

**“Can blockchain disrupt the traditional
airline distribution for the better?
If so, what are the benefits of this
new technology, and how can
it be implemented.”**

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ABSTRACT

The air transport industry has been predominantly traditional, based on long-established business models and archaic IT systems. However, the advent of Low-Cost Airlines (LCC), with their simplified enterprise framework, based on unbundling of fares and ancillaries, has undermined the industry. Due to increased competition, legacy airlines had to adapt accordingly, allowing non-airline systems to become the norm, such as dynamic pricing, predictive analysis and revenue management, which require collaborative IT systems. Yet airlines failed to fully benefit from these enhancements, as they were being held back by the archaic technologies that dominated airline distribution. Industry visionaries then started to look at emerging technologies such as blockchain or Distributed Ledger Technology (DLT).

The aim of this research is to determine whether blockchain has the potential to disrupt the traditional airline distribution system and whether this technology will expedite the required transformation of the industry.

The research question is answered through gathering insights on the topic from industry experts and intellectuals, who are specialists in distribution and emerging technologies. The responses received demonstrated that although blockchain has many use cases in the air transport industry, distribution is not one of them. Respondents deduced that blockchain cannot replace the traditional distribution system, as it is still an immature technology. Unless there is evidence of a successful and reliable venture, blockchain cannot be relied upon by the industry. Blockchain is subjected to issues pertaining to security, resilience, speed, scalability, regulations of cryptocurrency, and cannot be trusted with distribution - which is considered the driving force of the air transport industry.

Instead, respondents proclaimed NDC as the true disruptor. Whilst implementation may have taken a considerable amount of time and funding, it has been widely adopted in the industry including intermediaries, such as GDSs and travel agencies. Respondents also insinuated for IATA to be the neutral 'manager' in any development towards building a new distribution ecosystem.

On this basis, it is recommended that airlines and all players of the distribution system invest in blockchain or any viable emerging technology by funding research, opening up a portion of their inventories, allowing experimentations, integration and by collaborating with feedback. This cycle should be maintained in order for the industry to evolve effectively.

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GLASSARY OF ABBREVIATIONS AND DEFINITIONS

ACH:	Airline Clearing House
Aggregator:	A website or program that collects related items of content and displays them or links to them.
Agnostic:	In an information technology context, it refers to something that is generalized so that it is interoperable among various systems. The term can refer not to software and hardware, but also to business processes or practices.
ANSP:	Air Navigation Service Provider
API:	Application Programming Interface, which is a software intermediary that allows two applications to talk to each other.
ATON:	Aton is the cryptocurrency of Further Network
ATPCo:	Airline Tariff Publishing Company
B2B:	Business to business, is a type of transaction that exists between businesses
BAAS:	Blockchain-as-a-service
BSP:	Billing and Settlement Plan
DLT:	Distributed Ledger Technology, a technical terminology for blockchain
EDIFACT:	Electronic Data Interchange For Administration, Commerce and Transport. EDIFACT is accepted as the international EDI standard that has been adopted by organizations wishing to trade in a global context. A standard set of syntax rules have been ratified by the United Nations.
EMD:	Electronic Miscellaneous Document, official IATA standard document to facilitate fulfilment of optional or ancillaries services.
Ether:	Token or cryptocurrency for Ethereum
FinTech:	Financial technology is the new technology and innovation that aims to compete with traditional financial methods in the delivery of financial services
Gatekeepers:	The tech giants, such as Google, Facebook, Microsoft, Amazon and Apple, who interface with consumers.
Gateway:	A device used to connect two different networks, especially a connection to the Internet.
GDS:	Global Distribution System, which is a software that connects to a network that passes inventory and rates for airlines, rental cars and hotels to travel agents and travel sites.

- NDC:** New Distribution Capability, is a travel industry-supported programme by IATA for the development and market adoption of a XML-based data transmission standard. NDC is a protocol for fare distribution enabling airlines to file fares in multiple platforms consistently.
- OLTP:** Online Transaction Processing is a class of software programs capable of supporting transaction-oriented applications on the Internet. Examples in airline distribution include: look and book flight segments, modifying PNRs, etc.
- Open Source Software:** A software with source code that anyone can inspect, modify and enhance.
- OTA:** Online Travel Agents. E.g. Expedia.com
- P2P:** Peer to Peer is where computer systems which are connected to each other via the Internet. Files can be shared directly between systems on the network without the need of a central server.
- Payment gateway:** A payment gateway is a merchant service provided by an e-commerce application service provider that authorizes credit card or direct payments processing for e-businesses, online retailers, bricks and clicks, or traditional brick and mortar.
- Protocol:** Protocol, in computer science, a set of rules or procedures for transmitting data between electronic devices, such as computers. In order for computers to exchange information, there must be a preexisting agreement as to how the information will be structured and how each side will send and receive it.
- PSS:** Passenger Service Systems
- SaaS:** Software as a Service, which refers to a subscription-based model where the software is hosted in the cloud and accessed via the internet
- Schema:** A representation of a plan or theory in the form of an outline or model
- SGR:** Smart Guest Record
- Silo:** A system, process, department, etc. that operates in isolation from others.
- Smart Contract:** Smart contracts are a piece of software made to facilitate the negotiation or performance of a contract, being able to be executed, verified or enforced on its own. A smart contract can be viewed simply as a set of business rules that are executed as a transaction on the blockchain.
- SPR:** Smart Passenger Record
- State Channels:** State channels are basically two-way pathways opened between two users that want to communicate with each other in the form of transactions, privately and off-chain. Users use their private keys, and only the final transaction is added to the block.
- STR:** Smart Travel Record
- TMC:** Travel Management Company

Chapter 1

Introduction and overview of the subject area

The air industry is deemed as an epitome of technological innovation, particularly in the form of continuous enhancement to the latest aircraft, which are getting more fuel efficient, quieter, faster and with long-range capabilities. However, when it comes to technologies, like the back-end systems that the air industry relies on for functionalities, it remains very archaic. More so, the IT infrastructure of the air industry is fragmented, with many different systems run by different airlines and organisations. Even within an airline organisation, different departments are divided into different silos. Although improvements and upgrades are intermittently implemented, some of the long-standing systems remain irreplaceable, particularly in the airline distribution landscape.

