Towards the Airport of the Future with Blockchain

Exploring the possibilities of blockchain for passenger processing at Copenhagen Airport

Master's Thesis

(CINT01005U) – Contract number: CINT 15849

(CBUSO2000U) – Contract number: CBUS 16734

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Copenhagen Business School, Semester 4: 2018 – 2020

Date: May 15th, 2020

Physical page count: 104

Character count: 272.863 (119,9 standard pages)

Abstract

In line with industry trends, Copenhagen airport (CPH) is facing an increasing demand and a desire of passengers for a seamless journey. To facilitate a seamless journey and enhance passenger processing, CPH needs additional real-time information from stakeholders. This study aims to explore the possibility of blockchain technology to improve information sharing practices at CPH. Primary data was collected by conducting several interviews, supported with observations and industry documents. The analysis revealed the complex dynamics of relationships in the airport network, the reliance on information technology (IT) legacy systems to share data, and two prominent operational challenges related to passenger processing hindering the delivery of a seamless journey. By supporting dialogue, access, risk-benefit analysis, and transparency (DART), this study proposes that blockchain has a positive effect on value co-creation. Moreover, this thesis proposes that blockchain as IT exploration can reinforce both IT exploitation and exploration, leading to IT ambidexterity and operational ambidexterity. Furthermore, this study proposes that the current provision of a seamless passenger journey is derived mostly from non-shared resources. Lastly, this thesis proposes that blockchain increases complimentary resource endowments, business process specificity, and enhances governance mechanisms, giving rise to additional value derived from the network. Accordingly, blockchain enhances the provision of a seamless travel journey, increasing the competitive advantage of CPH and supporting the strategic outlook of CPH.

Keywords: blockchain, airport, network, value co-creation, ambidexterity, passenger processing, operations

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List of Abbreviations

Abbreviation	Meaning
A-CDM	Airport Collaborative Decision Making
ACI	Airline Council International
AOC	Airline Operators Committee
API	Application Programming Interface
CPH	Copenhagen Airport
COVID-19	Corona Virus Disease 2019
DART	Dialogue Access Risk-benefit Transparency
IATA	International Air Transport Association
IP	Internet Protocol
IS	Information Systems
IT	Information Technology
PRM	Person with Reduced Mobility
RBV	Resource-Based View
SLA	Service Level Agreement
TCP	Transmission Control Protocol
TTP	Trusted Third Party
USD	United States Dollar
DAO	Decentralized Autonomous Organization
GDPR	General Data Protection Regulation
XML	Extensible Markup Language

Introduction

Over time, the fast advancement of digital technology has resulted in the transformation of airports. This digital transformation is mainly concerned with evolving processes and services to deliver an improved experience to passengers and customers, with the assistance of technology (ACI, 2017). In line with this transformation, airports predict continued growth in IT (Information Technology) spending (SITA, 2019). This shows that digital developments at airports are ongoing and expected to continue. Further, there is an increase in demand for global air travel. Moreover, passengers want a complete experience, and prioritize a seamless journey, providing efficiency and comfort (IATA, 2019a). Hence, the airports are in an ongoing digital transformation.

Digital Transformation of Airports

This digital transformation of airports can be divided into several stages. First, the implementation of self-service has allowed the move from manual processes to the automation of certain key processing tasks, such as the bag-drop (Arthur D. Little, 2017). This can be referred to as the move from airport 1.0 to airport 2.0. Additionally, in recent years the use of technology has optimized the flow and processing of passengers (Arthur D. Little, 2017). Accordingly, the major technology trend for airports is the automation of the passenger journey, which provides a smoother travel experience (SITA, 2019). The journey from automation to passenger flow optimization can be referred to as airport 3.0 (Arthur D. Little, 2017). To facilitate the journey toward airport 3.0, airports are investing in emerging technologies, such as business intelligence, biometrics, and interactive navigation (SITA, 2019). These technologies allow airlines to offer more personalized information to passengers and enhance resource utilization to improve passenger processing (SITA, 2019).

The next step in the transformation of airports is a fully connected ecosystem, allowing superior proactivity and reactivity (Arthur D. Little, 2017). Accordingly, a seamless flow through the airport is supported by the integration of systems and services from airlines, security, customs, concessions, ground handlers, and other stakeholders (ACI, 2017). This revolution can be referred to as airport 4.0 and envisions an airport that adapts to real-time operational requirements and commercial opportunities (Arthur D. Little, 2017). Therefore, it benefits all stakeholders, by improving customer experience, while boosting revenue and reducing costs (ACI, 2017). However, creating this fully connected ecosystem means stakeholders have to rethink their current way of doing things.

Flying towards Airport 4.0 with Blockchain

To allow proactive and reactive processes, there is a need for increased information sharing among stakeholders involved. Blockchain technology is seen as a possible solution to overcome this challenge, as

it supports data sharing by storing data in a transparent, secure, and tamper-resistant way. Blockchain technology is still an emerging technology and has not been widely implemented in the aviation industry, but opportunities are being explored (Arthur D. Little, 2017). As of 2019, 72% of the airlines are doing research on blockchain, of which 15% have major programs dedicated to the technology (SITA, 2019).

To further explore the possibilities of blockchain to improve information sharing and operational performance at airports, a case study was conducted at the Copenhagen Airport (CPH). As part of this case study, interviews with several stakeholders in the aviation ecosystem were conducted to create a better understanding of the environment. From these interviews, several challenges in passenger processing were identified, such as missing passengers and the accuracy of predictions. Moreover, insights in the airport network context and wider industry were developed from observations and documents. This enabled an informed discussion on the possibilities of blockchain.

The remainder of this study is organized as follows. First, the topic is narrowed down in the scope and delimitation chapters, which describes the focus of this paper in further detail. Next, background information on the Copenhagen airport and the aviation industry are given. This is necessary to create a better understanding of the case. The third section consists of a literature review on relevant identified literature on blockchain, firm performance in networks, value-creation, and ambidexterity. Next, the underlying assumptions influencing the research, and the research design and methods will be explained. This is followed by an analysis of the collected data. Together the data analysis and existing theories lead to the discussion of the implications of blockchain on the operations and the effect on performance. Lastly, this paper concludes with the outcome of the study, followed by implications for future research and practitioners, and limitations.

1. Problem Statement

This chapter introduces the problem recognized at Copenhagen Airport (further just "CPH"). To investigate the identified problem, a research question and several sub-research questions are formulated. Moreover, this chapter provides an overview of previous research on blockchain technology and research on blockchain in the aviation context, to demonstrate the research gap this paper fills.

1.1 Problem Statement

The main problem identified at CPH is a lack of information sharing among stakeholders. The aviation ecosystem is highly complex and involves many stakeholders with their own information systems. These diverse systems do not always share data, creating several grey areas in operations. More precisely, there is not sufficient information on the passenger location and exact passenger numbers. This lack of information availability results in inefficiencies in operational performance, which prevents efficient passenger processing. Hence, the seamless journey for passengers is hindered.

As a result, 21% of passengers report waiting times of more than one hour and 50% of passengers spend at least 45 minutes waiting in line at airports (OAG, 2020a). The most waiting times occur in security checkpoints but also boarding lines, check-in and baggage drop play a prominent role (OAG, 2020a). Besides negatively influencing the customer experience, CPH is directly affected by congestion, as it leaves less time for passengers to shop and eat at restaurants (OAG, 2020a). Indeed, this was confirmed during the initial interview and observations. Even though CPH utilizes historical and incomplete data for the traffic predictions, they are only an estimate and can be improved thus reducing waiting times. Therefore, increased information sharing on passenger count could ultimately improve the passenger experience.

Furthermore, congestions result in delays, almost every fifth flight departing from CPH is delayed by more than 15 minutes (OAG, 2020b). This is not only a high cost for airlines it also impacts the scheduling of flights, the airport-airline relationship, and customer experience (Amadeus, 2017). Furthermore, the interview revealed that stakeholders do not share information on passengers' location at the airport which may result in operational inefficiencies, inferior passenger experience, and ultimately even delays.

1.2 Research Question

To explore the challenge of information sharing in the CPH airport network, the following research question has been formulated:

RQ: *"How can blockchain address information sharing challenges in the Copenhagen airport network to improve performance of Copenhagen Airports?"*

To answer the research question, three sub-questions have to be answered. First, a need exists for a clear understanding of the ecosystem dynamics and the characteristics of blockchain that can support and increase information sharing within the network. This leads to the question:

SRQ 1: *"How can blockchain technology support value co-creation?"*

Next, to look into firm performance this paper is interested in operational challenges related to passenger processing that can be improved by information sharing. Therefore, there is a need to understand the implications of blockchain on the operational performance of the airport. Accordingly, the following question is asked:

SRQ 2: *"How can blockchain support operational performance?"*

Lastly, to explore how blockchain can improve firm performance, the implications of information sharing on firm performance have to be identified. Hence, the following question needs to be answered:

SRQ 3: *"What are the implications of information sharing on firm performance?"*

1.3 Related Research

In the last years, research on blockchain has significantly increased (Casino, Dasaklis & Patsakis, 2019; Frizzo-Barker, 2020; Xu, Chen & Kou, 2019; Zhao, Fan & Yan, 2016). Moreover, blockchain initiatives within the aviation industry have gotten more attention. This section will give a general overview of the research topics within blockchain and blockchain in aviation.

1.3.1 Research on Blockchain

After the emergence and popularization of Bitcoin and other cryptocurrencies, the underlying technology has come to the spotlight. The blockchain technology has been a widely discussed emerging technology, in public debate, by academia, but also by executives in various industries. Blockchain technology has mainly been researched and deployed in the financial sector, various supply chain solutions, but also in charitable work. However, research on the technical side of blockchain outnumbers business-focused research (Xu, Chen & Kou, 2019). Thus, this study does not intend to discuss the technical implications of blockchain implementation but its potential implications on business operations in the airport ecosystem.

Further, accounting for 16% of the total research output, a case study strategy is scarcely used to investigate applications of blockchain in organizations (Wamba & Kamdjoug, Bawack, & Keog, 2020). On

top of that, only a minor part of research on blockchain uses strategic management and organizational theory to analyze cases. Therefore, the authors argue that a more social and organizational perspective on blockchain is vital to fully understand the implications of blockchain. Hence, this thesis aims to fill the research gap by looking into performance in networks, the concept of value co-creation, and ambidexterity literature.

Moreover, consulting companies have been investigating the implications of blockchain as well. According to Deloitte's Global 2019 Blockchain Survey (Pawczuk, Massey & Holdowsky, 2019) among executives of companies with at least 100 million United States Dollar (USD) annual revenue from selected countries, 53% of respondents place blockchain in their top five strategic priorities while only 6% are unsure or perceive blockchain as not relevant. In line with that, global spending on blockchain technology is projected to grow until 2023 (IDC, 2019). In addition, equity funding and investments in blockchain-based startups have been growing (CB Insights, 2019). At the same time, 43% of executives believe that blockchain technology is overhyped (Pawczuk, Massey & Holdowsky, 2019).

Hence, academic and industry research plays a vital role to examine the applicability and implications of the technology in various industries to help companies to make more informed decisions.

1.3.2 Research on Blockchain in Aviation

As mentioned above, research is key to understand and to drive the adoption of blockchain in various industries, though the amount of research on blockchain in aviation remains scarce. In research conducted for this thesis, only less than 40 relevant pieces of research on blockchain in aviation were found, of which solely limited amount of them was published in peer-reviewed journals. Yet, IATA (2018) released a whitepaper to raise awareness about possible applications of blockchain, its benefits and challenges. Further, Lufthansa Industry Solution (2020) launched the Blockchain for Aviation (BC4A) initiative to bring relevant stakeholders together. Researchers have looked into different use cases in aviation, mainly related to aircraft maintenance, unmanned aerial vehicles, air traffic management, digital identity, luggage tracking, loyalty programs, shared ticketing, automated airline travel insurance, and employee benefits.

For example, Aleshi, Seker, & Babiceanu, (2019) developed a blockchain solution to store transparent aircraft maintenance records with integrity. Others investigated spare parts traceability (Wang & Li, 2019) and authenticity of spare parts (Madhwal & Panfilov, 2017). Honeywell already offers new and used aircraft spare parts on its GoDirect Trade e-commerce platform which ensures the authenticity of parts by using blockchain (Kress, 2018). Regarding aircrafts, researchers investigated the application of blockchain for unmanned aerial vehicles (Alladi, Chamola, Sahu, & Guizani, 2020; Mehta, Gupta, & Tanwar, 2020) and air traffic management (Arora & Yadav, 2019; Bonomo et al., 2018; Duong, Todi, Chaudhary, & Truong, 2019). One of the most discussed topics is aircraft maintenance which involves maintenance records (Aleshi et al., 2019), spare parts traceability (Wang & Li, 2019) and authenticity

(Madhwal & Panfilov, 2017). Other research is concerned with airport ecosystems and operations, such as digital identity (IATA, 2018; Khi, 2020), and luggage tracking (Ludeiro, 2019). Moreover, in the context of airlines, the topics covered shared ticketing, loyalty programs (Vinod, 2020), and automated airline travel insurance (Li, Wu, Pei, & Yao, 2019). Accordingly, Hainan Airlines group implemented a blockchain-based e-commerce platform for employee flexible benefits (Ying, Jia, & Du, 2018). Lastly, Di Vaio and Varriale (2019) looked into airport operations by looking into Airport Collaborative Decision Making. While they focus on information sharing to improve operations, they focused on flight information and did not look into how increased information sharing can improve passenger processing.

Overall, the researchers conclude that blockchain initiatives are being explored within aviation, but a research gap is identified in the application of blockchain for operational challenges related to passenger processing.

2. Delimitation

This chapter explains the delimitation of this study. As pointed out previously, there are a lot of application areas for blockchain at airports, specifically related to operations. Yet, this study focusses primarily on passenger processing, which refers to the management of the flow of passengers within the airport.

2.1 Copenhagen Airport as Focus

Airports and other stakeholders within the airport network are deeply intertwined. This paper will look at CPH as the focal firm within the network, as they can be seen as the central organization and facilitator. Even though the focus is clearly on CPH, the case needs to be analyzed within the broader airport network perspective. Adhering to the interpretivist philosophy, various stakeholders within the network live in different social realities. The researchers recognize that it is vital to engage other stakeholders in the case as well but will zoom in on the implications of increased information sharing by deploying blockchain technology on the performance of the airport.

2.2 Selection of Stakeholders

Accordingly, this research investigates the CPH network, which consists of a vast number of different stakeholders. However, it is not feasible to discuss all stakeholders. Hence, selected stakeholders are considered as part of the network. These stakeholders are the airport, airlines, and ground handling. The researchers believe that these stakeholders form the core of operations related to passenger processing at the airport. This means that stakeholders such as the border protection, customs, concessionaires, catering firms, and PRM (persons with reduced mobility) service providers are excluded, for the sake of simplicity and as a result of lacking resources. However, their presence in the network is acknowledged throughout the paper.

2.3 Operational Perspective

While discussing a seamless travel journey, this research is not focused on passenger experience necessarily. This paper revolves around operational value, rather than seamless travel from a customer point of view. Nevertheless, passenger experience plays a significant role. Operations ultimately influence passenger experience, for instance by reducing waiting times or reducing delays. Therefore, passenger experience is mentioned and explored in the research, but it is examined through an operational point of view.

3. Copenhagen Airport

This chapter gives a thorough description of Copenhagen Airport, including their strategy, and business environment. Moreover, a description of the aviation industry is given, to create an understanding of their surroundings.

3.1 Company Background

Copenhagen Airports (CPH) serves as the main international airport in Denmark and originates back to 1925. The airport's major shareholder and operator is Copenhagen Airports A/S. It is listed on Nasdaq Copenhagen and the shareholder structure consists of Copenhagen Airports A/S (59,4%), the Danish state (39,2%), foreign, Danish private and institutional investors (1,4%) (Copenhagen Airports A/S, 2020). The company also owns and operates Roskilde Airport (Copenhagen Airports A/S, 2020b, p. 13). With an average of 82.895 passengers a day, nearly 30,3 million passengers traveled through Copenhagen Airport in 2019 (Copenhagen Airports A/S, 2020b, p. 7). The central position of Copenhagen Airport in Scandinavia leads to the airport functioning as a hub airport (Copenhagen Airports A/S, 2019, p. 19).

What differentiates Copenhagen Airport from other airports in the world is the relatively high level of passenger satisfaction. The satisfaction grew from 81% in 2018, to 86% satisfaction among passengers in 2019 (Copenhagen Airports A/S, 2020b, p. 21). This growth can be contributed to the many new facilities and the focus on customer experience at Copenhagen Airport. Especially their average waiting time in security is notably short, with only three minutes and 24 seconds (Copenhagen Airports A/S, 2020b, p. 23). In total, CPH invested 2.142,1 Million Danish Krone with the aim of being one of the most efficient, service-oriented, and sustainable airports in the world (Copenhagen Airports A/S, 2020b, p. 29). This shows that CPH focuses on airlines and other customers and puts a lot of emphasis on the passenger experience.

3.2 Company Strategy

The increased importance of sustainability in aviation, the growing demand for flying to and from Denmark, and technological innovations have created a need to prepare and transform Copenhagen Airport for the future (Copenhagen Airports A/S, 2020b, p. 5). In line with this, CPH adopted a new strategy in 2019 with the goal to become *"architects of the future airport"* (Copenhagen Airports A/S, 2020b, p. 15). The new strategy was founded on three principles: having a strong customer focus, innovativeness, and simplifying processes for efficiency (Copenhagen Airports A/S, 2020b, p. 15). These three principles come together in six focus areas laid out below and are depicted in Figure 1.

(1) Expand their positive role in society and contribute to sustainable travel. CPH aims to increase their social responsibility and commit to a sustainable and climate-friendly approach. (Copenhagen Airports

A/S, 2020b, p. 16). In line with this, CPH aspires to become emission-free by 2030 through innovative thinking, collaboration, and investments in infrastructure and technology.

(2) Take passenger journey and retail experience to the next level. CPH prioritizes the passenger experience. They want to provide passengers with a relaxed, relevant, and personal passage through the airport by leveraging digital innovations (Copenhagen Airports A/S, 2020b, p. 16). Commerce forms a large source of revenue for the airport and therefore plays an important part in this principle (Lars Nielsen, Personal communication, 20 February 2020).

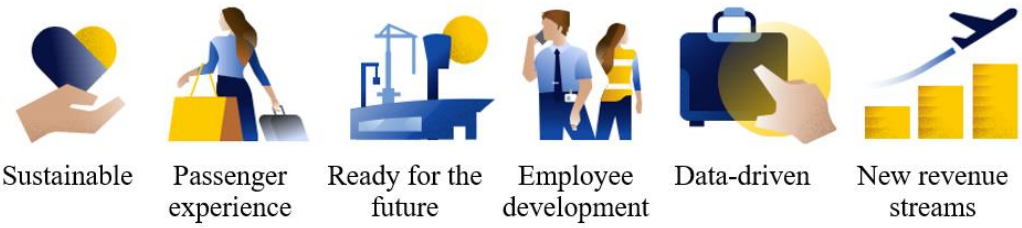
(3) Build CPH for the next generation. CPH aims to build an airport that is ready for the future. They want to build a sustainable and efficient airport that meets future demand for intelligent and flexible solutions (Copenhagen Airports A/S, 2020b, p. 16). This allows them to keep their strong position as a service-oriented airport.

(4) Develop the skills and organization of the future. CPH acknowledges the changing work environment as a result of technological developments and digitalization (Copenhagen Airports A/S, 2020b, p. 21)

(5) Create a digital and data-driven airport. More passengers demand a smooth and digital travel journey (Copenhagen Airports A/S, 2020b, p. 21). CPH believes data is the key to providing intelligent and new digital solutions, leading to an enhanced passenger experience.

(6) Build new revenue streams based on the core strengths. Lastly, CPH aims to distribute its solutions and knowledge to develop new sources of income and drive the transition (Copenhagen Airports A/S, 2020b, p. 16). Therefore, CPH is always on the look for new business areas, where they can utilize their expertise as a source for income.

Figure 1: *Six Strategic Take-offs (CPH, 2020, p. 16)*



3.3 Business Environment

The business activities from CPH can be categorized into two main operating segments: aeronautical and non-aeronautical business (Copenhagen Airports A/S, 2020b, p. 69). Aeronautical business involves everything related to the infrastructure and services to support air traffic, such as baggage systems, terminals, and IT. The non-aeronautical business concerns all other activities, for example, restaurants and boutiques. Both segments are vital for CPH and the combined value contributes to their financial performance and strategy.

3.3.1 Customer Groups

The airlines form the quintessential customer group of the airport. They pay to use aeronautical services based on commercially negotiated agreements (Copenhagen Airports A/S, 2020b, p. 13). The costs are transparent and non-discriminatory, from check-in and security through boarding and baggage handling to runway maintenance (Copenhagen Airports A/S, 2020b, p. 13). The aviation industry is highly competitive, so when attracting new routes and airlines CPH competes with other major hub airports in Europe, such as Amsterdam and Stockholm (Copenhagen Airports A/S, 2020b, p. 14). However, CPH ranks among the best airports in Europe in terms of service, quality, and price (Copenhagen Airports A/S, 2020b, p. 14). Besides airlines, CPH has three main customer groups: Passengers, shopping center concessionaires, and tenants (Copenhagen Airports A/S, 2020b, p. 14). The relations with these customer groups are managed by collaborations and agreements. CPH itself has 2.600 employees but works closely with airlines, ground handlers, concessionaires, authorities, and many more key stakeholders (Copenhagen Airports A/S, 2020b, p. 13). Therefore, they work with over 22.100 employees and more than 1.000 companies at the airport (Copenhagen Airports A/S, 2020b, p. 5).

3.3.2 Stakeholders

The main stakeholders at the airport involved in passenger processing related operations include the airlines and handling companies. Handling companies have a significant influence on operations at the airport by taking care of all ground operations. The main ground handler at CPH is SAS Ground Handling (SGH), owned by the SAS group and the biggest ground handling company in Scandinavia (SAS). Moreover, multinational companies such as Menzies and Aviator operate at CPH (CPH). The main airlines operating at CPH include SAS, Norwegian, Ryanair, and EasyJet (Naviair, 2018). Additionally, there are other stakeholders such as the police, custom authorities, PRM providers which operate at the airport. Not to mention, there is also a group of stakeholders that do not operate at the airport but hold significant influence over the airport. This group includes but is not limited to the Danish government, public transport, and the wider tourism industry. However, as mentioned in chapter 2, this paper will not focus on these latter groups.

3.4 Aviation Industry

CPH's new strategy, focusing on their role in society and passenger experience, is in line with the International Air Transport Association (IATA) their view on the future of the industry. As the trade association of airlines worldwide, IATA supports many areas of aviation activity and helps to formulate industry policy on critical aviation issues (IATA, 2019). Additionally, IATA highlights the importance of effortless travel experience and sustainability for the future of aviation (IATA, 2019). Nowadays passengers no longer just buy a ticket, but they buy an experience. Delivering a personalized and seamless experience is beneficial for the consumer, but also facilitates efficient use of the airport infrastructure (IATA, 2019).

Information technology plays an essential role in realizing this seamless experience. The major focus of technology investments is to reduce queues, speeding the transition through airport processes and providing better information to travelers (SITA, 2019). Currently, there are several initiatives that aim to improve this experience. The most notable initiatives exist in the area of automation of airport processes, improved baggage handling, biometric identification (One ID), and real-time information (IATA, 2018). Moreover, IATA has introduced the Airport Collaborative Decision Making (A-CDM) concept to improve the efficiency of airport aeronautical operations (IATA, 2019). A-CDM stimulates stakeholders at the airport to work more transparently and collaboratively. This means that they are encouraged to share data and information exchange.

3.4.1 Industry Standards

To realize these initiatives, IATA developed multiple standards for the aviation industry in collaboration with other organizations such as the Airport Council International (ACI) (IATA, 2020b). First, the common use standards allowing airlines or other handling agents to process passengers using shared technology such as check-in desks. This group of standards consists of Common Use Self Service, Common Use Passenger Processing System, Common Use Web Services and are supported by the Bar-Coded Boarding Pass and Technical Peripheral Specifications (IATA, 2020b). Moreover, messaging standards such as the Passenger Name Records (PNR) allow data transfer between stakeholders (IATA, 2020a). Lastly, data exchange initiatives aggregate information and allow stakeholders to access the necessary information on flight data and much more (IATA, 2020c).

An overview of the most significant common use standards, messaging standards, and data exchange initiatives can be found in Appendix A. To implement these standards there are several platform providers, such as Amadeus and SITA, that assist with the integration of technology to meet the increasing customer requirements (Arthur D. Little, 2017; SITA 2020). Both companies offer a wide range of products, from baggage reconciliation systems to passenger verification.

4. Literature Review

This chapter presents an overview of relevant literature on blockchain, performance in networks, value creation and ambidexterity, to create context for the present research.

4.1 Blockchain

To understand the implications of blockchain, this subchapter provides an overview of relevant literature on the concept of blockchain. First, the definition of blockchain is given, followed by a short history. This is followed by an overview of different types of blockchain and the benefits and challenges associated with the technology. Lastly, blockchain characteristics are compared to traditional databases to facilitate understanding of the discrepancy between the two.

4.1.1 Definition of Blockchain

Blockchain is an umbrella term for the system which describes the underlying technology of Bitcoin (Wamba et al., 2020). Accordingly, Narayanan & Clark (2017) emphasize there is no single definition of blockchain. In fact, Wamba et al. (2020) found 27 different definitions in their systematic literature review. Some early definitions of blockchain include Bitcoin in their definition while others use terms such as distributed ledger or distributed database to define blockchain (Wamba et al., 2020). This thesis omits definitions focusing on Bitcoin. This study will approach blockchain in line with Swan (2015, p. 1) who defines blockchain as a "decentralized transparent ledger with transaction records". Likewise, Casino et al. (2019, p. 56) refer to blockchain as "a distributed append-only time-stamped data structure".

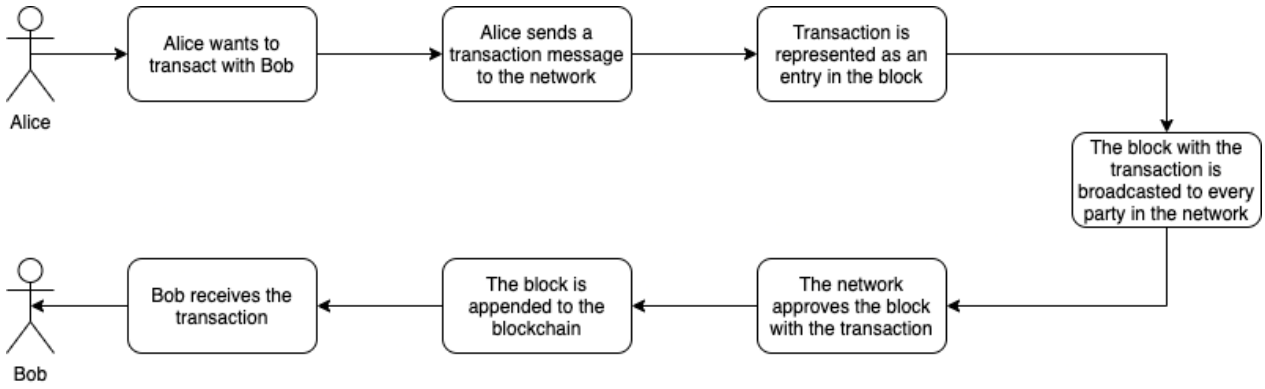
Blockchain is an append-only distributed ledger technology for storing transactions or digital records on a peer-to-peer network, oftentimes without a central authority (Yaga, Mell, Roby & Scarfone, 2018; Crosby, Pattanayak, Verma & Kaylanaraman, 2016). The name blockchain originates from the structure of records in the ledger which is a chain of blocks where each block is linked to the previous block with a cryptographic hash and timestamp (Wüst & Gervais, 2018). Each block contains information about the transaction (e.g. sender, recipient, amount). A new transaction updates the state of the blockchain with new values. In order to ensure consistency of records on all devices, blockchain networks use various consensus mechanisms (Yaga et al., 2018; Narayanan, Bonneau, Felten, Miller & Goldfeder, 2016). The transactions can not only exchange value among peers but can also trigger the execution of a code called smart contracts (Wüst & Gervais, 2018).

4.1.2 How does Blockchain work?

To illustrate how blockchain works, an example of a transaction between Alice and Bob is used, based on Crosby et al. (2016). A schematic overview of this transaction can be found in Figure 2 Alice wants to send

her money or data to Bob, so she sends a transaction to the network. Böhme et al. (2015) add that Alice proves the ownership and the right to transfer the asset by adding a private key to the message, which is not visible to the rest of the network. The transaction is represented as an entry in a block and is received by all parties in the network. Next, the network approves the transaction and the block is appended to the chain. The block contains a hash of the data in the block as well as a hash of the previous block. If any data in the block is changed, the hash of the block changes as well. Hence, the rest of the network notices any change in the data on blockchain (Böhme et al., 2015). All parties running the network update to the new version of the blockchain and Bob receives money or data from Alice.

***Figure 2**: Bob and Alice (Crosby et al., 2016)*



4.1.3 Brief History of Blockchain Technology

Blockchain technology builds on blocks of academic research from the 1980s and 1990s (Narayanan & Clark, 2017). It benefits from other research fields and technologies such as (a)symmetric-key cryptography, cryptographic hash functions, internet, game theory, and software engineering (Mougayar, 2016; Narayanan et al., 2016; Yaga et al. 2018). Mougayar (2016) aptly calls it a meta-technology. Blockchain technology is not only made up of several technologies, but it also affects other technologies. Mougayar (2016, p.37) lists various architectural layers of the technology: "a database, a software application, a number of computers connected to each other, clients to access it, a software environment to develop on it, tools to monitor it, and other pieces". Moreover, Mougayar compares the potential paradigm-shifting implications of blockchain technology to the World Wide Web. Similarly, Iansiti and Lakhani (2017) used the parallel to TCP/IP (Transmission Control Protocol/Internet Protocol). TCP/IP is a foundational technology and for that reason, adoption of blockchain technology may take decades while potentially laying new foundations for economic and social systems. The adoption of foundational technology begins with a single-use case, then localized private use, substitute for existing solutions, and transformative applications (Iansity & Lakhani, 2017). In fact, blockchain technology has followed the same development thus far as the three generations of blockchain suggest: Blockchain 1.0, 2.0, 3.0.

Blockchain 1.0.

The blockchain technology originates from the "Bitcoin: A Peer-to-Peer Electronic Cash System" whitepaper published by an individual or group of individuals behind pseudonym Satoshi Nakamoto in 2008, which led to the blockchain network being deployed in 2009. Lacity, Steelman & Cronan (2019b), as well as Swan (2015), refer to this event as the inception of Blockchain 1.0 represented by permissionless blockchain with a single use-case - cryptocurrency. Bitcoin was another effort to establish electronic cash (Yaga, et al., 2018; Narayanan, et al., 2016). The proposed Bitcoin blockchain-enabled peer-to-peer electronic cash transactions without any intermediary by solving the double-spending problem (Nakamoto, 2008). The problem was solved by the implementation of a distributed ledger of transactions with the proof of work consensus mechanism, along with methods of cryptography which act as an element of trust (Nakamoto, 2008; Böhme et al., 2015). In the following years, Bitcoin cryptocurrency rose in value, reaching an exchange rate of 20.089 USD for 1 BTC (Bitcoin) with a market capitalization of more than 336 billion USD in December 2017 (CoinMarketCap, 2020). Moreover, Google search engine noticed an increase in search queries on the topic of Bitcoin in 2013, 2017, and 2019 (Google Trends, 2020a). The hype generated around Bitcoin generated public attention around cryptocurrencies as well as the underlying technology, blockchain. A plenitude of alternative cryptocurrencies, so-called altcoins, were created, such as Ether, Tether, or Litecoin (Lacity et al., 2019a).

Blockchain 2.0.

The next important milestone was the establishment of the Ethereum platform (Buterin, 2014) starting the second generation Blockchain 2.0 (Swan, 2015; Lacity et al., 2019b). The main innovation was the so-called smart contracts, which are computer programs triggered by a transaction on the blockchain (Buterin, 2014). Hence, it enabled developers to develop applications on the blockchain. Nick Szabo (1994, p.1) first came up with the concept of smart contracts and defined them as "a computerized transaction protocol that executes the terms of a contract". Smart contracts allowed developers to implement applications beyond cryptocurrencies on blockchain (Swan, 2015).

The aforementioned developments motivated large companies and academia to start investigating other use cases of blockchain technology. The research on blockchain technology started in 2015 and has been a growing field ever since (Casino et al., 2019; Frizzo-Barker et al., 2020; Xu et al., 2019; Zhao et al., 2016). Some other scholars have already reported the first academic research activity on blockchain in 2013 (Yli-Huumo, 2016; Akar & Akar, 2020). Moreover, Yli-Huumo et al. (2016) indicated that most research was concerned with the technical perspective, and 80,5% of research on blockchain from 2013 to 2015 was investigated Bitcoin.

Furthermore, the technology started appearing in the Gartner hype-cycle (Gartner, 2019). The usability of blockchain for other industries was accelerated by the innovation of smart contracts. Hence, programmable blockchains for enterprise use emerged, such as R3 Corda (Brown, 2018) and Hyperledger Fabric (Hyperledger, 2018). Accordingly, IDC (2019) forecasts that spending on blockchain solutions will grow from 1,5 billion USD in 2018 to 15,9 billion USD in 2023. In line with this, it is expected that blockchain technology will receive the commitment and support of top management in firms (Seebacher and Schüritz, 2019).

Blockchain 3.0.

Lastly, the third generation, Blockchain 3.0, is centered upon interoperability (Lacity et al., 2019b). As the number of blockchain standards grow, there is an increasing need for blockchains to be interoperable (e.g. move records from one blockchain to another). The third generation promises to improve interoperability, scalability, security, and performance by allowing public, private blockchains, and legacy systems to connect (Lacity et al., 2019b). Besides that, Swan (2015) views Blockchain 3.0 as an enabler for a more decentralized society and further application of blockchain technology in more fields such as health, science, or arts.

4.1.4 Categorization of Blockchain Networks

Blockchain networks are divided into two categories based on the openness, network management and permissions; permissioned and permissionless blockchains (Yaga, et al., 2018; Underwood, 2016). In permissionless blockchains, anyone can join the network, similarly to the public internet. Permissioned blockchains can be compared to a corporate intranet where access to the network is restricted (Yaga, et al., 2018). Table 1 presents a summary of the different types of blockchain networks and their attributes.

Permissionless.

The term permissionless (also referred to as public blockchain networks (Jayachandran, 2017; Underwood, 2016)) refers to decentralized ledger platforms, which are opened to anyone. Participants are able to join the network without revealing their identity. Once in the network, everyone is allowed to read and write to the ledger without permission of any central authority. In fact, no central authority exists, thus the network is managed by open source community. Hence, such networks are highly decentralized, and a consensus model is necessary to prevent malicious users from compromising the network. That results in a less efficient network with slower transaction speed (Yaga, et al., 2018). A famous example of a permissionless blockchain network is Bitcoin.

Permissioned.

On the other hand, permissioned blockchain networks do have a central authority which authorizes users joining the network (Underwood, 2016). The level of control over participants can vary, i.e. an authority can restrict who has reading or writing access. As opposed to permissionless blockchain networks, permissioned networks can be instantiated and maintained on either open source or closed source software. Permissioned blockchain networks also use consensus models, however they are usually faster, less computationally intensive and more efficient, since one's identity is required to participate in the network. For that reason, a certain level of trust and accountability among participants remains (Yaga, et al., 2018).

Some authors subdivide permissioned blockchains into two groups; private and consortium (Casino et al., 2019). In private blockchain, one entity manages the network and acts as a gatekeeper. Opposed to that, consortium blockchain is a hybrid between private (permissioned) and public (permissionless). The network is managed by multiple entities called leader nodes (Casino et al., 2019). Accordingly, this study discusses consortium blockchain in the airport network context since it is suitable for interorganizational use. Moreover, the airport network consists of several interdependent stakeholders who can collectively contribute to the blockchain.

Permissioned blockchain networks are especially relevant in the enterprise context, where two or more organizations do not necessarily trust each other. The organizations settle on a consensus model for their blockchain network, which facilitates information sharing. The shared ledger may better inform their business decisions and holds everyone accountable. On top of that, external entities, like oversight or auditing bodies, may be included (Yaga, et al., 2018).

Table 1*: Different Types of Blockchain's and their Attributes (Ahmed et al., 2019, p. 3)*

Attribute	Public	Consortium	Private
Permissionless	Yes	No	No
Immutability	Yes	Partial	Partial
Efficiency	Low	High	Single High
Centralized	No	Partially	Yes
Identity	Anonymous	Approved participants	Approved participants
Access	Public read/Write	Can be restricted	Can be restricted
Transaction Processing Speed	Slow	Fast	Fast
Participation in Consensus	All nodes	Selected nodes in multiple organizations	Single organization

4.1.5 Properties and Benefits of Blockchain

The literature on blockchain commonly praises blockchain for its properties. The ledger of records, which blockchain technology is based on, is distributed. This means that every node in the network maintains the same copy of the ledger, ensuring that all parties involved have the same information (Hughes, Park, Kietzmann, & Archer-Brown, 2019). On top of that, it is decentralized, thus no single entity controls the blockchain. In the case of consortium, it can be a group of stakeholders controlling blockchain. The degree

of decentralization depends on the setup of network management and the ownership of the particular blockchain network. Further, the ledger is append-only, hence all nodes are able to read and write on the blockchain, but not edit or delete (Yaga et al., 2018). Since there are multiple writers and possibly no owner of the network, a consensus mechanism is necessary to ensure reliable, and consistent information on all nodes. Due to these properties, blockchain technology has proved to be an appropriate technology in various use cases, such as peer-to-peer digital exchange of monetary value without an intermediary (trusted third party (TTP)) (Yaga et al., 2018). A comprehensive overview of the benefits and challenges can be found in Table 2.

Benefits of blockchain.

Data integrity. The same version of blockchain is maintained on each node, decreasing likelihood of data loss (Gatteschi et al., 2018; Ruoti et al., 2020). The integrity of data on blockchain is further secured by the use of cryptographic hash functions. Pieces of data on the blockchain are grouped into blocks. Data in the blocks are hashed, creating its so-called digital fingerprint. Each block contains hash of all its data, and hash of the previous block, hence the blocks are chained together. Any change to the original data produces a completely different hash, which indicates that the data has been tampered with (Narayanan et al., 2016, Yaga et al., 2018). Therefore, blockchains tend to be tamper-resistant, or even labeled as immutable by some (Wamba et al., 2020; Golosova & Romanovs, 2018; Lacity, Sabherwal, & Sørensen, 2019a).

Auditability. Data integrity makes blockchain technology suitable for interorganizational use. The integrity of data implies benefits for participating members of the network. The single version of the information allows faster auditing or monitoring chain of custody of assets tracked on blockchain (Ruoti et al., 2020; World Economic Forum & Accenture, 2019; Xu et al., 2019).

