 1990; Ludwig & Orchard 2016; Taneja 2017).

The findings indicate that commercial airlines can substantially increase their efficiency-, cost-, flexibility- and security related performance by applying digital technologies both to the customer interface as well as the operational flight performance. The tehcnologies enhancing the customer experience are the Internet and the Internet of Things, Big Data and Blockchain, whereas the technologies that improve the flight performance are Augmented Reality, Automation and 3D-printing. These improvements in the economical performance further on increase the customer satisfaction, which in turn leads to increased profits and a potential to grow the market share.

However, the primary strategical focus for all commerical airlines should initially involve analyzing the current capabilities and strengths of the organization before concentrating on individual technologies. By choosing one or two strategical focus areas based on the core competencies of the firm, the company can potentially avoid an unfavorable situation where the executives of the firm would constantly have to weigh the trade-offs between multiple strategies. After developing a fitting digital strategy, the management is responsible for communicating the strategy in a clear and coherent way, build the requisite skills and engendering an atmosphere where the employees are encouraged to implement the strategy through trial and fail.

Figure 2 illustrates the key findings and the causal relationships between the characteristics of the commercial aviation industry in this current digitalizing phase (A), the relevant technical components that should be considered (B), and the potential outcome of adopting a solid digital strategy that exploits the technologies presented in section B.

This causal relationship in section B is furthermore summarized as follows: 3D-printing enables great weight savings that result in fuel cost reductions (1) whereas IoT offers a solution to track passengers' luggage, which leads to fewer lost baggage, which decreases the amount of compensations given to customers. Internet-based solutions in turn offer cost-effective platforms for instance in ticket sales (2) and Big Data enables a thorough knowledge of airline customers, which leads to better fitted solutions for the customers and further on more satisfied customers (3).

Automation in the flight deck reduces the amount of manual work needed, which leads to a better allocation of the flight crew's resources (4a), and additionally Automation in the flight deck reduces the risk of human error, which increases security (4b). Blockchain technology furthermore enables a more efficient allocation of a company's resources (5a) and when incorporated in the commercial airline industry, it offers improvements in the customer loyalty programs of airlines, which increases the number of satisfied customers and their loyalty towards the company (5b). This technology also increases the security of payments since the data of the transactions is not retained centrally (5c). Finally, Augmented Reality incorporated in the maintenance department decreases the risk of human error, which improves security (6).

Figure 2 also summarizes the key findings of this thesis and proposes a framework that commercial airlines could utilize. This framework can be seen as an ongoing process that starts from developing and implementing a profitable digital strategy that endorses the key characteristics of the competitive environment (A) and exploits the strengths and weaknesses of the company in consideration. The following step involves taking action and building the foundation to enable the adaptation of the key technologies (B). The profound adaptation finally leads to the migration from stage B to C, and the benefits of the digital transformation realize. After this, the cycle closes as the airline re-analyzes its core competences and adjusts its digital strategy accordingly to manage to continuously improve.