The focus of this study is to understand why the air transport industry is so slow in the technology it uses throughout. Various new technologies emerged, yet the same system prevails. The distribution technology has been the same for over 50 years, with limited enhancement, leading to oligopoly of GDSs.

This research looks at blockchain or Distributed Ledger Technology (DLT) as the potential technology to disrupt the distribution aspect of air transportation. Industry experts in distribution, technologies, and blockchain will be interviewed for the purpose of gathering data. It must also be noted that, not all airlines personnel who handle distribution are experts in blockchain. Due to the specialised area of focus of this research, there are only a select few individuals who will have an in-depth knowledge of both airline distribution and blockchain.

1.1 Technology constraint due to low profitability

Developmental constraint is perhaps associated with the high operating costs and thin profit margins of the air transport industry, which hindered any major investment in technology. Overall profitability for the air industry has been GBP 25 billion, representing a mere GBP 6 per passenger during 2017 (IATA, 2017). The highly competitive environment of the industry is conceivably another reason, with Low Cost Carriers (LCC) and their ultra-low fares. Airlines are therefore always looking for ways to reduce costs. Distribution accounts for 14% of the overall costs for US airlines (ICAO, 2017), and has become a major focus for airlines.

1.2 New business models

With internet came many innovative business models, one of which is the direct distribution by LCCs, who initially only relied on online sales via their own websites. Eventually they did manage to negotiate competitive deals with GDS, who were also

interested in the inventories of the LCCs. Other airline sales and non-airline products started to appear on LCCs websites.

Additional forms of distribution-businesses surfaced after the advent of internet, such as Online Travel Agencies (OTA), aggregators, metasearch sites, in addition to direct distribution via airline websites.

1.3 Product differentiation and dynamic pricing

Product unbundling is steering away from pay-all to pay-as-needed system, the airlines want a distribution system that effectively shows differentiation products. Dynamic pricing is another reason of moving away from traditional systems, so airlines could control how they file fare based on products or ancillaries. The old distribution system also did not support booking or paying for ancillary pricing, which is why GDSs are upgrading themselves.

1.4 New distribution landscape

First launched in 2012, New Distribution Capabilities (NDC) is an XML-based set of standard Application Programming Interface (API) that allow for comprehensive product differentiation, with a full and rich airline product content. IATA's NDC is a platform, that some experts consider to be the breaking point away from GDS. It provides the technology that fulfils airline and travellers' requirement, which was otherwise limited with GDSs. Six years after NDC's launch and adoption by many airlines, GDS started actively participating in NDC programmes and partnerships when they realised, they could be made redundant if no action was taken. Technologists are however sceptical of NDC, citing XML technology as old and outdated, having limited developments on its own. NDC is still being developed with many issues still unresolved, e.g. no comparison capability.

1.5 Blockchain as a disruptor of air transport ecosystem

Heralded as the 'Fourth Revolution' by Tapscott (Tapscott, 2016), blockchain is a relatively new and evolving technology with promises of disrupting industries and business. Some consider the emergence of bitcoin as a new type of cryptographic currency called 'cryptocurrency' to have undermined the long-established banking infrastructure which was based traditionally on fiat currencies. Although many are sceptical of this notion, this has led some technologists and futurists to evaluate blockchain as a disrupting technology that could possibly question the status quo of the traditional systems of air transport.

1.6 Blockchain for airline distribution

This research endeavours to determine whether blockchain has the potential and provision to reform the traditional airline distribution ecosystem, and under what conditions may it be implemented.

1.7 The Research Question

The thesis aims to investigate the research question: “Can blockchain disrupt the traditional airline distribution for the better? If so, what are the benefits of this new technology, and how can it be implemented.”

1.8 Airline Product Distribution – an overview

Perhaps the most important ‘intermediaries’ in the air transport system are the airline product distributors or GDSs. There has not been an alternative to distribution, which builds up the cost of distribution (oligopoly) and is a major concern for airlines. Additionally, airlines generally subscribe to more than one provider for extensive distribution capabilities. Other intermediaries such as banks and other related agencies also add cost and complicates distribution for airlines.

1.9 Types of Airline Distribution

1.9.1 Direct

Online: Supplier website

Offline: Airline sales offices, Call Centres

Direct channels transact directly with an airline’s computerized reservation system (CRS)

1.9.2 Indirect

Online: Online travel agencies (OTA), aggregators, metasearch companies

Offline: Brick-and-mortar travel agencies, travel management companies (TMC),

corporate travel agencies (CTA)

The indirect channels typically transact with a GDS for schedules, fares, and availability

2 Chapter 2

Literature Review

Blockchain is still a relatively new and evolving technology; with very few experts within the airline distribution, which makes literature on the topic very limited. Most of the literature for this research was assimilated from resources available online, in the form of press releases, company websites, articles and blogs by technology experts in air transport industry. International Airport Review, Airline Weekly, Travel Industry Blog, Travel Port, Tnooz, Medium, Skift are all online resources that have been significant in gathering data for this research. 'The Future of Airline Distribution, 2016-2021' a research conducted by Henry H. Harteveltdt of Atmosphere Research Group, commissioned by IATA in 2016, has been instrumental in the understanding of the changing landscape of airline distribution, and has been referred to a number of times in Chapter 2 and in the proceeding chapters. Key facts and analysis related to technological ventures are sources from reports by IATA, SITA, Accenture Consultancy, LSE Consultancy (commissioned by Amadeus), PhoCusWright, Winding Tree.com and Further's Ecosystem.com.