No down times. Moreover, the distributed design allows for possibly no down times of the blockchain (Hughes et al., 2019; Lacity, 2018b; Ruoti et al., 2020). The likelihood of any down time decreases with increasing number of running nodes (Beck, 2018).

Pseudonymity. In addition to that, permissionless blockchains tend to be pseudonymous, or even anonymous. A user in the blockchains network is not obliged to disclose their identity and yet is able to prove that they are rightful owners of given digital asset. This is achieved by leveraging (a)symmetric cryptography (Narayanan et al., 2016). Nonetheless, permissioned blockchains regularly require users to disclose their identity (Narayanan et al., 2016).

Automation. Furthermore, blockchains are programmable. Smart contracts, introduced by (Buterin, 2014), are self-executable pieces of code without any intervention of a trusted third party (TTP), subsequently cutting down administration costs, reducing risks, and improving efficiency of business processes (Zheng et al., 2020).

Trust facilitator. In addition to that, nodes can communicate directly (peer-to-peer) without depending on a TTP since all nodes receive same information and collectively maintain the network (Beck, 2018; Golosova & Romanovs, 2018; Lacity, 2018b). By definition, a TTP is a focal point of a network managing and distributing information. At the same time, the TTP maintains control over the network. Additionally, the value of the network increases with more members in the network (Lacity, 2018a).

Omittance of trusted third party. Omittance of a TTP in a blockchain-enabled network lets members govern collectively (Ruoti et al., 2020; Yaga et al., 2018). In addition, TTPs come with low transparency, higher transaction costs, higher cybersecurity costs, and have the ability to mute or tamper with records (Lacity et al., 2019a).

4.1.6 Challenges of Blockchain

On the contrary, blockchain is a nascent technology facing many challenges, both technical and societal (Hughes et al., 2019). Mougayar (2016) highlights technical issues such as secure transactions, interoperability, and scalability. First, technical challenges are described, followed by societal challenges.

Technical challenges.

Interoperability. A large number of blockchain solutions have been developed, however no standardization is in place, and therefore blockchains are not interoperable (Casino et al., 2019; Lacity et al., 2019b). The lack of interoperability ultimately hinders adoption of blockchain technology (Lacity & Khan, 2019). Furthermore, Lacity et al. (2019b) call for not only interoperability among blockchains, but also between blockchains and legacy systems. To achieve interoperability, plenty APIs (Application Programming Interface) need to be developed. Moreover, some researchers call for more user-friendly programming language to minimize possible mistakes in smart contracts (Ahmed et al., 2019; Ruoti et al., 2020; Swan, 2015; Yli-Huumo et al., 2016). The infamous coding mistake enabled the attack on Ethereum DAO (Decentralized Autonomous Organization) allowing hackers to steal 55 million USD in 2016 (Leising, 2017).

Scalability, latency & throughput. Some other widely cited issues are scalability, latency, and throughput of blockchains. Blockchains are not comparable to advanced transaction systems such as Visa network (Casino et al., 2019; Yli-Huumo et al., 2016). Moreover, time to validate a transaction may increase as more nodes join the network (Ahmed et al., 2019). The aforementioned issues are caused by the need to run a consensus protocol and the need to store entire a ledger on all nodes (Ruoti et al., 2020; Swan, 2015). However, permissioned blockchains tend to be far more efficient than public ones (Yaga et al., 2018).

Versioning. Apart from that, blockchain networks demand a high degree of governance and cooperation compared to TTP managed systems. If the network does not agree on an update of the blockchain, the network can split into two different blockchains with different nodes – so called versioning

or hard fork (Golosova & Romanovs, 2018; Narayanan et al., 2016; Swan, 2015; Yli-Huumo et al., 2016). This issue is more common in permissionless blockchain networks.

Energy consumption. Energy consumption of blockchain networks is also a highly discussed issue. Due to the distributed design of the technology, blockchains are more energy intensive than centralized systems. Especially public blockchains using energy intensive consensus mechanisms, such as proof of work, are highly criticized (Ahmed et al., 2019; Casino et al., 2019; Gatteschi et al., 2018; Golosova & Romanovs, 2018; Narayanan et al., 2016; Swan, 2015; Yaga et al., 2018; Yli-Huumo et al., 2016).

Security. Moreover, blockchain technology presents as highly secure due to the use of advanced cryptography. However, blockchains may be vulnerable in the future, after technological advancements like quantum computing (Casino et al., 2019). Yet, there are more security concerns present nowadays. Golosova and Romanovs (2018) add that blockchains can be attacked in various ways, for example Sybil attack or attack of 51% of nodes. Ruoti et al. (2020) claims that decentralized nature of blockchain technology makes it vulnerable to coordinated attacks. Yli-Huumo et al. (2016) affirms that security was one of the major research topics. On the other hand, other authors refer to security of data as a benefit of blockchain (Lacity et al., 2019a; World Economic Forum & Accenture, 2019; Xu et al., 2019).

Privacy. Even though users sometimes do not need to disclose their identity, privacy is a major challenge that blockchain technology is currently facing as data on blockchain can be visible to everyone in the network (Yli-Huumo, Ko, Choi, Park, & Smolander, 2016). Hence, members of the network are hesitant to store confidential information on blockchain possibly damaging their reputation (Gatteschi et al., 2018; Ruoti et al., 2020). The problem is also referred to as the lack of transactional privacy (Casino et al., 2019). Lacity and Khan (2019) add that adopters have legitimate concerns over industrial espionage and protection of intellectual property rights. However, researchers have been working on techniques which can resolve this problem, for example zero-knowledge proof (Casino et al., 2019) or sidechains (Singh et al., 2020; Li, Sforzin, Fedorov & Karame, 2017). Other literature may use terms such as, satellite, child, or sub-chains when referring to sidechains.

Oracle problem. Blockchain technology provides a tamper-resistant ledger but the data appended to the ledger may be fake. Therefore, a weak part of blockchain is the interaction with the real world. The entity (called oracle) which appends data to the blockchain may append fake or inaccurate information, referred to as the oracle problem (Yaga et al., 2018). In order to solve the problem, strong reputation, governance and trusted oracles are necessary to ensure truthful information (Gatteschi et al., 2018). The research often refers to this as the "oracle problem".

Societal challenges.

Regulation. Legal and regulatory uncertainties are the most cited societal challenge (Hughes et al., 2019; Lacity, 2018b; Lacity & Khan, 2019; Ruoti et al., 2020; Swan, 2015). Swan (2015) warns that

regulation could be one of the most defining factors of the future of blockchain technology. Certain pieces of regulation, like GDPR (General Data Protection Regulation), already post a challenge to placing personal data on blockchain (Yaga et al., 2018). Simultaneously, they highlight that permissioned blockchains may be more likely to satisfy regulators' needs. In fact, some blockchain consortia actively educate regulators about blockchain (Lacity, 2018b).

Lack of knowledge. A plethora of companies, blind sighted by the hype, invest in blockchain technology without having suitable use for it (Casino et al., 2019), and have unrealistic expectations (World Economic Forum & Accenture, 2019). Hence, before the technology is widely adopted, executives need to understand the technology, its capabilities, and challenges which are not only technical but also societal, involving a need of changing mindset (Lacity, 2018b). This involves participation on development of open-source software, sharing more information, or abiding by decisions of a blockchain governance body (Lacity, 2018b).

Public perception. Moreover, there have been incidents, such as the hack of DAO (Leising, 2017) which deteriorated blockchain's reputation and public perception (Swan, 2015). Another infamous event was the hack of Mt. Gox cryptocurrency exchange even though blockchain did not directly contribute to the incident (Millan, 2014). This can get in the way of adoption of blockchain based systems.

Network formation. The last challenge of establishing a blockchain network is the initial size of the network which in enterprise context requires extensive dialogue (Lacity, 2018a; Zavolokina, Ziolkowski, Bauer, & Schwabe, 2020) Attracting a critical mass of participants of the network is vital to increase value of the network (Lacity, 2018b).

Table 2: *Benefits and Challenges of Blockchain Technology (own representation)*

Benefits	**Challenges**	
	Technical	**Societal**
No downtimes	Interoperability	Regulation
Data integrity	Scalability, latency & throughput	Lack of knowledge
Auditability	Governance	Public perception
Pseudonymity	Versioning	Network formation
Trust facilitator	Energy consumption	
Omittance of TTP	Security	
	Privacy	
	Oracle problem	

4.1.7 Blockchain vs. Databases

Insofar, an understanding of blockchains as an alternative data storage to databases has been gained. In essence, both mechanisms store data, however each of them has unique characteristics and use cases. Blockchain and database designs can vary based on implementation and needs. Therefore, the comparison

is generalized, and deviations may apply. Table 3 provides a comprehensive overview of the comparison of blockchain and databases.

Degree of decentralization. As already discussed, the first instance of blockchain technology was the permissionless Bitcoin blockchain. This blockchain provides a prime example of a fully decentralized network where no single entity is in control and thus is maintained by the open source community. Permissioned blockchain may vary depending on the type. Consortium blockchains consist of a group of entities that together govern and maintain the network. Hence, power is not fully centralized. Lastly, private blockchains and databases are governed by one entity (Ahmed et al., 2019).

Peer-to-peer transactions. As blockchain networks are distributed, they allow participants to conduct peer-to-peer transactions without the presence of TTP. Traditionally all transactions are visible to other participants in the network. Nonetheless, as mentioned, researchers have been working on techniques that would support transactional privacy on a blockchain network. In contrast, databases do not allow peer-to-peer transactions (Casino et al., 2019).

Trust level among stakeholders. Traditional databases exist as centralized data storage systems. Even though there are instances of distributed databases, they are not designed with security in mind like blockchains. Unlike blockchains, databases are motivated by performance and capacity requirements, not security (Kolb, Abdelbaky, Katz & Culler, 2020). By design, blockchain assumes untrusted actors in the network. The ability to technically bring non-trusting actors into one network also eliminates the need for a TTP (Casino et al., 2019). Thus, the design of blockchain is also reflected in data integrity.

Data integrity. A major difference between blockchains and databases is the integrity of data. As mentioned, blockchains are designed with security in mind. In databases, the data can be changed as they do not usually use cryptographic primitives, such as hashing and signatures. In contrast, blockchains are append-only ledgers in which data cannot be changed, unless the majority of nodes agree on the new state (Dinh et al., 2018).

Traceability. The aforementioned use of cryptographic primitives makes blockchains less vulnerable to tampering. Especially, hash functions chain blocks together, which increases the integrity of data. Moreover, timestamping allows viewing all transactions in a chronological manner. Hence, for a given piece of information on blockchain, participants are able to view its past states. Thus, information stored on blockchain can also be auditable (Casino et al., 2019).

Incentives for validating transactions. Incentives are an inherent feature of public blockchains as those networks consist of a large number of unknown and untrusted participants. Hence, transactions are completed by validator nodes who are economically incentivized to do so. For example, in the Bitcoin blockchain, validator nodes are rewarded by a pre-defined number of bitcoins for validating a transaction. In contrast, permissioned blockchains do not require an incentive system for validators, as not everyone can join the network. In the enterprise context, participants' identity is usually known. However, permissioned

blockchains can use a penalization system in a situation where a participant misbehaves, for example by posting untruthful data. Finally, databases do not use incentives or penalizations (Casino et al., 2019; Kolb et al., 2020).

Throughput, latency, and scalability. As already discussed, throughput, latency, and scalability are some of the technical challenges of blockchain technology. In opposition, databases were optimized as time went by and are able to withstand larger throughput of data with less latency. As an example, the Visa network processes up to 55 thousand transactions per second as opposed to the Bitcoin network which process seven transactions per second (Wüst & Gervais, 2017).

Energy consumption. By now, it is known that permissionless blockchain networks are distributed, usually working with an energy-intensive consensus protocol. This allows to bring untrusted actors together; however, it demands more energy. However, permissioned blockchain networks can run on a leaner consensus protocol. Nonetheless, blockchain is distributed and identical data are stored on multiple devices. In contrast, databases may be stored on a single device which makes them the least energy-intensive (Ahmed et al., 2019).

Data structure. In general, databases are a more efficient mean of data storage. In relational databases, complex data structures can be stored in an efficient manner. On the other hand, blockchains are time-stamped ledgers of events with no complex data structure such as databases. Hence, blockchains are not effective for storing large amounts of data of different types (Ahmed et al., 2019).

Table 3: *Comparison of blockchain and database (own representation)*

Property	**Permissionless Blockchain**	**Permissioned Blockchain**	**Database**
Decentralization	High	Depends	Low
Need for TTP	No	No	Yes
Peer-to-peer transactions	Yes	Yes	No
Trust needed	No	Depends	Yes
Data integrity	High	High	Low
Traceability	Yes	Yes	No
Auditability	Yes	Yes	No
Incentives	Yes	No, penalization sometimes	No
Performance - throughput, latency & scalability	Low	Medium	High
Energy consumption	High	Medium	Low
Data structure	Simple	Simple	Relational database

4.2 Networks

The following chapter elaborates on the implications of performance in networks to create an understanding of performance in the airport ecosystem. After providing a definition of networks, an overview of classical

theories to explain firm performance is given. This is followed by an elaborate explanation of the extended resource-based view.

4.2.1 Defining Networks

The term network is broadly used in strategic management literature to indicate inter-organizational exchange between multiple firms (Chou & Zolkiewski, 2018). In line with this, Mathinheikki, Pesonen, Artto & Peltokorpi (2017) define networks as *"goal-oriented, value-creating systems"*. Similarly, Kauffman, Li & Van Heck (2010) refer to networks as the combination of capabilities of several firms to produce and deliver a product or service that could not have been produced by a single firm.

However, many different forms of cooperation can be distinguished. From an extensive literature review, Barringer & Harrison (2000) identify six forms of inter-organizational relationships: networks, consortia, alliances, trade associations, and interlocking directorates. The different relationships vary in the way participants are linked by ownership and structure. Following this Barringer & Harrison (2000) define networks as a constellation of firms with a focal actor, which work together to create products, services, or a new technology related to the focal issue. Accordingly, networks are managed centrally by dominant organizations (Mathinheikki et al., 2017). This paper will adopt a similar notion of networks.

4.2.2 Networks and Firm Performance

Strategic management literature has a long history aiming to explain firm performance (Cao & Zhang, 2011). A customer engages with a company because they perceive certain benefits from the product offered by the firm compared to other firms (Barney, 1991). Thus, creating value allows firms to perform an activity more cheaply or better than competitors, giving a firm its competitive advantage.

Classical views.

An often-used theory to explain the competitive advantage is the Resource-Based View (RBV). The RBV looks at the competencies of a firm itself to explain returns (Barney, 1991). The theory argues that resources and capabilities that are valuable, rare, inimitable, and non-substitutable (VRIN) will grant a sustainable competitive advantage over other firms (Barney, 1991). Thus, the RBV focusses on firm-specific resources and takes an internal approach to value creation.

However, there is a prevailing perception that value is created by multiple actors in a network setting (Vargo & Lusch, 2004). The move towards value creation in networks has resulted in an increased emphasis on interfirm collaboration in the strategic management literature and the recognition of collaborative advantage (Lavie, 2006). Traditional theories to explain firm performance, such as the resource-based view, lack sufficient explanation power of interconnected organizations due to the internal focus.

Accordingly, Dyer & Singh (1998) argue that the RBV overlooks the implications of the network of relationships in which the firm is embedded. Therefore, they introduce the relational view of the firm as a complement to the RBV. The relational view argues that the firm's critical resources may extend beyond firm boundaries (Dyer & Singh,1998). Interfirm relations allow resources to be combined in unique ways, creating a competitive advantage. The relational view emphasizes the network in which firms operate as the unit of analysis and provides an understanding of the sources of inter-organizational competitive advantage.

Collaboration in a network allows firms to take advantage of four relational resources. First, *(1) Interfirm relation-specific assets* are a source of a relational rent that arise when a firm invests in specialized assets in conjunction with the assets of an alliance partner (Dyer & Singh, 1998). Relation-specific investments can be derived from physical asset specificity, site specificity and human asset specificity (Dyer & Singh, 1998). Next, *(2) Interfirm knowledge-sharing routines* support collaboration with other firms by increasing inter-organizational learning (Dyer & Singh, 1998). Another way to generate a competitive advantage is by combining resources with *(3) complementary resources or capabilities* from a partner to generate synergies (Dyer & Singh, 1998). Lastly, transaction costs reduction and the willingness of participation in an alliance can be promoted with *(4) effective governance mechanisms*, comprising of third-party enforcement and self-enforcement, such as trust (Dyer & Singh, 1998). It is important to note that the four mentioned rents are interdependent. Therefore, leveraging one source of value can stimulate the actualization of another relational rent.

Extended resource-based view.

Another perspective that does incorporate the combination of common benefits and private benefits is the extension of the resource-based view (Cao & Zhang, 2011). Lavie (2006) integrates the relational view and social network theories, to reformulate the traditional RBV in the perspective of a networked environment. Lavie (2006) argues that a firms' complete set of resources consists of a subset of shared and a subset of nonshared resources. Following this, he proposes four rents leading to a competitive advantage. The rents and their relationships are depicted in Figure 3.

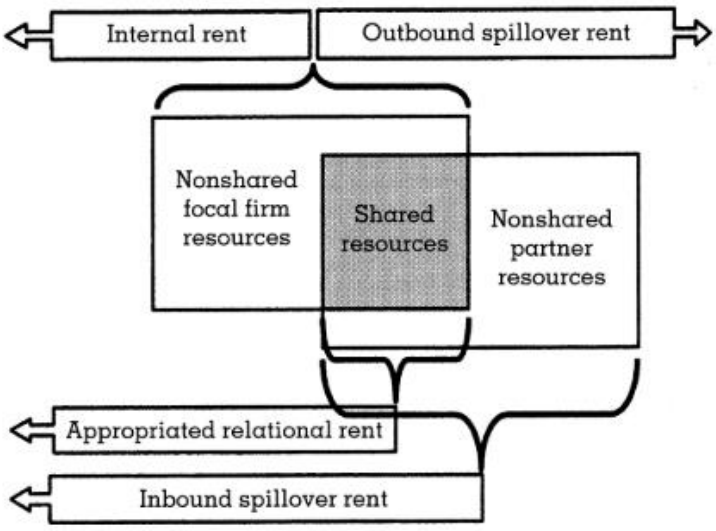
Internal rents. Internal rents are derived from the focal firm's own resources (Lavie, 2006). There are two sources of internal rents. First, internal rents can be derived from scarce resources (Lavie, 2006). Scarce resources entail a limited supply of resources, hence other firms cannot get access to the same resource base. Second, internal rents can result from specialized resources (Lavie, 2006). Specialized resources encompass resources that provide the firm with added value relative to the value other firms can extract (reference). So far, internal rents are comparable to the traditional resource-based view. However, when looking at networked firms it is important to incorporate interfirm resource complementarities. This refers to the fact that a focal firm can leverage the value of its own resources by accessing complementary

resources from other firms (Lavie, 2006). The value of a focal firm's internal resources is dependent on network resources, such as reputation (Lavie, 2006).

Relational rents. Relational rents are the common benefits resulting from the collaboration. These rents are extracted from relational specific assets, knowledge sharing, complementary resources, and effective governance mechanisms, as suggested by Dyer & Singh (1998) and are explained in the previous section. Relational rents can only be derived from intentionally committed resources, thus refer to the shared resources in the network (Lavie, 2006). Several factors are influencing the proportion of relational rents. First, the absorptive capacity of firms determines the learning from partners, increasing relational rents (Cao & Zhang, 2011). Second, the degree in overlap of resources and the relative scale of resources determine the relational rents appropriated (Lavie, 2006). Third, contractual agreements protect misappropriation of resources (Lavie, 2006). Moreover, in the short run opportunistic behavior results in a larger portion of relational rents but will damage the absolute relational rents derived from the collaboration in the long run (Dyer & Singh, 1998). Lastly, the bargaining power of the firm positively influences the proportion of relational rents captured (Lavie, 2006).

Inbound and outbound spillover rents. Inbound spillover rents refer to unintended gains from the shared and nonshared resources of the alliance partner (Lavie, 2006). Hence, this type of rent is derived from network resources. Inbound spillover rents from shared resources are dependent on the opportunistic behavior, bargaining power and absorptive capacity of the focal firm (Cao & Zhang, 2011). Inbound spillover rents from non-shared resources rely upon the isolating mechanisms used by partnering firms (Lavie, 2006). Outbound spillover rents can be understood as unintended leakage of resources of the focal firm. Hence, they are governed by the same dynamics as inbound spillover rents, but in the reverse direction.

Figure 3*: Composition of Rents (Lavie, 2006)*



According to the extended resource-based view, the combination of internal rent, inbound spillover rent, and outbound spillover rents are referred to as the private benefits for the focal firm. Correspondingly, value is a function of both relational rents and these private benefits. Table 4 summarizes the discrepancy between the different views of competitive advantage. While the relational view is useful to understand the strategic implications of relations among stakeholders, it does not acknowledge the private benefits gained by firms. Moreover, it does not deal with how relational rents are distributed among partners. When firms collectively create value, it becomes important to understand how stakeholders capture their individual share of value. Therefore, this paper follows the ERBV in analyzing firm performance and takes into account relational rents, as well as private benefits for value creation.

Table 4: *Views of competitive advantage (Adopted from Dyer & Singh, 1998)*

Dimension	**Resource-Based View**	**Relational View**	**Extended Resource-Based View**
Unit of analysis	Firm	Constellation of firms	Constellation of firms
Primary type of resources	VRIN resources	Relational rents	Private benefits and relational rents

4.3 Value Creation

This chapter will provide an overview of the literature on value creation in a network setting. Accordingly, this chapter will discuss the implications of value creation for services in a network, making use of the DART framework for value co-creation, as proposed by Prahalad & Ramaswamy (2004).

4.3.1 Defining Value Creation

The notion of value often plays a central role in business literature (Le Pennec & Raufflet, 2018). Perhaps the most well-known definition of value creation comes from Brandenburger and Stuart (1996), who define value as the difference between customers' willingness-to-pay and the opportunity cost of suppliers. Willingness-to-pay can be defined as the maximum amount of money the customer is prepared to pay for a product or service. The opportunity costs can be viewed as the highest alternative compensation. Therefore, firms have to differentiate themselves from competing firms to create a positive added value.

Regardless of this definition, a bulk of literature on value creation does not clearly define value but focusses on general benefits (Reypens, Lievens, & Blazevic, 2016). Consequently, there seems to be no common approach to value creation in business literature (Le Pennec & Raufflet, 2018). Instead, the concept of value creation in networks has been addressed from many different theoretical perspectives. Barringer & Harrison (2000) provide a comprehensive literature review on inter-organizational value creation and identify six theoretical explanations for forming inter-organizational relationships: transaction cost

economics, resource dependence, strategic choice, stakeholder theory, organizational learning, and institutional theory. These diverse underlying assumptions about organizations and society and different level of analysis influence the view on what value creation consists of (Le Pennec, & Raufflet, 2018). Hence, different kinds of value have been identified in network settings, depending on the theoretical approach taken.

Innovation. Perhaps the most mentioned outcome of collaborative initiatives in literature is innovation. It is argued that collaboration between partners has a positive effect on innovation, mainly coming from shared resources, information, and knowledge (Cao & Zhang, 2010; Lim et al., 2018; Matinheikki et al., 2017). Additionally, Chou & Zolkiewski (2018) argue that tensions arising from collaboration can also result in incentives for firms to create additional value by becoming more innovative.

Responsiveness and flexibility. Another way for firms to create value is by leveraging the network and its resources to increase their responsiveness and flexibility. Relationship-enabled responsiveness implies that a firm's responsiveness comes not only from the firm itself but also its key partners (Kim, Cavusgil, & Cavusgil, 2013). Responsiveness and flexibility have especially been given attention in the supply chain context (Lin & Shayo, 2012; Kauffman et al., 2010).

Process efficiency. Inter-organizational relationships can also increase process efficiency (Cao & Zhang, 2010; Lin & Shayo, 2012; Dyer 1997). Previous literature has shown that if the relationship between partners is credible, transaction costs decrease (Dyer, 1997).

Improved decisions. Moreover, the availability of information may lead to faster and improved decisions (Bagheri, Kusters, & Trienekens, 2018).

Absorbing knowledge. Next, firms can create value by absorbing knowledge from partners to expand their knowledge and act effectively (Janicot, Mignon, Walliser, & 2016). Integration of knowledge can lead to learning opportunities, market development and unique capabilities, ultimately creating value for firms (Le Pennec, & Raufflet, 2018).

Business synergies. Moreover, business synergies are identified as a source of value in inter-organizational relationships. Business synergies come from the combining of complementary resources and focuses on long-term strategic outcomes (Cao & Zhang, 2010; Barringer & Harrison, 2000).

Establish legitimacy. Lastly, establishing legitimacy may become a source of value for firms. Collaboration with certain partners can improve legitimacy and give the firm a certain reputation or image (Dyer, 1997; Le Pennec, & Raufflet, 2018). This can result in greater support for the organizations engaged in the partnership.

From these six identified outcomes of inter-organizational relationships, this paper approaches value as a beneficial outcome of the collaboration, related to the operational performance of a company. Hence, operational costs are reduced, or service delivery is improved.

4.3.2 Value in Services

Corresponding to the shift to a more relational perspective of value creation, there is also a shift to a service-centered view (Chakraborty & Dobrzykowski, 2014). Traditionally the focus of economic and marketing literature has been on tangible goods with embedded value (Vargo & Lusch, 2004). However, over the past decades, intangible resources, such as skills, information, and knowledge, and interactivity, connectivity, and ongoing relationships have been given importance (Vargo & Lusch, 2004). This has resulted in a stream of research focusing on the consumer and service provision, rather than tangible goods. In service provision value can be created through information interactions between the customer and the provider (Lim et al, 2018). Therefore, in services, the primary flow is information rather than tangible goods, and operant resources such as knowledge give the firm its competitive advantage (Vargo & Lusch, 2004).

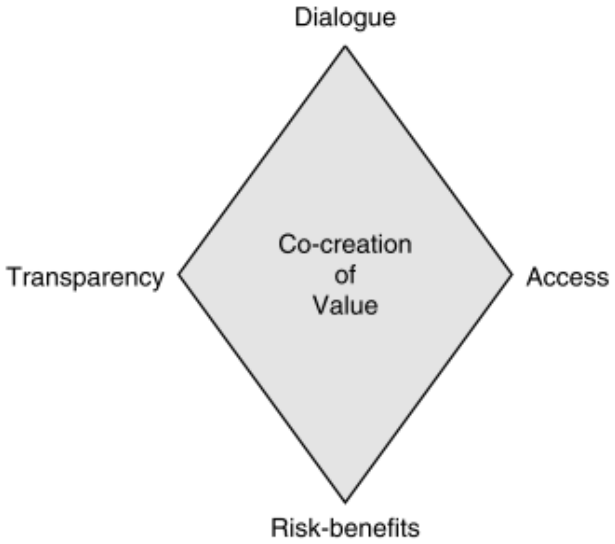
The use of information or knowledge applied in combination with the information of other members of the service chain enables firms to create an integrated solution for customers. The delivery of these integrated solutions often goes beyond the capabilities of a single actor and are therefore performed by multiple actors (Bagheri et al., 2019). Information interactions between producers and consumers are important to service innovation and contribute to value creation (Lim et al, 2018). However, value creation is only possible when a service is consumed since the interaction of the customer with the product creates the experience (Vargo & Lusch, 2004). Thus, the customer participates in the value creation process by interacting with the offered product. Accordingly, in service provision value is created through co-production with suppliers, business partners, allies, and customers.

All in all, the service design logic indicates the importance of stakeholders in an ecosystem working together when trying to create value from service provision. Moreover, the importance of information and knowledge sharing between stakeholders in value creation is highlighted. Therefore, this paper will be looking further into the information sharing between stakeholders to co-create value.

4.3.3 Value Co-Creation

Prahalad and Ramaswamy (2004) acknowledge the complexity of the process of value creation in networks. Therefore, they propose a framework to explain how value is co-created. The so-called DART framework proposes four building blocks that enable co-creation of value: Dialogue, Access, Risk-benefit, and Transparency. The framework is depicted in Figure 4. The original framework has a strong focus on value co-creation between traditional consumers and organizations. However, several scholars such as Chakraborty & Dobrzykowski (2014) applied the framework to a supply chain context. This paper will follow a similar approach and connect the building blocks of the framework with determinants of value creation in partner networks identified from the literature.

Figure 4: *Interactions for value co-creation (Prahalad and Ramaswamy, 2004)*



As pointed out in Chapter 4.3.2, data and information play a key role in co-creating value in a service-oriented environment. Yet, many determinants influence the creation of value in networks by determining the interaction between actors. In general, the determinants identified from literature can be categorized into seven categories: information availability, information quality, relation-specific investment, network structure, quality of relationships, incentive to participate, and communication efforts. It is important to notice that the mentioned determinants do not act independently of each other and should not be seen as stand-alone entities. On the contrary, they shape and overlap one another in the value creation process. An overview of the determinants and their connection to the DART framework can be found in

Table 5*: Determinants of DART (own representation)*

DART dimension	Definition	Determinants
Dialogue	Communication practices necessary to create a collaborative environment	Communication efforts *Strong interaction with quality of relationships and relation-specific investments*
Access	Availability of information and knowledge	Information availability Information quality Relation-specific investments
Risk-benefit	Extent to which network actors are able to assess the consequences of the collaboration	Incentive to participate Network structure
Transparency	An environment characterized by low level of information asymmetry	Quality of relationships (Trust, mutual understanding) *Strong interaction with nnetwork structure*

Dialogue.

Dialogue refers to the communication practices necessary to create a collaborative environment with stakeholders (Chakraborty & Dobrzykowski, 2014). However, dialogue goes beyond listening to stakeholders and focusses on empathic understanding of what they experience (Prahalad & Ramaswamy, 2004). Moreover, dialogue is concerned with communication and learning between two equals to solve a problem. Therefore, this dimension is highly influenced by the communication efforts taken by the stakeholders in the network. The communication efforts are supported by the quality of the relationship among stakeholders and investments in the relationship.

Communication efforts. Communication practices are necessary for creating a collaborative environment and to understand the needs and expectations of the actors in the network (Chakraborty & Dobrzykowski, 2014). According to Mathinheikki, Artto, Peltokorpi & Rajala (2016), frequent meetings can strengthen ties, and engaging stakeholders in decision making can promote trust between stakeholders. Moreover, sharing and discussing thoughts, ideas, needs, and expectations creates understanding and provides input for finding a balance (Reypens et al, 2016). Hence, collaborative communication is a way to increase engagement, create strong relationships and mutual understanding between partners in a network. Furthermore, communication is an important facilitator for organizational learning, since it supports inter-organizational knowledge transfer (Janicot et al., 2016). It is important to communicate between stakeholders to overpass contextual knowledge. Moreover, communication promotes mutual learning and understanding of why certain actions have been taken (Chakraborty & Dobrzykowski, 2014).

Besides interpersonal communication, it is also important that different systems can communicate with each other. In data sharing, a large amount of communication between stakeholders is supported by technology, which makes compatibility of the different systems important (Kim et al., 2013). The alignment of technology between partners increases inter-organizational interactions and reduces communication barriers, making the organization more responsive (Kim et al., 2013).

Access.

The access dimension was originally built around the notion that you do not have to own something to access an experience (Prahalad & Ramaswamy, 2004). Therefore, it refers to the availability of information and knowledge in the network. The access dimension is supported by the quality of the information and relation-specific investments that impose integration of the tools and formats used to collaborate and share information.

Information availability. It is widely recognized that the availability of data has several benefits for the firm. Advances in data collection techniques contribute to the availability of data and form the foundation for today's data-rich economy (Lim et al., 2018). With sensor technologies, data can be collected at every stage of the customer journey and supply chain. Moreover, inter-organizational information-processing capabilities result in large databases with data from multiple sources, possibly providing organizations with useful information. The availability and reach of information in the network and the inclusions of the previously hidden or unavailable information can improve organizational decision making (Chakraborty & Dobrzykowski, 2014). The combination of this data may create knowledge, which allows organizations to act effectively (Janicot et al., 2016). For example, analysis of the large amount of customer data leads to better understanding of customer decisions and behavior (Lim et al., 2018). Thus, when companies share information with each other, they are able to allocate their internal resources when and where needed (Lin & Shayo, 2012). Therefore, sharing strategic and tactical data likely improves the coordination of operations and efficiency (Hammervoll, 2009; Cao & Zhang, 2011; Wang & Wei, 2007).

However, there is also a downside to information availability. The sharing of data between parties can result in data overload, causing inefficiencies (Bagheri et al., 2019). Furthermore, partners in the network might be worried about data security and the abuse of sensitive data (Bagheri et al., 2019).

Information quality. Besides the availability of data, it is important that this data is accurate and relevant (Chakraborty & Dobrzykowski, 2014). In line with this Lim et al. (2018) point out the importance of the data collection process in information creation. Understanding the data and having sufficient information on the data source is needed to create useful information. Therefore, the format of the data becomes important as well. Adoption of standards for messaging (Kauffman et al., 2010) and integration of

systems using common notation principles (Bagheri et al., 2019) are important to secure the transfer of information. Moreover, common definitions of data are important for knowledge transfer between partners. Missing or inaccurate data can cause mistakes in reports and lead to wrong decisions being made. Hence, incomplete data and poor-quality data is a challenge faced by organizations that gets in the way of value creation (Bagheri et al., 2019).

Relation-specific investment. Relation-specific investments are defined as investments related to support transactions between partners (Zhao, Yu, Xu & BI, 2014). Certain relation-specific investments support the integration of stakeholders by adopting compatible systems (Zhao et al., 2014). When firms make use of compatible systems and common processing standards it strengthens the relationship between firms. Relation-specific investments demonstrate commitment and trust between partners (Hammervoll, 2009; Dyer, 1997). When firms invest in the relationship, they indicate that they have positive expectations for the future of the partnership. Moreover, making adaptations creates technical debt and reduces future flexibility (Zhao et al., 2014). The increased commitment to the partnership and the increased cost of leaving the partnership results in coordination effectiveness, reducing transaction costs (Dyer, 1997). Furthermore, relation-specific investment promotes information sharing and coordination effectiveness by increasing technical integration and mutual trust between stakeholders (Zhao et al., 2014). This leads to an increased availability of information. Lastly, relation-specific investments increase the contribution of stakeholders, giving them greater bargaining power. Therefore, relation-specific investments influence the structure of the network (Zhao et al., 2014).

Risk-benefit.

The risk-benefit dimension refers to the extent to which network actors are able to assess the consequences of the collaboration (Chakraborty & Dobrzykowski, 2014). The outcome of the collaboration should be beneficial to all stakeholders to secure incentive to participate. Therefore, the decision to participate is highly dependent on the structure of the network and the division of power.

Network structure. Especially with a large number of stakeholders, the network faces structural challenges, jeopardizing the goal of the partnership and limiting the chance of success (Bagheri et al., 2019). Challenges can arise from power distance, size differences, and feeling of superiority. These challenges occur at the stage of forming the network but are also present throughout the collaboration.

An actor's position in the network is linked with the possibility to exert power over others (Matinheikki et al., 2016). Moreover, the centrality of an actor in the network can influence the interactions in the network. First, the selection of members is influenced by the power distribution in the network. Power imbalance can deter firms from wanting to participate in a collaboration out of fear of becoming too

dependent on the focal firm (Barringer & Harrison, 2000). Furthermore, when an organization has a central position, they have certain bargaining power and can influence concept development. Therefore, strong actors in the network can coordinate the formation of the network goals, possibly leading to unbalanced outcomes of the partnership (Lavie, 2006). Therefore, the bargaining power of firms and the position in the network are important for the distribution of benefits (Lavie, 2006). Additionally, mutual benefits and aligned incentives promote harmonious relationships and improve the stability of the network (Chou & Zolkiewski, 2018).

Besides the centrality, the density of the network is an important facilitator of the relationship between stakeholders. A dense network is characterized by tight relations and fosters fast information flows and trust between stakeholders (Matinheikki et al., 2016). Therefore, more information and knowledge are being transferred in dense networks, leading to greater potential for value-creation.

Incentives to participate. To create value from the collaboration, stakeholders must coordinate their efforts and create effective interaction across different stages in the collaboration (Zhao et al., 2014). Moreover, successful collaboration requires each participant to share gains and losses equally. Firms might pursue their self-interest and maximize short-term private benefits. However, in the long run, this kind of opportunistic behavior can threaten the effectiveness of the network (Matinheikki et al., 2017). Therefore, in the long run, opportunistic behavior results in less relational rents (Lavie, 2006).

Likewise, the outcome of the collaboration should be beneficial to all stakeholders (Cao & Zhang, 2011). One way to ensure this is by co-creating performance measures (Bobbink et al, 2016). This allows a certain level of control and supports the sharing of improvements with other actors (Bagheri et al., 2019). Creating a transparent environment where the outcomes of the collaboration are shared in an appropriate manner is necessary to maintain a sustainable relationship among stakeholders (Reypens et al., 2016). Moreover, sufficient capturing of value for each stakeholder is critical to incentivize ongoing commitment and investment in the relationship between stakeholders. Reypens et al. (2016) argue that the capture of value can be managed by anticipating the value to be created, assessing the common outcome, and transferring the created value into each organization. They highlight the importance of continuously evaluating the possible results and their value for the organization in creating a sustainable collaborative environment. Hence, conflicting interests or lack of intrinsic motivation can result in a lack of incentive to participate, which possibly leads to a lack of information flows between partners (Bagheri et al., 2019). This could cause a lack of awareness of what the other actors are doing and lead to missed opportunities for value creation (Bagheri et al., 2019).

Transparency.

There is a lack of a common understanding of the transparency dimension (Chakraborty & Dobrzykowski, 2014). Following Chakraborty & Dobrzykowski (2014), this paper defines transparency as the reduction of information asymmetry between firms (Prahalad & Ramaswamy, 2004). Therefore, this dimension depends on the quality of relationships, structure of the network, and their effect on information availability. Having tight relationships will positively influence the level of trust between stakeholders, leading to a more honest and transparent attitude (Chakraborty & Dobrzykowski, 2014).

Quality of relationships and information asymmetry. High-quality relationships are characterized by a high level of trust, mutual understanding, and commitment (Chadee, Sharma, & Roxas, 2017). Lack of trust in relationships will prevent the sharing of resources and capabilities and get in the way of information sharing between stakeholders (Bagheri et al., 2019; Schneider & Sachs, 2017). Therefore, a lack of trust within the network will slow down progress and make effective collaboration difficult. Likewise, commitment is needed to provide stakeholders with the confidence in a sustained relationship (Wang & Wei, 2007). Furthermore, the fit between missions, values, and/or strategies of stakeholders is important for realizing value. Differences between disciplines and the perception of partners hinder mutual understanding and have a negative effect on the relationship (Bagheri et al., 2019). A misalignment in a shared mission, values or strategy causes communication and knowledge sharing barriers, leading to decisions that are not in line with the interest of other actors, damaging the relationship between partners (Murphey & Arenas, 2015).

Overall, high-quality relationships protect partners from the exploitation of transaction-specific assets and prevent opportunistic behavior between partners (Wang & Wei, 2007). Moreover, high-quality relationships increase transparency and support the sharing of resources and capabilities, allowing greater potential for value creation within the network (Chadee et al., 2017).