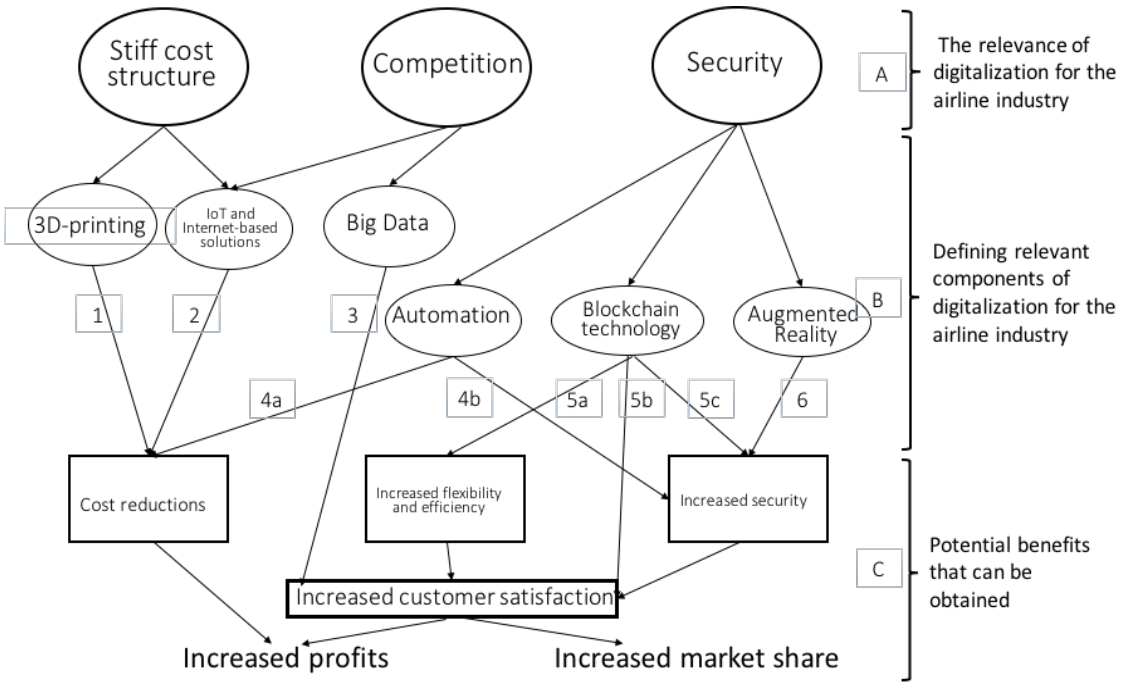

Figure 2

5.1 Implications to research

The findings of this paper represent a comprehensive outline that highlights the principals of the topics discussed. These findings mostly corroborate previous findings, which

indicate that digitalization has an impact on every industry, and can offer major advantages when addressed appropriately and integrated into the company's strategical focus, but offer also some dissenting perspectives due to the broad scope of this topic in general. These dissenting perspectives mainly relate to the challenges of the adaptation to digitalization and the potential hazards of adopting the specific digital components. The previous research perhaps does not highlight these challenges sufficiently, and thus, there is plenty of room for future research that focuses on the various trends in more detail.

The nature of this constantly evolving topic combined with the results of this paper also indicates that new innovations and tendencies are likely to emerge. These trends might currently be developing, but still lack literary acknowledgement. Similarly, the present trends that are considered relevant might subside or transform into new orientations that furthermore add to the potential of extensive future study.

5.2 Implications to practice

The findings of this thesis indicate that digitalization is an expansive topic with great relevance due to its dominance in the current economy. Therefore, the complete benefits and challenges of it are not unambiguous or simple for any company to grasp. This implies that all companies regardless of the industry they operate in should closely evaluate the consequences exclusively applying to them.

Especially commercial airlines, that are proven to have a low level of digitalization yet crucially need the adaptation of it, should thoroughly assess their strengths and weaknesses in this field. Thereafter, the adaptation of the most significant technological trends is vital for any commercial airline operating in a competition-intensive environment.

5.3 Limitations and future research

This thesis attempted to analyze the concept of digitalization and the most relevant technological trends in a manner that recognizes their existence and relevance based on the currently available academic literature, rather than analyzing the individual components particularly thoroughly. Additionally, this thesis does not provide an

elaborate guideline applicable to all commercial airlines as such, but instead a general framework that can be modified to fit various types of airlines depending on their characteristics. However, the details of this modification were not discussed in thesis and the lack of empricial data to test this framework also limited the feasibility of the presented framework.

Hence the future research could address the individual digital trends more thoroughly and provide a framework that would suit a specific type of commercial airline, for instance a low-cost airline. Also analyzing data extracted from a specific airline or multiple airlines could potentially enable new fields of research that could lead to various consequential findings.

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