2.1 The traditional distributing system, GDS

The literature that covers the topics of traditional airline distribution, any conceived problems, restriction and constrains associated with it, and the reason why airlines are moving away and considering new alternatives are discussed in Chapter 1 and 2. For an accurate and in-depth understanding of the traditional airline distribution landscape for this research, the e-book titled 'Revenue Management. A Practical Pricing Perspective' (2011) edited by Ian Yeoman and Una McMahon-Beattie has been a good resource. Also, the following two chapters were consulted in writing this research: 'Chapter 7 - The Future of Airline Distribution and Revenue Management' by Ben Vinod provides comprehensive information on airline product distribution, and how it has evolved over the years. Published in 2011, Vinod's prediction of the future of distribution is still valid. Also, 'Chapter 8 - Global Distribution Systems Capabilities, Origin and Destination Control and Dynamic Pricing' by Karl Isler provides in-depth details on the traditional distribution system; the history and developments including post-Internet era; how it functions and how it is linked to dynamic pricing.

2.1.1 History of the Traditional Airline Distribution System

Following WWII, the general aviation experienced an influx of air travellers. Then airline tickets were booked by phone. Perhaps as early as 1946 airlines experimented with the computerized reservation system in order to keep track of bookings and passenger information. GDSs were originally created by airlines in the 1960s, starting with American Airline's introduction of Semi-Automated Business Research Environment (SABRE) built by IBM in 1963, which essentially created a digital database for flights that could be reserved by phone, followed by many airlines established their own reservation system and placed terminals in their ticketing offices which allowed seats to be booked directly from a centrally maintained inventory database. These were "ultimately given to travel agencies, carefully programmed to disfavour rival airlines" (Airline Weekly, 2010), again first by Sabre in 1976, followed by United Airline's Apollo and Galileo systems, which evolved into a full-fledged travel technology company Travelport, which then became independent in 2006. Travel agents required direct access to those systems and automating their side of the booking and ticketing process as well. In 1987, Amadeus was founded by a group of European airlines including Air France and Lufthansa, and then went public in 1999. In the 1980s and 1990s, airline started to form consortiums with the purpose of building global distribution system (GDS) allowing airlines and travel agents to communicate via a common distribution protocol and network allowing price discrimination management.

However, during the same time, U.S. regulations made these systems lose their usefulness as core assets and airlines divested most of their direct holdings in the GDS and independent distribution companies emerged, about four of the larger ones sharing the major part of the travel market with a few smaller ones (Isler, 2011). In 2004, it was again deregulated.

After 2005, airlines also outsourced their PSSs to three major GDS operators: Amadeus, Sabre and TravelSky, which increased those companies' power over airlines, yet Harteveltdt (2016) predicts that airlines will make steady efforts to take back control of their distribution.

By 2012, China started relaxing restrictions on foreign travel distribution companies, Travelport being one of the first to partner with TravelSky of China. In 2015, Sabre acquired leading Singapore-based GDS Abacus. As of 2017, three main players dominate the North America and Europe, with Amadeus with 43.5 percent market share, followed by Sabre with 36.3 and Travelport with 20 percent (Skift, 2017).

However, Isler (2011) denoted that as travel agents still sell the majority of network airline tickets and therefore constitute the most important distribution channel.

2.2 GDS functionality

GDS allows agents to check schedules, seat availability and fare information as well as book seats and issue tickets. Whenever a booking is made at the GDS terminal by the travel agent, a message is transmitted to the airline inventory system allowing it to update its booking status, store necessary passenger information and send updates about the changes in seat availability status to other GDSs. When the agent issues a ticket, the GDS transfers information to the billing settlement plan (BSP), a system administered by IATA (International Air Transport Association) which handles payments and the disbursement of commissions to travel agencies.

According to Vinod (2011) “the distribution vendors deliver higher yielding tickets than supplier websites in exchange for long-term assurance of full content and a broad set of protection”. However, a major advantage of GDS is the fact that they distribute for many airlines simultaneously, reaching out to areas where a particular airline is not the main provider in the market. GDS is indispensable to areas where customers, for various reasons, still heavily rely on brick-and-mortar travel agencies.

2.2.1 GDS connectivity enhancement over the years

The traditional protocol for interactive availability, sell and seat maps between an airline’s CRS and travel agency desktop required EDIFACT (Electronic Data Interchange for Administration, Commerce and Transport).

Later on, GDSs provided XML (eXtensible Markup Language) as an alternative to distribute products offered by LCCs, which enabled travel agencies to view real-time availability, flight information and seat maps. Navitare collaborated with Sabre to enable this capability for LCCs, followed by many more. With XML, the GDS were able to display and sell air content with a presentation similar to that used by the airline through their websites, with the added benefit of reduction in communication costs.

By 2010, efforts were made by several airlines, GDSs, OTAs and TMCs to successfully file fares that allowed bundling and unbundling via ATPCo fare filings. These were to be settled via standard Airlines Reporting Corporation (ARC) and Billing & Settlement Plan (BSP) solutions called Electronic Miscellaneous Documents (EMD).

2.3 Developments during Post-Internet Era

The emergence of the Internet offered a new distribution channel which was first used by low cost carriers (LCC) most efficiently, although eventually LCCs started using GDSs. Eventually, most airlines starting using a web page on the internet to sell flights, however,

many of them are linked to a GDS distribution channel or to the in-house inventory system with similar distribution capabilities like the GDS. None of the network airlines have not abandoned GDS distribution entirely.