4.4 Ambidexterity

Lastly, this chapter will elaborate on ambidexterity, with a focus on ambidexterity in inter-organizational relations enabled by information technology. First, a thorough description of the fundamental concepts of ambidexterity will be given. Subsequently, IT ambidexterity will be explored, followed by operational ambidexterity.

4.4.1 Exploitation and Exploration

March (1991) first discussed the terms exploration and exploitation in organizational learning. March refers to exploration with terms like; “search, variation, risk-taking, experimentation, play, flexibility, discovery, innovation” (March, 1991, p. 71) while exploitation is defined with terms such as; “refinement, choice,

production, efficiency, selection, implementation, execution" (March, 1991, p. 71). While these terms provide a guideline to distinguish between exploitation and exploration, they do not provide an explicit definition. Hence, Gupta, Smith, and Shalley (2006) illustrate the importance of clearly defining both terms. However, they acknowledge that the terms are ambiguous, and one can view exploration and exploitation either by the type of learning or the presence versus the absence of learning.

On one hand, the presence or the absence of learning perspective treats exploration as any activity involving learning and innovation whereas exploitation is simply using past knowledge (Gupta et al., 2006). In that sense, exploration is "search for the new knowledge" and exploitation is "ongoing use of a firm's knowledge base" (Vermeulen & Barkema, 2001, p. 459). On the other hand, the type of learning perspective recognizes that both exploration and exploitation are linked to different types of learning and innovation. Benner and Tushman (2002, p. 679) define exploitative innovations as improvements in existing compositions, while exploratory innovations are bringing about a shift to new technologies. Gupta et al. (2006, p. 694) ultimately argue that one should distinguish exploration and exploitation based on the type or amount of learning. This is consistent with the literature on ambidexterity in the field of information systems (Napier, Mathiassen, & Robey, 2017; Chen et al., 2020). Therefore, this paper will adopt a similar understanding of exploration and exploitation.

4.4.2 Ambidexterity in Networks

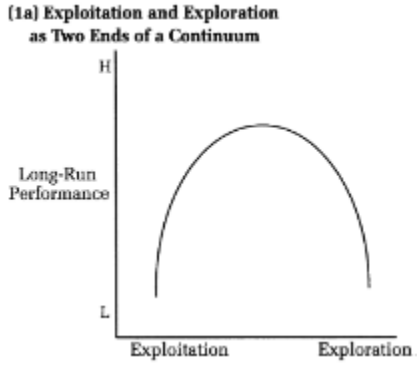
To achieve sufficient levels of exploration and exploitation, two major approaches are distinguished: ambidexterity and punctuated equilibrium. The punctuated equilibrium, also called sequential ambidexterity in IS (Information Systems) literature (Raisch, Birkinshaw, Probst & Tushman, 2009), is an approach of cycling between periods of exploitation and exploration (Gupta et al., 2006). Contrary, ambidexterity is defined as a process of simultaneously engaging in both, with loosely connected subsystems of organization with distinctive focus either on exploration or exploitation (Benner & Tushman, 2003). Organizations generate competitive advantage through exploratory and exploitative innovation (Benner & Tushman, 2003; Tushman & O'Reilly, 1996). Further, ambidextrous organizations achieve superior financial performance (Gibson & Birkinshaw, 2004). There are two views of ambidexterity based on the relationship between the exploration and exploitation: continuum and orthogonal view.

Continuum view.

Some argue that both exploitation and exploration compete for scarce resources and hence companies make a trade-off between the two, making them incompatible with each other. Further, exploration may suffer from lack of resources since the return on exploration is often to some extent uncertain and does not provide immediate feedback (March, 1991). In contrast, exploitation provides an immediate return, catching organizations in a *"success trap"* (March, 1996). Hence, both ends of the continuum play a zero-sum game

(Gupta et al., 2006). Gupta et al. (2006) conclude that exploration and exploitation are two ends of the continuum when resources are scarce and the unit of analysis are individuals, subsystems within an organization. Therefore, punctuated equilibrium may be an inevitable choice for individuals and subsystems with scarce resources as illustrated in Figure 5.

Figure 5: *Exploitation and Exploration as Continuum (Gupta et al., 2006, p. 697)*



Orthogonal view.

However, it is important to notice that not all resources are scarce. Information is the prime example of such an infinite resource. Furthermore, organizations may access resources from both inside, but also outside of the organization. Resources can be broadened by accessing them from the outside of the organization (Gupta et al., 2006). It is observed that organizations work in a broader social system and therefore organizations are interdependent (Gupta et al., 2006). Hence, the concept of ambidexterity applies not only to an organization but also to the broader social system. Looking at organizations through this lens, it is implied that resources of organizations may span out of the organization's boundaries in order to achieve an ambidextrous approach (Gupta et al., 2006).

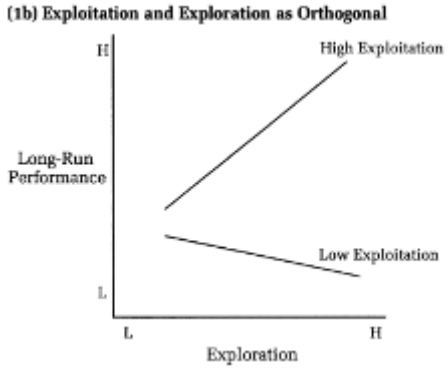
Organizations can form countless partnerships and form alliances, thereby increasing resources and the possibility of using them for exploration or exploitation (Koza & Lewin, 2000). In line with this, Stuart (1998) claims that alliances create the potential for innovation since they provide access to additional resources. Therefore, the internal resources of a firm can be supplemented by external resources from alliances (Wassmer, Li, & Madhok, 2017). Hence, exploration beyond organizational boundaries can be more impactful than sole internal exploration (Rosenkopf and Nerkar, 2001). Moreover, Eisenhardt and Martin (2000) add that firms can become obsolete when sourcing knowledge only internally. Thus, there is a broad consensus that organizations can access external resources to derive value from them.

These partnerships are influenced by the strength of the relationship. Tiwana (2008) claims that strong ties enable knowledge integration and steady information flow while weak ties are needed to explore

new ideas by acquiring novel knowledge. Additionally, Xu and Cavusgil (2019) distinguish between horizontal and vertical alliances. Horizontal alliances consist of direct competitors whereas vertical alliances comprise of contributors to a value chain. Horizontal alliances contribute to firms' knowledge depth, thus contributing to exploitation. In contrast, vertical alliances contribute to knowledge breadth, contributing to exploration. They suggest that firms competing in various markets pursue vertical alliances whereas firms with industry constraints and limited resources should pursue horizontal alliances.

Hence, in organizations with subsystems and several individuals, exploitation and exploration are not two ends of continuum but orthogonal, where resources can be close to infinite. According to the orthogonal view, it becomes vital to achieve high levels of both exploitation and exploration to achieve a high long-term performance. Therefore, in organizations with abundance of resources an ambidextrous approach is an appropriate way to insure high long-term performance (Gupta et al., 2006). This thesis focuses on information and a larger organization within a network and therefore takes the orthogonal view. In line with this view, this paper looks at ambidexterity as a process of simultaneously engaging in exploitation and exploration, as shown in Figure 6.

Figure 6: *Exploitation and Exploration as Orthogonal (Gupta et al., 2006, p. 697)*



4.4.3 IT Ambidexterity

Ambidexterity has become increasingly popular within IS research (Werder & Heckmann, 2019). However, due to the interdisciplinary nature of IS, ambidexterity can be viewed from diverse lenses. Werder & Heckmann (2019) provide a comprehensive overview of literature on ambidexterity within IS research and distinguish between several research streams. From an ambidextrous IT capability point of view, the majority of literature within IS research is focused on combining efficiency and flexibility. Hence, ambidexterity is viewed as balancing process alignment and process adaptability (Napier et al., 2011). Yet, from an IT-enabled organizational ambidexterity perspective, IT ambidexterity can be defined as the ability of an organization to simultaneously manage current and emerging technologies (Lee et al., 2015). Accordingly, IT ambidexterity balances the need to align significant short-term digital technology

investments with long-term strategic business planning and digital capability development (Piccinini, Hanelt, Gregory & Kolbe, 2015). Together these two streams form the majority of research output on ambidexterity within IS research (Werder & Heckmann, 2019).

IT Exploration.

Accordingly, explorative IT capabilities are referred to as the deployment of new IT resources to support business processes and strategies (Wei, Ke, Liu, & Wei, 2019). Innovative IT architectures extend the reach and richness of the knowledge base of a firm (Chen et al, 2020). Thus, novel IT capabilities and practices possibly generate novel information access and processing capabilities, allowing for greater benefits from information sharing (Wei et al., 2019). Hence, IT exploration identifies opportunities and supports a new understanding of existing transactions (Chen et al, 2020). Furthermore, IT exploration is associated with increased flexibility, allowing change and adaptation (Chang, Wong, Eze & Lee, 2019). The modularity of IT supports this, by reducing the development time of new innovations and allowing the reuse of existing IT assets (Chang et al, 2019). Hence, a flexible IT infrastructure allows alteration to existing IT components in response to requirements (Chang et al, 2019). Therefore, exploration reinforces long-term strategic business planning and digital capability development (Piccinini et al., 2015).

IT Exploitation.

On the other hand, exploitative IT capabilities concern refinement and extending of existing IT resources (Wei et al., 2019). Hence, IT exploitation allows a firm to refine and reconfigure existing knowledge and use these existing resources to create new insights (Chen et al, 2020). Exploitative IT capabilities enable an organization to process information from partners, as existing IT applications can relate newly acquired information with existing information (Wei et al., 2019). Additionally, IT exploitation is associated with control and integration (Chang et al., 2019). An integrated IT infrastructure enables a firm to share information, coordinate activities, and align processes (Chang et al., 2019). Moreover, standards and guiding principles can increase the understanding of existing internal resources (Chang et al., 2019). Therefore, the same level of information sharing can result in more value, as a result of effective exploitative IT capabilities (Wei et al., 2019). Furthermore, integration mechanisms allow the automation of activities and processes (Heckmann et al., 2016). Hence, the exploitation of IT resources results in process alignment.

Balance between exploitation and exploration.

IT exploration increases a firm's capacity to collect, recombine, and apply new IT resources (Wei et al., 2019). This provides an extensive foundation for exploitative IT capability development (Tai, Wang & Yeh, 2019). On the other hand, IT exploitation deepens the IT resource bases of organizations and supports the capability to absorb and apply new IT resources (Wei et al., 2019). Hence, exploitation and exploration are

interdependent and complement each other. However, too much emphasis on exploitation can damage exploration, resulting in the obsolescence of IT resources (Chen et al., 2020). Yet, when exploration exceeds exploration there is little refinement of the core infrastructure, and an organization might have difficulties in capturing the value provided by exploration (Chen et al., 2020). Therefore, reaching IT ambidexterity is vital to effective deployment of potential and current IT practices and the integration and adjustments of IT, to support business processes. (Lee, Sambamurthy, Lim, & Wei, 2015). Accordingly, IT ambidexterity improves operational ambidexterity by facilitating operational processes (Lee et al., 2015).

4.4.4 Operational Ambidexterity

From an operational perspective, ambidexterity refers to the organization's initiatives in alignment of its current operations while also adapting effectively to changing environmental demands (Lee et al., 2015). Inter-organizational networks can support this by increasing revenue and reducing costs, as a result of shared resources (Wassmer et al., 2017; Koza & Lewin, 2000). Likewise, Nazir & Pinsonneault (2012) argue that electronic integration facilitates efficient and effective communication and sharing of specialized knowledge and facilitates the coordination of process activities.

Operational exploration.

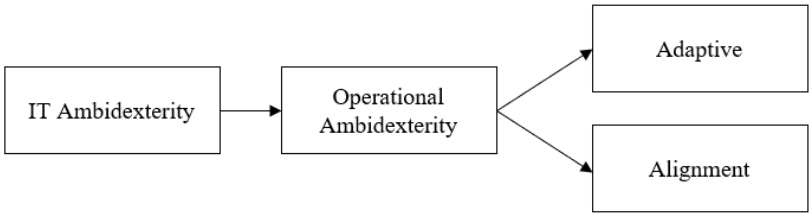
Operational exploration refers to inventing new operational techniques or operational processes (Lee et al., 2015). A firm can change or invent new business operations (Gibson & Birkinshaw, 2004). In some cases, improving operations can lead to the development of a new service. Thus, operational exploration increases the adaptiveness of the organization by granting the ability to keep up with industry practices and adapt business models correspondingly (March, 2006). External integration can contribute to operational exploration, since having information from different sources allows firms to learn about the market environment, customers, and competition (Nazir & Pinsonneault, 2012). These new insights allow firms to re-think current practices and gives space to unconventional approaches (Nazir & Pinsonneault, 2012).

Operational exploitation.

On the other hand, operational exploitation refers to the improvement of current operations by increasing efficiency (Lee et al., 2015). Increasing efficiency is concerned with the reduction of the cycle time of current operations and reducing costs and errors, without changing the way tasks are being performed (Lee et al., 2015). Therefore, operational exploitation is concerned with the proactiveness and responsiveness of an organization. Responsiveness is the capability to timely react to emerging opportunities in the environment, often as result of a change in customer demand (Benner & Tushman, 2002). Additionally, proactiveness can be seen as the ability to seize opportunities, by anticipating and responding in a proactive manner (Lee et al., 2015). Operational exploitation can be supported by the integration of external

information, since it provides organizations with the ability to capture insights from partners that are now connected, creating transparency in the environment (Nazir & Pinsonneault, 2012).

Figure 7: *IT and Operational Ambidexterity (own representation)*



Balance between exploitation and exploration.

Together, IT ambidexterity and operational ambidexterity have a significant influence on an organization's current operations and long-term performance. An imbalanced approach can significantly reduce the flexible response to market changes, by being trapped in a particular way of performing activities (Lee et al., 2015). Yet, as mentioned previously, a focus on exploration can result in difficulties to capture the value provided by exploration (Chen et al., 2020). This shows the importance of balancing operational exploration and exploitation. Operational ambidexterity results in an organization aligning processes, enabling proactive and responsive capabilities, as well as being adaptive. A schematic overview of this relation is presented in Figure 7.

5. Methodology

This chapter will discuss the underlying philosophical assumptions influencing the data collection and analysis. Moreover, it includes an elaboration on the research design, including the purpose, approach, and methodological choices made. Furthermore, a clarification on the choice and implications of the case study strategy is given. This is followed by a detailed overview of the data collection methods and process, including primary data, secondary data, and the literature review. Lastly, the data analysis process is discussed.

5.1 Research Philosophy

Underlying philosophical assumptions influence and shape the research design. Research philosophy refers to the beliefs and assumptions about the development of knowledge and is split up into three components. First, ontological assumptions touch upon the physical and social reality (Orlikowski & Baroudi, 1991). On one hand, the empirical world can be seen as objective and independent of humans, resulting in one reality. On the other hand, the world can be seen as socially constructed by human actions. Second, epistemological assumptions are concerned with what constitutes valid knowledge and how knowledge is communicated (Saunders, Lewis & Thornhill, 2016, p. 127). Third, axiological assumptions refer to the role of values and ethics of both the researcher and participants in the study (Saunders et al., 2016, p. 128). The data collection methods and data analysis procedures used in this study will be influenced by the underlying assumptions about reality and knowledge creation. Hence, this chapter will elaborate on the philosophical stand taken and its implications.

5.1.1 Interpretivism

In recent years interpretivism has become a well-established philosophy in the information systems research field (Wynn & Williams, 2012). Correspondingly, the present study follows the interpretivism philosophy. Interpretivism emphasizes the fact that humans create meanings (Saunders et al., 2016, p. 130). The social world is not given but constructed by humans through their actions (Orlikowski & Baroudi, 1991). Hence, reality and knowledge are social products, and cannot be understood independently of the social actors. Moreover, different actors from different backgrounds make different meanings, under different circumstances and at different times (Saunders et al., 2016, p. 130). Accordingly, there are multiple social realities, rather than one universal law. The purpose of interpretivist research is to look at different perspectives to create an understanding of these different social worlds and contexts.

Interpretivism as means to explore.

There are broadly speaking three arguments made in research to advocate for an interpretivist approach. First, it is often argued that the exploratory nature of a study is a justification for interpretivism. This would imply interpretivism is used to search for hypotheses that could subsequently be tested by a positivist approach. However, according to Walsham (1995) this is a weak claim on its own, as it regards interpretivism as inferior and does not do justice to the philosophy. Thus, this claim has to be supplemented with additional arguments.

Interpretivism as complementary.

Next, an often-mentioned argument is that interpretive approaches can be justified as complementary to positivism. This claim sees interpretivism as equal, rather than inferior. In line with this, Orlikowski & Baroudi (1991) argue that IS research lacks diversity in research assumptions and a plurality of perspectives. For a long time, IS research has been predominantly characterized by the underlying philosophy of positivism. Positivism assumes an observable social reality and is focused on unbiased facts that produce law-like generalizations (Saunders et al., 2016, p. 136). While there is nothing wrong with the use of the philosophy of positivism, the exclusive use of these assumptions resulted in limited research insights by neglecting other worldviews (Orlikowski & Baroudi, 1991). The interest in qualitative research in the domain of information systems has increased over the years (Goldkuhl, 2012). Qualitative research is often directly associated with interpretivism. However, it is important to notice that qualitative research does not necessarily imply interpretivism, and other philosophies can be applied as well. Hence, more diverse philosophical lenses have been adopted to analyze the complexities of information systems.

Interpretivism as alternative.

It has been suggested that particular research issues are more appropriate to approach from an interpretive perspective (Walsham, 1995). This argument claims interpretivism should be seen as an alternative to positivism and goes beyond interpretivism as complementary to positivism. Certain research issues demand an understanding of the social processes involved in the design, development, and use of information systems in an organizational context (Walsham, 1995). In IS research, interpretivism can shed light on the context of information systems and the process whereby the information system influences and is influenced by its context (Goldkuhl, 2012). Therefore, rather than a technological deterministic view, interpretivism encourages the social construction of technology, which implies that society determines technological change and human action shapes technology (Bijker, 1995, p. 20-100). Actors in social groups decide what parts of a technology are useful and together construct the technology.

Interpretivism in this research.

Accordingly, this paper supports the vision of interpretivism as an alternative and argues taking an interpretivist approach will provide the necessary assumptions to understand the potential of blockchain at the airport. Innovation in the service area is heavily reliant on the collaboration between actors (Møller & Sørensen, 2017). Therefore, actors in the network are dependent on each other and there is a high level of social interaction. Thus, the airport operates in a network, which is characterized by complex dynamics and heterogeneous actors. However, the actors in the network perceive different challenges and have different views of the interaction between stakeholders and their own role in this process. This claim is supported by interviewees, who point out that they are not aware of other stakeholders' challenges. Additionally, interviewees state that they do not always feel understood by other stakeholders. Hence, there is no objective reality, but rather multiple realities, in the airport ecosystem.

Furthermore, throughout this paper, IT is seen as an enabler of relationships and networks. In line with the social construction of technology, this study assumes that the actors from different social groups in the network actively shape the outcome of information systems that foster information sharing. Therefore, it becomes important to create an understanding of the highly complex dynamics of the network that shape the collaboration and outcome. Knowledge will thus be generated by focusing on perceptions and interpretations of different actors, to understand the implications of information sharing on operational performance. Consequently, this paper aims to see the world through the eyes of the actors doing the acting and understand their point of view in the context of the unique environment.

5.2 Research Design

This subchapter will elaborate on the plan of how the research question is answered. The objectives of the study are explained, together with the methodological choice and theory development.

5.2.1 Research Purpose

The main aim of this paper is to explore the possibilities for blockchain at airports, with a focus on the operational side of the passenger journey. This means that this research looks into current operations and cooperation between stakeholders at the airport. Primary data was collected to provide insights into the aviation ecosystem. The aim was to better understand and clarify current challenges, if any, in the interaction between stakeholders that influence the passenger flow. Hence, this paper is concerned with gaining more insight into the airport ecosystem and is focused on what is happening in the environment. Next, this research looks into how blockchain can potentially mitigate these challenges and where it could create value. To achieve this, interviews were conducted with employees from different stakeholder groups, about their experience towards the cooperation in the network and their experience with sharing of information to smoothen operations.

5.2.2 Research Approach

There are three approaches to theory development: deduction, induction, and abduction. A deductive approach uses data to evaluate propositions or hypotheses (Saunders et al., 2016, p. 145). Contrarily, an inductive approach uses data to identify themes or patterns and create a framework from this (Saunders et al., 2016, p. 145). However, the two can also be combined in an abductive approach. Here, subsequent data collection is used to test identified themes or patterns (Saunders et al., 2016, p. 145). In this study, the insights derived from the data will be used to develop a suggestion. The gathered data will be analyzed and used to develop a richer perspective on the possibilities of blockchain at the airport. Hence, a predominantly inductive approach is taken to theory development. The deductive approach was disregarded since testing theoretical propositions would not fulfill the nature of an exploratory study. However, to guide the data collection and analysis this research utilized a preliminary research question and theoretical background, based on insights of initial data collection.

5.2.3 Methodological Choice

The IS research field commonly uses both quantitative and quantitative research methods. Quantitative methods stem from natural sciences and are focused on numeric data, whereas qualitative research methods find their foundation in social sciences and are generally concerned with non-numeric data (Myers & Avison, 2002). As laid out in the previous section, this paper uses an interpretive research philosophy, which is often associated with qualitative research (Denzin & Lincoln, 2011), since researchers need to interpret socially constructed and subjective meanings gathered in data collection of vastly non-numerical data about the phenomenon being studied (Saunders et al., 2016, p. 168). Further, qualitative research explains relationships between participants and their meanings to which a variety of data collection techniques help. For data collection techniques this implies that data collection is usually non-standardized as opposed to quantitative studies (Saunders et al., 2016, p. 168). Therefore, a qualitative approach helps to understand the challenges in passenger processing from different angles. Moreover, the airport setting is highly complicated oftentimes causing a “black box” effect to non-familiar outsiders, especially consumers as well as researchers. Therefore, a quantitative approach would not sufficiently describe the complicated nature of the airport ecosystem, and a qualitative research methodology is considered more appropriate.

5.3 Research Strategy

Overall, the research strategy is defined as “a plan of how a researcher will go about answering her or his research question” (Saunders et al., 2016, p. 177). Qualitative research gives researchers a wide range of strategy options, such as action research, narrative research, case study research, ethnography, and Grounded Theory, which are all commonly deployed in qualitative research (Saunders et al., 2016, p. 178).

5.3.1 Case Study

To explore the possibilities of blockchain at the airport, this research requires an in-depth understanding of the processes and context. To get this understanding, access to CPH, and other stakeholders operating in the airport ecosystem was obtained. Accordingly, a case study strategy was selected to guide the research. Yin (2014, pp. 45–46) uses a two-fold definition to define a case study method, highlighting the in-depth nature and use of multiple sources of evidence to study a phenomenon in its real-world context.

In-depth contextual understanding.

Accordingly, case studies enable a rich understanding of a contemporary phenomenon (Yin, 2014), which is valuable for this research. In line with this, case studies are praised for enabling examination of a single case or multiple cases in-depth, whereas research strategies with large random samples provide breadth (Flyvbjerg, 2006). Moreover, a case study strategy is fit for research in areas where only several previous studies have been conducted (Benbasat, Goldstein, & Mead, 1987). Blockchain is still an emerging technology, and the research on the implications are limited, so a case study can be beneficial. Further, Flyvbjerg (2006) argues that context-dependent knowledge from case studies is vital to study human affairs. Hence, a case study will help to better understand the social and relational aspects of information sharing in the aviation industry.

Multiple sources of evidence.

Subsequently, this study investigates the phenomenon of information sharing at the CPH Airport. Moreover, the complex nature of relationships in the network offers many variables of interest rather than data points. Hence, multiple sources of evidence are secured through the deployment of multiple data collection sessions and techniques. Lastly, the study benefits from theoretical propositions derived from prior research, such as the extended resource-based view, operational ambidexterity, value creation, and blockchain technology literature.

The case study research strategy does not imply solely interpretivism, but it lets researchers choose between research philosophies (Saunders et al., 2016, p. 185). For interpretivists, the advantage of the case study strategy is that it can generate rich descriptions and subsequently develop a theory (Yin, 2014). It aids to enhance understanding of what is happening and why, possibly explaining its effects and implications which complements the purpose of this thesis. To achieve that, a case study is a fit for qualitative, quantitative, and mixed-method research. Yin (2014) argues that various data collection methods utilized in case studies, such as observations, semi-structured and in-depth interviews, artifacts, archival records, and documents. Moreover, it is common to combine multiple data collection methods when conducting a case study (Benbasat et al., 1987). Due to the need to provide a rich description of phenomena, this thesis relies

on observations, semi-structured and in-depth interviews. Furthermore, secondary data, such as annual and industry reports, are used. Accordingly, various data collection methods are deployed to create a rich understanding of the phenomena. Hence, this research is conducted using a multi-method qualitative methodology.

5.3.2 Case Development

Yin (2014) adds that a case study strategy is not only apt for studies requiring in-depth extensive descriptions of phenomena, but also for questions seeking to explain present circumstances of phenomena over which the researcher has little to no control. Therefore, a case study method is frequently used within research asking "how, why" and "what" questions. The form and nature of the research question are relevant to the research design. This research is guided by the question:

"How can blockchain address information sharing challenges in the Copenhagen airport network to improve performance of Copenhagen Airports?"

Therefore, this research follows an exploratory approach. As mentioned before, case studies are extremely suited to create deep understanding and clarification. Hence, an exploratory approach is compatible with a case study design. However, it should be noted that an exploratory nature is not the only possible nature of case study research. Researchers may also choose to pursue descriptive or explanatory studies (Yin, 2014).

To explore the possibilities of blockchain, a case at Copenhagen Airport was selected. The selection of this case is mainly based on information availability. The researchers established access to the environment through personal connections, which increases the amount of information available. Moreover, the geographical location played a role. The researchers are based in Copenhagen, making CPH easily accessible. Hence, the case is selected to ensure rich information from diverse stakeholder groups, creating more valuable insights and a deeper understanding of the phenomenon being studied.

5.3.3 Case Propositions

Following Yin (2014), propositions generally lead the attention to something that should be examined in a case study. Propositions guide the research in a certain direction and provide a guide as to where to look for evidence. However, since this study follows an exploratory approach, no propositions have been made. Nevertheless, there is a need for a general purpose of the case study. The purpose of this case study is to identify issues in passenger processing that can be resolved with increased information sharing among stakeholders. This purpose will lead the current case study towards data collection to identify issues in present operational processes related to the customer journey.

5.3.4 Unit of Analysis

Moreover, Yin (2014) claims that a case concerns a person, group, an organization, an association but also an event or process. Therefore, it is vital to define the focal case examined by the study. In the context of this thesis, CPH Airport is examined within the context of the broader airport network. In addition to data collection at the airport with airport representatives, other stakeholders within the network are interviewed. These include ground handling, airlines, and a blockchain in aviation expert.

Single case study.

As outlined above, the case study strategy can vary depending on the purpose of the study. Two groups can be distinguished between case studies, based on two dimensions (Yin, 2014). The first dimension concerns a single or multiple case study design. On the one hand, multiple cases create more robust evidence and are reliable. On the other hand, they are resource-intensive, i.e. time-consuming and oftentimes expensive. However, Yin (2014) claims that single case studies are appropriate when the case is critical, unusual, common, revelatory, or longitudinal. The case in this study is a common case study, as it allows a thorough investigation of an everyday situation (Yin, 2014). Benbasat et al. (1987) affirm that for an exploratory case study, a single case is sufficient to serve as a pilot study in order to familiarize oneself with the phenomenon.

Indeed, a multiple case study approach would enhance the transferability of this study. However, access to more airports was not negotiated. Moreover, the researchers are familiar with the selected airport and were able to observe both from the passenger and visitor perspectives. Lastly, the thesis was conducted in the course of five months, which was not a sufficient time allowance for a multiple case study. Hence, the study benefits from a closer focus on a single case, which enables researchers to create a richer in-depth understanding by the ability to talk to multiple stakeholders in the airport ecosystem.

Embedded case study.

The second dimension concerns the differentiation between holistic and embedded case studies. A holistic case study refers to a single unit of analysis within the selected case. In contrast, an embedded case study examines multiple units of analyses within one case, such as various departments within one company. Accordingly, the design of this case study is classified as a single-case embedded. As mentioned above, solely one case was selected to examine the potential of blockchain technology in the airport context. In order to examine that, it is necessary to have multiple units of analysis to gather information from various stakeholders, in this case, the airport, airline, and handling companies.

5.4 Literature Review

Saunders et al. (2016, p. 70) mention three ways to use literature for a research project. First, a preliminary search in literature helps to generate, refine topic, and ideas. Second, a critical literature review introduces

the context and relevant theoretical frameworks for a given research topic. Lastly, authors can use literature to place research findings in a wider body of knowledge.

This research project uses literature accordingly. First, topics such as blockchain in aviation and information systems in aviation were searched along with a field visit at the CPH airport to identify and refine the topic of interest. To do so, authors utilized not only journal databases but also a general search engine, or relevant aviation and blockchain industry resources. Further, a critical literature review was conducted combined with more interviews which helped to identify theory for the case. The authors used an inductive approach to theory development in this thesis. Hence, relevant theories were explored based on data collection. The data collection revealed dynamics of relationships, gaps in information sharing which were subsequently explained with selected theories. Thus, the literature review introduces and explains the benefits and challenges of blockchain technology, reviews networks and firm performance with a focus on the extended resource-based view, zooms into value co-creation in networks using the DART framework, and lastly reviews literature on ambidexterity with a specific focus on IT and operational ambidexterity. Finally, the research findings were examined in the context of existing literature and industry practices.

5.4.1 Type of Literature Review

Literature reviews can be divided into five types depending on their purpose: argumentative, integrative, historical, methodological, systematic, and theoretical (University of Southern California, 2020). This thesis performs a vastly theoretical review as it introduces relevant theories to the reader and explains theoretical frameworks that are used to analyze the case. Furthermore, a part of the blockchain technology review shows patterns of historical review as it explains the timeline of this nascent technology. Apart from that, value creation determinants, and benefits with challenges of blockchain technology were gathered using integrative principles. Accordingly, several concept matrices are attached in Appendix B and C.

A critical literature review is crucial as it helps to demonstrate knowledge, awareness of the current and past research, and puts the conducted research in context. A critical approach is vital to select viable resources, introduce relevant theories as well as include relevant information (Colquitt, 2013). The literature review utilizes a wide range of literature, specifically IS and organizational theory, as Saunders et al. (2016, p. 72) suggest.

Adhering to Webster's and Watson's (2002) guidelines, the review is concept centric. Thus, concepts are structured into chapters which provide clear definitions of the key concepts used in the thesis. Further, the articles and authors used for each concept are grouped into themes in a concept matrix to provide an overview of used articles and themes to the reader. These matrices can be found in Appendix B and C. The concept matrix is placed in attachments. Apart from that, the literature review is clearly structured to ease the orientation in the thesis for the reader. Hence, chapters are divided into subchapters, enriched by tables and figures visually representing key concepts.

Structured Review.

To obtain the most relevant resources, the review was conducted in a structured manner (Webster & Watson, 2002). Hence, source material was obtained from selected full-text journal databases using a set of keywords and parameters, such as language, or literature type. In order to target search queries more specifically, authors used connectors and characters (e.g. AND, OR, NOT, *). Further, each article was selected based on criteria by reviewing the title in the first round and the abstract in the second round. Moreover, additional sources are derived by going "forward" and "backward". Going backward refers to accessing additional sources from the list of references in articles obtained by indexed search whereas going forward refers to identifying sources that cited articles found in indexed search using Web of Science collection (Webster & Watson, 2002). Forward and backward approaches are especially useful to derive additional valuable research that would be excluded by the keyword condition (Levy & Ellis, 2006).

Typology of literature.

As for the typology of sources, prevalently secondary literature but also grey (primary) literature was utilized. The secondary literature involves formally published pieces such as books and journals. In contrast, grey literature includes sources not controlled and published by commercial publishers, for instance, conference proceedings, reports, or white papers (Saunders et al., 2016, p.83). The grey literature was solely used as complementary information providing context, especially in the blockchain technology review. Accordingly, mostly secondary literature consisting of books and peer-reviewed journal articles were utilized to ensure the quality of sources (Saunders et al., 2016, p. 83).

5.4.2 Literature Selection

All literature was gathered, managed, properly formatted, and exported in Mendeley reference management software. Doing so minimized the risk of displacing any relevant sources as well as to optimize management of references resulting in minimized risk of unintended plagiarism (Saunders et al., 2016, p. 110). The following sections describe the process of the structured literature search and selection for each chapter in the literature review.

Blockchain.

The blockchain research stream is relatively nascent, starting back in 2008 and receiving attention in the research community in 2013. Therefore, the quality of articles can vary based on the author, type of publication, and other aspects. Hence, systematic literature reviews conducted by other scholars were utilized in order to select the most influential publications in blockchain research. The systematic literature review was performed based on keyword search in Scopus, Business Source Complete, Springer Link, and

ACM. The strings searched for in the titles and keywords were ((Blockchain OR "Block chain") AND (systematic review)). Notably, Xu, Chen & Kou (2019), highlights the most influential publications by their number of citations. These publications include Swan (2015), Narayanan et al. (2016), Böhme et al. (2015), and Yaga et al. (2018). To further enrich the literature review, forward and backward search helped to identify additional relevant sources. The overall criteria included peer-reviewed journal articles in English only.

In addition, the blockchain technology literature review makes use of grey literature. As mentioned before, the blockchain technology research stream is nascent, and especially publications from earlier years, like Bitcoin whitepaper from Nakamoto (2008), are a crucial source of knowledge. In fact, the publication of bitcoin whitepaper is considered to be a starting point for blockchain technology.

Lastly, the authors of this thesis searched for blockchain research in aviation in order to identify the research gap and to summarize the state of research in this sub-stream. The databases used were Scopus, Web of Science, Business Source Complete, Springer Link, and ACM.

Value creation in networks.

The search for literature on value creation in networks was performed in Business Source Complete and Springer Link databases since value creation draws from strategic management and organizational theory. Limiting the search solely to technical research neglects the interdisciplinary characteristic of IS research. The selected literature was used to construct the literature of the network chapter, as well as the value creation chapter. Since this study involves a network context, the search was narrowed down to value creation in networks. The term network is broadly used in business and management literature. Hence, to encompass the concept of networks several terms were used, including network, collaboration, inter-organizational, and partnership. Thus, the following string was used in the search: ("value creation" AND (network OR collaboration OR inter-organizational OR partnership)).

The string was searched for in abstracts to ensure that the themes are the central focus of retrieved articles. In order to ensure the quality of articles, the search was narrowed down to English articles published in peer-review journals. The search resulted in a pool of approximately 100-160 articles per database from which 19 relevant articles were selected. The inclusion of the collaboration component between stakeholders to create value was a selection criterion for selected articles. Notably, articles with no clear focus on network, partnerships, and to a certain extent information sharing were excluded.

The keyword search was supplemented with backward and forward strategies, to include further relevant literature. This was mainly done to include fundamental theories, which not appeared from the search. For example, the articles gathered from the search discussed the service-dominant logic, but our results did not include papers from Vargo & Lusch (2004) who are considered main authors in this field. Similarly, a lot of papers talk about value co-creation, hence we included Prahalad & Ramaswamy (2004)

who are considered influential authors in the field. In total, seven papers were collected using backward or forward approaches.

Ambidexterity.

Ambidexterity was selected as a relevant theory for this case. Two relevant streams within ambidexterity literature were identified. First, this paper makes use of literature on ambidexterity in a network context. Second, since this paper is concerned with blockchain, literature on IT ambidexterity was included. The search for both streams was performed in the Business Source Complete and Springer Link databases. Since network was not an appropriate keyword and terms "exploitation" and "exploration" appeared in some articles instead of the term "ambidexterity, the following string was used: ((Ambidext* OR (exploration AND exploitation)) AND (collaboration OR alliance OR partnership OR inter-organizational). Subsequently, the string (Ambidext* OR (exploration AND exploitation) AND (information technology OR information systems) was used.

To narrow down the number of articles the aforementioned strings were searched for in the abstracts. Furthermore, the search was limited to peer-reviewed journal articles in the English language. This resulted in a pool of approximately 100-200 articles per database. However, within the databases, there was a high degree of overlap in literature. Only articles with a clear focus on IT ambidexterity related to operations or inter-organizational relationships and information sharing were included. IT ambidexterity influences business processes and has a strong connection with operations. Hence, this search also captured relevant literature on operational ambidexterity.

For the ambidexterity in inter-organizational relationship stream, this resulted in the selection of 18 relevant articles. Furthermore, from the IT ambidexterity search string 11 articles were included. Moreover, the keyword search was again supplemented with backward and forward strategies to include fundamental theories, which did not appear from the search. These included publications from highly cited authors in the field of ambidexterity, such as March (1996). In total 34 articles were selected.

5.5 Data Collection

The majority of the collected data to answer the research question resulted from interviews with different stakeholders. However, this paper uses a multi-method qualitative research design. Walsham (2006) argues that interviews should be supplemented by other forms of field data when conducting research based on an interpretive philosophy. This rests on the assumption that dynamics within social groups and contexts cannot be grasped only by what people say (Walsham, 2006). In line with this, Yin (2014) argues that the opportunity to collect data from multiple sources is one of the strengths of case studies. Triangulation of sources and methods of data collection can add depth, breadth, complexity, and richness (Saunders et al., 2016, p. 207). Therefore, besides interviews, this research uses documents and participant observations as

additional sources of data. In the following sections, all the data collection methods will be explained in more detail.

5.5.1 Interviews

In this study, primary data were collected through interviews. Interviews are regarded as one of the most important sources of evidence for case studies (Yin, 2014). In an exploratory study, in-depth interviews can be extremely useful to create a better understanding of the context. (Saunders et al., 2016, p. 392). From an interpretivist view, interviews can be used to try to understand the different views of different actors who interpret their own social world (Saunders et al., 2016, p. 389). In line with this, the interview data is also socially constructed. It is produced by the interpretations of the participant and the interviewer (Saunders et al., 2016, p. 389). The interviewer has a significant role in constructing meaning (Saunders et al., 2016, p. 389). Therefore, throughout the interview process, the researchers aimed to be reflective.

Types of interviews.

In total six interviews were conducted with industry practitioners. The interviews were non-standardized and ranged from structured to unstructured or in-depth. The first interview was part of a face-to-face visit at CPH, where the Specialist & Key Account Manager Optimization and Passenger Solutions, Lars Nielsen, gave a tour at the airport. This interview was used to help the researchers understand and refine their ideas about the research objectives (Saunders et al., 2016, p. 388). Therefore, this was an unstructured informal conversation, to better understand the airport environment. The second interview was a semi-structured, face-to-face interview conducted with a baggage handler from SAS Ground Handling. The third interview was conducted with the same participant as the first interview. However, this time it was an internet-mediated semi-structured interview. To get the airline perspective, the fourth interview was held with a team leader at Turkish Airlines. This interview was conducted through email; hence it was structured. The fifth interview was conducted with an Information Manager Passenger Services at KLM. This was a semi-structured telephone interview. Lastly, an interview with the co-founder of Blockchain Aero Technology, Dominic Jackson was semi-structured and conducted over the phone. An overview of the conducted interviews and additional information can be found in Appendix D. Moreover, the transcribed interviews are attached in Appendix E.

5.5.2 Participant Observations

Participant observations were used as an additional primary data collection method. In total, two participant observations were carried out at the beginning of the research process. These include observations from the passenger point of view. More specifically, the researchers traveled from and to the Copenhagen Airport

observing the process from getting to the airport all the way to the airplane, with a specific focus on passenger processing.

The data collection for this research is concerned with the exploration of the dynamics of a social environment and information sharing among stakeholders, to ultimately improve the passenger flow. Participant observations can add richness to the data collection, by entering into the social world of the research participants and participating in their activities (Saunders et al., 2016, p. 354). The deep level of immersion is one of the key strengths of participant observations (Saunders et al., 2016, p. 356). Hence, observations enable the direct experience of the travel journey and airport environment. Accordingly, this research used participant observations in the initial phase to better understand the complex environment of the airport and to create familiarity with the context. Moreover, observations allow for a better understanding of the smooth passenger experience.

This research observed the travel journey from a passenger point of view, by actually being a passenger. Hence, the researcher adopted a complete participant role to conduct observations. This means that while observing, the researcher was part of the environment that was being researched (Saunders et al., 2016, p. 358). Moreover, the purpose of observing was not revealed during data collection (Saunders et al., 2016, p. 358). At the time of observing, the researcher acted as passenger, and no one in the environment could distinguish between a regular passenger and the researcher. In total two sets of observations were documented. The data were noted down on a smartphone, so no one in the environment would be aware of the observation. Different types of observations can be distinguished. Primary observations focused on what happened at a certain time (Saunders et al., 2016, p. 362), and concern the events in the passenger journey. Moreover, interpretations of these events were combined with feelings associated with these events. Lastly, contextual data was included on the related setting, such as the role of stakeholders. This resulted in diary style descriptive observations, portraying particular events, and the experience and emotions involved. The documented observations can be found in Appendix F.

5.5.3 Documents

Besides primary data, this research also uses secondary data. Secondary data is data that has been collected for another purpose than the current research (Saunders et al., 2016. p. 317). In this study, secondary data is mainly used to support primary data and to get more in-depth insight into the aviation industry.

Text documents.

The collected secondary data consist of text documents and includes annual reports, industry reports, fact sheets, white papers, and websites. First, the annual report from CPH contains a thorough description of their initiatives and goals and have therefore been used to get a better understanding of the company's strategy. Besides the annual report from CPH, this study also draws from reports from influential

organizations within the aviation industry. Annual reviews, as well as white papers from IATA, SITA, and Arthur D Little (commissioned by Amadeus), gave a detailed description of industry developments, procedures, and standards. As an industry association, IATA leads a number of industry initiatives, such as A-CDM, and publishes white papers about new technologies. Moreover, SITA and Arthur D published papers that give additional insight in the digital transformation within the industry. Hence, these are relevant to CPH and to this study. Furthermore, by analyzing the IATA website, insights about the technology standards and initiatives within the industry were gained. This supported the current research in establishing an understanding of the prevailing information systems and technological developments. Lastly, an industry report from OAG provided additional insight in the aviation industry and passenger processing. A comprehensive overview of the document used in this study and their source can be found in Appendix D.

5.6 Quality of Research

Reliability and validity are fundamental measures to determine the quality of research (Saunders et al., 2016, p. 202). However, it can be argued that the concepts of reliability and validity are inappropriate for qualitative research based on interpretive assumptions (Saunders et al., 2016, p. 202). Hence, for this research, the concepts of reliability and validity are extended with transferability and credibility.

5.6.1 Reliability and Transferability

Reliability refers to the replication and consistency of the study (Saunders et al., 2016, p. 202). The main source of data used in this study is semi-structured and unstructured interviews. However, the lack of standardization of semi-structured and unstructured interviews can lead to concerns about reliability. Yet, this research is concerned with exploring current challenges related to passenger processing, which are dynamic and likely to change over time. This study does not intend to be repeatable and derives its strength from the flexibility which semi-structured and unstructured interviews provide (Saunders et al., 2016, p. 399).

Moreover, this study is concerned with exploring a challenge, rather than generating statistical analysis (Saunders et al., 2016, p. 399). Therefore, complete generalizability is not desired. Rather than focusing on generalizability, this study is interested in transferability. To increase transferability the research design, context, findings, and interpretations are thoroughly described, allowing other researchers to conduct a similar project (Saunders et al., 2016, p. 340). However, to achieve a certain level of generalizability interviews have been conducted with a wide cross-section of participants within the airport network (Saunders et al., 2016, p. 340). Moreover, by testing the applicability of existing theory this research aims to demonstrate a broader significance of the findings (Saunders et al., 2016, p. 340). Accordingly, Walsham (1995) distinguishes between four types of generalization from interpretative case studies: the development of concepts, the generation of theory, the drawing of specific implications, and contribution of rich insight.

This thesis aims to draw propositions and potential implications of blockchain technology on the airport setting from an operational perspective.

5.6.2 Validity and Credibility

To ensure validity and credibility participants were chosen based on their level of experience. All interviewees have a significant background in aviation or blockchain. Hence, they have built up a certain level of expertise in their field. Moreover, open questions were asked to encourage the interviewee to provide extensive answers. Furthermore, by conducting interviews with practitioners from different stakeholder groups, a variety of angles have been explored. By representing all views in the research fairness is promoted, increasing the authenticity.

Additionally, using multi-method supports triangulation, and adds credibility, validity, and authenticity to the study (Saunders et al., 2016, p. 349). Using multiple sources confirms that the researcher interprets the data appropriately (Saunders et al., 2016, p. 205). To further ensure validation, clarifying questions and probing questions were asked during interviews to create an in-depth understanding. Moreover, summarizing statements have been used to validate appropriate understanding with the interviewee. In the case of the e-mail interview, this was done by sending a follow-up mail. Lastly, the discussion between research partners and outsiders enabled the reflection of ideas and findings.

Yet, this research was conducted during the COVID-19 (Corona Virus Disease 2019) outbreak, restricting the data collection. Due to restrictions imposed by the Danish government to control the COVID-19 outbreak, interviews were mainly conducted through voice-, video-call and over mail. Moreover, there was restricted access to practitioners in the aviation industry. The implication of calling and email interviews is that there is no personal contact, hence it is difficult to build trust with interviewees. However, because of the difficult circumstances, all interviewees had been working from home and regularly participated in phone or internet-mediated meetings.

Observations

There are some concerns about the quality of the participant observations. First, it can be argued that there is a lack of understanding of the operational processes at the airport, which would result in observer error. However, the aim of the observations is to experience the travel journey and understand the airport environment. Therefore, this study argues there is no need for knowledge of these processes. The most contemporary issue concerns observer bias, where the researcher uses their own subjective view to interpret events (Saunders et al., 2016, p. 364). This study uses observations from the perspective of a lived experience; hence it is subject to bias. The observations are based on the reality observed by the researcher and might differ from other passengers' perception. It is therefore important to consider different interpretations of the situation (Saunders et al., 2016, p. 364).

Documents

Overall, secondary data was used to enrich contextual knowledge and provides information to enhance understanding of the case company, aviation industry, and technical developments within this industry. It must be acknowledged that in the internal documents data can be presented and collected in a biased manner (Saunders et al., 2016, p. 335). Hence, organizations might emphasize favorable data. To ensure data quality, legitimate sources have been used. Therefore, only documents from well-known and established organizations and authorities in the aviation industry, which have an excellent reputation, were considered. These mainly include publications supported by IATA and ACI. Moreover, numerous white papers used in this study are supported by independent market research agencies and external consultancy agencies. Accordingly, the validity and credibility of the secondary data have been safeguarded.

5.6.3 Access and Research Ethics

The researchers acted as external researchers, as there was no prior contact with the organization (Saunders et al., 2016, p. 225). Hence, access had to be negotiated. The main share of access to CPH and stakeholder groups was obtained through the supervisor of this study, Sabrina Abdullah. These existing contacts were supplemented with the creation of new contacts through LinkedIn. Moreover, all the secondary data used in this study was publicly available, so there were no difficulties regarding obtaining access.

All participants of the interviews participated on a voluntary basis. Hence, participants were asked for informed consent. Before commencing the interview, the purpose of the interview was clearly stated, to give the interviewee an understanding of the implications of their participation (Saunders et al., 2016). Moreover, participants were explicitly asked permission to record the conversation. Lastly, data is represented honestly. The view from diverse stakeholders within the aviation industry is considered throughout this study. Additionally, to ensure academic integrity this research adheres to the principles of APA (American Psychological Association) referencing.

5.7 Data analysis

As Saunders et al. (2016, p.568) claim, data analysis and data collection are a gradual iterative process. Hence, the data analysis can be divided into two broader stages. First, a preliminary data analysis was conducted at the beginning of the research process. It was commenced with observations from a passenger point of view and with the first introductory interview connected to the Copenhagen Airport tour. This initial stage allowed researchers to observe the airport environment and identify challenges in passenger processing. Afterward, the research was narrowed down to operational challenges of passenger processing caused by the lack of information.

Hereafter, the second part of the analysis was initiated. With this focus, more primary data was gathered in the form of interviews with relevant stakeholders involved in the ecosystem, as well as industry

insiders. Nevertheless, an initial literature review to gain a theoretical perspective was conducted before the main data analysis was commenced. Using an inductive approach, this allows researchers to link the research to existing knowledge and to start with an initial analytical framework (Saunders et al., 2016, p.570). Hence, this research uses four theoretical perspectives to start with: blockchain technology, networks, value creation, and ambidexterity.

These four concepts allowed researchers to structure the analysis into three coherent sections which are the airport network, data exchange, and operational challenges. Chapter 6.1, the airport network, relates mainly to the theoretical perspective of value creation, as it is concerned with the relationships and interactions involved in the service provision. Furthermore, Chapter 6.2, data exchange, connects to the theoretical perspective on networks and blockchain, since it is concerned with the (technical) resources in the network. Lastly, Chapter 6.3, operational challenges, discusses the outcomes of information sharing and digital transformation, hence this section relates to the theory of ambidexterity. However, it should be noted that there is no clear division between the theoretical perspectives and concepts. On the contrary, they overlap and interact with each other.

The structured analysis of the data aided researchers with an understanding of the specific operational challenges within the airport environment. Furthermore, it increased the understanding of business processes in the value chain, current data exchange practices, and relationships in the network. These findings were then used in the discussion part where relevant theory is fitted on the findings, thus ultimately forming propositions and possibilities of blockchain technology.

5.7.1 Thematic Analysis

The chosen approach is a thematic analysis as the purpose of it *"is to search for themes, or patterns, that occur across a data set"* (Saunders et al., 2016, p.579). This approach involves coding the qualitative data which helps to discover themes and patterns (Saunders et al., 2016, p.579). Thematic analysis is an appropriate method of the data analysis as it is apt for analysis of both large and small amounts of primary data. Furthermore, it identifies and produces a thematic description of the data. The identified themes and patterns can be used for further exploration (Saunders et al., 2016, p.579).

Moreover, the thematic analysis approach can be used in a variety of philosophical stances and therefore is in line with interpretivist philosophy. The approach uncovers different interpretations of the phenomenon from different stakeholders on topics like information sharing (Saunders et al., 2016, p.579). On top of that, inductive and deductive theory development approaches may be used. Since this study takes the inductive approach, the thematic analysis examines the data without imposing a rigid theoretical framework on the data set (Saunders et al., 2016, p.579). Using an inductive approach along with thematic analysis allows exploring occurrence and recurrence of themes that are likely to modify the research question in the process, as observed when conducting this research (Saunders et al., 2016, p.579). However,

as Saunders et al. (2016, p. 582) argue, a purely inductive approach is not viable as a large amount of time is needed in order to code every single unit and meaning of data to decide on a research focus. Hence, they suggest using a preliminary research question and an initial theoretical framework, as deployed in this thesis.

To code the interviews, NVivo 12 qualitative data analysis software was used. In this particular research, the coding process consisted of four rounds. However, this process is recursive, and therefore the rounds overlap (Saunders et al., 2016, p.580). In the first round, authors were initially getting familiar with the initial data (observations and the airport tour interview), which allowed the identification of preliminary theoretical propositions and the research focus. This was done by reading and rereading, memo writing, discussing, sketching, and summarizing.

The second round involved coding by both researchers independently from each other. The data was coded, which helped to analyze the complex and large amount of qualitative data. The codes were used to summarize the meaning of the extracted part of the text (Saunders et al., 2016, p.580). Doing so helped to easily manage and retrieve relevant pieces of information. All codes were either a single word or phrase, while the units of data coded ranged from parts of a sentence to a paragraph. The names of codes were created based on descriptions of the unit of data (Saunders et al., 2016, p.582).

In the third round, the codes were merged into themes and patterns in an open dialog between both researchers. Themes are broad categories grouping codes which are relevant to each other and codes which are relevant or significant for the research question (Saunders et al., 2016, p.584). A comprehensive overview of the themes with respective codes, descriptions, and examples can found in Appendix G. Lastly, the themes were refined and integrated into three sections stemming from the initial theoretical framework. The themes were also regrouped and renamed as authors reread the data and found nuances or new findings. To develop well-grounded propositions, the themes were tested by seeking alternative explanations (Saunders et al., 2016, p.586). For example, one interviewee claimed that the airport does not receive data on the number of passengers on a flight. The researchers then specifically sought an alternative explanation by another interviewee who contradicted this claim. Moreover, secondary data, such as documents, and further primary data collection were utilized to complement and verify primary data.

6. Analysis

This chapter provides a thorough analysis of the collected data. The analysis is divided into three sections, the airport network, IT and data exchange practices, and operational challenges. Within these broad sections, several themes are discussed. The data is presented as a series of claims about the environment and observations which support these claims.

6.1 The Airport Network

A broad theme emerging from the interviews is that the airport ecosystem is a complex network, involving many stakeholders working together to provide one service. The airport, airline, and handling companies can be viewed as the main players involved in passenger processing. However, there are many other stakeholders active at the airport, such as the border patrol, restaurants and shops, public transport, and cargo handlers (Diederik van Thiel, information manager, KLM).

6.1.1 Relationships

The airport can be seen as the center of the network. All stakeholders involved in creating a seamless passenger journey work together at the airport. However, this is not a conscious choice to work together. Rather, the stakeholders happen to find themselves at the same physical location by coincidence (Interviewee 4, information manager, KLM). The central position of the airport within the ecosystem gives the airport the role of a facilitator within the network. This means that the airport provides other stakeholders with the necessary resources and infrastructure, such as runways, departure halls, infrastructure, baggage basements, parking spaces, and much more to run their operations (Diederik van Thiel, information manager, KLM).

Dependency on Stakeholders.

The stakeholders in the ecosystem have a common interest in ensuring a smooth passenger experience. On its journey, a passenger navigates through different processes and interacts with various services provided by different stakeholder groups. Therefore, stakeholders depend on each other. If one stakeholder makes a mistake this impacts the overall experience of the passenger. Accordingly, interviewees mentioned the need for a broader view: *"We need to see the big picture if we want to improve the overall flight experience"* (Erhan Kiloren, team leader, Turkish Airlines). Hence, all stakeholders have to work together to collectively ensure a seamless travel experience. Therefore, it also becomes important for a stakeholder that all other parties that interact with the passenger meet their desired level of customer experience. Hence, stakeholders need to adhere to other stakeholders' standards and policies (Erhan Kiloren, team leader, Turkish Airlines). In line with this, CPH recognizes the need to support stakeholders if necessary. *"It's very important for us*

always to be aware of our stakeholders doing and if you're suffering, how can we maybe assist them or help them that's important" (Lars Nielsen, optimization and passenger solutions, CPH).

Formal Nature of Relationships.

Furthermore, the relationships are characterized by a high degree of formalized agreements. The network is characterized by a customer-supplier relationship, allowing stakeholders to have certain expectations from each other, based on agreements they make (Diederik van Thiel, information manager, KLM). In line with this, service level agreements (SLA) direct the industry. These SLA specify the agreed-upon level of service and include information-sharing practices. Stakeholders explicitly state their expectations and desires from other stakeholders. *"We share our announcements and we inform our needs in order to improve our standards"* (Erhan Kiloren, team leader, Turkish Airlines). Accordingly, it is common that when sharing data, the use of this data is agreed upon between parties beforehand. This is documented in the agreement and ensures the data is only used for the purpose it was requested for or meant for (Diederik van Thiel, information manager, KLM). As one interviewee points out, the agreements between stakeholders about the use of data seem necessary as a result of mistrust in the environment: "*We still have discussions with the airport about when I make this data available to you, I want you to sign and assure me at least 26 times you will not use this data for anything else because this could potentially be a disadvantage for me"* (Diederik van Thiel, information manager, KLM).

However, there is another side to the formal relationships. The cooperation between stakeholders is to a certain extent out of necessity, rather than voluntarily. The complexity of the ecosystem and the airport in their facilitating role creates a certain dependency on each other. Hence, "*The airport cannot operate without airlines, and the airlines need the airport, the best result is the result of collaboration, on commercial and operational fronts"* (Diederik van Thiel, information manager, KLM). Therefore, stakeholders are to a certain degree forced to work together.

Paradoxical Relationships.

Our interviews show that the semi-forced and formal relationships within the ecosystem result in complex dynamics between actors. Overall, interviewees acknowledge that the relationships in the ecosystem can be considered satisfactory and healthy and are as efficient as they could be (Erhan Kiloren, team leader, Turkish Airlines). However, while all interviewees say the relationship can be considered as good, there also seems to be some disagreements and friction within the network. As one interviewee comments, the formal contact can be perceived as unpleasant and disrespectful: "*Sometimes they act just like the military, do this, do that because we pay you"* (René Pedersen, baggage handler, SGH). To conclude, the relationship is a paradox between formality and collaboration and can be compared to a *"healthy marriage"* (Diederik van Thiel, information manager, KLM).

Lack of accountability and transparency.

From interviews, it appears there is a lack of accountability and transparency within the ecosystem. Especially when moving towards a seamless travel experience, a passenger does not realize who is responsible for what service, since operations are intertwined. Hence, the passenger does not know where the data comes from and where it is being stored (Diederik van Thiel, information manager, KLM). Moreover, certain stakeholders, such as the airline are held more accountable by passengers when something goes wrong along the journey. For example, lost luggage can be the fault of many parties involved, but passengers will most likely blame the airline. "*The check-in guy is from SAS, but when he pushes the button, it is no longer SAS their responsibility anymore, it is the airport. But you don't know that when you are missing your luggage. If something goes wrong you just say SAS is sh*t"* (René Pedersen, baggage handler, SGH). However, this lack of transparency and accountability is mostly present from the customer point of view. The formal agreements within the network ensure accountability for operations within the ecosystem.

6.1.2 Various Motives

All stakeholders face their own challenges and have their own interest in creating a smooth passenger journey. Hence, every stakeholder has different motives to create a smooth passenger experience, besides improving the overall customer experience. For airlines, the main challenge is on-time performance (Lars Nielsen, optimization and passenger solutions, CPH). Yet, ground handlers are impacted by congestions and confused passengers, as they have to provide additional services (Diederik van Thiel, information manager, KLM). Therefore, the main interest of ground handlers is to create efficiency in service provision by avoiding congestions. Lastly, for airports, the main interest is to boost commerce and get passengers to spend more money (Lars Nielsen, optimization and passenger solutions, CPH).

Importance of Commerce.

Commerce is the main source of revenue for the airport. Hence, the airport aims to increase the window for customer spending (Lars Nielsen, optimization and passenger solutions, CPH). The importance of commerce for the airport results in an effort to increase the time passengers spend in the transit area. "*If you have more time, you'll spend more money"* (Lars Nielsen, optimization and passenger solutions, CPH). Therefore, a smooth passenger flow is essential, as this will decrease waiting times and increase the time travelers have in the transit area. The importance of passenger processing for shopping is not only highlighted by the airport itself, but also by the industry (OAG, 2020a; Arthur D. Little, 2017).

Yet, passengers tend to find the gate as early as possible, out of stress and uncertainty of missing important updates (OAG, 2020a). This negatively affects the spending of passengers, as it prevents them from exploring shops and restaurants. "*When they finally found the gate, they will only spend money in the*

units surrounding the gate, if there are no units, they won't look for units. They'll just stay there and they won't spend money" (Lars Nielsen, optimization and passenger solutions, CPH). When asking travelers what would motivate them to spend more time at shops and restaurants, they indicated they desire more consistent, proactive, and trustworthy flight information (OAG, 2020a).

Airport design choices.

The CPH airport is designed to increase commerce and the spending of passengers. Passengers are guided through the tax-free shop when entering the transit area (Lars Nielsen, optimization and passenger solutions, CPH). Moreover, high-end shops are located close to gates where the financially stronger passengers would fly from (Lars Nielsen, optimization and passenger solutions, CPH). Furthermore, only stores CPH believes support their brand and will perform well are given a site at the airport. "*We make sure that the brands that we represent are the brands that most of the passengers like, and prefer"* (Lars Nielsen, optimization and passenger solutions, CPH).

Moreover, CPH's airport design takes into account the optimization of passenger flows. Passengers are often not prepared at touchpoints, slowing down processes (Lars Nielsen, optimization and passenger solutions, CPH). With signs, stickers, and supporting staff the airport attempts to nudge passengers by preparing them for activities at touchpoints, such as taking out their passport at border security (Lars Nielsen, optimization and passenger solutions, CPH). Furthermore, the airport tries to divide passengers into groups to speed up processes. "*When you drive at the highway, and you need to take a turn, you look at the signs and you know, which lane you should choose this the same idea that we've been doing here"* (Lars Nielsen, optimization and passenger solutions, CPH). By doing this, passengers have already grouped appropriately when arriving at the border control, once again speeding up the process.

However, despite the efforts taken to improve passenger flow, there are still inefficiencies. Initiatives to nudge passengers in the right direction do not always have the expected and desired result. *"Yeah, and then we have the print on the floor. Does it work? No, the effect is limited."* (Lars Nielsen, optimization and passenger solutions, CPH). Another example of such inefficiency is that passengers have difficulties finding the exit and baggage claim at CPH, regardless of the repeated efforts in improving this (Lars Nielsen, optimization and passenger solutions, CPH).

6.1.3 Communication among Stakeholders

Another theme emerging from the interviews is the extensive communication practices in the airport network. These practices are aimed to create mutual understanding and support operations.

Mutual understanding.

Stakeholders do not always fully understand each other's position and challenges. As one of the interviewees points out, he is mainly concerned with his own operations: *"I can't see the stress of the gate manager when the plane is late. I just take the luggage out, and I don't see 200 people who are standing and wanting to fly"* (René Pedersen, baggage handler, SGH). However, specifically the airport is reflective of their position in the network with respect to others. The airport recognizes that they are more profitable than most other parties (Interviewee 1, optimization and passenger solutions, CPH). Moreover, the airport takes initiative to support stakeholders and shows interest in their operations. They discuss with stakeholders how they can help them and whether they have any current challenges that need any assistance (Lars Nielsen, optimization and passenger solutions, CPH). Hence, the airport tries to establish understanding and encourages awareness of the situation of stakeholders.

Communication practices.

There is a high degree of communication between stakeholders in the form of physical meetings. The airport has a dedicated department focused on the relationship with airlines, where every airline has a representative that makes sure their interests are taken up with (Lars Nielsen, optimization and passenger solutions, CPH). Hence, this department ensures a good relationship between the airport and various airlines.

Besides this department, there are monthly meetings scheduled by the Airline Operators Committee (AOC). This is a large meeting with all stakeholders in the network, such as airlines, the police, customs, and PRM provider (Interviewee 1, optimization and passenger solutions, CPH). These meetings are organized by an objective party and allow all stakeholders to present their challenges or developments influencing the network (Lars Nielsen, optimization and passenger solutions, CPH). In these meetings, a variety of issues is being discussed, such as Key Performance Indicators (KPI) and the SLA (Lars Nielsen, optimization and passenger solutions, CPH).

Next to these scheduled meetings, there are also meetings being held whenever necessary. Interviewees point out that meetings are held on all fronts, from high to low, as often as needed, which varies a lot (Interviewee 3, team leader, Turkish Airlines; Interviewee 4, information manager, KLM). An example pointed out by one of the interviewees is arranged meetings to ensure the desired level of customer experience of stakeholders. *"We also arrange meetings with other departments like police and handing companies to improve customer experience. we share our reports regularly and ask them to improve their service if necessary"* (Interviewee 3, team leader, Turkish Airlines)

6.2 IT and Data Exchange Practices

An overarching theme identified from the interviews is related to the existing technology practices at CPH. Therefore, the following chapter will discuss the IT infrastructure and data exchange practices in the airport network.

6.2.1 IT Landscape

Several legacy systems were developed at different times with various purposes leading to poor interoperability of IT systems. As Erhan Kiloren from Turkish Airlines mentions, systems are not all compatible and interconnected. Accordingly, Amadeus reports the same industry practice of using several legacy systems that are not compatible. The systems were developed gradually over the years and hence not all system architectures are compatible, resulting in increased costs and poor usability (Arthur D. Little, 2017). The prevailing presence of legacy systems may be explained by the focus on consumer-facing IT investments as Dominic Jackson (Independent consultant, co-founder of Block Aero) noted that IT investments in the aviation industry are neglected, unless it's consumer-facing. ACI (2017) confirms that digital transformation is mainly focused on processes and services with the aim to improve customer experience. Furthermore, Amadeus highlights that airport ecosystems lack a digital mindset constraining them from identifying, prioritizing, and implementing new digital solutions. The current rigid decision-making processes may not be suitable for digital innovation strategy which requires more dynamic decision processes (Arthur D. Little, 2017).

6.2.2 Data Sharing

The interviews revealed two types of data sharing, necessary data sharing, and voluntary information sharing. Both themes will be further discussed below.

Necessary data sharing.

Airports, airlines, and other stakeholders already share certain data out of necessity to deliver a service to customers. The cooperative nature of providing a flight service demands a certain degree of information sharing, such as passenger figures (Diederik van Thiel, information manager, KLM). In addition to that, the airport also requests information from stakeholders operating on its premises, for example for invoicing (Erhan Kiloren, team leader, Turkish Airlines). Moreover, sometimes there are legal obligations that make sharing of data necessary (Lars Nielsen, optimization and passenger solutions, CPH).

Overall, data is primarily being shared purposefully based on agreements. *"We have solid agreements about this, and other data is not being shared. We share data purposefully, so only column A to C from a larger table for example"* (Diederik van Thiel, information manager, KLM). Multiple interviewees confirmed that data sharing is based on arrangements between parties, such as the SLA (Lars Nielsen,

optimization and passenger solutions, CPH). This is also in line with the formalized agreements discussed in Chapter 6.1. Agreements enable stakeholders to legally control what the shared data can be used for by the other party (Diederik van Thiel, information manager, KLM). At the same time, entities must ensure that the sharing of data is compliant with legal obligations (Erhan Kiloren, team leader, Turkish Airlines).

Voluntary data sharing.

However, not all information is shared out of necessity. Since stakeholders collaborate frequently and deliver a single service to the end-customer, they can benefit from additional information being shared. In this case, the exchange of information is voluntary, as the stakeholders recognize the convenience (Diederik van Thiel, information manager, KLM). However, it appears that some airlines share more data with airports than others. While Erhan Kiloren from Turkish Airlines states: *"Information is shared after departure and shared for all flights. We also share information before the flights. It depends on the situation"* (Erhan Kiloren, team leader, Turkish Airlines), Lars Nielsen from CPH Airport adds that this information is not received from all airlines.

From the airport point of view, the willingness to voluntarily share information is present. As Lars Nielsen points out: "*I think we should share as much information as we possibly can. And if there's information that we could share with the stakeholders we would love to do"* (Lars Nielsen, optimization and passenger solutions, CPH). The awareness of the notion that other stakeholders have a crucial role in the overall customer experience at the airport, causes the airport to help stakeholders by sharing forecasts about traffic. Hence, they give, for example, recommendations on the number of tracks and staff needed at the border patrol at a certain time (Lars Nielsen, optimization and passenger solutions, CPH).

Means of data sharing.

The means of data sharing widely differs based on the type of data that is being exchanged. Nevertheless, there is not a single data sharing system for all types of data (Erhan Kiloren, team leader, Turkish Airlines). Hence, not all systems are compatible with each other. In some cases, there is no digital form of data exchange, and the information is presented in an analog form. For example, the aircraft crew declares themselves by showing physical documents (Lars Nielsen, optimization and passenger solutions, CPH). In other cases, the data exchange is digitized, mostly in the form of a database or by linking (Diederik van Thiel, information manager, KLM). However, not all information is shared in that way, and it can still involve more primitive ways. Erhan Kiloren from Turkish Airlines suggests that data is shared with stakeholders by email or via other systems. Such a system for information transmission includes a messaging service called Web Telex. "*We share passenger figures with airport via WEB TELEX systems. Each company and even each department have their own addresses"* (Erhan Kiloren, team leader, Turkish Airlines). This kind of information transmission may include different formats and standards. Hence, to

standardize information sharing, the aviation industry has been converting to a new standardized digital format of data sharing, XML (Extensible Markup Language), which enables A-CDM (IATA, A4A & ACI, 2017).

As for the frequency of the data exchange, interviewees agreed that data are shared daily and automatically (Lars Nielsen, optimization and passenger solutions, CPH). However, the data are shared in a passive way and stakeholders cannot manage the data collaboratively. Yet, stakeholders recognize the benefits this could provide: "*An even greater good would be if data would be managed collaboratively, and also store collaboratively so every party can get to it"* (Diederik van Thiel, information manager, KLM).

6.2.3 Perceived Barriers to Increased Information Sharing

The interviews show that if data sharing takes legal matters, privacy, and decency into account, there are no perceived downsides to increased information sharing (Diederik van Thiel, information manager, KLM). On the contrary, there is a willingness to share more information within the network, especially from CPH (Lars Nielsen, optimization and passenger solutions, CPH). However, when information is not treated in the right way, it can damage individuals and brands (Erhan Kiloren, team leader, Turkish Airlines). Hence, interviewees acknowledge the importance of compliance with laws such as the GDPR. In regard to this, it is important to notice that stakeholders do not necessarily care about personal information. "W*e basically don't care who the passengers are. We're not interested in their names. It's their pattern, and how they move how they react"* (Lars Nielsen, optimization and passenger solutions, CPH). It is noted that stakeholders' lack of trust could be one to the barriers of increased information sharing and digital transformation of airports. *"The development of trust between the key airport stakeholder groups is an essential step to move from department-driven initiatives to a more holistic approach to digital transformation"* (Amadeus).

Change in mindset.

One of the mentioned reasons that could explain why data is not being shared, is because of commercial rhetoric. "*Data is valuable, it is worth money and can be used commercially"* (Interviewee 4, information manager, KLM). Moreover, the lack of information sharing can be attributed to the fact that the industry is not ready yet. There has been a move over the past 10 years from not sharing information, to slowly realizing there is no need to be so protective (Diederik van Thiel, information manager, KLM). Currently, the argument of sharing information with stakeholders is growing in popularity, especially among younger generations (Diederik van Thiel, information manager, KLM). According to this argument, data sharing is favorable to the firm and its customers, hence there is no reason to hold on to the information so tightly. However, as one of the interviewees points out: *"We are not ready for this, just like another large part of the world is not"* (Diederik van Thiel, information manager, KLM). Moreover, reports on digital transformation within the aviation industry support this claim by adding that people-readiness challenges

should not be underestimated (Arthur D. Little, 2017). Hence, there is a need for a change in mindset within the industry.

6.3 Operational Challenges

The last underlying theme identified from the interviews is operational challenges hindering a seamless journey. Two apparent challenges can be distinguished: unallocated passengers and staffing predictions. Moreover, an industry transformation toward a seamless journey was identified and airports use each other's expertise to facilitate a seamless journey.

6.3.1 Challenge of Unlocated Passengers

An emerging theme in the interviews was the passengers' location. This kind of information is especially important for airports and airlines. Passengers' location is captured by many stakeholders within the ecosystem (e.g. airport, border patrol, handling company), however, the information is sandboxed. The airport does not know exactly where in the airport the passenger is (Lars Nielsen, optimization and passenger solutions, CPH). Moreover, the airport is not aware of whether the passenger is coming to or has arrived at the airport. "*We need information from the check-in system that the passengers or that the airlines use, we need to know whether the passengers are checked in or not"* (Lars Nielsen, optimization and passenger solutions, CPH). The same applies to airlines who are not aware of passengers' locations, for example, whether a passenger has entered the airport and where they are located at the airport (Erhan Kiloren, team leader, Turkish Airlines).

In the end, this information gap results in the airport and airlines unable to make informed decisions. For example, when passengers board the aircraft, airlines are not aware of passengers' location. If a passenger is late, the airline cannot make an informed decision on whether to wait for the passenger or not (Lars Nielsen, optimization and passenger solutions, CPH). Nonetheless, such information sharing system does exist and is already set up at other airports, such as Heathrow. Hence, they are able to make an informed decision whether to wait and call for the passenger or offload the passenger (Lars Nielsen, optimization and passenger solutions, CPH).

Apart from that, data on passenger location may be leveraged to personalize the travel experience. This is beneficial to improve processes and to create a seamless passenger experience. For example, proactive information on the arrival of baggage can be supplied to passengers (Diederik van Thiel, information manager, KLM). Moreover, data on passenger location can be used as input to boost commerce. It would enable the airport to use this data to send messages to passengers´ mobile devices, creating awareness about certain offers, favorite stores, and much more (Lars Nielsen, optimization and passenger solutions, CPH).

Delays.

Missing passengers at the gate results in offloading baggage and causes delays. When a passenger is not on board of the plane, the luggage has to be removed. This means a section of the plane has to be offloaded to find the right piece of luggage, after which everything has to be loaded in again (René Pedersen, baggage handler, SGH). Therefore, this is demanding work from the baggage handlers and takes significant time. It can take up to 25 minutes, depending on the location of the baggage (René Pedersen, baggage handler, SGH). Hence, the unloading of baggage can result in delays, which impacts various other stakeholders.

Delays are expensive for airlines, cause rescheduling at airports, and have a negative impact on the overall passenger experience (Lars Nielsen, optimization and passenger solutions, CPH). Airlines are motivated to make its flight arrival and departure processes as fast as possible since they are charged for the time spent on a parking slot. *"Because otherwise the flight will be late and it's a big cost for the company if the plane is parked for too long. Because it's by minutes you pay maybe $5,000"* (René Pedersen, baggage handler, SGH). Furthermore, when a plane is delayed this can disrupt the flight schedule. Consequently, there are changes in the allocated gates, resulting in even more delays caused by confused passengers (Lars Nielsen, optimization and passenger solutions, CPH).

6.3.2 Challenge of Staffing Predictions

Forecasts related to staffing are made on historical data, rather than real-time figures, therefore compromise accuracy. CPH uses data from earlier years to predict the number of passengers arriving and departing on a certain time a day (Lars Nielsen, optimization and passenger solutions, CPH). Airlines do share certain figures with the airport to improve shared processes such as check-in. Likewise, airlines recognize that passenger figures help stakeholders in the network. *"Passenger figures have been shared before flights arrive in CPH Airport. This information helps the relevant stakeholders be prepared before the arrival"* (Erhan Kiloren, team leader, Turkish Airlines).

Similarly, CPH highlights the importance of data on passenger numbers (Lars Nielsen, optimization and passenger solutions, CPH). These forecasts and passenger numbers are used to make predictions on counter allocation and staffing at several touchpoints at the airport, such as the allocation of check-in counters to an airline, security staff and lanes, and border control (Interviewee 1, optimization and passenger solutions, CPH). With the data, they aim to predict how many tracks they should open throughout the day. Hence, predictions on passenger flows have a large impact on the operations at the airport and can be seen as crucial.

Inefficient Resource Allocation.

As a result of the lack of real-time information, operational choices are not always optimal. The use of historical data and expected numbers results in a gap between anticipated and actual numbers of passengers.

Hence, CPH recognizes a need for information to be adjusted throughout the way (Lars Nielsen, optimization and passenger solutions, CPH).

Inaccurate predictions result in inefficient allocation of physical and human resources. For example, if an airline can manage its operations with less counters than anticipated, these counters could have been used for something else (Lars Nielsen, optimization and passenger solutions, CPH). Hence, CPH would like to have more real-time data available to them, to bridge this gap. *"I think that those figures could be even more correct if we share more data"* (Lars Nielsen, optimization and passenger solutions, CPH). Furthermore, the inefficient resource allocation results in longer wait times for passengers in the key checkpoints. Accordingly, IATA (2019a) reports that passenger dissatisfaction is the lowest in security checkpoints and the border control.

6.3.3 Industry Transformation

From the interviews and documents, a digital transformation in the industry was recognized, to satisfy future demand. Moreover, to enable a seamless journey, innovative solutions related to passenger processing are used.

Changing demand.

The airport has a need to transform operations, allowing them to prepare for future demand and follow industry trends. First, there is an increasing demand for global air travel. In line with this, CPH also expects more passengers over time, which means they need more physical space (Lars Nielsen, optimization and passenger solutions, CPH). CPH prepares for this by building a new pier, baggage factory, and opening additional space for commerce. Moreover, passengers have higher expectations. "*Passengers no longer simply buy an air ticket; they purchase a travel experience"* (IATA, 2019b). Improving this overall experience is the focus within the aviation industry. People especially want to be notified about flight status, baggage information and waiting times (IATA, 2019b). Moreover, according to IATA (2019b), 65% of the passengers are willing to share personal information to speed up airport processes. CPH embraces this change in customer demand and recognizes that passengers *"expect a relaxed, relevant and personal passage through the airport"* (Copenhagen Airports A/S, 2020b).

Seamless journey.

This changing demand has resulted in an industry trend in creating a seamless passenger journey. To fulfill the increased demand for information services and enhance passenger experience smart solutions should be adopted. *"In order to enhance the passenger experience, optimize operations and develop new relevant services for our passengers, partners and customers, we need to use data intelligently and develop new digital solutions*" (Copenhagen Airports A/S, 2020b). Hence, there is a transformation going on in the

industry in which business and IT are becoming more intertwined (Diederik van Thiel, information manager, KLM). This transformation has resulted in the use of digital innovations to collect and process data and communicate information that will create smart solutions resulting in a seamless journey for passengers. One digital innovation CPH is currently examining to create a seamless and personalized travel experience is biometrics (Lars Nielsen, optimization and passenger solutions, CPH). The airport competes with other airports on what they can offer the passenger in transit, and by making their journey through the airport as smooth and effortless as possible (Lars Nielsen, optimization and passenger solutions, CPH). Hence, for CPH the overall passenger experience is seen as a way to differentiate themselves.

Passenger processing technologies.