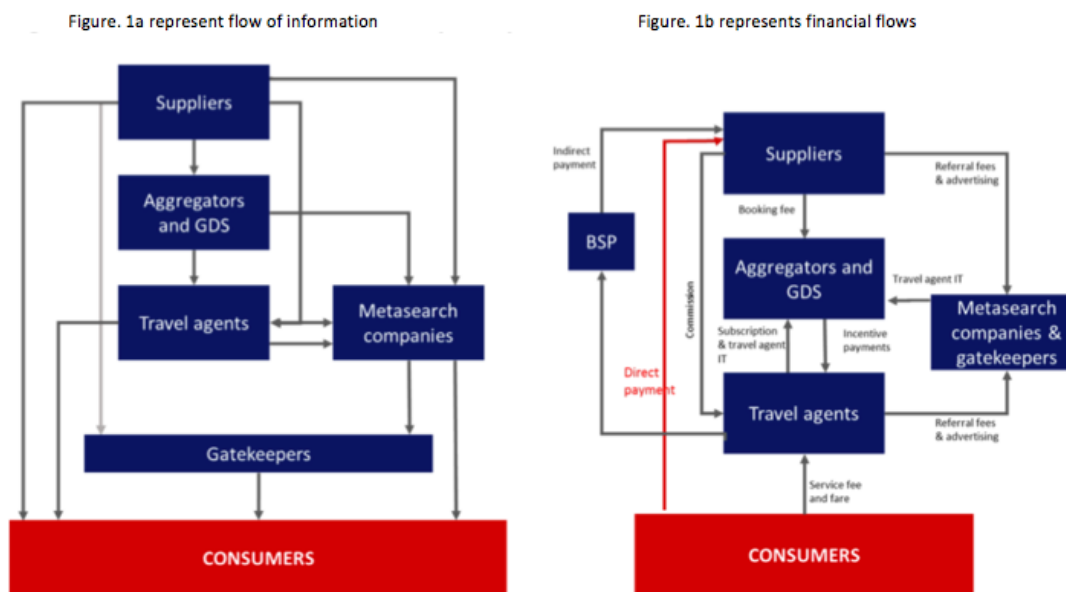
OTAs and TMCs still place bookings using GDS platforms, since they offer the most comprehensive collection of travel inventory across the globe (Sheivachman, 2017). Priceline started a new trend by abandoning booking fees in 2008 in an attempt to improve booking volumes and share, followed by other OTA the following year, leading to OTAs with a surge in booking volumes beyond the planned growth (Vinod 2009). The revenues dropped were offset by non-air products like hotels, car rental, etc. whose business model is based on advertisement and referral fees.

Despite the increasing spread of Internet distribution and the tempting possibilities for price discrimination, GDS channels still prove to be essential since they are used by travel agents to distribute products and prices of various subscriber airlines at one location.

According to a research carried out by Skift in 2017, four companies dominate the travel distribution landscape: Amadeus, Travelport, China’s TravelSky and Sabre.

Figure 1a represent a typical flow of information in the current air transport distribution, whereas Figure 1b shows the complex financial flows. These figure highlights the various types of intermediaries involved in the distribution system. Many different independent companies are further involved within each intermediary, all of which compete with one another.

Figure 1: The travel industry distribution today



Source: Amadeus/LSE Consulting, 2016

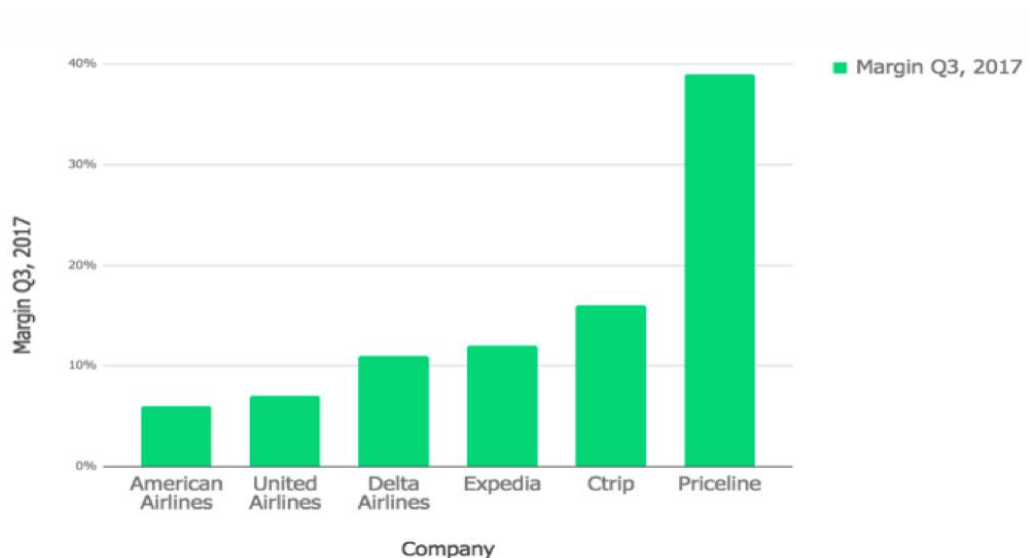
2.4 The proliferation of OTAs

Airlines were some of the founders of OTAs, for example, American Airlines created Travelocity through Sabre, and four major US airlines were the founders of orbitz.com, however over the years the online ticket sales for flights have taken over by OTAs (D'Souza, 2017). On the other hand, GDSs participated in the OTA market. Amadeus launched Opodo, and Travelport, which owns Galileo and Worldspan then bought orbitz.com. According to Atmosphere Research conducted on behalf of IATA (2016), OTAs account for 1 in 5 flight bookings.