The CPH airport is already looking ahead in the future to possibly implement technologies which would enable more accurate passenger tracking, such as biometrics (Lars Nielsen, optimization and passenger solutions, CPH). Nonetheless, the industry has been investigating other passenger counting and tracking technologies as well. SITA (2014) lists other technologies among which are Wi-Fi sensors, Bluetooth beacons, laser counting, RFID, NFC, indoor GPS, GSM, thermal imaging, laser counting, or video analytics, including biometrics in form of facial recognition. CPH airport already uses passenger counting technology which allows them to monitor traffic in key areas. *"There is a device on the ceiling which tracks the passengers. We have it at the security, check-in, and the passport control."* (Lars Nielsen, optimization and passenger solutions, CPH). The system gives them ability to see which passengers are moving or being idle allowing to identify congested areas (Lars Nielsen, optimization and passenger solutions, CPH). Further, the airport is analyzing historical data in combination with some present data to predict traffic at the airport (Lars Nielsen, optimization and passenger solutions, CPH).

6.3.4 Learning from Each Other

Airports that are not direct competitors learn from each other to improve their operations. Since CPH only has a limited number of counters and physical space, they are forced to be very efficient when it comes to counter allocation. Other airports from over the world see this and are interested in how they do this. Therefore, they come to Copenhagen for a tour around the airport and learn from CPH their processes (Lars Nielsen, optimization and passenger solutions, CPH). Furthermore, CPH actively looks for airports with more efficient processes they can learn from (Lars Nielsen, optimization and passenger solutions, CPH). In line with this, CPH does not see themselves as first movers. On the contrary, they prefer to look at what others do so they can see if the investment is worth it (Lars Nielsen, optimization and passenger solutions, CPH).

The collaborative learning within the industry results in airports taking on consultancy roles, and advising other airports on process optimization (Lars Nielsen, optimization and passenger solutions, CPH).

However, the collaboration between airports and the sharing of information is less with directly competing airports, such as Oslo. "*I mean, they're competitors towards us. So we're obviously maybe not sharing the information with them, like we are sharing information with airports that are far away from us"* (Lars Nielsen, optimization and passenger solutions, CPH).

Furthermore, airports and other stakeholders form international associations which amongst other activities investigate the digital transformation of the industry. For example, ACI (2017) published the best practices for the digital transformation of airports.

7. Discussion

This chapter provides a discussion of the findings of the research. The findings are interpreted with the theoretical background provided in the literature review. First, the implications of blockchain for value co-creation are discussed. Second, chapter 7.2 elaborates on the impact of blockchain on operational ambidexterity. Next, the current firm performance is discussed, to understand the implications of blockchain on future performance. This is followed by an integration of all theories, providing an answer to the research question. As previously mentioned, this paper treats the concept of blockchain as a consortium blockchain throughout the discussion.

7.1 Value Creation in the Airport Network

The following chapter discusses how blockchain technology enhances value creation at CPH. To assess value co-creation, the DART framework is applied to the airport network context which is followed by an assessment of the potential of blockchain technology on value co-creation. The DART components can be seen as building blocks for value-co creation, as they determine the interaction between stakeholders in the network (Prahalad & Ramaswamy, 2004). Table 6 provides an overview of the implications of blockchain on these DART dimensions.

7.1.1 Value Co-Creation

CPH airport forms the center of the airport network. According to the definition of networks, they are the focal firm which works together with a constellation of firms to create a service (Barringer & Harrison, 2000). The stakeholders in the network have a shared objective of delivering a service to customers. Since they work at the same physical location, they are highly dependent on each other and have to work together to create a smooth journey for passengers. At the same time, the stakeholders must work at CPH airport as long as they want to operate in Copenhagen. Thus, CPH airport is the provider of the essential airport "platform" on which stakeholders operate. Hence, the delivery of the service of a seamless travel journey is realized by multiple actors and can hardly be reached by a single stakeholder.

Moreover, delivering a shared service requires information from different stakeholders, enabling integrated and smart solutions. Therefore, the primary flow of exchange is information, rather than physical goods (with the exception of baggage). Suppliers and customers create value in the network by exchanging this information. Hence, this is in line with the service design logic, which emphasizes the importance of stakeholders in an ecosystem working together when trying to create value from service provision (Vargo & Lusch, 2004). Hence, the airport network can be explained from a service-centered view, where value is created through co-production with the airport, airlines, ground handlers, and passengers. Therefore, the DART framework can be applied to explain the interactions which support value co-creation.

7.1.2 Dialogue

This section further elaborates on the communication efforts taken in the Copenhagen airport network and discusses the potential effect of blockchain.

Interorganizational communication efforts.

The airport network is characterized by a high degree of communication between stakeholders. The frequently scheduled meetings with all stakeholders and meetings whenever perceived necessary create room for dialogue. According to the dialogue dimension of the DART framework, this increases the engagement of stakeholders and strengthens the relationship (Mathinheikki et al., 2016). Moreover, frequent communication between stakeholders should promote trust (Mathinheikki et al., 2016). However, regardless of the high level of communication in the airport network, there is a relatively low level of trust between stakeholders. The relationships are governed by formalized agreements, and stakeholders are afraid of the misuse of shared resources. Furthermore, the dialogue dimension argues that communication can create an understanding of the needs and expectations and supports harmony within the network (Chakraborty & Dobrzykowski, 2014). In the airport network, stakeholders do not always see the challenges of other stakeholders. Therefore, meetings are used to create mutual understanding and awareness of stakeholders' needs. Thus, while communication initiatives are aimed at improving the quality of the relationship between stakeholders, this is only effective to a certain extent.

Compatibility of systems.

Besides interpersonal communication, the dialogue dimension is also concerned with communication on system-level and the compatibility of systems (Kim et al., 2013). This is based on the idea that technology alignment between stakeholders can reduce communication barriers. However, in the airport network, not all systems are compatible and interconnected. This results in ineffective and inefficient communication of information between stakeholders. While there are industry efforts that impose standards and aim to increase communication between stakeholders, in practice this is not optimal yet. It appears that sometimes the necessary information for a stakeholder in the network is collected by someone, but it is not shared with the stakeholder in need of this information. Other times, information is shared, but a lack of information management within the company could potentially be the cause of the information not reaching the right destination. Thus, the information is sandboxed, resulting in less value creation.

Influence of blockchain.

Permissioned blockchains are inter-organizational systems by nature. The value of blockchain grows for its users as more participants join the network (Lacity, 2018b). The necessary collaborative nature of blockchain makes it a highly political system. Thus, the setting and management of a blockchain network

inherently require extensive dialogue among stakeholders, which to a certain extent already exists at the airport. Hence, the current environment partly contributes to blockchain implementation.

Nevertheless, the level of trust among stakeholders remains relatively low and they are hesitant to share information. Thus, the relationships are formalized in the form of service level agreements. However, blockchain technology serves as a facilitator of trust as the system is decentralized a not controlled by a single entity (note that in the case of permissioned blockchain, it can be controlled by a consortium or single entity). By eliminating the need for a TTP, stakeholders are able to negotiate the design, governance, and other aspects of the network to their needs.

Additionally, a system-level dialogue is necessary for value co-creation in networks. However, various means of information exchange exists, such as email, web telex, or databases. Blockchain technology can either replace or build on top of these systems using APIs and smart contracts. Further, as blockchain technology enables peer-to-peer communication, it could increase the interconnectedness of all stakeholders in the ecosystem, potentially leading to more effective information sharing and creation of more value.

In the end, an extensive dialogue, increasing mutual understanding will be necessary to establish initial trust and understanding among stakeholders. On one hand, a certain level of dialogue is necessary for the implementation of blockchain. On the other hand, blockchain can support dialogue by reinforcing trust and increasing the interconnectedness of systems.

7.1.3 Access

The access dimension refers to the availability of useful information to stakeholders (Prahalad & Ramaswamy, 2004). The information availability and integration within the network and the influence of blockchain are explained next.

Information availability.

Within the airport network, there is a certain level of information which is being shared out of necessity. Additionally, stakeholders engage in voluntary information sharing practices. This increases the availability of information in the network that is being shared. Furthermore, advances in data collection techniques increase the availability of information (Lim et al., 2018). By implementing passenger counting and tracking technologies CPH generates additional data on passenger location. However, CPH does not possess the desired data collection techniques yet and is inquiring future possibilities, such as biometrics. This will reveal previously hidden or unavailable information (Chakraborty & Dobrzykowski, 2014).

However, there is a large volume of data available in the aviation industry, perhaps an abundance. When there is too much data stakeholders do not longer know where to find the relevant information (Bagheri et al., 2019). Hence, data overload could possibly explain why the airport claims they do not have

certain information, whereas the airline claims to share it. Alternatively, it may be caused by the deployment of a number of single-purpose systems where information is shared.

Data quality and integration.

Furthermore, the industry has set certain standards that impose common notation, such as the XML standard. This ensures the transfer of data in a standardized way (Kauffman et al., 2010). However, information at the airport is mainly the product of historical data, limiting the accuracy of this information. This limits the quality of the information available and reduces value (Bagheri et al., 2019). Accordingly, the information accessed by other stakeholders is usually with a significant delay. Thus, stakeholders usually do not work with real-time data. As a result, the stakeholders at the airport environment act reactively instead of proactively which has a negative effect on a seamless passenger journey.

Lastly, the airport network is represented by a large number of legacy systems, developed independently from each other, leading to poor interoperability of information systems. From this point of view, there is a lack of investment that supports the relationship between stakeholders. This lack of technical integration impedes information sharing.

Influence of blockchain.

Some information in the airport network is already being captured, however it is not shared. For example, the information on the location of passengers is available in selected checkpoints (e.g. security checkpoint, border control), yet it is not shared. Apart from that, stakeholders do not receive up-to-date information resulting in a reactive rather than proactive mindset. Using blockchain technology, information sharing practices can be automated with immediate access which involves not only sending information but also invoking consecutive actions based on the shared data by using smart contracts.

Further, the interviews revealed that information sharing is not necessarily standardized, leading to inferior information quality. Sole adoption of a blockchain-based system would not solve information quality problems. Hence, it is necessary to standardize information sharing format, most likely by utilizing the industry XML standard. Moreover, as blockchains are append-only systems, the data stored on it cannot be altered. Hence, stakeholders can trust the current state and the quality of data on the blockchain. Additionally, that makes the data on blockchain easily auditable. Adopting the standard and data integrity of blockchain increases the quality of information, subsequently leading to greater value creation (Bagheri et al., 2019).

Setting a blockchain-based system would likely require investment from all stakeholders. Such investment can be classified as a relation-specific investment as it supports transactions between stakeholders (Zhao et al., 2014). Currently, there is a lack of investments in shared IT systems. Using

compatible or a common system for information sharing not only simplifies access to information in the ecosystem, but it also strengthens relationships by showing commitment (Hammervoll, 2009; Dyer, 1997).

7.1.4 Risk-benefit

The risk-benefit analysis concerns itself with the informed evaluation of the outcome of the collaboration, which is influenced by the network structure (Prahalad & Ramaswamy, 2004). Accordingly, this section will discuss the network structure and incentives to participate in the CPH network and propose implications of blockchain on the risk-benefit analysis.

Network structure.

There is a common objective and high level of dependency in the airport network. Moreover, the relationship is, in the end, a supplier-buyer relationship, granting certain expectations. This provides certain stability in the network and ensures clarity of the outcome of the collaboration. Yet, the airport is the center of the network, as all stakeholders come together at the airport. Hence, the airport has a role of facilitator and aims to create a supportive environment for all parties involved. This gives the airport a significant level of bargaining power and the possibility to influence the collaboration (Matinheikki et al., 2016). In accordance with this, CPH airport is financially stronger and has, therefore, a strong influence in the development of the seamless travel experience (Lavie, 2006). However, because of the high level of competition in the industry, airlines hold a lot of bargaining power as well. Hence, they can mandate a desired level of service from the airport and other stakeholders. With this power stakeholders can influence the goals and outcomes of the collaboration, possibly leading to unbalanced outcomes and giving rise to tensions in the network (Chou & Zolkiewski, 2018).

Incentive to participate.

The decision to participate depends on the structure and division of power in the network (Lavie, 2006). However, the relationships within the airport network exist out of necessity. Therefore, there is a limited choice to participate in the cooperation, and stakeholders are to a certain extent bounded to work together. Yet, the outcome of the collaboration benefits all stakeholders. The stakeholders have various motives to ensure a smooth travel experience and they all benefit from it in unique ways. This ensures intrinsic motivation to participate in the collaboration. Formalized agreements dictate the network and allow assessment of the consequences of the collaboration. The formalized agreements prevent the opportunistic behavior of stakeholders, ensuring the effectiveness of the network. Nevertheless, formalized agreements can be reinforced only retrospectively. Yet, this establishes a high level of control in the network.

Influence of blockchain.

So far, this section laid out that the CPH airport is a central player with high influence in the network. The central role of CPH suggests that it may be an initiator of a blockchain system. However, the environment is characterized by the lack of trust among stakeholders in the network. Further, this is backed by the presence of formalized agreements which are put in place to ensure that the shared information is not misused.

Blockchain technology addresses this issue as the governance of the network is decentralized and all stakeholders possibly contribute to the design, governance, and maintenance. Besides that, formalized agreements and uncertainty regarding the use of information may be addressed with smart contracts which specify what the information can be used for and by whom. Nonetheless, the agreements still need to be negotiated along with the governance mechanism of blockchain. Moreover, research has been investigating privacy-preserving techniques of data sharing which potentially decrease the risk of information sharing. These techniques involve zero-proof knowledge (Casino et al., 2019) or private peer-to-peer communication with sidechains (Li et al., 2017). Hence, the implementation of decentralized governance and programmable agreements support the assessment of the outcome of the collaboration.

7.1.5 Transparency

Transparency is concerned with the trust in the network and the true motivation or goals of stakeholders (Chakraborty & Dobrzykowski, 2014). Hence, the quality of relationships and the influence on information asymmetry are discussed next, followed by the impact of blockchain.

Quality of relationships and information asymmetry.

There is a lack of accountability and transparency within the network, stemming from passengers' unawareness of which stakeholder provides which part of the service. Hence, space is created for opportunistic behavior. Stakeholders can perform an action without it directly affecting them, while it can harm others. In the long run, this sort of behavior would negatively impact the relationships (Matinheikki et al., 2017). Yet, there is a shared mission and commitment to delivering a common service, which minimizes the threat of opportunistic behavior. However, from an operational point of view, all stakeholders have their own stake and interest in ensuring this experience. Hence, the different challenges faced by different stakeholders, result in different interests within the seamless passenger journey and get in the way of mutual understanding. The lack of mutual understanding can have negative consequences on the outcome of the collaboration on the individual stakeholder level, and lead to missed opportunities for value creation (Cao & Zhang, 2011; Bagheri et al., 2019). Additionally, the lack of trust in the environment prevents the sharing of data and gets in the way of transparency (Bagheri et al., 2019).

Yet, the absence of transparency is limited by necessary data sharing, regulated by law or agreements between parties. Hence, the formalized agreements and regulated environment reduce information asymmetry.

Influence of blockchain.

An inherent advantage of blockchains is that the technology maintains data integrity while the system is decentralized (Yaga et al., 2018). Therefore, multiple stakeholders can input data while preserving transparency and data integrity, since every record on the blockchain is signed by the contributor. Furthermore, blockchain is an append-only system so information added by one stakeholder cannot be changed by anyone (Wamba et al., 2020; Golosova & Romanovs, 2018; Lacity et al., 2019a). The data integrity and transparency of blockchain makes the behavior of all stakeholders accountable. Moreover, a stakeholder on one end of the supply chain can hold another stakeholder accountable. Ultimately, more accountability motivates stakeholders to act diligently resulting in more efficient operations and value co-creation. Additionally, it will be beneficial for the relationships in the long run. Blockchain involves increased communication between all stakeholders which can have a positive effect on the quality of relationships in combination with increased transparency. Therefore, blockchain supports transparency by increasing accountability in the airport network.

Table 6*: The influence of blockchain on the DART dimensions*

DART Dimension	Influence of Blockchain
Dialogue	Blockchain supports dialogue by reinforcing trust among stakeholders and increasing the interconnectedness of systems
Access	Blockchain supports access by increasing the availability and accuracy of information
Risk-benefit	Blockchain supports risk-benefit analysis by programmable agreements and decentralized governance
Transparency	Blockchain supports transparency by increasing integrity and accountability in the airport network

7.2 Ambidexterity and Operational Performance

Passenger processing at the airport is a complex process, which relies on the coordination of the operational processes. Many stakeholders in the ecosystem engage in the delivery of the customer journey, which requires information exchange among each other. Moreover, the CPH airport as well as the whole industry expect the increased demand of passengers in the coming ten years. Additionally, passengers progressively

prioritize the efficiency and effortlessness of the overall journey. Hence, the use of IT is vital for efficient, scalable passenger processing to meet the growing number of passengers.

As laid out, CPH facilitates an airport network which consists of a number of stakeholders, who cooperate to create value. Even nowadays, stakeholders share certain types of information to be able to offer and improve their services. As mentioned in Chapter 4.4.2, information may be treated as an infinite resource which can be accessed from within and outside of the organization (Gupta et al., 2006). Especially in the case of the airport ecosystem, the information has been shared to a certain degree, and the stakeholders are highly interdependent. Hence, exploration and exploitation in this context are orthogonal. Thus, it is vital to maximize both exploration and exploitation to ensure increased long-term performance.

7.2.1 Current Exploitation and Exploration Initiatives

Currently, CPH is exploiting the existing IT infrastructure to increase insights in operations related to passenger processing. This optimization of processes is supported by the design and layout of the airport. Furthermore, they also explore possible innovations and try to prepare for future demand. Hence, they engage in exploration and exploitation. The discussion of IT and operational exploration and exploitation follows. Additionally, Table 7**Error! Reference source not found.** provides an overview of the most significant activities.

Exploitation.

A lot of industry infrastructure is built on legacy systems (Arthur D. Little, 2017). These established systems can be used to refine existing knowledge. In this way, effective IT exploitation can derive more value from the same amount of information (Chen et al., 2020). The existing infrastructure, knowledge, and resources are used to extract additional insights while the infrastructure is being maintained and refined. Moreover, this is sometimes combined with information from other stakeholders. CPH accesses data from outside of their organizational boundaries, as they closely cooperate and communicate with other stakeholders. The stakeholders at the airport have strong ties and thus their relationship mainly enables knowledge integration and steady flows of information (Tiwana, 2008). As an example, CPH uses historical data in combination with data from airlines to predict traffic at the airport. The historical data is used in combination with passenger count data from some airlines to predict expected traffic. Especially because of the limited physical space and number of counters, this is of high importance to CPH. However, it appears that CPH is not able to exploit some data from stakeholders, as certain data seems to be shared with them, but not used. The airlines claim to share information on incoming flights, such as the nationality of passengers, but CPH is neither aware of that nor exploits that information.

Further, CPH exercises operational exploitation by optimizing their existing infrastructure. For example, visual clues (e.g. signs) are tailored to the considerable amount of Chinese passengers arriving at

the airport. This mitigates confused passengers. Furthermore, passengers are notified to prepare their passport for inspection when waiting at the passport control. So, CPH actively acts to avoid congestions at touchpoints. The airport has been able to reveal the need for these initiatives by collecting information from passengers by conducting surveys and observations. Such exploitative activities streamline operations of the airport by reducing the need for additional staff to help passengers navigate the airport and reduce the wait times at border control.

Exploration.

As for IT exploration, the airport is taking a risk-averse approach. The airport representative pointed out that CPH is usually not a first mover. Instead, they observe the industry practices, consult their approach with partner airports, and adopt a new innovation when it is proven to generate returns. One of the explorative activities the airport considers is the use of biometrics for more accurate real-time tracking of passengers and to offer personalized services. Accordingly, the technology is already investigated at the Singapore Changi airport (Aravindan & Geddie, 2018). While CPH airport currently engages in exploration, it has not investigated blockchain technology.

The airport engages with stakeholders in exploratory activities outside of the organization. This includes airports who are not direct competitors of CPH, like Singapore or Istanbul Airport. The collaboration with them is in a rather consultative manner compared to collaboration with other stakeholders at the CPH airport. Thus, the communication is not as intensive. The strength of the relationship can be categorized as weak ties which promote exploration of new ideas and acquisition of new knowledge (Tiwana, 2008).

CPH's exploratory initiatives are largely motivated by the expected growing number of passengers in the upcoming ten years. Accordingly, the airport has finished building a new airport pier and has planned expansion of the shopping mall at the airport. Similarly, a new baggage factory is being constructed. As previously mentioned, the airport has been conducting data with surveys. This cannot only can lead to further exploitation, but this allows the airport to explore new kinds of services. As an example, the airport representative mentioned that they investigate new services tailored to families as it is a significant customer segment for them.

Ambidexterity of CPH.

It can be argued that CPH airport has a focus on exploitation. In the case of CPH, the network is characterized by legacy IT systems, to optimize processes. This is in line with the rest of the aviation industry (Arthur D. Little, 2017). The greater importance of exploitation can result in the obsolescence of IT resources (Chen et al., 2020), which limits interoperability Accordingly, certain information is not being

shared or sandboxed. Ironically, the focus on exploiting current IT resources to optimize processes, results in a lack of integration of stakeholders, getting in the way of operational performance.

This lack of information sharing and integration has a negative effect on the offering of a seamless journey. Not utilizing certain information by stakeholders, causes two identified operational challenges related to passenger processing. First, the lack of information sharing related to passenger location results in delays. Second, the inaccurate information on passenger numbers results in inefficient resource allocation.

Table 7: *Overview of IT and Operational Exploitation and Exploration*

	IT	Operational
Exploitation	- Legacy systems - Historical data	- Visual clues - Physical airport layout
Exploration	- Risk-averse - Biometrics	- New pier and baggage factory - Investigates new service offering

7.2.2 Exploitation with Blockchain

The aforementioned operational challenges negatively impact the performance of the airport. However, they can potentially be resolved with the exploitation of the capabilities of blockchain technology. Table 8 provides a summary of the most significant effects of blockchain on exploitation.

Operational Challenges.

The limited sharing of data, or limited use of shared data stemming from possible unawareness results in inaccurate predictions on passenger traffic. Not all airlines share data and IT systems within the airport network are not interconnected. Hence, the shared data is not updated real-time and so the shared passenger count may be inaccurate, as more passengers can buy a flight ticket for a given flight, or not check-in. The second challenge for airports, airlines and other stakeholders alike, is that they are unaware of passenger location. Not knowing the passenger location may negatively influence the baggage onloading and offloading, passenger experience and even cause flight delays. Nonetheless, the information on passenger location is already collected at all checkpoints, however the data is sandboxed and not shared.

Automate and Coordinate.

Blockchain allows the airport to use existing resources to create new insights. Using blockchain technology, information sharing can be automated while using standardized format, such as the upcoming industry standard XML. IT exploitation in the form of more effective information sharing using standards can create additional value, as this will increase the understanding of existing resources (Chang et al., 2019). Moreover, blockchain enables an organization to process information from stakeholders. Existing IT applications can

relate newly acquired information with existing information (Wei et al., 2019). Having real-time data about traffic will enable the airport and other stakeholders to be proactive instead of reactive. For example, additional security checkpoint stands can be opened before the customers line up. Hence, the activities of the airport and the security checkpoint are coordinated, creating a seamless journey for the passenger. Moreover, blockchain can enable multiple participants to contribute to a single ledger of data while preserving integrity of the data. Hence, each stakeholder can update the status of passenger location when they pass a checkpoint. Having the additional real-time information result in less delays and higher passenger satisfaction.

TO-BE Process.

Implementing a blockchain-based system may increase stakeholder informedness and address the two aforementioned operational challenges. Having the additional data could enhance the operational performance by predicting traffic more accurately, identifying passenger location, subsequently enhancing passenger experience at the airport while reducing costs for other stakeholders by exploiting the existing infrastructure. The rest of this section illustrates how the blockchain-based system could work. Note that the illustration is simplified. In reality, additional stakeholders are involved in some of these processes, for example in ticket purchasing.

The idea of blockchain is that all stakeholders share and contribute to the same data repository while keeping integrity of data. Thus, information about passenger processing may be shared to ensure a seamless journey for passengers. When a passenger buys a ticket, the airline issues a booking confirmation. At the same time, the airline can upload information about the new ticket purchase for a flight departing from CPH airport on blockchain. That way, the airport and other stakeholders processing passengers at the airport have up-to-date information about expected number of passengers coming to the airport on a given day. Therefore, especially the airport can allocate resources according to the real-time passenger figures. Moreover, they can coordinate their activities with other stakeholders, such as border control, to prevent any congestions throughout the passenger journey.

Next, the passenger obtains a booking confirmation and checks-in for the flight. Consequently, the airline issues a boarding pass, updates passenger's progress on the blockchain and on top of that records that the passenger has arrived at the airport if they do so in a check-in kiosk. Alternatively, the airline can access passenger's location if the permission is given. Afterwards, the passenger scans the boarding pass and reaches the security checkpoint. The airport records the information that passenger reached security checkpoint and uploads the information on blockchain. In the case of an overseas flight, the border police updates passenger's location once they pass the border control. Likewise, passenger's location may be updated when they enter the airport lounge. Lastly, when the passenger boards the flight, the airline updates the passenger's location and thus confirms that the passenger is leaving airport premises.

Throughout the process, all authorized stakeholders can view passenger progress information resulting in more informed decisions and new possibilities for stakeholders. Especially, the airline can make an informed decision on takeoff, to prevent delays. By being aware of the passenger's location they may decide to offload the passenger's baggage proactively if the passenger is not in proximity to the gate. Alternatively, the passenger can receive a proactive push notification, based on their location, reminding them to come to the gate. This can become even more effective with more granular data on passenger location from advanced passenger tracking technologies (e.g. biometrics). Besides that, baggage handlers can wait with baggage onloading if passenger is likely not to board the plane. Hence, the exploitation of information can result in less delays at the CPH airport and higher passenger satisfaction.

7.2.3 Exploration with Blockchain

To facilitate the additional exploitation, the airport has to explore blockchain technology first. Blockchain is a foundational technology and it leads to generation of new services and increased collaboration in the industry. Table 8 provides a summary of the most significant effects of blockchain on exploration.

Blockchain as a foundation.

First, adopting blockchain technology requires a high degree of IT exploration as it is an emerging technology, which has not been widely applied in the aviation industry yet. The exploration of blockchain can support business processes, especially within operations, as blockchain's characteristics and capabilities support information sharing. Blockchain technology is a foundational technology, hence its deployment can lead to creation of more value than anticipated (Iansity & Lakhani, 2017). Similar to internet, blockchain technology is a foundation for further innovation, involving new business models or business processes (Mougayar, 2016) as it enables payments and smart contracts which speeds up and simplifies business processes.

In general, more information sharing among stakeholders leads to better informedness within the network, which subsequently allows them to better prepare for the future demand by exploring either collaboratively or alone. Integrating external data from other stakeholders possibly increases operational exploration since it enables them to learn more about customers (Nazir & Pinsonneault, 2012). As blockchain enables shared data storage, a variety of data may be shared on blockchain. Exploration of other technologies like biometrics generates more data which can be stored on blockchain and leveraged by all stakeholders to create new services and business models. Hence, the implementation of blockchain may cause further IT exploration as it increases reach and richness of knowledge base (Chen et al, 2020).

Nonetheless, it needs to be ensured that only truthful and accurate data are uploaded on blockchain. Therefore, the so-called oracle problem has to be solved before the information is shared, otherwise it can lead to false information being shared instead of value co-creation. The oracle problem can be resolved by

using trusted secure certified devices with high accuracy. Using a blockchain-based system may provide stakeholders an environment where they share information directly.

New service creation.

This additional data may lead to exploration of new services or operational processes. As an example, the airport or bars and restaurants may launch food delivery within the airport as previously seen at San Diego International Airport (OAG, 2020a). Other innovative business model with new operational processes may be personalized check-ins. Hotels and other businesses may check-in passengers' baggage, which are later transferred to the airport. When other stakeholders like hotels join blockchain, the information about baggage becomes integrated and visible to all other stakeholders in the value chain.

Towards collaborative aviation industry.

As the technology becomes more widely used in the industry and blockchains become more interoperable, CPH airport will have an infrastructure ready for information sharing also with other airports. Outsiders may have more trust in data on blockchain as they are tamper-resistant and are based on consensus of all stakeholders participating in the blockchain network. The harvested data can be shared with other stakeholders which can benefit with optimized operations, less delays, but also can offer personalized content for passengers across the whole trip from airport to airport. To facilitate this, new techniques allowing interoperability of blockchains and other IT systems need to be developed. Hence, the implementation of blockchain technology can result in increased IT and operational exploration as well as exploitation which supports the improvement of operational performance. Furthermore, being an ambidextrous organization improves firm's long-term performance.

Table 8: *Overview of IT and Operational Exploitation and Exploration with Blockchain*

	IT	**Operational**
Exploitation	- Automation - Additional insights	- Coordination - Proactiveness
Exploration	- Foundation for further innovation	- Future demand and collaboration - New services

7.3 Collaboration and Firm Performance

This chapter will discuss the implications of information sharing on firm performance, to anticipate the change in performance after implementation of blockchain. In the airport network, data is currently being shared within a number of processes. Hence, there is a set of shared resources in the network. However, there is also information which is currently not being shared. Combined with stakeholder's own resources,

this constitutes the non-shared resources. The total amount of resources available to a stakeholder comprises of their non-shared resources and shared resources (Lavie, 2006). By leveraging internal, relational and spillover rents, these resources allow the airport to perform certain activities better or cheaper than competitors, leading to a sustained competitive advantage (Lavie, 2006). The following sections will further elaborate on the rents derived by the airport, which contribute to a smooth journey.

7.3.1 Internal Rents

Internal rents are derived from non-shared resources (Lavie, 2006). Hence, they are the resources owned by the airport, consisting of tangible and intangible assets. First, historical data on aggregate passenger number is used to make predictions on expected passengers at a certain date and time. These resources are used for planning purposes. Second, passenger flow optimization efforts result in a smoother travel journey. As already mentioned, signage is used to direct passengers through the airport efficiently. Nudging of passengers improves the efficiency of processes by preparing passengers for an activity that will happen. Moreover, CPH provides a mobile application for passengers with information on shops and restaurants located in the transit area, updates on their journey, and additional services. Together, these initiatives ensure that passengers experience an effortless flow through the airport, increasing the time in the transit area. Lastly, the airport layout is purposefully designed to provide a smooth journey to passengers to spend money. Only stores endorsed by CPH are present, and their location is based on the customer segment they serve. These stores and restaurants can be seen as interfirm resource complementarities, as they provide additional value to the physical site of the transit area at CPH. The airport's transit area becomes more valuable, as value is derived from the reputation of concessionaires.

The aforementioned resources can be categorized as specialized resources. This means that they allow CPH to extract added value from these resources (Lavie, 2006). Hence, historical data, passenger flow optimization, and the physical layout of the airport increase the competitiveness of CPH, by ensuring a seamless travel experience.

7.3.2 Relational Rents

Besides internal rents, the collaboration in the network allows the airport to take advantage of relational rents. Relational rents are the common benefits arising from the collaboration (Dyer & Singh, 1998).

Relation-specific assets.

According to Dyer & Singh (1998), interfirm relation specific assets arise from site specificity, physical asset specificity, and human asset specificity. First, physical assets such as self-automated baggage-drop and self-check-in service points increase the potential for relational rents at the airport. However, physical asset specificity and site specificity are not a major contributor to relational rents in the airport network. The

original relational view proposed by Dyer and Singh (1998) focuses on distributed supply chains, manufacturing a physical product. For this type of firm, physical asset specificity and site specificity are more significant. However, at the airport stakeholders collaborate out of necessity at one physical location, providing service and exchanging limited physical resources. Hence, the authors of this paper argue that the airport is more concerned with information interactions. Besides human asset specificity, Dyer & Singh (1998) do not recognize intangible assets. However, Subramani & Venkatraman (2003) supplement relational rents by recognizing business-process specificity as an additional source of asset specificity. Business-process specificity can be defined as the degree to which business processes of one firm are specific to the requirements of the partnering firm, and include context-specific processes (Subramani & Venkatraman, 2003). At CPH, stakeholders communicate with each other and make agreements to ensure partners meet their desires and standards. Hence, it can be assumed that specialized routines within the airport network are a source of relational rents.

Knowledge sharing.

Yet, relational rents can result out of interfirm knowledge sharing routines, leading to organizational learning (Dyer & Singh, 1998). The stakeholders in the network have frequent meetings where they exchange developments, challenges and conditions. These meetings are a source of knowledge exchange and an opportunity for stakeholders to learn from each other. Moreover, CPH airport exchanges knowledge with airports that are not directly competing to improve operations. Hence, when an airport is performing outstandingly in a certain area, this knowledge can be leveraged by other partner airports. Therefore, the sharing of knowledge between stakeholders is a source of new information and knowledge and provides benefits to all stakeholders in the network.

Complementary resources.

Moreover, complementary resources from stakeholders collectively generate greater benefits (Dyer & Singh, 1998). In the case of the airport network, the main source of complementary resources is data sharing. Stakeholders work towards the same service but have different data available to them. Moreover, the data from stakeholders in the network cannot be obtained elsewhere. When combining this data, the value increases and synergies arise. The combined data gives a complete overview of the processes in the environment and can be used to improve operations. Therefore, shared information is a source of relational rents. Moreover, shared physical resources, such as the check-in desks, are located at the airport but operated by different stakeholders. Hence, the airport makes use of its own infrastructure in combination with stakeholders' capabilities. This allows an increase in the overall capability of the airport to guarantee a smooth travel experience.

Governance.

Lastly, governance plays an important role in generating the aforementioned rents, as it encourages and orchestrates participation (Dyer & Singh, 1998). The current airport network is governed by formal contracts, including service level agreements. Moreover, self-enforcing agreements, in the form of informal safeguards play a role as well. On one hand, the airport network is characterized by a low level of trust between stakeholders. Yet, there are initiatives to create mutual understanding and trust, such as AOC meetings. On the other hand, stakeholders are highly dependent on each other. The airport cannot operate without airlines and vice versa. This dependency supplements formal contracts as a governance mechanism.

7.3.3 Spillover Rents

Inbound and outbound spillover rents refer to the unintended gains from a partnership (Lavie, 2016). However, while there is cooperation in the airport network, they are not alliance partners. Stakeholders are working together at the same physical location, providing a common service, but in the end take part in individual supplier-buyer relationship. Therefore, spillover rents from non-shared resources are not of significance to the relationships within the airport network, as non-shared resources cannot be as easily accessed in the same way as in a formal alliance.

Yet, spillover rents from shared resources result in a tension between sharing and not sharing certain information in the network. While stakeholders show willingness to share information, in practice this has only happened to a certain extent. This could be explained by the prevailing mindset that information is valuable and should be protected. Hence, the main reasons for not sharing this information is the fear of outbound spillover rents. Stakeholders in the network fear that the resources can be used for another purpose that might damage them in some way in the future.

7.3.4 Current Firm Performance

As a consequence of the hesitation to share information, there is a moderate amount of complementary assets in the airport network. Additionally, the airport benefits from some asset specificity, by joined investments in digital solutions and by establishing a moderate level of business process specificity.

The dependency of stakeholders on each other, forces processes to be tailored and coordinated to some extent. However, all airports play a facilitating role in a network where stakeholders are dependent on each other. Therefore, all airports enjoy some relational rents. Yet, all airports differ in their digital maturity and have different levels of digital solution, resulting in different physical asset-specificity (Arthur D. Little, 2017). Moreover, depending on the level of interaction and integration within the network they generate different levels of business process specificity. Moreover, all airports learn from other airports' processes, potentially mitigating process specificity.

While formal contracts including SLAs provide limited additional value over other airports. Therefore, currently the main source of competitive advantage from passenger processing at the airport arises from their non-shared resources, generating internal rents. Accordingly, there is a limited advantage of relational rents in the airport network, and the airport is unable to create a competitive advantage out of the collaboration.

Table 9: *Influence of Blockchain on Performance*

	Internal Rents	**Relational Rents**	**Inbound Spillover Rents**	**Outbound Spillover Rents**
Derived from	Passenger flow optimization Historical data Physical Layout	Complementary data and competencies	Using information for own advantage	Damage resulting from the use of information by stakeholders
Influence of Blockchain	*None – blockchain is a shared resource*	1. Increased interaction 2. Business process specificity 3. Prepare for future demand	Enhanced governance mechanisms	Enhanced governance mechanisms

7.4 Flying towards Airport 4.0 with Blockchain

By increasing the dialogue, access, risk-benefit and transparency dimensions in the airport network, blockchain supports value co-creation among stakeholders, by strengthening the interaction among stakeholders. This increased interaction encourages information sharing in the network. Hence, blockchain can be seen as a system that enhances the opportunities for the co-creation of a personalized seamless journey, by effectively leveraging additional information from stakeholders. This is in line with Prahalad & Ramaswamy (2004), who argue that opportunities for value creation are enhanced significantly by co-creation of experiences as the source of unique value. Thus, the increased interaction among stakeholders enhances sharing of information between stakeholders, resulting in added value for the airport. Furthermore, by exploiting the capabilities of blockchain, previously unavailable data is made available and additional insights are created. Accordingly, the capabilities of blockchain combined with the increased interaction in the network leads to greater rents from complementary resources.

Moreover, blockchain is often viewed as a novel infrastructure for information sharing, enabling responsive, proactive and adaptive operations at CPH. By supporting both IT exploitation and exploration, blockchain can achieve greater IT ambidexterity. IT ambidexterity positively influences operational ambidexterity, supporting the coordination of activities of stakeholders, while allowing adaptability to meet

future demand. Hence, as infrastructure for information sharing blockchain increases the opportunity for business process specificity in the CPH airport network, since current and future business processes of one stakeholder to be coordinated with the requirements of another stakeholder. This is supported by the increased interaction among stakeholders. Collectively this reduces costs, and enhances the service provision, by ensuring the delivery of a seamless passenger journey.

Furthermore, programmable agreements increase the possibilities for formalized safeguards in the network. Additionally, the decentralized governance of blockchain and the ability to reinforce trust will increase the self-enforcing safeguards. Hence, several governance mechanisms are enhanced with blockchain. The increase in effectiveness of governance results in increased potential for relational rents (Dyer & Singh, 1998).

In conclusion, Table 9 provides a comprehensive overview of the influence of blockchain on performance. Blockchain is able to address operational challenges by increasing information sharing and specialization of business processes. Together, the increase of complementary resources endowment and business process specificity in the Copenhagen airport network results in greater relational rents and a seamless passenger journey. Moreover, this is supported by the ability of blockchain to enhance governance mechanisms. Hence, the total amount of relational rents from the collaboration with blockchain exceeds the relational rents without blockchain. Accordingly, CPH has the ability to appropriate a larger part of relational rents, providing added value relative to other airports. This means CPH is able to gain a competitive advantage from blockchain by offering a seamless travel experience to passengers.

Supporting the CPH strategy.

Besides positively influencing the seamless journey and increasing the competitiveness, blockchain also supports the objectives of CPH. Correspondingly, blockchain is in line with the strategic goals of CPH, as presented in Table 10. The alignment between business and IT has been given a lot of attention in research. Accordingly, previous research widely recognizes the importance and benefits of aligning IT and business for organizations (Tai et al., 2019; Lee et al., 2015). Therefore, the alignment between blockchain and CPH their strategy is crucial.

While this use case of blockchain does not directly affect sustainability, the foundational technology does support innovative thinking and collaboration, and can be expanded to collaborative initiatives contributing to sustainability. Moreover, this research proposes that blockchain supports the delivery of a seamless passenger journey, by tackling operational challenges. Besides increasing customer satisfaction, this means passengers have more time to spend money at the airport. Personalization of the journey, based on additional insights from data, can further support this. Moreover, blockchain supports operational exploration and digital innovations to meet future demand. As blockchain is a foundational technology, it can also result in the creation of new services and revenue streams. Lastly, the strategic goal of CPH,

developing skills and an organization for the future, supports the adoption of new technologies such as blockchain, by preparing employees and the organization for change.

Table 10: *Blockchain and the Strategic Goals of CPH*

(1) Sustainability	**(2) Passenger Experience**	**(3) Ready for the Future**	**(4) Employee Development**	**(5) Data-Driven**	**(6) New Revenue Streams**
Support collaboration and innovation	Seamless journey and personalization	Ambidextrous	Supports the adoption of new technology	Additional information and insights	New service creation

8. Conclusion

This exploratory study aimed to investigate how blockchain technology can improve information sharing practices at the Copenhagen airport. The airport, like the rest of the industry, is facing an increasing demand and a desire of passengers for a seamless travel experience, which requires the industry to become proactive based on the real-time information. To facilitate this, information sharing related to passenger processing needs to be increased. Blockchain technology supports data storing and sharing in transparent, secure, and tamper-resistant way. Accordingly, the main research question was formed: which requires the industry to become proactive based on the real-time information. To facilitate this, information sharing related to passenger processing needs to be increased. Blockchain technology supports data storing and sharing in transparent, secure, and tamper-resistant way. Accordingly, the main research question was formed:

RQ: *"How can blockchain address information sharing challenges in the Copenhagen airport network to improve performance of CPH Airport?"*

To answer this, an exploratory case study research was designed as it allows to create an in-depth understanding of passenger processing at the airport ecosystem. As the in-depth understanding is critical for the case, data were collected with multiple methods to create rich understanding. Five semi-structured or in-depth interviews, one semi-structured email interview, an airport tour, and participant observations were used as means for data collection. Additionally, knowledge was derived from secondary data such as industry reports and annual report of CPH. Furthermore, the literature review of relevant concepts was conducted which were utilized to analyze the case findings. These concepts include blockchain technology, value creation in networks, and ambidexterity.

The findings from the data collection revealed the complex dynamics of relationships in the airport network. While the stakeholders depend on each other, the relationships are formalized. Moreover, the stakeholders are working together to deliver a common service to customer. However, each stakeholder has different interests. In addition, the airport has a central position in the ecosystem as it hosts other stakeholders on its premises.

Furthermore, the stakeholders in the airport network heavily rely on legacy IT systems. These systems were developed over time and hence are not compatible and interconnected. Thus, communication is fragmented into various means of data sharing such as databases, links, emails, or web telex. The legacy IT systems along with stakeholder's mindset limits the amount of information sharing. Accordingly, most information sharing currently results out of necessity.

Lastly, the data collection identified two prominent operational challenges caused by the lack of information sharing with regard to passenger processing at the CPH airport. The lack of information sharing

causes challenges when predicting traffic causing challenges when scheduling staffing. On top of that, stakeholders lack information on passenger location resulting in flight delays and degrading passenger satisfaction. Lastly, the stakeholders acknowledge the need for digital transformation and adoption of new technologies in order to satisfy the increasing demand passengers' needs.

8.1 Answering the Research Questions

To answer the research question, three sub-questions were formulated to guide the research. The first sub-research question was aimed at deepening the understanding of the implications of blockchain on value co-creation, as the stakeholders collectively provide the passenger journey.

SRQ 1: *"How can blockchain technology support value co-creation?"*

By analyzing the findings with the DART framework, this study proposes that blockchain can have a positive effect on value co-creation. First, blockchain reinforces trust and increases the interconnectedness of systems, positively contributing to dialogue in the network. Second, blockchain increases access, by enhancing the availability of information. Third, with programmable agreements and decentralized governance blockchain reinforces informedness about the outcome of the collaboration. Lastly, blockchain underlines accountability in the airport network, increasing transparency. Overall, by supporting the DART dimensions, blockchain can support the interaction between stakeholders, leading to enhanced information sharing.

The second sub-research question was formulated to explore the implications of blockchain technology on operational performance.

SRQ 2: *"How can blockchain support operational performance?"*

Applying ambidexterity theory to the findings increased the understanding of the impact of characteristics and capabilities of blockchain on operational performance. This thesis proposes that blockchain as IT exploration can reinforce both IT exploitation and exploration, leading to IT ambidexterity and operational ambidexterity. Accordingly, blockchain capabilities support information sharing, reveal hidden information and create additional insights. This allows the airport to simultaneously align their processes with stakeholders, while adapting to future demand. Therefore, by supporting operational ambidexterity, blockchain can support business-process specificity among stakeholders in the airport network.

The last sub-research question was aimed at obtaining an understanding of the effect of the current information sharing practices on the performance of CPH, to be able to anticipate the change after implementation of blockchain technology.

SRQ 3: *"What are the implications of information sharing on firm performance?"*

Utilizing the extended resource-based view to analyze firm performance, this study proposes that the current competitive advantage resulting from the provision of a seamless passenger journey, is derived mostly from non-shared resources. Passenger flow optimization, physical layout and historical data are the core of current passenger processing initiatives. Hence, CPH takes limited advantage of relational rents and does not optimally benefit from their network.

Together, the three sub-research questions facilitate the answer to the research question. First, the DART framework shows that blockchain can support information sharing between stakeholders, increasing the complementary resource endowments in the collaboration. Moreover, the capabilities of blockchain further support information sharing and insights gained. Next, by supporting both IT and operational ambidexterity and enhancing interaction among stakeholders, blockchain increases business process specificity. Additionally, programmable agreement and increased trust enhance governance mechanisms, accelerating the possibility for relational rents. Therefore, blockchain can advance complementary resource endowments, business process specificity, and governance mechanisms, giving rise to additional relational rents.

The rise in relational rents results in a higher potential for rent appropriation by the airport, increasing their added value relative to other airports. Accordingly, blockchain enhances the provision of a seamless travel journey, increasing the competitive advantage of CPH. Moreover, blockchain is in line with CPH's strategic outlook, supporting the beneficial outcome of a blockchain initiative at CPH.

8.2 Managerial Implications

The following section will discuss the implications for management. First, the authors argue that alternatives to blockchain should be considered. Next, blockchain has a lot of technical and operational implications, but the social aspects of the theory should not be neglected.

8.2.1 Acknowledge Alternatives

Blockchain technology may not be the only solution to facilitating increased information sharing as there are other ways for stakeholders to share and store information. In fact, stakeholders can do so with a shared database linked with internal resources facilitated by APIs. However, databases are centralized systems which comes with advantages as well as disadvantages compared to blockchain, as laid out in Chapter 4.1.7.

First, databases offer superior technical performance for cases where high throughput, scalability, and low latency is necessary (Wüst & Gervais, 2017). Therefore, the airport, should identify how much data is going to be shared, in what frequency along with the need for timeliness of data. Second, databases are

centralized which often implies the presence of a TTP on whom stakeholders are reliant. In contrast, blockchain can eliminate the reliance on a TTP and at the same time ensure high up time of the system due to the distributed nature. Hence, the airport and stakeholders have to analyze the importance of storing data on its premises, and vitality of no downtimes. Third, blockchain networks rely on computing-intensive consensus models, ensuring integrity of the data. Therefore, the data on blockchain can be seen as 'a source of the truth' (Narayanan et al., 2016). Furthermore, blockchain allows peer-to-peer communication while maintaining privacy with encryption of transactions (Li, et al., 2017). Distributed databases are less energy intensive, but data in databases can be altered, updated, or deleted as opposed to blockchains which are append-only systems (Kolb et al., 2020). While distributed databases cannot provide the same level of data integrity, there is a need for more trust among stakeholders. Accordingly, the airport needs to consider the level of trust in the network. Apart from that, most blockchain solutions are simple chronological data structures which are not appropriate for managing complex data structures, as relational databases are (Ahmed et al., 2019). Therefore, the complexity of data should be taken into account when making a decision on adoption of blockchain.

In order to determine whether blockchain-based system is the appropriate solution for the airport network, stakeholders have to weigh benefits of the blockchain technology over the additional costs associated with implementation and maintenance of blockchain. Lastly, it is important to note that the characteristics of blockchain may vary depending on the implementation of blockchain. For example, the chosen consensus mechanism influences scalability of the network as well its electricity consumption (Yaga et al, 2018).

8.2.2 Social Aspect of the Transformation

In comparison to traditional centralized IT systems, a blockchain-based system requires increased communication efforts, as it is decentralized and managed by a group of stakeholders. Therefore, the nature of blockchain is highly political, and setting the network may require more intensive negotiations and time. Accordingly, the social aspect of the implementation of the technology should not be neglected. Development of initial trust and embracing collaboration is vital to the implementation of blockchain.

Respectively, it should be noted that while this paper is focused on the performance of the airport, this does not mean that the performance of other stakeholders can be neglected. To a certain extent all stakeholders in the airport network collaborate out of necessity and are dependent on each other. Hence, a good relationship between stakeholders is important, to create harmony in the environment and sustain the collaboration. Accordingly, the airport must ensure that stakeholders capture sufficient value from the collaboration and that there is an incentive to participate, as described in the risk-benefit dimension of the DART framework. This will be crucial to successful ongoing collaboration in the airport network.

8.3 Limitations

This thesis comes with certain limitations, which need to be addressed. The first limitation is the consequence of the timing of the study. This thesis was written during the COVID-19 outbreak, which limited the research in several ways. The outbreak had immense consequences for the aviation industry and limited the availability of participants. Thus, this research suffered from participant drop out. As a result of the COVID-19 outbreak, Norwegian Airlines subsidiaries declared bankruptcy in Denmark and the scheduled interview with one of the employees was canceled. Similarly, the researchers were going to attend the Blockchain Expo Global in London (https://blockchain-expo.com/global/) to get additional insights from blockchain experts. The expo was supposed to include an event specifically about blockchain in aviation which would be an opportunity to collect more primary data and conduct interviews. However, due to the outbreak, the conference was canceled.

Because of the aforementioned reasons, the researchers were only able to obtain access to limited representatives from each stakeholder group. This limits the data collection, as this provides a too narrow view. In conclusion, the timing of the research resulted in a lack of breadth and depth of the collected data. Therefore, to supplement the perspective of a ground handling company at CPH, Diederik van Thiel from KLM ground operations at Schiphol airport (Amsterdam) was interviewed. The researchers acknowledge this is in conflict with the single case study. However, in order to minimize the interference, the interview discussed the entire industry, without a specific focus on Schiphol.

Next, again partly because of COVID-19, only limited access to CPH was obtained. Therefore, the researchers acquired only limited knowledge of the IT infrastructure of CPH and gained an incomplete picture of the airport network. This knowledge was supplemented with publicly available documents. However, this resulted in several grey areas, decreasing the reliability of this study.

Lastly, the present thesis concerns a single case study. This means that it is not possible to compare different airports with each other. All airports differ in their digital maturity and have different needs and priorities with digital transformation (Arthur D. Little, 2017). Therefore, this research is tailored to CPH and can only be extended to airports of similar digital maturity and size. Therefore, a comparison of different airports in a multi-case study would provide more generalizable results.

8.4 Theoretical Implications and Future Research

This research adds to the research community by exploring opportunities for blockchain at airports. More specifically, this paper discusses the influence of blockchain on passenger processing. Accordingly, this thesis adds to the theory by showing that blockchain can support passenger processing, resulting in a seamless journey and increased competitiveness of the airport. Moreover, this research proposes the relevance of adaptability to performance and competitive advantage. Lavie (2006) does not take this into consideration in the formulation of the extended resource-based view. However, more recent research

confirms the relation of adaptability and dynamic capabilities on agility and competitive advantage (Lee et al., 2015; Reeves & Deimler, 2011). Accordingly, this research supports the view of adaptability as a competitive advantage complementing to competitive advantage derived from the positioning of resources.

In this thesis, the authors focused on the theoretical implications of blockchain technology for CPH airport. Nevertheless, the study is exploratory and accordingly forms propositions. To test these propositions and to practically address the information sharing challenges, the research should advance with the development of a prototype. This thesis treated blockchain as a concept with a set of characteristics according to the blockchain technology research while blockchain implementations can vary. In order to develop a prototype, an appropriate blockchain solution will have to be chosen which may be an enterprise-grade blockchain such as Hyperledger Fabric, R3 Corda, or Ethereum for Enterprise. Therefore, this research can serve as a stepping stone for future research on blockchain in the aviation industry.

Apart from that, this thesis investigates the implications of blockchain technology at the CPH airport. As presented, many stakeholders operate on the premises of the airport forming the so-called airport ecosystem. Blockchain is an inter-organizational information system and the deployment of the technology will not be possible without other stakeholders. Hence, future research should further investigate the implications of blockchain technology on other stakeholders like airlines and ground handlers. Accordingly, further research in the appropriation of value could provide additional insights in the implications for all stakeholders into the network.

The inter-organizational and decentralized nature of blockchain technology implies that the implementation of blockchain requires extensive negotiations to conform to the needs of all stakeholders. As it is decentralized, there are multiple governance models which can be applied based on the type of blockchain. Permissioned blockchains, further specified as private blockchains are usually governed and owned by one actor. In opposition, consortium blockchains are owned and governed by a group of actors (Ahmed et al., 2019). Future research may investigate an appropriate type of blockchain and governance model for the airport network.

Additionally, from the findings of this present study, it could be noticed that the relationships in the airport network are highly complex and paradoxical. To better understand the implications of the relationships between stakeholders, social network theories could be utilized. Another interesting concept that could be applied to shed light on the complex network are digital platform theories. Because of the facilitating central role of the airport in the network, it can be viewed as a physical platform, where stakeholders are complementors. Taking a platform approach might lead to additional and alternative insights.

9. Perspectivation

Our thesis trajectory started with a visit at the airport, where Lars Nielsen guided us around, together with our supervisor Sabrina Abdullah and a peer student. During this tour, Lars told us a lot about CPH and we had the opportunity to ask many questions. This helped us to narrow down our research focus and find a possible application scenario for blockchain. Overall, the tour positively contributed to our research. Therefore, we experienced this visit as extremely useful in our overall research project. Moreover, by working with the same case as several other groups of students, we were able to discuss ideas and get inspiration from each other during the initial phase of research. Additionally, working as a group of students on the same case allowed us to exchange contacts for potential interviewees.

However, we also perceived some challenges during the process. Especially in the first months, we perceived the feeling of being directionless. It took us quite some time to define our exact research direction, and we changed it a lot throughout the process. Looking back, we spent too much time focusing on the literature review, before we started data collection. Once we began collecting data, we realized that it was extremely helpful to talk to people in order to get a better understanding of the environment to frame our research. Additionally, we were not always certain about how to structure certain chapters and what to include. To tackle this challenge, the "Craft of Research Series" provided by the CBS Library has been a valuable resource to us.

Overall, we have learned a great deal from writing this thesis. By writing together, it made us more aware of effectively transferring our thoughts and arguments to the reader. This made us rethink our way of writing and transferring knowledge. Additionally, we have learned a lot about the research process itself. Writing this thesis made us understand that research is a challenging process, with many setbacks. For every step forward, we had to take two steps back. This has also made us learn a lot about our work ethics. We both experienced difficulties in coping with the many setbacks and the feeling of being lost in the process. Additionally, due to the COVID-19 outbreak, we were forced to work from home. Yet, when not leaving the house, days can become dauntingly long and similar. This caused demotivation, especially when combined with a setback. However, we always managed to get through it. Throughout the process we both developed routines, that worked best for ourselves. Accordingly, we learned new ways of working and motivating ourselves.

In the end, we are satisfied with the result. This thesis will probably not revolutionize the aviation industry overnight, yet we view our thesis as a necessary building block in the adoption of blockchain and our development as academics. We are looking forward to seeing where the digital transformation within the industry is going next and will never look at traveling in the same way.

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Appendices

Appendix A

Table. Industry data sharing initiatives

Initiative	**Abbreviation**	**Short Description (IATA 2020a; IATA 2020b; IATA 2020c)**	**Category**
Common Use Self Service	CUSS	Standard which allow different airlines to share one physical self-service counter	Common use
Common Use Passenger Processing Systems	CUPPS	Standard which allow different airlines, service providers or other users to share physical check-in or gate podium positions	Common use
Bar Coded Boarding Pass		Standard for the Bar Code Data format use on mobile and physical Boarding Passes	Common use
Common Use Web Services	CUWS	Concerns standardized data exchange which enables connection to self-services applications	Common use
Technical Peripheral Specifications	ITPS	Concerns standardized data exchanges between departure control systems and common use devices	Common use
Flight Data eXchange	FDX	Aggregated database containing flight data	Data exchange
Aviation Accident Information	ADX	Aggregated database containing aviation accident information	Data exchange
Flight Data Connect	FDC	Aggregated database containing flight safety concerns	Data exchange
Indicent Data eXchange	IDX	Aggregated database containing safety trend monitoring and reporting, and incident investigation	Data exchange
Advanced Passenger Information	API	Standard format for additional passenger information such as passport data to enable transmit to government agencies.	Messaging standard
IATA Open Air		Standard enabling interoperability between airlines	Messaging standard
Reservations Interline Procedures	AIRIMP	Communications standards for passenger reservations	Messaging standard
Passenger Name Records	PNR	Messaging standard for passenger information	Messaging standard
Airline Industry Data Model	AIDM	Reference for industry-agreed vocabulary and data standards	Messaging standard
Aviation Information Data Exchange	AIDX	Standard for flight information	Messaging standard

Appendix B

Table. Blockchain challenges literature

Citation	Challenges												
	Technical								Societal				
	Interoperability	**User-friendly developer tools**	**Scalability, throughput, latency**	**Versioning / Hard forks**	**Energy consumption**	**Privacy**	**Security**	**Oracle problem**	**Regulation and legal**	**Reputation of the technology**	**Education of management**	**Need for change of mindset**	**Build critical mass of**
Ahmed et al. (2019)		x	x		x		x		x				
Casino, Dasaklis & Patsakis (2018)	x		x		x	x	x				x		
Gatteschi et al. (2018)		x	x		x	x		x					
Golosova & Romanovs (2018)			x	x	x		x						
Halaburda (2018)													
Hughes, Park, Kietzmann & Archer-Brown (2019)	x		x				x		x		x		
Yli-Huumo et al. (2016)		x	x	x	x	x	x						
Lacity (2018a)	x								x				x
Lacity (2018b)									x		x		x
Lacity, Sabherwal & Sørensen (2019)			x				x						
Zavolokina, Bauer, Ziolkowski & Schwabe (2020)									x			x	x
Lacity & Khan (2019)	x						x		x			x	
Mohsin et al. (2018)	x				x	x	x		x				
Narayan et al. (2017)				x	x								
Ruoti et al. (2020)		x	x			x	x		x				
Swan (2015)		x	x	x	x	x	x		x	x		x	
Wamba, Kamdjoug, Bawack & Keogh (2020)	x		x			x	x		x				
World Economic Forum & Accenture (2019)	x		x				x				x		
Xu, Chen & Kou (2019)							x						
Yaga, Mell, Roby & Scarfone (2018)			x		x		x	x	x				

Table. Blockchain benefits literature

	Benefits							
Citation	**No down times**	**Data integrity**	**Auditability**	**No dependency on TTP**	**Shared governance**	**Automation**	**Pseudonymity**	**Trust facilitator**
Ahmed et al. (2019)								
Casino, Dasaklis & Patsakis (2018)		x	x	x	x			x
Gatteschi et al. (2018)		x		x		x		x
Golosova & Romanovs (2018)		x		x				x
Halaburda (2018)								
Hughes, Park, Kietzmann & Archer-Brown (2019)	x	x		x				x
Yli-Huumo et al. (2016)								
Lacity (2018a)					x			
Lacity (2018b)	x	x		x		x		
Lacity, Sabherwal & Sørensen (2019)		x				x		
Zavolokina, Bauer, Ziolkowski & Schwabe (2020)	x	x			x			x
Lacity & Khan (2019)					x			
Mohsin et al. (2018)	x							
Narayan et al. (2017)							x	
Ruoti et al. (2020)	x	x	x		x	x		x
Swan (2015)								
Wamba, Kamdjoug, Bawack & Keogh (2020)		x		x				x
World Economic Forum & Accenture (2019)		x	x			x		
Xu, Chen & Kou (2019)		x				x		
Yaga, Mell, Roby & Scarfone (2018)		x	x		x		x	x

Appendix C

Table. Value creation in networks literature

Citation	Determinants						
	Information quality	**Information availability**	**Relation-specific investment**	**Network structure**	**Incentives to participate**	**Quality of relationships**	**Communication efforts**
(Schneider & Sachs, 2017)						x	
(Matinheikki, Artto, Peltokorpi, Rajala, 2016)				x	x	x	x
(Chadee, Sharma, Roxas, 2017)						x	
(Barringer & Harrison, 2000)							
(Murphey, Arenas, & Batista, 2015)							x
(Bobbink, Hartmann, & Dewulf, 2016)					x		
(Janicot, Mignon, & Walliser, 2016)							
(Lin & Shayo, 2012)		x					
(Le Pennec, & Raufflet, 2018)							
(Dyer, 1997)		x	x			x	
(Brandenburger & Stuart, 2015)							
(Zhao, Yu, Zu, & Bi, 2014)			x		x		
(Matinheikki, Pesonen, Artto, Peltokorpi, 2017)				x			x
(Chou & Zolkiewski, 2018)				x			
(Chakraborty & Dobrzykowski, 2014)	x	x			x	x	x
(Reypens, Lievens, & Blazevic, 2016)					x		x
(Cao & Zhang, 2010)		x			x		x
(Wang & Wei, 2007)		x					
(Kim, Cavusgil, & Cavusgil, 2013)							
(Kauffman, Li, van Heck, 2010)				x			
(Lavie, 2006)		x			x	x	
(Lim, Kim, Kim, Heo, Kim, & Maglio, 2018)	x						
(Bagheri, Kusters, & Trienekens, 2018)	x	x		x	x	x	x
(Hammervoll, 2009)		x	x		x		x
(Dyer & Singh, 1998)		x	x		x		
(Vargo & Lusch, 2004)		x					x

Appendix D

Table. Document sources

Source	Title	Document type
Copenhagen Airports A/S	Travelling Towards the Airport of the Future	Annual Report
IATA	Annual Review 2019	Annual Report
IATA	Global Passenger Survey: 2019 Highlights	Fact Sheet
OAG	Punctuality League 2020	Fact Sheet
SITA	Passenger Counting and Tracking Technology Comparison Fact Sheet	Fact Sheet
OAG	The Airport Delight Report: Humans vs. Machines	Industry Report
ACI	Aviation Community Recommended Information Services (ACRIS)	Webpage
IATA	A4A-IATA Reservations Interline Procedures (AIRIMP)	Webpage
IATA	Airline Industry Data Model	Webpage
IATA	Aviation Info. Data Exchange (AIDX)	Webpage
IATA	Common Use Group	Webpage
IATA	Global Aviation Data Management (GADM)	Webpage
IATA	IATA Open Air	Webpage
IATA	Passenger Data Exchange Database	Webpage
ACI	Airport Digital Transformation: Best Practice	White Paper
Arthur D. Little (commissioned by Amadeus)	Airport Digital Transformation	White Paper
SITA	Air Transport IT Insights 2019	White Paper

Table. Interview sources

No.	Interviewee	Company	Profession	Work Experience	Date of interview	Duration
1	Lars Nielsen	CPH	Specialist & Key Account Manager Optimization and Passenger Solutions	3 years (15 years in aviation)	20-02-2020	120 Minutes
2	René Pedersen	SAS Ground Handling	Baggage handler	31 years	13-04-2020	56 Minutes
	Lars Nielsen	-	-	-	17-04-2020	46 Minutes
3	Erhan Kiloren	Turkish Airlines	Team Leader - Operations	10 years	16-04-202	E-mail
4	Diederik van Thiel	KLM	Information Manager Passenger Services	2 years (13 years in aviation)	20-04-2020	29 Minutes
5	Dominic Jackson	Block Aero Technologies	Independent Consultant (Co-founder Block Aero Technologies)	3 years in aviation	27-04-202	27 Minutes

Appendix E

Interview 1: Airport Tour Snippets - Lars Nielsen

[P-LN] *Starting here is the A pier which is divided into two. This is the B pier. Normally we tend to place large beverage places, restaurants close to the piers because of what passengers normally do in their comfort zone is they find out, where am I departing from? I'm departing from B pier. Okay, I'm at the B pier. What I want to do, what do I want to shop or I want to ear? I don't want to go to the other end of the airport to chase a specific product. I'll just settle down here. And then I will as eat some of you and maybe do some shopping. So we're also looking at putting some more units and some more shops and restaurants out in the piers because there's hardly nothing out there. There's a few vending machines and some few units, but passengers would like to go to the gate they depart from. And if there's anything close by, they are willing to shop.*

[I-JW] They can take all the walls down very quickly. Yeah, these aren't really walls. It's just one big hall.

[P-LN] *Two years ago, when we decided to extend the airport in that direction, connecting the A pier and the B pier to build will be called airport terminal expansion West. This is the western part of the airport to build more units and to create more square metres for shops and restaurants*

[P-LN] *This is around 200,000 square metres I think, we are now constructing a new area which is 80,000 square metres, the biggest construction project at CPH since 1992.*

[I-LS] So there is room around there for to further expansion?

[P-LN] *Limited just because on the other side we have the highway. Then we've got Kastrup, so we can't go in that direction. We've got the water also so we can go much further that direction. We've got the runways, we can't go much further in that direction. So we are trying to look at the current location, how much more square metres can be created. And we believe that we can actually grow up until 55 million passengers on this location right now. Going further, we need to look at the ocean. There could be small islands out there to extend the airport into the ocean, which is seen in other airports as well. But on this location, we can go up to 55 millions. But we need to build more capacity not only shopping, check in counters, baggage factory, which we're actually building now, brand new baggage factory connected to it.*

[P-LN] *So this part of the transit area is also, I mean it's for a special segment of travellers, actually the largest group of travellers in India, between 15 and 39 years. So here you'll find products for the younger age. And the area that we are going to see in a minute is for passengers financially a bit stronger.*

[P-LN] *Yes, the flights to Asia and the flights to the Middle East. So we have brands. So you can see that we've done some thoughts behind the location, but we could see that we were missing products. Now we have central Hugo Boss and a few different brands down here that are more related to to the younger passengers. There also strong bias in this group of passengers. I have a nephew he's 16 years old. He buys t-shirts for thousand danish kroners. I buy five for that price. But we need to get there also strong buyers. And we have something that we call "spend per heads", which is the average amount that our passengers spent. I'm not allowed to say how much it is. But we would like to see if we can raise that even more*

[P-LN] *The more the passengers spend, the more we make, all the shops make, the more they make, the more we make. And the longer they stay.*

[I-JW]
So you want to keep them out of the gate as long as possible?

[P-LN] *We want to make them be able to check in as early as possible to pass security and to help us stay here as much time as possible here in the transit area. Yes, do not stress and they go to the flight. 10 years ago, you could check in two hours before. There was a few times where you can check in three hours before you could go to the States. Two hours before that was the normal window that you could check in. So when you were checked in, dropped your bag, and you have passed security, you have maybe an hour. And then there was half an hour that you had to go to the gate that gave you a window of 30 minutes. You don't have time to shop sit down for a meal, in 30 minutes. So you just grab something, you go to the gate. So that's also why we are trying to create a bigger window where the passengers could check in so they can check in on the telephone, you can check it on the computer print their own boarding pass, they can print their own tags, they can drop their bags in counters that are supervised but not manned they can scan their own bag. They can send it away and they can check in for six hours on certain airlines before you spend hours up here. Passengers actually would like to sit and wait because that's what they expect from travelling. Many passengers travel maybe two three times a year if they're not business travellers so they expect time to sit down. Do some shopping, go to the tax free, get something to eat, get a drink, they expect that.*

…

[P-LN] *We could dig into every data and see exactly that. We have interviews with passengers every day in the gates asking them who they are, where they're from, nationality, where they live, where they flying, how often do you fly? Are you a frequent traveller? Age? Which needs do you have? What did you buy? What*

did you not buy? What would you have loved to buy? We ask them so many questions and that data we divide in all the different departments.

...

[P-LN] *This is our main square as the airport is designed right now, called Nytorv, like Kongens Nytorv back in the town.*

[P-LN] *Yes, the King's Square in the city centre. And as you can see here, Burberry, Gucci, Saint Lorraine, brands that I don't even know because I don't probably earn much money to buy things there, but they're located here because our heavy loaded, passengers normally pass by here for flying to the Middle East. They will come up from there see this, these fantastic shops. You won't see many passengers in here as you can see in February, but they maybe need to sell one or two items to have a good day.*

[P-LN] *I just want to take you into the tax free shop because as I told the first group or actually you mentioned, we actually tend to push the passengers into the tax free shop. On purpose we want all our customers we want them to go into, to buy products. You may like it, you may not but many of us do exactly the same. We can actually go around.*

…

[P-LN] *Security is the SSC synchronised security checkpoint. We have more than 20 tracks they use technology obviously to optimise. They have two tracks which are used for testing optimality, which we see from other airport, Schipol for instance. They're using a technology that is also used in banks, for instance. So they have a centralised point where all the passengers come through, and that they can see with numbers and arrows where to go to, which track to go to because otherwise, the first tracks will be the one that's only occupied because they won't see the tracks to the right to the left. And we have different KPIs and our security is a big performer. They're very, very good. The waiting time here is very few minutes. And on our busiest day we can open all the tracks. And on our busiest days you will not wait more than 10 minutes.*

[P-LN] *That is where the stress level is the highest. You don't relax until you've passed security. I know for myself when I travel, I don't relax until I'm on this side of the security that I feel homesick. Now that's also why we try to make it as quick as possible. I think it has something to do with the authorities and security*

and restrictions and what are you allowed to carry and not allowed to carry and everything? Just the stress factor in the passport control, the border control is not as high as here. So, yeah.

[I-JW] So how many minutes? You said, their goal if it's 10 minutes or less? 10 minutes or less? And so your best interest is to have as little queue as possible.

[P-LN] *Yeah. So you need to predict how many passengers you get every day. So that forecast is based on how many passengers will depart today. Yes, so they're doing their planning and their manning is based on that forecast.*

[I-JW] Do you forecast it based on capacity of the airplane? Or do you get actually the data of the airline about the tickets?

[P-LN] *We actually get the figures, the expected figures from the airlines. And then we use also historical data. So the data is, we go through the forecast the day. And normally, it's around 1000 passengers plus minus from from the forecast of it's actually very correct.*

[I-LS] Do you factor in any like external data? Like holiday?

[P-LN] *Yes, we call it red days. Eed days is days with hundred thousand passengers through our airport. That's red days. So that's obviously alert, and then we call for extra staff, obviously, or if we can see bad weather coming in. Yeah, something like that. So we use all the predictions and the data that we can to make sure that we have the correct amount of stuff working.*

[I-LS] Do you know if a passenger already checked in or you don't have that data?

[P-LN] *That's interesting question because we're actually in a dialogue with Norwegian, which is the second largest carrier, because it would be crucial for us to know if you're missing a passenger at a gate. Would be fantastic if the system could tell us whether they are present on that side of security or in the transit area.*

[I-LS] Because right now it cannot?

[P-LN] *Nope. Okay. So the opportunity is there. The data is there. It exists. No, we actually just need our security system, the system that they work in to be able to talk to the airlines DCS system, the check in system*

or the system. So in Heathrow, actually British Airways and Heathrow, they know exactly if a passenger is on the wrong side of security or on the wrong side of the border control. Okay, so if that's the case, they will just offload the passengers. There's no reason to call the passengers. Yeah. We're working on that. Because that's that's knowledge that we knew the airlines and the handlers.

...

[I-JW] How do how do you assign the gates? Do you have like a schedule for the whole day before and then you just push it here when it is time?

[P-LN] *One day before and then the plan will be thrown up in the air because then comes all the out of schedule flight arriving early flight arriving late, okay, and then we completely change the whole day. If a stand is occupied, then we need to assign another stand. That's also why we don't show gates too early.*

[I-JW] Yeah. So it's because of shopping and because of the changes.

[P-LN] *We don't want to have too many gate changes, because that will confuse the passengers and they can actually miss their flight. Because they will be sitting with their music and when they find out that that is a new gate, it's maybe too late. The window that we have that we have agreed on is five hours. See these flights depart at 4, then 3 and half,...*

...

[I-JW] Do you have any counters or live cameras?

[P-LN] *There is a device on the ceiling which tracks the passengers. We have it at the security, check in, and the passport control. I can see the life picture that people, small dots, they're queuing up and waiting. They're red, and if they're in progress and moving they are blue. So the security supervisors, they use it. And the coordinators for the border controls use it as well. And I use it also historical basis to see on the busiest days if they've been waiting time 15 minutes or 40 minutes in the border control. I need to find out what went wrong.*

...

[P-LN] *This is something that is very difficult for our passengers to find for some reason. The way to the access to baggage claim and exit. We've come up with ideas whether we should make it completely yellow, maybe some kind of flashlight, but the passengers can't find their way down. So that's something that we need to have as a part of the scope, in our new product expansion 80,000 square metres, we have to somehow make their way to the reclaim area more intuitive. So, passengers arriving here, passing the border control, ending up here and they always grab you. Where do I go to collect my bags? Right over here, because for me, it's obvious. It's right here but for the passenger they can't find it and I don't know why.*

[P-LN] *The border control pier C for all non-Schengen passengers. Limitations on square meters when it comes to the amount of passengers that we can actually have here. So what we normally see on the very busy day is that the line goes 200 metres in that direction, making it a bad experience for the passengers because then they can't see that there's an ABC possibility if you are B, automatic border control, they won't see it before they come up to maybe this point. They won't see that there's something called EU tracks. For EU citizens. They're all passports. So passengers normally tend to be queuing longer than they should have. And that's something that we've worked really hard on.*

...

[P-LN] *If they are a crew with the EU passport they can use the automatic border control but if they decide to do so, they have a special track where they can do so. But if there's no queue at all, they could just go into the different tracks. But on a busy day, it's pretty nice for them to have an assigned track where they can be checked.*

[I-JW] Do you know who are the employees of the airline? Do you have like a list of all employees who work here?

[P-LN] *They are carrying, the captain is carrying general decleration showing that this is my crew. They're on my flight. And that's his responsibility. And then they show their airline ID, crew ID and the passport.*

...

[P-LN] *Yeah, and then we have the print on the floor. Does it work? No, the effect is limited. But I mean, we are well known for putting up this because people think it's funny. So there's a bit of publicity for us. My recommendation is to remove it when we extend the passport control. When we have the full capacity, then I will remove it.*

...

[P-LN] *But also because the police were here. The border control agents were already waiting for them that's crucial. So here we've been using, I mean, when you drive at the highway, and you need to take a turn, you look at the signs and you know, which lane you should choose this the same idea that we've been doing here. We replaced it, replaced this with some more fancy lighting at some point put up some lights so we can switch it on, switch it off. It was actually my project because we can see that the passengers were confused. They did not know where to go so they ended up in the wrong tracks, get to the boarder control and then start all over again.*

[P-LN] *So what we did was EU passengers on the left side because the EU tracks are always the tracks to the left, all passports in the middle and connecting flights to the right. So logic-wise intuitive without thinking the passengers will look down on the region, okay, look at the flag and go this direction. So we have already divided the passengers before they end up here in this zone. That is very important data.*

[I-JW]
The boarder control is staffed by the Danish police, right? Yes. And so you somehow communicate with them about how many passengers you expect?

[P-LN] *We help them. We help them on a daily basis, on a weekly basis, we sens them a forecast and suggest to how they should man their border control and the tracks, define down to the very hour. Okay, we recommend that you have 10 tracks open, which is the full capacity up here from 12 to 2:30, for instance. And they follow that.*

[I-LS] So it's based on your recommendations...?

[P-LN] *Our recommendation, our data and our forecast. I mean, we have departments only working with data and I mean, the police is operational, they chase bad guys. Yeah, so they don't have a team that can go into that data, but we have. We will also extend the boarder control up here with either four or six tracks. where we stand actually right here right now. When we start this huge project that will be done somewhere between 2023-2024 giving us the capacity to reach the 40 million passengers within the next less than 10 years.*

[P-LN] *Yes. based on data. Based on that the Chinese passengers are fantastic speaking Chinese, but they don't understand and cannot read anything else but Chinese, and they arrive in huge groups.*

...

[P-LN] *This is the new area called terminal expansion West. It was opened about two years ago where we try to target this younger generation. Yes. It's quite clear. The atmosphere here is very nice. We've got music, Cocks and Cows, Mikkeller where we provide fantastic beer. Also for families because you have the play ground. Personally, I like this area because I think it's brought something new into the airport to target the younger generation.*

[P-LN] *Yeah, there are a few playing areas. But that's something that we want to see more in the future. Because I mean, we really want to work with families and the family problems.*

...

[P-LN] *The parents? Not necessarily they normally ask, when they use the wayfinding machines. This area has become quite popular, so that many families know that there's a playground up here. But the families are very important to us. And we're also looking into if we can create some kind of package to a family where the journey starts with a company coming home, at your house or your apartment to collect your bags. And make sure that the bags are checked in. So you just arrive on the day with your kids and what you need to carry on. There's this family track which we have every summer, both for the families because they get stressed when they have business passengers up their neck. So when the families that are gathered with other families there's an understanding that yes, it takes time and it's a mess.*

[P-LN] *But we would like to to reconsider it. Because I think that's something that maybe a family of four or five, maybe would actually pay extra money for to get some help. My department, in my team, we are working to see if we can come up with something. A different way to make some money to make profit. Alright. That's almost it. Let's go to the fantastic weather.*

Interview 2: René Pedersen

[I-LS] Could you explain a bit more about your job at the airport?

[P-R] *I handle luggage. All the luggage under the floor in the airplane. That's what my department does. You know, cargo, we put in. Cargo is build somewhere, and all the paperworks and stuff. We put it in to the machines and in big boxes, small boxes, everything.*

[I-LS] So if I understand correctly you load the luggage into the airport.

[P-R] *Yeah. And we bring the luggage from the sorting area to the machine. And that's where we sometimes lose because if I'm in a hurry, we always have a time limit, always. So if I have two wagons and I have a stressful day, I go out with two wagons and I place one wrong. You know, I should go to one parking place and another parking place and then I maybe put it wrong. But I have a scanner, so when I go out, I have to check one piece of luggage on each wagon and shoot it and then it say okay. Then I know that the the baggage is for this plane. So when I go from sorting area and drive the luggage through the machine I check it and then I get an okay from from my scanner because everything's on the barcode. But it can miss if I'm in a hurry and I say, I trust the guy who sent me.*

[I-LS] You mean you would not scan it in this case?