OTAs are websites that aggregate airline and travel products, and sell them without redirecting to the airline website, like metasearch sites. OTAs connect to GDSs to access real-time data on availability and fares. OTAs also directly handle the actual bookings and customer service, exactly like a brick-and-mortar travel agency. They also market and advertise their products independently.

The difference between the profit margin is evident from Figure 2, where three OTAs are way ahead of the top three airlines in the US in the third quarter of 2017.

Figure 2: Profit margin of the top 3 airlines and OTAs in 2017



Source: D'Souza, 2017

China is the fastest-growing market for OTA, with distribution in China is almost entirely through OTAs. In the US, around 30% of online airline bookings are done through an OTA, in comparison with China, which is 77.5%. In 2016, Ctrip acquired Skyscanner, one of the world's largest travel search platform. Chinese consumers book their flights through OTAs,

because of their preference for booking trips on their mobile phone – a mode which Ctrip has heavily invested upon.

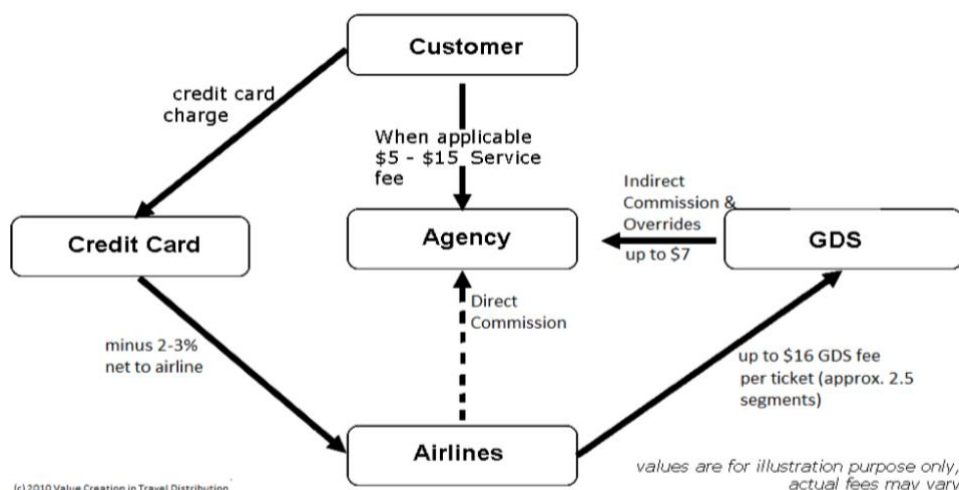
Airlines like Ryanair and Allegiant are becoming online travel agents themselves. In addition to selling their tickets and partner airlines, their websites host an array of non-air travel products as third-party distributors.

2.5 Lack of motivation for investment in IT

From a technological perspective, it is easily possible to combine and aggregate sources, e.g. content from different GDSs with LCC content and direct connect content, points out Strauss (2016), who believes that the GDSs prohibit technology providers to market their tool as confirmed by the US Airways-Sabre trial. Figure 3 shows how GDSs benefit from Airlines in exchange for the services and relevance they provide.

Other reasons for the lack of motivation in IT investment boils down to many people who do not like change, and many airline and airport executives who are scared of becoming redundant. Travel agents and agencies also seem to be reluctant to adopt new technology because a technology that simplifies procedures will make them exchangeable and obsolete (Strauss, 2016).

Figure 3: Value creation in travel distribution



Source: Strauss, 2016

2.6 Distribution Fees

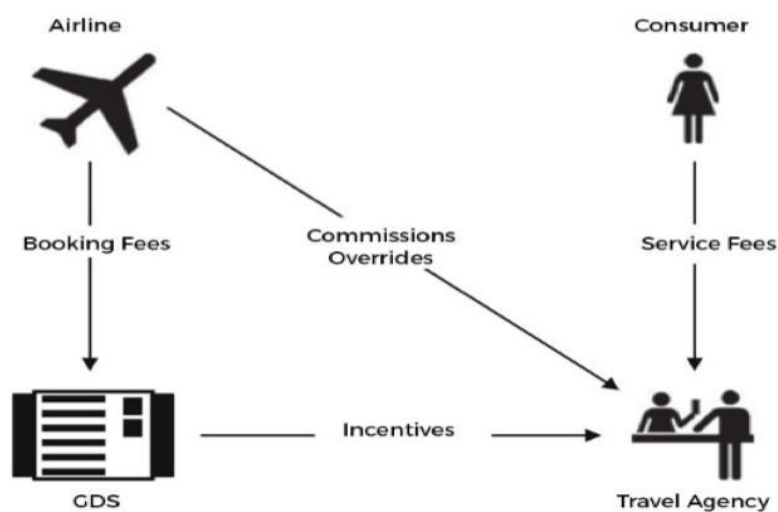
Airlines are always looking for ways to reduce costs, given the low profit margins. Distribution accounts for 14% of the overall costs for US airlines (ICAO, 2017), and has become a major focus for airlines. During 2015, Lufthansa challenged GDSs by imposed a surcharge of GBP 14 for all booking done on GDS, and others followed. However, this claim remains disputed. According to a report by Infrata in 2017, which was commissioned by European Travel Technology Services Association (ETTSA) and European Travel Agents and Tour Operators Association (ECTAA), denounced the claims by airlines, stating that the cost differential is presently much smaller than airlines contend. For Network Carriers the cost of direct distribution is GBP 11 versus GBP 12 for indirect, when calculating all the additional cost airlines have to bear in direct distribution and sales.

The key to the continued dominance of GDS is the cost they charge per transaction. According to a report by Skift (2017), “Fees for an airline booking are usually between 2 and 4 for a ticket, and about 20 percent for a hotel booking. Business models differ from company to company for travel providers, travel agents, reservation systems.”

GDS providers assert that the booking fee is a price for the added-facilities that an airline receives, including access to a global network of travel agents, agencies and OTAs. The other cost to GDS is the payment is IT-related, such as fee for software-as-a-service, or implementation of system access and consultation.

Travel agents receive indirect commission and overrides from GDSs as well as direct commission from Airlines, as shown in Figure 4.

Figure 4: The flow of distribution fee



Source: Skift, 2017

The distribution system companies argue that these fees represent a sum much lower than it would take to build a new distribution system or perform the marketing needed to encourage the bulk of travellers to book directly on an airline website. While ostensibly a small percentage of airlines to pay, it adds up when a billion seats are being booked each year, including other payments for access to the systems and other services. (Skift, 2017)

Airlines asserted that by allowing the GDSs to operate much of their distribution technology, they were able to reduce their IT investment and keep relatively small IT departments (Herteveldt, 2016)

2.7 Additional costs related to distribution

In addition to the various fees that airlines pay to GDS for distribution and marketing, there are many more including but not limited to OAG scheduling, NDC membership, ATPCo, ticket processing costs, credit card fees, transactions fees, surcharges and travel agents' commission.

IATA Senior Vice President for Financial and Distribution Services, Aleks Popovich (2017) indicates that from searching online for an airline ticket to the time of the arrival at a destination, there around 26 business partners involved in the whole process, with each intermediary taking a profit margin; which is often higher than the airlines. Financial institutions, which includes banks, card schemes, etc. that are involved in the air transport industry take the less risk and retain higher margins.

IATA's financial settlement systems handle approximately GBP 287 billion (USD 400 bn) per year, of which GBP 5.5 billion (USD 7.7bn) goes into banking fees, which is more than 20% of the estimated net profit of the entire global airline industry in 2016 (IATA, 2017).

2.8 Important components of the traditional distribution landscape

Airlines publish their fare data including all rules surrounding them through ATPCo, whereas the scheduling data is located in another system in OAG – both of which is pulled into the GDS, and then onto travel agencies, OTAs, TMCs.

More than 430 airlines publish in excess of more than 1 billion airfares at a given time through airline-owned airfare database Airline Tariff Publishing Company (ATPCo), which has been a critical component in airline distribution for more than 50 years, but some airlines and analysts see its role shrinking in the future. ATPCo's partnership with Farelogix to launch NDC-enabled effective dynamic pricing. ATPCo's acquisition of Routehappy in

February 2018 is perhaps a step towards maintaining relevance in the ecosystem by being the clearinghouse for all multimedia content relevant to airlines (Rose, 2018).

2.9 Other technology-driven distribution platforms

Gatekeepers such as Google, Amazon and Apple can disrupt the travel distribution industry through their advertising mode, according to a study by LSE, commissioned by Amadeus (2016). These gatekeepers can direct customers to particular players, whether airline or travel agents, in return for a fee. They can target consumers with tailor-made advertising based on search history, profile or conversation through messaging apps. Paid search results and targeted advertising allow gatekeepers to grow large volumes of traffic acquisition for other players in the industry.

According to Nielsen (2015), Facebook is the leading smartphone app, with over 126 million users each month in 2015, while Google Search, Google Play, Google Maps and Gmail clocked up a combined 348 million users per month.

2.9.1 Sponsored search advertisement to search engines

Advertisements on search engines, which displays the sponsored product alongside non-sponsored products on web search results is another form of attracting customers.

2.9.2 Social networking site

Web-based communities such as social networking sites, wikis and blogs has reinforced interactivity, and sharing experience. Online vendors recognise the traffic that social networking brings to their sites (Vinod, 2011)

2.9.3 Mobile applications for travel

A survey conducted by PhoCusWright indicated that travellers will use smart phones to access supplier sites, navigation assistance, find local attractions, read user reviews and access social networks (Rose and Schetzina, 2009)

2.10 New Distribution Capabilities (NDC) initiated by IATA

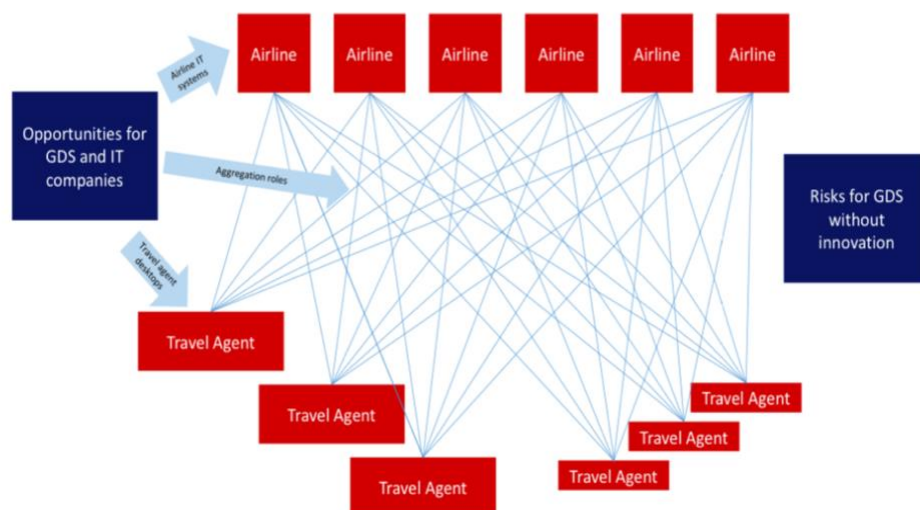
New Distribution Capability (NDC) is a programme launched by IATA in 2012 to improve on the distribution of travel products, by allowing product differentiation and time-to-market with full and rich content based on a set of XML-based standards, addressing the limitations of the traditional distribution ecosystem. It is an open industry-supported programme to use and implement by third party, intermediaries and IT providers, including non-IATA members. Figure 5 and 6 shows the differences in the GDS or indirect aggregation mode and opportunities in direct aggregation model.