[P-R] *Yes, but today we have to do it. It's like part of our working protocol. Because it's always safe to first in what you see with luggage. And if you don't show up for the plane we have to take the luggage. We know the luggage is inside because we can see it on the scanner. But you're sitting and drinking at the bar upstairs and you lose track of time. The guy in the lobby calls you and calls you and you do not come. Now we suddenly have to empty all the luggage to find your luggage. And then we have to load it again, as fast as possible. Because otherwise the flight will be late and it's a big cost for the company, if the plane is parked for too long. Because it's by minutes you pay maybe $5,000, if you have a gate for too long, because there is another plane that has to come.*

[I-JW] Does it ever happen a plane is late because you have to unload and reload the baggage?

[P-R] *Yes, because it mainly depends on the passengers. If all passengers are on time and everything, then there's no problem. It's first when we have to peek out because a lot of planes today are with big boxes with luggage inside. A container might stay in, so you have to take four containers out and then you have to pick number five, open it, find the luggage, to close it again. That can take about 20 minutes, 25 minutes maybe.*

[I-JW] So you know in which container the luggage is in?

[P-R] *Yes, let's take it from the beginning. It would be easier to understand. Now, you get to the airport and you leave the luggage to the check-in guy. He puts it in the machine and gives you your boarding pass. He pushes the button. The luggage is going by the tracks now. But that's not my issue, it's not SAS.*

[I-LS] Then who is doing that?

[P-R] *The check-in guy is from SAS, but when he pushes the button, it is no longer SAS their responsibility anymore, it is the airport.*

[I-LS] Okay, so as soon as he kind of lets go of it and ownership transfers to Copenhagen airport.

[P-R] *Yeah. In the right terms. But you don't know that when you are missing your luggage. If something goes wrong you just say SAS is shit. So, now the luggage is leaving. Then it is going by tracks, under the ground and sometimes there maybe a backpack, a string which is sitting there. Then you suddenly have two or three hundred bags sitting there, because the belt does not stop, it just keeps going.*

[I-LS] Who fixes that?

[P-R] *That's Copenhagen airport. Copenhagen airport has all the tracks. When it goes down the track, it goes through X-ray machine with a lot of images. If there is too much steel, or something else that looks dangerous, it goes through a seperate track through another X-ray machine. But this is a manual machine, there is a guy sitting and looking at the piece of luggage. He can open it, see what is in side, and put it back on the belt. When it come to the baggage area, we have a big building with tracks inside, when it comes in it gets scanned and makes a big round on the carrosale. Then the barcode is scanned and the computer system knows where to put it. If the machine is on the ground it will go on the track and go down the belt to the box. When it comes to the box, it is my responsibility.*

[I-JW] So the ownership is back to SAS?

[P-R] *Yeah. But first before it is in the box, if I can see my luggage sitting on the track, I cannot take it. Even if there's two seconds till the machine leaves, I have to say to a CPH guy, please come my luggage is up there. If he does not have time, we miss a luggage.*

[I-LS] Okay. So then you have ownership again and then you transfer it to plane?

[P-R] *Then when it comes to the box. If it is a belly plane we call it, that's a small plane where each piece goes inside. If it is a container then it goes in boxes. Before it goes in the box, I scan the barcode on the box. Now the scanner knows, when I take this it goes into this box. So I know, this luggage is in this box and then we can find out. Then on the load sheet, the load master, outside. If we have to take a certain number, we*

can see, oh it is in container three. But if now the plane is loaded, there is usually people inside. There are two compartments for luggage in a plane. If it is in the front compartment we cannot just take the two infront out, then the plane would lift. So we have to take all the containers out from the other side. Then it is an even longer time. So it depends on where it is located.

[I-JW] Do you make an estimate of how long it's gonna take?

[P-R] *No we cannot tell, because sometimes I am standing by the plane and my people are already on the next plane, because we are late on this one. We cannot just stand and wait when there is already a next plane at the gate*

[I-JW] Do you then communicate anything to the airline?

[P-R] *We give a certain time, but we cannot say. Even in the box, it may be when I open the box. It's the first one. But it also might be the last one, then I have to take 40 pieces out, before I hit 41, and have to put 40 back again. That's why it's very important that people are on time at the gate. Because usually if we have to take people out of the plane, then we use a lot of time. Because somebody was just sitting and drinking. But also you might get sick, there can be a lot of things. And then we have to take charge. But if you get sick, you usually know it before. Before it's loaded. Then we can find it, because from the last luggage comes down, we close the box. It is 20 minutes before takeoff, then we have to say we cannot get any more. Because you also have another thing which is called quick transfer baggage. Then you send a guy from the baggage area to one plane. Let's say you come home from Thailand. I go out to the plane and I take the luggage directly where the guy are standing and loading the luggage. I stand by his side and I say everything from this plane going to Stockholm I should have. Then I have a wagon, and I put everything that comes of the track and goes to stockholm on the wagon. So instead of going to the sorting* area, I go directly to the next plane.

[I-LS] So that would be for a transfer flight?

[P-R] *Yeah. on a transfer flight.*

[I-JW] And do you scan each barcode on the luggage? Or do you see where it's going?

[P-R] *I see it because you have three letters and a number. You know the flight code? Yeah.*

[I-JW] Yeah, you mean for example CPH.

[P-R] *Yeah, but, but it's a little different on tracks because it's standing the different way. Okay, the installation is on the reader from down to up. So if I go from Copenhagen to Stockholm, there's only Stockholm. Copenhagen doesn't show because it doesn't matter where you come from. It's where you go.*

[I-JW] How often does it happen that you miss one of those luggages when someone is transferring?

[P-R] *It's, it's very, very often because when you do it manual, of course when you have compact compartments, and you have to look after two compartments, then it's teamwork. It's not only me, it's also the other guys. And we have to trust each other. So sometimes it's only two pieces, there is only a few passengers taking a connection and sometimes it's 40, it's a bus, it's a travel agent, whatsoever. You have 40 people, and then you have to take 40 luggages directly. And then when the passengers check in to the plane, then the load master on the ground he gets it in the scanner, and the pieces are standing. He knows everyone is on board, so we can take this wagon and load it. From when the plane lands to the next, we can do it in 20 or 15 minutes. Depending on how quick the luggage comes out.*

[I-LS] What happens when the plane lands?

[P-R] *We unload it and bring it to sorting area. We own the luggage until we put it on the tracks inside the sorting area. When I leave it on the track, it's not my responsibility.*

[I-JW] Okay even if you transfer flights then it has to be put it into sorting area.

[P-R] *We might have one plane landing in the morning, and the other one flying in the evening. Then we have a lot of waiting tracks. Every hour the waiting tracks empties on the sorting area and the luggage that is needed is taken. The luggage that is too much goes inside the waiting area again. That's also why you can check-in in the morning and fly in the afternoon. Let's say you check-in, you can go into the city, go to tivoli, come back in the evening and fly.*

[I-JW] One more question regarding the transfer flights. So let's say I'm flying to from, let's say from Stockholm to Copenhagen, and then from Copenhagen to New York, for example. And I didn't catch a flight in Stockholm, but my luggage was already on the plane, what happens?

[P-R] *Can't be. It never happens. It must not happen because without you, your luggage cannot fly. The plane doesn't fly before we have found your luggage. Because you don't know what's inside.*

[I-LS] And what happens, like, let's say the luggage gets lost on the way.

[P-R] *It could be because the tag is broken. Then we have some special guys who can, we can track it. We called them tracers. And if I have a luggage on the plane without tag, I go down to them and say this one came in with the plane from Stockholm. And then you take it back, okay. Then you go after the order systems because first you make a report that we have found a luggage. We see if there's names, or old tags, we can find out a lot of things about people.*

[I-LS] Okay so based on the tag you can find out information about people?

[P-R] *if you're on a plane to Stockholm and you want to go with a later plane. Then the check-in guy says okay and makes the reservation and then the machine will take your trunk off the track and down to the tracer. The tracer takes the piece of luggages and scans it and makes a new tag. Then you take the trunk and put it on the track again.*

[I-JW] What happens if the tag is lost, for example it got torn?

[P-R] *If it gets torn and we can't find out anything. Then we put it in this special room where you can X ray, that's a Copenhagen Airport guy who X rays. Then you can go and open it. It is some guys who have special authority from customs. I cannot open the bag. If I open a bag, I get in trouble.*

[I-JW] So then they open the bag and see what is in there?

[P-R] *They find some personal receipts, from everything, people usually put them in the trunk.*

[I-JW] When a bag is checked-in, is there any additional information written to the system? Like, colour, size?

[P-R] *No, and that's a big big fault. Because usually, if we have 10 let's say we have 10 wagons, with twenty pieces of luggage on everyone, standing in two layers. We know we have to get this number, instead of saying we need this one, it's a red backpack. It's also how experienced the person who talks to the customer is. If someone loses a black suitcase, just try to find that. It's much faster if you know what you are looking for. So communication is important. But the person in direct contact with the customer has never been where I am, never. He might look out the window and say oh that's how they put things in the plane.*

[I-JW] Is there any other type of information that could help you when looking for luggage?

[P-R] *No, because the rest of the information we have ourselves I have the information what box it is in. I'm not even sure that the person in the gate can see what box it is because they drive the other system, they just have the passenger list. So, if the person in the gate with a passenger list cannot go in and see in our system, then it's it's not necessary to know because then we can find the information ourself*

[I-LS] What does the process look like when a flight is delayed?

[P-R] *Already before delay, we know things before you know things. I can see the plane from Stockholm to Copenhagen is half an hour late. Then when it lands in Copenhagen it goes to Budapest. I can see that is not possible. So the flight command can also see. So they say we give you the delay on 10 minutes by starting. Because then people know something. But sometimes, we know we have 15 minutes, 20 minutes, no problem. It's a lot of people we have to move, we also have to look at what is profitable. Is it okay to wait five minutes, or because it's like a generator. Because if this flight is late, the next flight and the next flight are gonna be*

late. Because the sky is very busy. So it's very hard to catch up time because then you're flying too close to the other guys.

[I-LR] Okay, so you get stuck in this circle. Are there any other problems you walk into on a daily basis?

[P-R] *I've been out there for 31 years. I hate luggage but everything is different and it's very free. I don't have your boss like if you're sitting in an office, I go out every day. But generally when they when they start building airports, they should construct it in a different way.*

[I-LS] Could you elaborate on that?

[P-R] *Because you have a lot... every time someone have to take the luggage there's chance for fault. The less hands get the luggage, the less room for mistakes. So when the check-in guy has the luggage, instead of putting all the luggages in the sorting area they could say this plane is standing on a gate out there. They could make a track under the ground directly from the counters to the planes instead. So when it goes by a scanner, the scanner knows where to put the luggage. Then when it comes to the gate, or the side of the plane, it comes up with a whole in the ground or something. All the luggage from this plane goes up in this whole. Then nobody touched it. We still have to scan it because if people do not show up you have to take it out. That would be the easiest way to do it.*

[I-JW] Okay. Back to earlier, when there's a delay, I was just wondering who sends you the information? Is it the airline telling you that they're late or is it the company?

[P-R] *SAS handling, we work very tight together SAS of course. But for the other companies, it's the agents who say we give it so much time or we fly at this time. If we loading Turkish Airlines, then it's Turkish Airlines who says to us, you have five minutes and then we go. For example, Qatar never flies late.*

[I-JW] They rather leave luggage behind?

[P-R] *They leave everything behind. They just fly. But they can pay everything, it is also money that we are talking about.*

[I-JE] How is the communication with other airlines than SAS, do you have less information?

[P-R] *No, they just expect us… sometimes they act just like the military, do this, do that, because we pay you. But you do not pay us to talk bad or whatever, because if you're not good to me, I'm very slow..*

[I-JW] So how would you say the relationships between you and airlines are?

[P-R] *Usually they are good. But there is also a lot of cheating. If you take Pakistan airways, never fly with Pakistan airways. They can do magic, because when they check people inside and the plane is out of balance.*

Suddenly there are infant on board instead of grown ups. And we're not just talking one or two, but let's say 50 or 60. And every suitcase goes in by a certain weight. So we do not sign Pakistan airways, we do not sign the papers.

[I-LS] So normally you would sign off once you loaded a plane?

[P-R] *Yes, but that's the problem of them, not us. If they cheat on the system that is on them not on us, we do what they tell us. But if something would happen, you have a bad taste. But it would have a bad taste. Yeah. If it fell down because sometimes we're standing and looking when it go up it's like a bumblebee.*

[I-LS] What about overbooking, what kind of impact does that have on you? When you have too many people booking the flight, they come to the airport with their luggage. Do you already tell them when they come to check in desk: Hey, you cannot come on the flight because we always booked our Do you have to go all the way to gate?

[P-R] *Usually I think they tell before that the plane is overbooked. We can check your in, but it's not sure you will get on. And then you'll get a standby label. So then the load master can see when the luggages come to them, oh it's stand by, I leave it. So then maybe ten minutes before take off, the gate calls and tells the stand by is okay or the stand by is not okay. Again, we can on this flight, where are the standby passengers. We can have some coming from Stockholm who's late and doesn't show up. Then they can go. So usually I think they tell them in the gate and already in the check-in, and when they come through the gate, the gate gives the final answer, but the luggage gets the standby mark. It is a big mark next to the handle, so you cannot grab the handle without noticing it. Then we have our have some other stickers that say priority. That's the expensive guys. The last thing we put in the plane is the priority because they go out first. Yes, they usually go out first and they are business people who pay the triple price. They have to be brought to the track first. When you stand inside the luggage area and see stand by luggages come first. You see the people who pay the price for the ticket would get angry. Because they get promised the service.*

[I-JW] So when the stand-by does not get on the plane it goes back to the check-in desk?

[P-R] *Yes, then the load master calls a driver and the driver comes and take the luggage and go to the track area and then the passenger is in the arriving area. Or sometimes if the standby passenger is not, the stand-by passenger is in the gate and we can say, what do we do now? You can get on the next flight, then we take the luggage, go through the tracers, make a new tag and put it on the next plane.*

[I-LS] What about the drivers just mentioned? Who do they work for?

[P-R] *The drivers is also us, I can be a driver, I can be a loadmaster. It is all the same department.*

[I-JW] Okay and when you drive it you go directly to plane or pick up area, you don't put it on the carousel?

[P-R] *I go to... It depends on if the passenger are rebooked. Then I go through the tracers and they make a new tag and the tracer just puts it on the track and then it goes on the carousel and it put it down to the plane, where I stand and I can take the luggage and put it on the wagon and drive out to the next day because inside the sorting area there's about 160 or 80 boxes. So we have 180 planes moves up at one time.*

[I-JW] Are there any other inconveniences you run into?

[P-R] *If it's raining it is difficult to read the tags. The automatic scanners won't be able to read it. But that's not my problem. That's Copenhagen Airport their problem. There are a lot of different angles to see the problem from. I can't see I can't see the stress off the gate manager when the plane is late. I just take the luggage out, and I don't see 200 people who are standing and wanting to fly.*

[I-LS] So you would say different people have their own problems.

[P-R] *Yes, but I think that's maybe the problem in a lot of companies generally. That's the top does not know what is going on generally. And it would be nice to see some of the guys sitting in the offices taking the big decisions. Why don't take my place one week?*

[I-LS] Yes, just to see how it is.

[P-R] *Yeah, because we had to make some savings and we had some guys from a big company. So we had a company come in who comes to look at your company and says here we can cut, and here we can cut. Yeah, we had a guy come in and we put him inside a plane. we said, just take all the boxes here and put them outside and when you empty four and a half ton sitting, you sit like a tailor. That's from 10 to 35 kg, so you have a bad back, you have bad shoulders, everything is crushed on you …. Now I forgot … I forgot what I wanted to say.*

[I-LS] No worries. Are you the only handling company at Copenhagen airport?

[P-R] *No, there is three, it is because of European law something, it insists that we have to be at least three companies for handling. So there's no monopoly.*

[I-LS] Which other ones are there?

[P-R] *There are, one called Menzies…. and one called Aviator. But Menzies is a big company, SAS is only Denmark, Sweden and Norway. But if you look where Menzies handles luggage, you see a very big company built, a lot of money. Also aviator, that's also a big company.*

[I-LS] And the airline decide who they work with?

[P-R] *Yes, contracting. So we get a contract for two years and then they have to use ours. So we have a lot of airlines. But even if we end flying style lines, that's a lot of companies in an alliance we do not handle Lufthansa, even if we have alliance with them because they think they got a better offer from another company. But usually we work nearly the same way. It's the same thing we do, we take things in and out of planes*

[I-JW] Okay, so just one more question. In terms of other stakeholders, other companies who you communicate with, it's mainly the Copenhagen airport and airlines, right?

[P-R] *Yeah.*

[I-JW] Is there any other company you have any contact with while you're doing your job? I was wondering maybe the catering of food?

[P-R] *Yes. When the plane come in it's totally war. Because, the ground personal, that's me or my department. First we have to give the plane power, shocks and we set it up. But outside, we have a catering car, we have a fueling car. We have two, transporters for for luggage. Everything's going on same side of plane. Okay, so it's totally war, you know?*

(Drawing)

We have two two tracks where we can put luggage on. And then there's a truck with wagons on. So we can have a two wagons. Same down here. But you have a big truck, the fueling car, which is going in here, under the wings. And we have a big catering car coming here. And a big catering car here. So it's totally war on who goes first, because there isn't a deal, that says you go first, you do that.

[I-LS] How do you coordinate this?

[P-R] *Sometimes, it depends on how stressed people are. But the plane doesn't leave before the fuel man. Yeah, the plane doesn't leave before anything's done. But instead of the fuel man, could also fuel from this side, I don't know why he has to use this one. Same, the catering cars. I think they can go up here, because sometimes this one is like out here. So I have 10 wagons in a big snake. Then when the luggage guys put one wagon on I just move a litte and then the next wagon goes. So it is a big fight.*

[I-LS] Does it get in the way of you doing your work?

[P-R] *Yes, because sometimes if we have put all the stuff together here and the fuelman come here, he can not get in and around so you have to be in a certain place so that's a big fight everyday. That would also be if the airline or the because of the companies or anything have an agreement like this and then everyone is fine. Because a lot of times the fuelling does not take that long. But if we do that first, we have to when we*

empty the plane, we have to move all our gear back. So the fuel man can get in, then when the luggage comes, we have to go forward again. So and then today, when you have the places where the planes are, the planes are getting bigger and bigger. So sometimes you have maybe like two and a half meters between wingtips. So then you have to take all your stuff through sometimes.

[I-LS] So there are two belts loading luggage. So there are two areas. So do you know where the piece of luggage is .

[P-R] *Yeah. Because on the end of our track here when I take from the wagon I have a scanner, it's like a ring. So I just go like bliep, and then you say blob, if it's not okay. So it's a different type, and you can hear it even if you have a headset, because our headsets work like we can stand here and talk like normal, but you can't hear the plane.*

Interview 3: Lars Nielsen

[P-LN] *But yes, my business is pretty much hit by this. And I think that we will be some of the last businesses that will be opened up. Because I mean, one thing is that we can open up the airport, but we need somewhere to fly to before can open up. But that's how it is.*

[I-JW] Do you already anticipate any date when you're going to open?

[P-LN] *Nope. No indications whatsoever. I think that opening up. I mean, what we have now is somewhere between 15 to 20 arrivals and 15 to 20 departures each day and then around between 1015 cargo flights coming in. We've got lots of cargo flights coming in with medicine, obviously. But to open up more than that, we have no indications when when that could be. So we just take it step by step looking, I mean, locally on the Danish government, what they decide and then also global, what's going on in other parts of the world. And yeah, I don't think somewhere in May is realistic, I think, maybe not even June. So hopefully we'll be able to maybe in, somewhere in July, to open up for flights within Scandinavia, maybe the North Atlantic region, Greenland Faroe Islands, maybe the northern part of Europe, but I mean, the situation in southern Europe and in the UK is critical. So I don't see them opening up for anything before maybe autumn.*

[I-LS] Yeah, that's the thing. You're also very dependent on other countries

[P-LN] *Very much, very much. And we're also very dependent on how will people react after that. Will they dear to travel, will the maybe limit the amount of journeys, will there be parts of the world where they either can't go or doesn't dare to go. So that's, that's interesting. I think that eventually, plus the senior segment*

will they dear to traveled or will they just stay at home. Yeah, there are so many questions to be answered when we start opening up again. And when we are on the other side of this nightmare.

[I-JW] Right. Yeah, hopefully the outcome will be positive, as positive as possible.

[P-LN] *Yeah. Well, we will go back to where we were, it will take a few years. That's what we predict maybe two four years before we are with before, but but but it will take some time. It will obviously take some time.*

[I-JW] Okay. Um, so the last time we're at the airport when you were showing us around, we noticed that you talked about how some people end up missing flights because they are sitting in lunch or they're listening to music and they miss a gate change or forget to board flight. So we're just wondering if you're looking into any ways how to eliminate this issue?

[P-LN] *Yes, I mean, some of the important things that we are I mean, that are crucial for us is the cooperation with our stakeholders and sharing information which is crucial if we should improve on on that matter. That means we're looking into sharing more information with us from the airlines and also the ground handlers to reach out to the passengers more efficiently than we do today.*

[I-JW] Okay, because what do you, right now believe that gets in the way of sharing this information? So right now that information is not being shared, right. So you're trying to improve it

[P-LN] *Yes, we would like to know more specific where the passengers are physically in the airport. Are they on what be called land side, which is the other part of security, terminal two, terminal three. Did they pass security? Did they pass the border control? Are they sitting in a lounge when they In the western part of the airport in the eastern part of the airport, where are the passengers? We would like to know more about where the passengers are, that would make us more efficient when it comes to the whole departure process so we can locate the passengers, where are they?*

[I-LS] Yeah, but do you have, is that information available? Like is it being measured where the passenger is?

[P-LN] *That means that we need to to be able to cooperate more efficiently with the airlines because they have their check-in system on boarding system. We call this a DCS system. We need for information from them to be able to track the passengers because that information could be feeded into the security system. So we can see physically whether they are on one or the other side of security that also comes to the to the*

border control, for instance. Yeah. So we need to have our system set up against the airlines system to be to be able to track the passengers more than we do today.

[I-JW] But as you just pointed out as well, seeing what our passenger is at certain wing or like in certain gate, like how would you get that information. Because there are no really touchpoints once you go behind like security until you go to your gate, like the in between face

[P-LN] *I think we're actually looking more to biometrics to be able to track the passenger so that we know where they are. And that needs to be connected also to the airlines DCS systems into our IT system so that we can work so we can track the passengers around the airport. But that also means investment in some sort of biometric technology. Which we have, we already see it in some of the best airports in Asia, for instance, In Singapore, we see in other airports that are more forward than we are and have invested a bit more in biometrics, that they're more able to see where the passengers are in the airport and contract them. If we can track the passengers, we're also able to push messages to them and we are able to store crucial informations about the pattern that the passengers follow when they travel. That means we can actually send them messages to their tablets to make them aware of some favorite brands, maybe close by favorite restaurants, and so on. That could be rather interesting.*

[I-JW] Can you be a bit more specific on what kind of information airlines have that you would reall need or which would be useful for you.

[P-LN] *We need information from the check-in system that the passengers or that the airlines use, we need to know whether the passengers are checked in or not. Yeah. Because that has to be set up to our systems so that we can stop tracking the passengers and to be able to track the passengers on their journey. In the airport. We need cameras set up in the airport as well so that we via biometrics know physically where the passengers are. There's both the investment in biometric technology in the airport and also sharing information with airline to us.*

[I-LS] Because right now the airline doesn't share that information with you. Do you think? Do you believe there's any reason why that information is not being shared?

[P-LN] *I think it's because of the finances that is obviously a cost on the short run. But on the long term basis, it's obviously also an investment that is, that is a benefit for both us as an fo but also for the airlines. I mean, obviously financial, we will look at if we can make the passengers I mean, spend more money. I think I mentioned spend per head, which is based on how much money does all passengers in average spend*

per head like to see if we can raise that and be more efficient so that the the passengers will see more opportunities to buy stuff for the airlines. They will know about where the passengers are. So if passengers, for instance, are missing at a gate, should we wait for them? Or should we just offload them and find their bags and then depart? That depends on where are they? Are they? I mean hundred meters away from the gate, then haven't they even passed the Border Patrol, then there's no reason to wait for them, then we could just offload them. So from the airlines perspective, it's about on time performance, which is crucial that to depart on time. And for us, I mean, it's to get passengers to spend more money, to be honest.

[I-JW] How would you in general describe the relationship between you and the other stakeholders in the industry?

[P-LN] *I would say it's good. It's very good. before the crisis, we obviously need to as an airport, know that our business is is obviously struggling. We were actually also struggling many allies were struggling before the crisis. Some of the big airlines, I think Norwegian is, is a good example of an airline was really really fighting for their, for their existence. So, I mean, we as an airport, we make money, we could make more and we would like to make more and we do not make as much money as we did the previous years. So we were actually also going back a bit before the crisis. We need to be aware that many airlines are suffering and also So their ground handlers so they don't have the same finances and amount of money to invest in, for instance, new technology, their main focus is on the operation and to make it work as smooth as possible. So that's important for us to know that that we financially are stronger than our stakeholders. We're also trying to help them to make their operation smoother. So we also invest money that will make our ground handling operation. And also the airlines, you're in order to help them.*

[I-LS] Do you mean we have an example for that?

[P-LN] *The self service baggage drop, which you saw in terminal two and terminal three, a lot of that in the first phase of implementing and helping the airlines to get on that system and on that platform in the airport is financed by us an IT project manager and me for instance. So we helped the the airlines to develop their self service baggage drop concept. So we actually invest money in order to help the airlines because it's, it's a good service for the passengers. And it's also a huge help for the ground handlers because they can save staff. If you for instance, look at that Norwegian operation on a normal Saturday morning, they have probably, I don't know, seven 910 flights, maybe 1200 1500 passengers departing within one and a half hour. And if you look at the amount of staff to help those passengers, they maybe have four or five, six staff members that have the check-in area to help 1200 1500 passengers. If you go back 10 years ago, you would have seen maybe 20 check-in agents to to cope with that amount of passengers. That's of huge cost saving*

for that, for the handlers and if the handlers doesn't use that much staff, there's also cost savings for the airlines obviously. And also, we would like to extend the check in window, we would like to make it possible for the passengers to come as early as possible to the airport or come to the airport when they want. Because the earliest that you can check-in the more time you will get at the transit area. And if you have more time, you'll spend more money.

[I-LS] How are you trying to do that?

[P-LN] *That is by self service baggage drop so that the ground members doesn't need to have that much stuff. maybe one or two staffs can open up. I mean 10 self service baggage drop counters and the passengers can basically help themselves and you have, you only need a very small amount of staff to help the few passengers that may have an issue or problem. Norwegian for instance, and slo SAS in terminal three, they opened their check in for o'clock in the morning and their passengers can check in throughout the whole day. Instead open up only two hours before, because they don't have this product. And I mean, those passengers, they won't spend much money because when they passed security, I mean, they'll maybe buy a bottle of water, go to the toilet or a restaurant and then they'll go directly to the gate. That's something that we can actually see that the passengers prefer to find the gate as early as possible. And when they finally found the gate, they will only spend money in I mean the amount of units surrounding the gate or out the gate and if if there are no units, they won't look for units. They'll just stay there and they won't spend money.*

[I-LS] Do you see any downside of sharing more information between you and the other stakeholders for any of the parties, but especially you?

[P-LN] *No, I think we should share as much information as we possibly can. And if there's information that we could share with the stakeholders we would love to do. We don't care, we basically don't care who the passengers are. We're not interested in their in their names. It's their pattern, and how they move how they react. That's what's interesting for us, we don't need to go into details about the passenger, we just look look on data. Where were they before? We don't, I mean, we don't care why they do if they do, we just want to know what they do so we can push messages. And obviously, we do lots of interviews with the passengers. We have a whole team running around the airports, daily, interviewing passengers. Just asking them lots of lots of questions. So that that we make sure that the brands that we represent are the brands that most of the passengers like, and prefer.*

[I-JW] Could you give us an idea how big this team is?

[P-LN] *Then I need to, I think there's, I'm not sure. But I know that we on a daily basis, we have interviews going on in the transit area. It could be a handful, maybe on daily basis. Surveys that they do is, I mean we have departments working on all those questions and looking into all that data which we collect on the daily basis. It's very crucial for us to make sure that it's, I mean, you can't as a brand, just say we would like to open up a store or shop or restaurant in the airport, we need to make sure that there's also a market for it. So to make sure that if that's something that we, that we see as an airport, I don't know if it was your group that I said that we don't have any McDonald's in the transit area. We don't have any Burger King. And I mean, it's not because they don't want to open up a restaurant. But we don't see that brands connected to what we stayed at CBH, we want something else.*

[I-JW] In general, how much do you rely on other stakeholders' data, or share data in making predictions and decisions?

[P-LN] *Not as much as we want to, but I mean, if you go to landside, terminal two terminal three, the whole counter allocation, how many counters should we allocate to an airline? At what time? I mean, for us, it's it's very important to know how many passengers are expected. We have a forecast based on data for, I mean, earlier years. So we always forecast how many passengers will arrive in the airport today, both departing and arriving, and also at which time throughout the day. And we use that for planning security staff. How many tracks do we have open throughout the day, and in the hours and the peaks that we have? We also shared with the police, how many tracks in the border control should they open and when. And that's also what we use for the application of how many counters should we open, how many counters should we allocated to each airline and when that's very crucial, but I think that those figures could be even more correct if we share more data*

[I-LS] So if I understand correctly right now, that's based on historical data, rather than actual data from the airline, for example, how many passengers will they expect.

[P-LN] *I'm working on collecting data on the booking figures for the next period for the next week maybe. So instead of basing our allocation on historical forecast, it will be preferred if we could base it on life data, how many passengers are booked on your flights tomorrow for example. We only get that information from a few airlines. We get it from Emirates, for instance. Because there's a huge difference, whether Emirates Emirates with a airbus 380 which is fully booked that 650 passengers or it's only half booked, and that's a difference between maybe instead of 11 counters, they could actually manage their operation with with six counters then the rest of the counters. I could use for something else. So actually we allocate the check in based on that the flights are fully booked, but they aren't. They are maybe. I mean, only fully booked a few*

times throughout the year, and there are areas where there's very low booking figures. So I would like to have that information from all the airlines. We're working on that.

[I-JW] Okay, so far, we talked about the airlines a lot. But last time, you also talked about Schiphol Airport and you have more closer collaboration with them. So we were we want to ask if if there's any kind of information shared between you or any shared resources between you and Schiphol or other airports

[P-LN] *Yeah, I mean, we have cooperation with with with a few airports, both in Europe airports that we mock up. Again, airports that are rather similar to our airports when it comes to to, to the volume. That could be Vienna, for instance, Zurich. But then we also, obviously on some, that have invested a lot of money in modern technology and biometrics, like I think I mentioned that we are normally not first movers at CPH we tend to look at what works. And if it's successful, maybe we go down that track, very seldomly, we are we are first movers. We see if a new idea is a success or not before we throw money after it. That's the strategy From from our board that we should not be first movers, we should, I mean throw our money at something that has been proved is a success.*

[I-LS] Is there a reason behind that?

[P-LN] *Just to make sure that we invest in the right strategy, so that we don't do investments that won't be a success.*

[I-JW] So if I understand correctly, the partnerships with our airports involve mainly sharing information about applying new technologies or new processes.

[P-LN] *Yes, it's more technology and the process around some certain area. It's no secret that CPH we're very, when it comes to to the counter allocation and the check in we are very efficient because we don't have that many counters. If you look at other airports, they have huge terminals, lots of counters. But but we are able to manage 30 million passengers a year with a rather small amount of check-in counters. And that is obviously something that other airports are looking into and asking us, how's that possible? How can you manage that huge amount of passengers with rather limited amount of counters. So they come to Copenhagen and we make a tour around the airport and show them how we can, how the process works, and how we're able to have that much traffic, with with the amount of characters that we have, that's interesting, and then it could be something else that we are interested in. If we can see that some airport is more efficient on a process than we are then we will obviously set the team to look at them and see what are you doing that's making this work so good.*

[I-LS] 25:52
So it's more about learning from each other. If I understand correctly

[P-LN] *Yes. The reason that the the new, very big airport down in Istanbul, the new Istanbul airport, they've been using us as consultants on on how they should operate this new airport. That's rather interesting that we use each other and learn from each other.*

[I-JW] So you perceive yourself and our airports as partners rather than competitors.

[P-LN] *Or both. If you look at at the airports close to us, I mean, Oslo, maybe some of the Northern European airports in Germany as well, Hamburg, they're, I mean, they're competitors towards us. I mean, so we're obviously maybe not sharing the information with them, like we are sharing information with with with airports that are far away from us. So so so we're not stealing passenger from one another. I mean so obviously, there's a lot of tactic in it, we're also working with with Changi Airport in Singapore. I mean, they're so far away from us, so why not share information and data and experience with them?*

[I-JW] So, regarding that, do you receive any data about incoming flights and that could be either from airports or the airlines or maybe other stakeholders as well?

[P-LN] *Yes. We receive, our traffic department receives information from an airline on when the aircraft departs from the department station, so we know, as much as possible about the aircraft before it arrives. There's so much data when an aircraft depart from a station, which is crucial for many stakeholders not only us as an airport but also for the ground handlers how many passengers are on board the flight, how much bags or how many bags are checked in, how many bags are transit bags that needs to be collected as the first funcion and take them to another aircraft? When does the flight arrive? How many passengers needs to go on a connecting flight? There's so much data that we need to make make the arrival as perfect as possible. And there's data that we need. When will the aircraft arrive in Copenhagen? Which stand is available for them? Do we have a stand available or do we need to remote park because the capacity is short, so there's so much data which is sent automatically to the to the airport that the aircraft will arrive in. That's very crucial not only for us, but also for many other stakeholders. Also the police, for instance on the border patrol is the flight household or is it completely full? How many agents should be sent to to the border patrol?*

[I-LS] So just to clarify, do you currently get that information about the passengers, the amount of passengers the amount of baggage that's on the flight?

[P-LN] *Not from all airlines*

[I-LS] Okay, so like you said, from Emirates, you do but not from all

[P-LN] *There are more data to collect. We would like to know more specific how many passengers on board the flights? We could actually see here under the corona crisis that the departing station before the airline was was sent to Copenhagen, the things that they shared wasn't that valid actually, because what we could see when the crisis really broke out, that lots of passengers, they didn't, I mean, cancel their tickets. So sometimes we were expecting based on booking figures that the flights arriving before, but then there were 70-75%. No show. So that of 200 passengers. I mean, there were maybe only 50 passengers on board of the flights. So one thing is what was planned, but the most important thing is what is the actual figures on the fight before it arrives in Copenhagen? That needs to be adjusted throughout the way.*

[I-JW] So we just talked about like how you communicate with other airlines and like how you kind of learn from each other? How is this communication with other stakeholders? Do you have the same amount of collaboration with airlines, for example?

[P-LN] *I mean with the airlines, we have a department called airline sales. And they have, every airline has a dedicated key account manager that communicates with the airline and make sure that that their interests and requests and wishes are taken up with cph. We also have a huge meeting with all stakeholders, both the airlines, but also the fuelers, the ground handlers, the police, the customs, falck is our prm provider, it's called AOC meeting and that's every I think it's the first Tuesday of every month where they AOC, airline organization committee. They invite CPH actually, so we are not setting that meeting we are the guests so they take up subjects that they think are interesting, and then they invite us to come in and update or give a presentation.*

[I-LS] Okay, so that's a meeting with all the stakeholders involved.

[P-LN] *That meeting is with with all stakeholders in Yes.*

[I-LS] Okay, and could you give an example of what is discussed during those kind of meetings?

[P-LN] *We're discussing so many things, the whole baggage factory, we are discussing the on time performance, the overall on time performance, construction projects. If there are issues somewhere, maybe a process isn't working as it should be, it could also be the performance of the police and the Border Patrol. It could be the security performance, go through the KPIs and the SLA. There, there could be many, many things discussed on those meetings. Very interesting actually.*

[I-LS] Okay. So every Airport has their own Airline Organization Committee, which is independent of the airport if I understand correctly

[P-LN] *Yes, so they actually they, they invite, we are always there CPH as an airport, but but it's up to them, which subjects to be discussed. Then we also have on a monthly basis, we invite our operation... We invite the ground handlers to what we call a production meeting with the ground handlers management, together with our operation, management, where we discuss issues, how are they performing? How can we maybe help them? Do they have any issues with I mean, staff for the summer peak and stuff like that, that's also helped with with each ground handler on a monthly basis, that's also very good. We need to we need to be aware of how are our stakeholders, how are they performing? And if they're not performing, why are they not performing and what is their action plan to solve these issues or these problems. It's very important for us always to be aware of our our stakeholders doing and if you're suffering, how can we maybe assist them or help them that's that's important.*

[I-JW] It sounds like you have quite... at the airport ecosystem there's quite like a cooperative spirit. But there are some friction points where you are competitors, for example as you mentioned competing between sales at the airport and on the airplane. Are there any other friction points like this?

[P-LN] *No, not that I can come up with right now. If you look in Scandinavia, we are obviously competing against Oslo, and also Stockholm to be a preferred hub. We would like passengers to choose our airport to transit in, so that you fly by Copenhagen and then maybe on an SAS flight to the USA or maybe on a Qatar flight to Asia or or Emirates, for instance. So, we're trying to get the preferred airports in Scandinavia and are competing against Oslo and and Stockholm. That's, that's for sure. Where we compete is obviously what can we offer transiting passengers in transit? How can we make their way through the airport to their next flight as smooth as possible, as fast as possible? What needs do they have if they're in transit, sometimes they're in transit only 45 minutes, which is the minimum connecting time you should have a minimum of 45 minutes to make it to the connecting flight. But sometimes you may have four hours in transit. What needs other than would you like to be able to take a shower, to have maybe the possibility to have a meeting room*

for instance, that's very interesting. And that's something that we're looking into how can we improve and how can we become the preferred airport, before you board the aircraft that will take you to the long distance, I mean, the long haul.

[I-JW] So you mentioned before that in some cases you share information with airlines like with Emirates. When you do so, do you know how the information is shared? Is there use of a third party solution or how is the setup?

[P-LN] *Well, we obviously share information on on the whole baggage concept, that's very important to the to the airline that arrives CPH for instance, how fast are the bags offloaded and from the aircraft how fast does the bags start to run on the on the belt? So that information we share with the airlines, to see their performance, their performance are relying on the ground handlers, how efficient are the ground handlers to offload the bags and to take them to the baggage factory and put them on the belt? How good is our infrastructure, working in order for the handlers to to to reach the belt as fast as possible? So that information is also shared with the airlines. And then there's the part where they shoot at us as an airport.*

[I-LS] For like from a more technical or practical perspective, I'm not sure if this is something you know, but how is that information communicated between parties, through which systems?