Executives at Verteil Technologies view NDC as perhaps the first form of disruption to the traditional distribution system relying on GDSs. They also developed a system that runs in parallel or synchronised with the traditional GDS system, such as EDIFACT. This aligns with the prediction made in the report by LSE (2016). Figure 5 shows the GDS-centric models of airline distribution, which looks completely different from figure 6 where airlines are able to directly connect to travel agencies using NDC.

Figure 5: Indirect GDS aggregation model



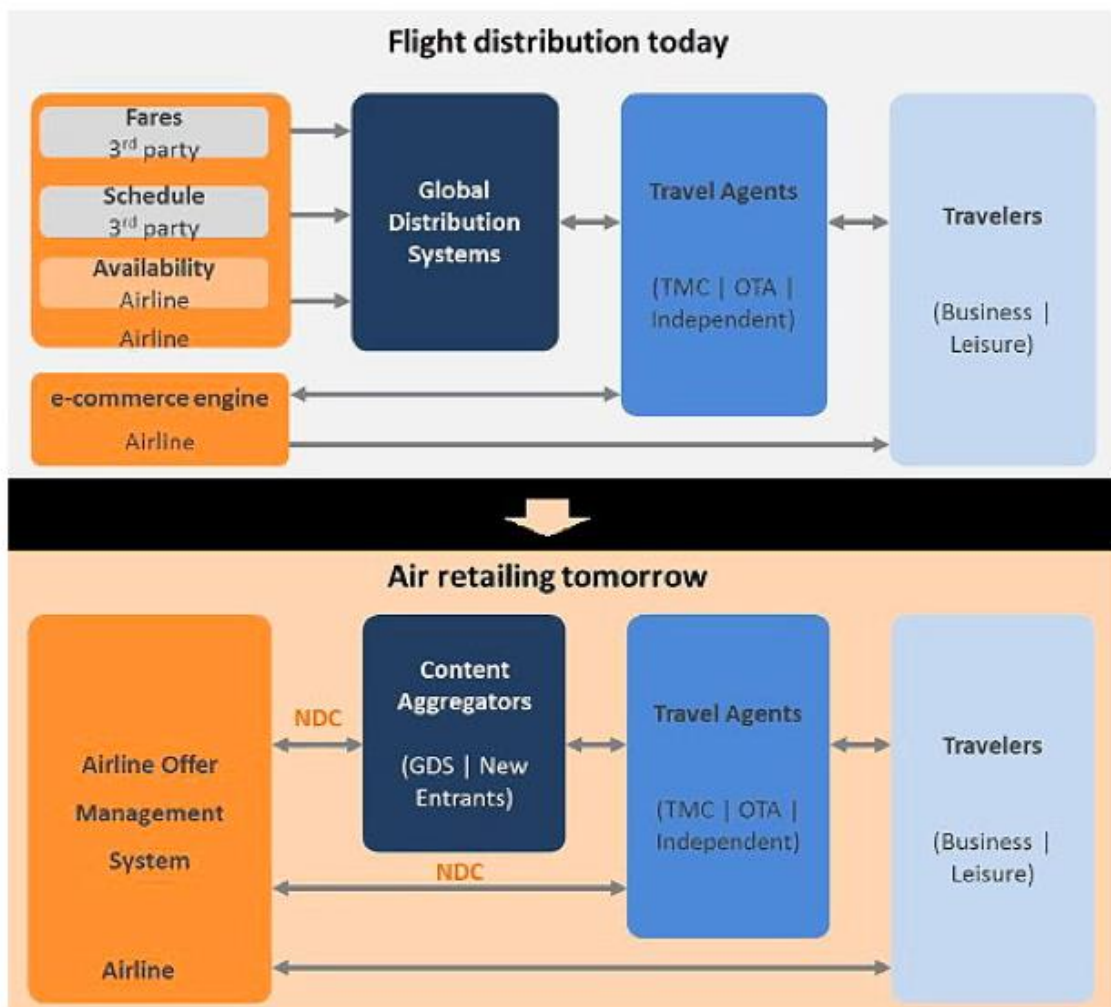
Figure 6: Direct aggregation model



Source: LSE, 2016

Many industry experts see NDC as an opportunity for GDS expansion. Some airlines executives interviewed by LSE research (2016) suggested that NDC could circumvent the GDS allowing airlines to connect directly with travel agents and other players. Others suggest that the likelihood of airlines agreeing the detailed standards necessary for direct connect to operate at scale is very low and would take years. Figure 7 shows the difference between the distribution in a pre and post NDC application. Some executives, commented that the seven years that it took NDC to be where it is, based on many conferences and meetings, is very disappointing. Many believed that the industry, with its IT infrastructure based on multiple silos, need to come together and upgrade to a unified, advanced and simplified system, whether it's blockchain or something else.

Figure 7: Traditional flight distribution vs new air retailing



Source: Travel Daily News Asia (2015)

The latest and perhaps a major development has been the adoption of NDC by ATPCo and GDS providers. American Airline is working closely with GDSs, particularly in helping Sabre build an IT solution for NDC (Jonas, 2017). Travelport also plans to deliver NDC capabilities for agency subscribers in 2018. Travelport aims to have the fully integrated display of NDC-enabled content alongside the GDS workflow, within the Smartpoint desktop system by 2019 (Shurrock, 2018). Gianni Pisanello, Vice President of the NDC-X programme, a dedicated NDC unit at Amadeus IT Group, expects the first level of solution to be ready for global deployment by the first quarter of 2019, and said “it is straightforward for OTA to adopt because the typical OTA flow is similar to the NDC flow: shop, order and pay” (Jonas, 2018).