[P-LN] *That's set up automatically that we share this information on a daily basis with the airlines based on. I mean, it's the service level agreement that has been made with the airlines. The SLA, as we call it. And all information and data connected to the agreements that we have made with the airlines is shared automatically on a daily basis with both the ground handles and all the airlines how we're performing. And that is I mean, waiting time at the border control waiting time in the security, offloading of the bags, all that kind of information that's shared with with with the airlines on a daily basis.*

[I-LS] Okay, so there's a shared database between those stakeholders to share that information.

[P-LN] *Yes. So the airlines and they know specifically everything about the performance Yesterday all the delays given which delays were given the reason for the delays and also the actions if it's a pattern for instance, then we need to look at okay. If we have delays that occur very often then we have to go to dig deeper and just to find out what's going on and what's, how can we solve this?*

[I-JW] One more thing we talked about last time a bit, the handicapped passengers that are served by Falck. How does that process look like? Does the airline that care of that because they have the information that you are handicapped, or how does that work?

[P-LN] *Falck really tries to get the airlines to inform the passengers if you need assistance to make the airline aware of that. Because again, it is based on a forecast. So the amount of staff that is planned to come to work is based on known people coming to the airport. There is this grey zone of a passenger that have not informed the airline and are coming to the airport and saying: Oh I need a wheelchair and I am actually a PRM passenger. They will obviously plan on what they know, and have a certain amount of extra staff. They know some passengers will book the service at the airport. We can see the amount of PRM passengers is increasing by 7% a year.*

Interview 3: Erhan Kiloren

We are especially interested in the increase of information sharing on the operations, to reduce costs and increase service provision. Therefore, we are curious about the current operations at the airport and how these are influenced by collaboration between stakeholders and information sharing practices. Throughout the questions, we will be talking about the ecosystem, which refers to the network of stakeholders involved in the aviation industry (e.g. airport, airline, customs, ground handlers, concessionaires, …).

Could you tell us a little bit more about your position at Turkish Airlines? What are your responsibilities and how long have you been working there?

I have been working at Turkish Airlines since 2010. I currently work as a Team Leader. I am responsible from operational tasks, payments and agreements in general.

In your annual report, you highlight customer focus as one of your strategic goals. How important are partnerships with other stakeholders in the aviation industry in order to achieve that?

As passengers must go through different kinds of processes (checkín, passport control, security check, etc.) and meet the responsible staff on the way, it is important that all staff meet customer expectations and do the best service possible. One mistake could potentially effect the overall flight experience of a passenger. Therefore, we need to see the big picture if we want to improve the overall flight experience.

Who are the most important stakeholders in creating efficient operations relating to customer experience?

All the involved stakeholders in operations are equally important. Handling firms are potentially play more vital role in operations related to customer experience.

How would you describe the relationships between you and other stakeholders in the aviation industry?

It is as efficient as it could be.

How much and what kind of information is currently being shared in the ecosystem?

We share information with our stakeholders every day. The info varies from passport restrictions to aircraft weigh balance, system updates and additional flights, and so on…

Is there any information which would help you to improve customer experience, but currently have no access to?

As I mentioned, it would be nice if we were immediately informed as passengers go through security check and passport control. So we would know when they have arrived to the airport and went through the passport control. With this information, we will avoid the risk of overbooking if a passenger has not arrived, we could accept other passengers who are waiting as standby. In the meantime, if we know that the passenger is not going through the passport control close to departure time' we could start the offloading process and avoid the risk of delaying the aircraft.

How do you obtain information on passengers' baggage location (in case of missing luggage)?

Turkish Airlines uses barcode readers for all passengers baggage. Thanks to this system, we know where the baggage is latest scanned. However, there might be minor mistakes caused by the system, the staff or the missing scan on the baggage.

Why do you believe that certain information is currently not being shared? For example, airlines do not share the number of checked-in passengers with airports which would help them to predict traffic more accurately and subsequently speed up security checkpoint screening and border control. Why is that?

This is not true. All passenger figures has to be shared with airports for invoicing and marketing purposes.

Any other information not being shared (e.g. Data about incoming flights - number of passengers, their nationalities, ...)

This is also not true. All passenger figures has been shared before flights arrive in CPH Airport. This information helps the relevant stakeholders be prepared before the arrival (Fx for passengers who needs special care)

Passenger details including nationalities is also being shared with the police before the arrival via our systems.

What, if any, do you believe would be the downside of sharing more information between stakeholders?

The kind of data we share is already a must and approved by law. All data must be shared in legal ways. Otherwise, it could threat persons and corporates' brands.

Are the information systems, which you and stakeholders use, interconnected and compatible with each other?

No it is not all compatible and interconnected. We share data with stakeholders by email or via other systems if the matter is regarding themselves.

How and how often do you communicate with stakeholders in the network ecosystem? (Physical meetings, digital communication, etc...)

As often as it is needed which varies a lot.

Follow-up

You mentioned that the customer experience is made not only by your staff but also by others, like handling firms, border patrol, security checkpoints. From your side, how do you attempt to improve the customer experience at these touchpoints?

Customer experience is one of the most important things for us. We do have our own policy to follow and make sure that our stakeholders meet with these requirements. Its very important that the airport, handing comp and other stakeholders are qualified to meet with our policies. I belive that CPH aiport is qualified to meet with our Customer experience policy. We share our announcements and we inform our needs in order

to improve our standards. We also arrange meetings with other departments like police and handing companies to improve customer experience. we share our reports regularly and ask them to improve their service if necessary. To summarize, we audit all departments and create reports and share with them.

How exactly do you share data with the airport (e.g. database, email, etc.)? Do you share data on a voluntary basis or only data you have to send based on regulatory requirements? Is there a shared information system between for example you, the airport and baggage handlers?

We shared information via databases. There are several systems that you can share data with stakeholders. Its depandt what information you want to share. For example, police use their own system and our system must implement to send data to their system to share data. It's not a voluntary basis, its regulatory requirements by law. We share passenger figures with airport via WEB TELEX systems. Each companies and even each department has their own addresses. The system send message to other stakeholders to inform necessary info. For example our system send passenger figures from web telex to airport telex address for invoicing and marketing purposes.

You mention that figures about passengers are shared. However, is that before or after the flight takes place? How often is this information shared?

This information is shared after departure and shared for all flights. We also share information before the flights as well. It depends on the situation.

If we understand correctly, you inform the airport about the exact number of passengers on a flight that is departing from the airport?

We informed the exact numbers both departing and arriving from the airport. We must inform the airports with passenger figures where you depart and where you land. For example, when the flight departs from ISTANBUL, Turkish Airlines inform IST and CPH airport immediately after take-off via TELEX. Its not only the passenger figures, the information content cargo, mail, PRM passengers, dangerous goods, etc.. figures too.

Interview 5: Diederik van Thiel (translated)

[I-LS] Could you tell me a bit more about your position?

[P-DT] *I am an information manager for ground services, which means that I am responsible for everything IT related to the ground handling processes of KLM. I don't know if you know the company or if you have looked into it, but you have KLM the airline and KLM ground handling. KLM ground handling is the party*

that does everything above and underneath the wing while turning around the plane. So, when a passenger has to be handled, baggage has to be handled, the plane has to be handled, then this will be ground services. There, I take care of all IT, and these days IT is used to refer to anything technical. However, the majority of my work, for 90% my job is about innovation in this area. So the IT innovation, everything that has to do with the development, everything to do with transition. This is both applications wise as business-wise because the lines between business and IT get more blurred. Whether it is about data services, which shows you something, or in general a smart solution related to passengers, or end-users, the staff. This can be anything. It has been a very agile transformation the last 5 or 6 years, which we are still in the middle of. You see that we get into the business area as IT, and the other way around.

[I-LS] Could you tell me a bit more about the dynamics between different stakeholders?

[P-DT] *Ultimately, we are all parties that by, I would almost call it coincidence, happen to be active at the airport. You ofcourse have the airport itself, which is a company on it's own, with all resources that they make available, that's actually all they do. So they provide runways, departure halls, infrastructure, bagage basements, parking spaces, and more. They are a facilitator of the whole system. Then you have the handlers, which are all the parties that take care of turning around, as we call it. At Schiphol, KLM is one of them, but there are also others, such as Menzies and more. Then you have the airlines, which are the customers itself I would say. They operate flights and have their own representation, their own interest, being they need to be handled etc. This are the three main parties. Besides this, there are several other parties such as the border patrol, restaurants and shops, public transport, cargo handlers and some others. All parties use their own data in a certain way, they produce their own data and use this. Mainly for operational handling, but also for other things, such as passenger handling, predictions and controlling processes etc. There are several links or exchanges between parties, sometimes out of necessity because the airport needs to know how many passengers will depart at a certain time for example. However, sometimes the exchange is voluntarily, because we share processes, like the check-in process. Here, it is convenient for all parties, so the handler, airport and the border patrol can track passengers in their journey. In that case we can choose to, and we do to a certain extent, to share this information, so the passenger has a seamless journey or hassle-free journey, as we say. This is done without the passenger realizing who does what for thim, where his data comes from and is being stored. The passenger just notices that when he comes as station one he is being recognized, hereafter at station two for example the border patrol, he thinks, hé I am being recognized immediately, I can just walk through. Next, at station three the airport will tell him that his bagage is on track 6, without the passenger even asking for this information. This gives the passenger a very smooth travel experience. This is also in our own interest, to prevent that the passenger has any disruptions in the journey and does not get stuck half way, this would mean they have to go to a information desk to get help or need assistance from an agent. It needs to be seamless, because he needs to*

get through the departure area as fast as possible. This is partly done by literally exchanging data, so let's say just sending data...

[I-LS] How should I imagine this, sending data?

[P-DT] *Databases or data overviews, which is ofcourse the old fashioned way, but it still happens sometimes. Ideally, or at least one step forward, you would of course share data by linking to each other, through all kind of links that can be made. An even greater good would be if data would be managed collaboratively, and also store collaboratively so every party can get to it. We are currently in the second phase, where data is being shared and exchanged through links. This of course has to be in line with privacy concerns, where GDPR plays a very important role, and is very important to follow. That is how the world looks like for us in a nutshell.*

[I-LS] You just said that you share information voluntarily?

[P-DT] *Yes, but not completely. It is covered with the agreement that the data can only be used for the specific purpose it was requested for or meant for. In a more generic way, data can only be used to inform passengers about something specific. So we do have it written out what the data can be used for, and the way in which this may be done, that it needs to be done with consideration for the privacy and that the data may only be used by authorized persons with the right permission. We have solid agreements about this, and other data is not being shared. We share data purposefully, so only column A to C from a larger table for example.*

[I-LS] Is there an specific reason why certain information is not being shared.?

[P-DT] *Well… it is not necessary. Okay, let me say that differently. The first reason why it is not being shared could be commercial reasons. Data is valuable, it is worth money or can be used commercially. The second reason could be… Let me say it like this, the other reason is, I believe that we are just not there yet. I get what you think, your mindset, or at least the young and fresh mindset from this area, where more people vouch for sharing data to the max, as this can only be beneficial to you and your customer. So why would you panic about sharing so much, and why would you keep it close to you. But we are simply not that far yet. We still have discussions with the airport about when I make this data available to you I want you to sign and assure me at least 26 times you will not use this data for anything else, because this could potentially be a disadvantage for me. So phase one we passed, where we absolutely made no data available and did not share anything, that was about 10 years ago. Phase 2 is that we now slowly start to discover that we should not panic so much about sharing data and that we can better talk about how we can collaboratively safeguard compliance with GDPR. The next phase should be that we share all data openly, but we are not ready for this, just like another large part of the world is not. We talked about it in the*

beginning of the conversation, on how corona brings something about, which could be something positive as well. I believe that it will work similarly for data sharing. If there is all of the sudden something huge at stake, or if there is a situation in which it appears to be needed to share information, some event happening in the world, then it would turn out how valuable it can be for both parties to share data. Then there will be a breakthrough and a huge step forwards, in which the impossible suddenly becomes possible.

[I-1] Do you believe there could be a downside to sharing more information?

[P-DT] *To be honest, I do not think so. You have to do it right, you have to do it decent, especially with the GDPR. This can of course become an issue, especially when sharing with third parties. But as long as you do it with decency, and make sure rules are safeguarded, then I do not see a disadvantage. The more the better.*

[I-LS] Is information about passenger numbers being shared with the airport?

[P-DT] *Yes, a lot is being shared, purely operational ofcourse. Because the airport needs to make a schedule based on the amount of planes and the amount of passengers that have to go through the airport. So it is mainly an input for forecasting and planning. I believe airlines share this information, so from every airplane we know the details. For the number of passengers, it doesn't matter who they exactly are, it is about the number and the spread.*

[I-LS] How would you describe the relationships in general?

[P-DT] *I am in doubt. On one side I would call it formal, but it is more than formal. It is almost a partnership, but it is also not a partnership. It's actually in between. In the end, we are just customer and provider. The airport is the facilitator, or whatever you want to call it, they provide something, and we pay for this, just like every other party. Therefore, you can have certain expectations, for that matter you have agreements with each other and can have expectations from each other. On the other side, the airport cannot operate without airlines, and the airlines needs the airport, the best result is the result of collaboration, on commercial and operational fronts. So, I would say we have a very good relationship and at long last on all fronts have a healthy marriage, let's just keep it with that.*

[I-LS] How is the communication between you?

[P-DT] *Yes on all fronts, from high to low, we have operational physical meetings.*

Inte*rview 6: Dominic Jackson*

[I-JW] So if I understood correctly, you've worked with an aviation industry for personally two years before, right?

[P-DJ] *Yeah, correct. And, I have been still working in it now. Well, a lot of the work I'm doing at the moment is coronavirus-related forecasting and stuff like that in the aviation industry.*

[I-JW] Okay. Since we're mostly interested in passenger processing, I'd like to ask you are you or were you in some way involved in the passenger processing optimization?

[P-DJ] *Not at an operational level, so not actually down on the ground. But when I was at ICF (note: a global consulting services company), I was doing due diligence for airport transactions so I was basically helping to buy and sell. And a lot of that had to do with cost control and optimizing revenue. And so anytime you improve the check-in or the security process, you're potentially lowering the operational costs and increasing the chance that passengers will buy more stuff commercially when and before they get on the plane. So it was something that I looked at from the economic, like investment perspective, and technologies. I know what good looks like, what bad looks like, what the current problems are. And some of the technological solutions that are being touted to keep the trendline moving.*

[I-JW] Yes. That is what we're actually looking into, especially how the inefficiencies, for example in the security checkpoints at airports, can negatively impact the revenue of the airport because they are very much reliant on the revenues from shopping at the shopping mall at the airport. So, since you looked into it a bit in you work, are you aware of the data sharing practices there, because the airport ecosystem consists of many different stakeholders like airport, airlines, the security checkpoint, the border police, are you aware of how they kind of share information? In what way?

[P-DJ] *My understanding is they don't share a lot of information. They're not allowed to share data with each other because of data protection and commercial sensitivity. Obviously security-related data can be shared. Obviously, there are ad hoc agreements, depending on what jurisdiction you're in. But, you know, there's border controls and security cooperating, but obviously the security or border control is not passing a lot of data onto airlines that can personally identify people. And they're certainly not sharing it between airports. So you can't share that data with an airport in another jurisdiction.*

[I-JW] How would you describe the nature of relationships between the stakeholders at the airport?

[P-DJ] *I mean, it depends on what country you are in. In some countries, a lot of the functions are actually more unified, right. If you are talking about Western Europe, you have almost all the airports privatized. So you've got private management, you have security that is paid for by the airport, you have the airlines that all operate on a commercial basis as private entities and you have a border control that's usually provided by the state management. Obviously, in some countries, like in the USA, the TSA is part of the government. So your potential for more alignment there than you do in other countries.*

[I-JW] Okay. You said in your past job, you looked into how much money basically they've been losing on these inefficiencies. Did I understand it correctly?

[P-DJ] *We've never come up with a figure for like how much money is lost through quote-unquote inefficiencies, but we would have a database where I could benchmark the cost of security between airports. I had benchmarks for how many passengers would be processed through security per hour from one airport to another. So the average time to proceed from check-in through to the departure lounge across the airport. So we know what good looks like, we know what bad look like and then you'd also be able to correlate that with commercial revenue obtained to the passenger. And then we identified what all the good airports doing and then you know, we could propose implementing the best practices at other airports as a basically a value creation mechanism for investors who wanted to have a great story for an airport if they're going to make an investment.*

[I-JW] Are your findings accessible anywhere online or is it all confidential notes?

[P-DJ] *No, it is proprietary due diligence information. That's why investors will pay, a quarter of a million dollars to advisory firms to do to due diligence because they have all this proprietary information for multiple assignments.*

[I-JW] Okay. Now, I would move a bit towards the use of blockchain in the industry. So, the startup you co-founded, Block Aero, you intended to solve or optimize the asset management process within the aviation industry, right? So for airlines and other stakeholders.

[P-DJ] *Correct.*

[I-JW] So what issues were in the industry that your startup intended to solve or solved?

[P-DJ] *The main problem is that record-keeping is not standardized for aviation assets. And a sort of a paper trail must be maintained for everything to not only operate but also to be transacted between parties in the aftermarket. So if I don't have the paperwork that can prove this component has been properly maintained from its birth through to the present day, I may be fined if I operate an aircraft with that part in it and also very unlikely to find a buyer for that part because I can't prove what maintenance may need to be done. So the buyer would just discount the value to junk. And so we saw blockchain solution to deal with that problem because you could have a sort of decentralized, common ledger that would store the information about all these parts across the aviation supply chain. And basically that would eliminate that problem of paper going missing, or paper has to be sorted out, or records being forged. And basically would hopefully increase the liquidity of the trading of aviation assets.*

[I-JW] So, in order to achieve that, you need as many stakeholders in your platform as possible, right?

[P-DJ] *Yeah, you need you it's sort of a social network, right? You need a critical mass of stakeholders to rally around it.*

[I-JW] I actually found a similar solution. I'm wondering if your startup were was connected with that. Somehow, I think Honeywell developed a similar platform based on blockchain for trading used aircraft parts.

[P-DJ] *Yeah. We were sort of a bit confused about it because it doesn't really solve any issue. Sure it logs that a transaction is taking place, like eBay, but with blockchain reporting that transactions happened. So that's great. But what you actually need to do is you need a full digital record of everything that that part's been through from when it was created through to now. That means you need to upload and store huge amounts of information about all the shop visits, have that part's been through, or that engines been through or whatever. All of the service built-in compliance or directive compliance, or the bills of sale. And that platform is not doing that. Their platform is literally just this transaction is the data point of sale. And now it's off. Unless everyone came back and used that platform again, as the only place to trade these parts. Our solution was more about. We are in the MRO. So the MRO is logging it and pushing that data to the asset. The airlines are locking their operational data, the manufacturer is birthing the part on the blockchain has created. So it's a whole value tree of cycle. But you're correct. There are like there are lots of initiatives. Blockchain is a very obvious solution to this problem in terms of the technical attributes of blockchain. It's just very hard to do because there's lots of it's, it's highly political, and IT investments in the aviation industry unless it's consumer-facing, it is very neglected, I think.*

[I-JW] Okay. So you said different information about the asset is recorded on the blockchain. How is it in pracitce uploaded to the blockchain? Is it automatic entry manual entry who can enter information? How do you basically ensure that the information on the blockchain is truthful?

[P-DJ] *So you talk specifically about Block Aero?*

[I-JW] Yes.

[P-DJ] *Okay, so there are multiple ways to write data to the blockchain. So first of all, the blockchain was an enterprise blockchain. So it's built on Hyperledger Fabric. So this meant that you had to be part of the network to, you know, read or write data, right. So basically, for approved stakeholders, we worked with airlines and turbine services and solutions and a number of other companies so they would be approved members of the organization and then at that point, they can either push data to the blockchain via an API, or with their Oracle CMRO, or their tracking system, or, you know, whatever ERP system they're already using to manage their maintenance in house that pushes the data to the blockchain. Or we had built a browser-based client with like some natural language processing stuff built into it. So people could upload PDF files, that are usually output from, you know, a shop visit process or a transaction. And those could be sort of interpreted by the software. And then that creates like a sort of digital version of that paper document. And then a user can approve that right into the chain.*

[I-JW] And then, technically, how is the data stored on blockchain? Do you store only hash of that file, do you store the whole file on the blockchain? How is this approached?

[P-DJ] *Yes, it's not about file per se, though there was a full data structure that was written that want that. Basically, there are already standards for these parts. So like there are already electronic standards. So Spec2000 is the main one, but there are other electronic standards for storage of this data. They're just not actually widely used in the industry. So basically, we just quantify those standards into a data structure on the blockchain. And as we extracted data, it would be written onto the blockchain as data structures. But then yes, of course, if there are any supporting documents, we keep a hash of those as well. So that you could prove that the source of that you could still prove that this data populating data structure was signed or was derived from a given document. If you did want to go further into this particular topic, I would recommend having a quick look at Spec2000. Because it's basically a data structure for storing the storage of aviation asset data that was created around the year 2000 by Airlines for America (A4A), but it's been adopted on a very ad hoc basis.*

[I-JW] Okay. So that's probably similar to what they're trying to establish now in commercial aviation, where they have their own XML standards for sharing data.

[P-DJ] *Yeah, I mean, yeah. You're talking about XML standards now for the sharing of like, operational data, right?*

[I-JW] So that data could be codified on the blockchain. Basically you can take groups or types of information, and then you upload that on the blockchain. So you have a relatively lean structure of data.

[P-DJ] *Yeah, I think they were. I mean, it has been like, over nine months now. I can't remember exactly the number of fields, but it's all in Spec2000 there's a certain number of fields, maybe 50 or so fields, maybe only 15 of those are mandatory fields, the rest is optional. And the data just populate those fields. And that's it. If you have a supporting piece of paper documentation, that's great. But the idea is that you want to move away from you know, we want to create a world where a digital record is the primary source of verifiability of parts, not the paper document. The paper document sure if you want to print data and display it on a piece of paper, that's your choice. And I will not buy an engine, for example, if I don't see a cart full of paperwork in front of me. As a company that asset decrements its vaůue from its beginning. If you think of an analogy in banking, right now, I have a certain amount of money in my bank account, that amount of money essentially exists digitally. It's not like my bank has got a paper record of all the money I've deposited and withdrawn. And I have to keep that with me to prove to people if I want to do a transaction, how much money is in my bank account. If I want to print a bank statement, I can do it. That's fine. If I want to print statements and show people I can do that. But it's the digital record at the bank is actually the reality.*

[I-JW] Okay. Then on the other hand, what would be a weak side of this blockchain solution compared to the current solution, which is pretty much paper record mostly.

[P-DJ] *So this thing as I think like from a technological standpoint, blockchain is a perfectly viable way to do it. There's not a quote unquote weakness per se. Another alternative way to do it would be you would have a central organization or someone like that maintaining a central database of all this information as people engage in transactions, they just report all their data to some central body. Like that's fine. There's another perfectly valid way to do it. You know, the main sort of weakness to any of these solutions or any of these, like cross-industry initiatives is not actually the technology. It's the political willingness for everyone's come together and cooperate.*

[I-JW] How about the economic point of view? Because you run the database, basically the ledger, on multiple devices?

[P-DJ] *Yeah, but well, I'll put it this way.Let's say a used aircraft in the aftermarket is worth like 30 million or something like that, engines worth five to 10 million, and all these assets transacts like on average once every five years. In terms of the benefit that you would get versus the cost of maintaining it is trivial.*

[I-JW] Specifically, you said you use the Hyperledger Fabric at Block Aero. Yeah. Do you use any validation mechanism? Is it proof over proof of authority? Or what kind of mechanism?

[P-DJ] *Hyperledger Fabric is essentially a type of proof of authority system. There's no mining. It's an enterprise network where you can only get onto the network basically if you are in a group. And so your incentive using the network properly is that essentially everyone else will see if you're doing like terrible things on the network.*

[I-JW] So your reputation is what holds you accountable?

[P-DJ] *Reputation and also the policies in the chain code.*

[I-JW] Okay. And then, from your point of view, do you see any other areas within the aviation industry where blockchain could be applied?

[P-DJ] *There are many, many areas that blockchain could theoretically be applied. I think I've become somewhat of a pessimist on the use of blockchain in aviation, just because I think it's, it's just too hard to get people to cooperate with each other. It is too hard to get, you know, all of these sort of competing airlines, competing maintenance shops, competing manufacturers of parts to get together and cooperate. Yeah, I just think people would rather go off and do their own thing. And they'll only get behind initiatives like this if I care brings in some unifying international kind of law that makes it so. But it takes like five years to sort of draft legislation to be appended to the annexes. And you know has to go through so much politics. Maybe blockchain is a great solution for developed economies that have lots of money spent on fancy new technology. But other countries have far less sort of resources to invest in infrastructure and there's lots of other low hanging fruit in terms of airspace management and other safety initiatives that can be dealt with first before we move on to some flashy blockchain. Just to make traders of aircraft parts do things more efficiently.*

[I-JW] Is it your point of view only for the aviation industry or for the world in general, that it's just too difficult to apply blockchain because of the political nature of it?

[P-DJ] *I'm sure there are success stories. I'm sure there are some industries where the incentives aligned to make people want to cooperate with each other. I mean moving back into the airport space, and the sharing of personal data, like one of the huge problems you have in that space, is just that you're dealing with like, if, you know, if you're the British government, you're dealing with the personal information of your citizens. If you're talking about border control, so you're very constrained in terms of how you can share that with other people. You can only give it to other people by international agreements. And that's all essential. You're down to politics or membership in international organisations. How does a blockchain solution sort of blend into that whole process? I mean, my CTO, Adam described blockchain as basically like, it's like coding with one hand tied behind your back, you have. So it's such a rigid system that only allows you to do certain things. And it basically requires the users to constrain themselves and bind themselves to a fixed way of doing things. And all you need is to come to some international agreements that that effect in terms of aviation affects all daycare members. All you need is a significant number of countries to say no, they don't agree and it won't happen.*

[I-JW] Good. That's been it for questions we had for you. If you have any questions, feel free to ask

[P-DJ] *I'd be interested to see, certainly what is the official title of your thesis.*

[I-JW] It's kind of a work in progress.

[I-LS] So, basically really getting into how blockchain can improve passenger processing. But we focus mainly on the airport. So we take the airport's perspective kinda. To see how they can improve their operations. Hence increased commerce by having by sharing more information with stakeholders

[P-DJ] *Have you guys already had to wind up an interview with the V chain for example. I think they renamed themselves to Zen Zen or something like that. So basically, like these guys are like, from what, from what because I used to maintain like a big database of all of the, like capacitors basically like in terms of directly in our space and then just in other tangential spaces, and like these guys are like, essentially these guys are like trying to facilitate the like frictionless sharing, you know, passenger information other relevant, you know, data that would that affects like check-in security processes, border controls at airports, and they're, you know, they're working with assets to develop, they're like one passport sort of concept. So, I mean, I would interview these guys they'll know specifically like a lot in your sector.*

[I-JW] Yeah, super interesting. Thank you for now. Yeah, I think we looked into like all kinds of watching anything initiatives in the industry but for some reason, we didn't come across this.

[P-DJ] *So from what I can tell these guys are like the leaders in that space. I've no doubt there's like there must be a couple of other competitors to them because any good idea has a couple of teams surrounding it trying to do it. Yeah, in Block Aero we, I think at one point I counted the 12 companies that were trying to, you know, pretty much look like doing exactly the same thing.*

[I-JW] Awesome. All right. That was amazing. Thank you. Thank you for taking the time to talk to us.

[P-DJ] *Yeah, my pleasure.*

Appendix F

Observation: Flight from CPH to AMS on the 9th of February 2020

08-02-2020

I checked in through the SAS app with my mobile phone and picked a seat as much in front of the plane as possible, so I can get out as fast as possible. There will be someone waiting for me in Amsterdam, so I want to be able to get off the plane as fast as possible.

09-02-2020

On the morning of my flight, I looked online if my flight has been canceled or delayed. The weather forecast has been reporting extreme weather conditions, and at this point several family members have already texted me to check up with my travel plans. There is a code orange in the Netherlands, and a lot of flights from Copenhagen have been canceled. Therefore, throughout the day I keep checking the SAS app and the Dutch news on updates regarding the weather. For the same reasons, I left the house rather early, a little over two hours before my flight. Taking public transport it will take me about half an hour to 45 minutes to get to the airport. Arriving at the airport, I go straight to the security check. I scan the boarding pass on my phone to get through the gates. There is an interactive sign that points me in the direction of the shortest queue. There are six people in line in front of me and I have to wait for about 5 minutes. I am picked out for a random check, which only takes a few seconds. Overall, the security process takes me about 7 minutes.

I get a juice from Joe & the Juice. The staff is extremely friendly and has a little talk with me about Copenhagen Business School. After, I directly go to my gate and wait for boarding, while I watch some videos. I keep checking the SAS app for updates but do not expect the flight to get canceled. After half an hour boarding starts. As usual when flying SAS, boarding is done in different sections to speed up the process. A long line forms, with some people circling around, waiting to line up until their boarding section is shown on the screen. Boarding is smooth and we are able to depart on time.

Observation: Flight from AMS to CPH on the 13th of February

12-02-2020

As usual when back home I am extremely busy, trying to do as much in a short time frame. Therefore, I did not remember to check-in and was rather late. The SAS app did not perform as wanted and I was unsure if I actually checked in, but due to bad internet connection, I did not look further into it.

13-02-2020

On the day of my flight, I have a fast dinner at home and leave for the airport about two and a half hours before departure. My mom is driving me and it will take us approximately half an hour. Once at the airport

I walk straight to the security. Due to constructions at Schiphol, I have to walk for quite a bit. In the meanwhile, I look for my boarding pass on the SAS app. However, the app is not functioning properly, I am unable to retrieve my boarding pass, and assume something might have gone wrong with checking in, making me slightly anxious. I look at the signs to see what check-in desk to go to. Luckily for me, I have to be at desk number one, and I find myself right in front of it. There is no one besides me, so I can easily talk to the ground handler and ask her if she can print my boarding pass. She asks for my passport, so I hand over my passport and within seconds I have a printed boarding pass. I am relieved everything worked out. Next, I proceed to security. As usual at Schiphol, there are some employees who guide me to one of the security lines. I have to wait for about five minutes. I can leave my laptop in my carry-on, which pleasantly surprises me. I know my way around Schiphol, and SAS usually leaves from the same gate, so I walk towards that direction. I know there is a Starbucks right next to the gate, so wait to get my coffee there. Once I have my coffee I take a seat at the gate and try to do some work. The boarding is in sections, and I am in the second, therefore I am asked to line up next to the priority lane and wait. There is an employee trying to coordinate the boarding, but a lot of people are confused about the procedure. A lot of people try to board but have to go back in line, as it is not their turn yet. Hence, the process is rather chaotic and the employee seems stressed. He is raising his voice, trying to make sure everyone can hear him. However, the location of the gate is not helpful, as it is located right on a corner. Therefore, the line is blocking other passengers as well. The boarding takes rather long. Once everyone is seated the plane is unable to take off. Over the intercom, the crew is telling us that there is a maintenance related issue and we have to wait for a bit. After 15 minutes there is another notification, stating that there is something wrong with a light that is broken and this needs to be fixed before we can depart. It is getting very warm in the plane and the crew is opening the emergency exits to get some fresh air in. From this moment on I get a SAS notification through the app every 20-30 minutes, saying the flight has been delayed with another 20-30 minutes. In total, I got 4 notifications. Besides the SAS app notifications, the crew is updating us. From this, it becomes clear the app notifications are not very relevant and are lacking behind. Once the broken part is delivered we still have to wait for some documentation. Throughout the delay, the crew also has no idea how long it exactly is gonna taken. Hence, they keep providing us with new updates it is going to take longer. In total, the delay was over two hours. Once almost arrived in Copenhagen I check the time. The crew is giving updates on what to do in case you have a connecting flight. Due to the delay, it seems like I have to hurry up to make the last bus. Therefore, I am slightly stressed. I end up having to run through the airport, to make it home.

Appendix G

Table. Codebook

Theme	Code	Description	Example Quotes from Interviews/Documents
Collaboration	Motive to collaborate	The motive of stakeholders to collaboratively create a seamless journey	"*This is also in our own interest to prevent that the passenger has any disruptions in the journey and does not get stuck halfway, this would mean they have to go to an information desk to get help or need assistance from an agent"*
	Dependency	The dependency of stakeholders on other stakeholders	"*One mistake could potentially affect the overall flight experience of a passenger. Therefore, we need to see the big picture if we want to improve the overall flight experience"*
	Necessity	The forced nature of the collaboration	"*The airport cannot operate without airlines, and the airlines need the airport, the best result is the result of collaboration, on commercial and operational fronts"*
	Airport as facilitator	The central role of the airport in the network	*"You have the airport itself [...] with all resources that they make available, that's actually all they do, they provide runways, departure halls, infrastructure, baggage basements, parking spaces, and more"*
Relationship	Quality of relationship	The perceived quality of the relationship among stakeholders	*"So, I would say we have a very good relationship and at long last on all fronts have a healthy marriage, let's just keep it with that"*
	Formal agreements	Formalized agreements dictating the collaboration	*"It is covered with the agreement that the data can only be used for the specific purpose it was requested for or meant for"*
Accountability	Change of custody	The ownership of the process by stakeholders	"*The check-in guy is from SAS, but when he pushes the button, it is no longer SAS their responsibility anymore, it is the airport. But you don't know that when you are missing your luggage. If something goes wrong you just say SAS is shit"*
	Transparency	The transparency in the environment on which stakeholders is responsible for what service	*"This is done without the passenger realizing who does what for thim, where his data comes from and is being stored."*
Commerce	Commerce		*"Number one income is the shopping system, number two is the parking slots, number three are fees that airlines pay for each passenger. So shopping is very important"*

	Spending per head	Increase the overall consumption of passengers	*"Along with the impact on customer experience, every minute a passenger spends waiting in line directly impacts airport revenue by limiting the amount of time available to visit gate-side shops and restaurants"*
Airport layout	Design choices	Physical layout choices of the airport contributing to their goals	"*Burberry, Gucci, Yves Saint Laurent … they're located here because our heavy loaded, passengers normally pass by here for flying to the Middle East"*
	Passenger flow	Initiatives to streamline passenger flow through the airport	"*When you drive at the highway, and you need to take a turn, you look at the signs and you know, which lane you should choose this the same idea that we've been doing here"*
	Nudging passengers	Initiatives to prepare and push passengers at touchpoints	"*Yeah, and then we have the print on the floor. Does it work? No, the effect is limited."*
Necessary data sharing	Necessary data sharing	The perceived necessity to share data with stakeholders	"*There are several links or exchanges between parties, sometimes out of necessity because the airport needs to know how many passengers will depart at a certain time for example"*
	Legal obligations	Compliance with legal obligations	"*The kind of data we share is already a must and approved by law. All data must be shared in legal ways."*
	Agreement based data sharing	Sharing of data, which is covered by agreements	*"We have solid agreements about this, and other data is not being shared. We share data purposefully, so only column A to C from a larger table for example"*
Voluntarily data sharing	Voluntarily data sharing	The choice to share data out of perceived benefits from additional sharing	*"Sometimes the exchange is voluntarily, because we share processes, like the check-in process, here, it is convenient for all parties, ... In that case we can choose to, and we do to a certain extent, to share this information."*
	Willingness to share information	The willingness to share information with stakeholders	*"I think we should share as much information as we possibly can. And if there's information that we could share with the stakeholders we would love to do."*
Communication	AOC	Meetings facilitated by the AOC	"*We also have a huge meeting with all stakeholders, both the airlines, but also the fuelers, the ground handlers, the police, the customs, Falck is our PRM provider"*
	On-demand meetings	Requested meetings by one of the stakeholders	*"We also arrange meetings with other departments like police and handing companies to improve customer experience. we share our reports regularly and ask them to improve their service if necessary"*

	Mutual understanding	Creating an understanding of the desires and wishes of other stakeholders	*"We discuss how can we maybe help them? Do they have any issues with, staff for the summer peak and stuff like that "*
Means of data sharing	Data exchange	The systems and procedures used to exchange data with stakeholders	"*We share data with stakeholders by email or via other systems"*
	Analog data	Non-digitized information	*"The captain is carrying general declaration showing that this is my crew. [...] And then they show their airline ID, crew ID and the passport"*
	Frequency of data exchange	The frequency at which data is being exchanged	"*That's set up automatically that we share this information on a daily basis "*
Legacy systems	Interoperability and compatability		*"It is not all compatible and interconnected" & "It is not uncommon for these systems to have been developed gradually over the years, which may result in multiple legacy systems, and system architectures that are unnecessarily complex with implications for ease of use and overall cost"*
	IT investment	The mindset and initiatives towards IT investments in the industry	*"IT investments in the aviation industry unless it's consumer-facing, it is very neglected"*
Barriers to information sharing	Mindset	The prevailing mindset in the industry about the sharing of data	*"I get what you think [...] the young and fresh mindset from this era, where more people vouch for sharing data to the max, as this can only be beneficial to you and your customer. So why would you panic about sharing so much, and why would you keep it close to you. But we are simply not that far yet"*
	Monetary value	The commercial value of data	"*Data is valuable, it is worth money or can be used commercially"*
	Information misuse	Using information for an unintended purpose, not in line with agreements and legal obligations	"*As long as you do it with decency, and make sure rules are safeguarded, then I do not see a disadvantage, the more the better"*
Unknown passenger location	Missing Passengers	The incapacity to locate a passenger at the airport	"*Are they on what be called land side, which is the other part of security, terminal two, terminal three. Did they pass security? Did they pass the border control? Are they sitting in a lounge when they In the western part of the airport in the eastern part of the airport, where are the passengers?"*

	Flight disruption	Delays of flights and consequences for subsequent flights	*"Because otherwise the flight will be late and it's a big cost for the company if the plane is parked for too long"*
	Offloading	The offloading of baggage as a result of a passenger not being on board of the plane	*"The guy in the lobby calls you and calls you and you do not come. Now we suddenly have to empty all the luggage to find your luggage. And then we have to load it again, as fast as possible"*
	Informed decision making	The ability to make informed decisions based on accurate information	*"So in Heathrow, actually British Airways and Heathrow, they know exactly if a passenger is on the wrong side of security or on the wrong side of the border control. Okay, so if that's the case, they will just offload the passengers. There's no reason to call the passengers"*
Staffing	Resource allocation	The allocation of physical and human resources to support passenger processing	*"How many counters should we allocate to an airline? At what time?"*
	Forecasting traffic	Predicting the number of passengers that will have to be processed.	*"We have a forecast based on data for, I mean, earlier years. So we always forecast how many passengers will arrive in the airport today, both departing and arriving, and also at which time throughout the day"*
Digital transformation	Seamless journey	Creating an efficient and effortless (smooth) journey for the passenger	*"How can we make their way through the airport to their next flight as smooth as possible, as fast as possible?"*
	Changing demand	Evolving passenger demands, resulting in the need to transform (digitally)	"*Passengers no longer simply buy an air ticket; they purchase a travel experience"*
	Digital innovation	Digital solutions that enable the digital transformation	*"I think we're actually looking more to biometrics to be able to track the passenger so that we know where they are"*
	Collaborative learning	Sharing knowledge to learn from each other	"*If we can see that some airport is more efficient on a process than we are then we will obviously set the team to look at them and see what are you doing that's making this work so good"*