2.11 GDSs adopting NDC

According to LSE report (2016) NDC could be viewed either as an alternative to GDS or an opportunity for expansion. Some airlines interviewed suggested that NDC could circumvent the GDS allowing airlines to connect directly with travel agents and other players in distribution. Other industry experts expect NDC to create new opportunities for GDS companies and other aggregators, as the complexity of information will require more sophisticated aggregation in the long run. A number of interviewees by LSE also expected that NDC would run in parallel with the EDIFACT system traditionally used by the travel industry companies.

Amadeus: Gianni Pisanello, vice president of the NDC-X programme at Amadeus IT group said, “It is straightforward for them to adopt because the typical OTA flow is similar to the NDC flow: shop, order and pay.” He expected that the first level of the solution to be ready for global deployment by the first quarter of 2019 (Jonas, 2018).

Sabre: American Airline is working closely with GDSs for NDC adoption and helping Sabre to build an IT solution for NDC – according to AA senior vice president of global sales, Alison Taylor (Jonas 2017).

Travelport: Travelport plans to deliver NDC capabilities starting in the second half of 2019. For agency subscribers, Travelport at the point of sale would combine NDC-enabled content alongside the GDS workflow, within the Smartpoint desktop system, with fully integrated search, book and manage function afterwards.

2.12 Blockchain technology as an alternative for airline distribution

Størner and Heller (2016) suggest the use of Blockchain technology with IATA's NDC and ONE Order to make it more efficient, generic and transparent than the current proposed messaging system. Heller advocates that since the process of implementation is still underway, it could be adjusted. Størner believes that the shared ledger by IATA will make the traditional interline settlement obsolete. Blockchain provides a payment audit trail which cannot be tampered with, whereby reducing the time and costs of payments in multiple currencies and geographical areas.

2.13 IATA and blockchain

IATA announced in 2017 that it had begun considering how blockchain payment system could facilitate the industry. Under the IATA Financial Committee, it has set up a pilot scheme. But, as blockchain does not meet the requirements of the global regulatory framework, worldwide roll-out is impeded. Aleks Popovich, IATA Senior Vice President, Financial and Distribution states that "Undertaking such a transformational innovation of the industry on this scale would require two things: more resources and more willingness to take on risk. Implementing blockchain requires a complete change of philosophy as well as a change of technology. Previous financial technologies have reconfigured the shop-front. By contrast, blockchain is a complete revolution in the back-office. And airlines, typically, do not do revolutions. This is where IATA can help, by affectively managing some of the risk and developing a blockchain system on behalf of its members." (IATA, 2017).

2.14 Literature on blockchain technology

Manager Innovation at IATA, Houman Goudarzi's article '5 Winning IT Strategies Enabling End-to-end Digital Transformation' published on 24 March 2016 on LinkedIn is perhaps the first publicly-available article on the distributed ledger technology, which explains the technology in layman's terms. '6 Technologies that will Revolutionise the Aviation and Airport Industry in 2017' (2017) posted in International Airport Review has been one of the pioneering articles linking blockchain to air transport industry, which has been shared over 1.7K times by February 2018. Although Goudarzi has not written anything about airline distribution, many of his articles have been instrumental for the researcher's better understanding of blockchain and its uses in air transport.

Travel technologies expert, editor for Medium and an avid writer Trond Vidar Bjoroy has written several articles that are indispensable for understanding the basics of blockchain in air transport. Posted in Medium, the article 'Blockchain in Travel for Dummies' (2017) is an

easy to understand detailed article on applications of blockchain in air transport industry, citing Winding Tree project, which is considered the first blockchain-based open travel marketplace. 'How Blockchain Could End Travel Industry Pain Points' (2017) posted on Medium and coindesk.com, points out at the technology-related issues in the air transport industry and why blockchain is the potential solution, touching upon blockchain for distribution.

It is noteworthy to mention that perhaps the first research analysis on blockchain disrupting travel distribution and settlement process was published in May 2016 in phocuswright.com by Norm Rose, a senior travel technology analyst and consultant on emerging technologies. A recent video by Norm Rose in ITB Berlin Conference (March 2018) explaining blockchain and its updated current role in air transport is available at https://www.youtube.com/watch?time_continue=298&v=T3rXb6g3uSg

Several blogs by Michael Strauss has helped the researcher in understanding the role of technology in many aspects of distribution. Strauss describes blockchain's potential to eliminate intermediaries such as GDS, credit card companies, clearing houses, in 'Travel Technology for Dummies: What are Incentives, Commissions and Overrides?' (Travel Industry Blog, 2017). Strauss also explains why he thinks that NDC will have issues in adoption in his blog 'The reality behind NDC: Why NDC won't break down the GDS oligopoly – yet' (Travel Industry Blog, 2017).

SITA Lab has several publications, research papers, whitepapers on successful projects and blockchain related ventures. They have been a great source for this research. All projects were undertaken by teams led by Kevin O'Sullivan, Lead Engineer at SITA Labs. 'FlightChain' project which was carried out in 2017 with British Airways, Heathrow, Geneva Airport and Miami International Airports using 'smart contract' residing on a blockchain, for shared control of data by airlines and airports.

Chapter 3 will cover in detail the topic of blockchain, its use cases in air transport and look at the projects of airline distribution on blockchain.

3 Chapter 3

Description of Case study

Blockchain is conceptually the next infrastructure platform that could eliminate the middle man in travel and also reduce fraud. Since travel is so distributed and global, blockchain is a possible way to help make travel booking more direct and efficient. Absence of intermediaries could allow reduction in costs, and faster transactions, which are the two main attractions of blockchain. Some innovators and IT enthusiasts are therefore, considering all the possible industries that could be disrupted, including the aviation industry.

3.1 Blockchain definition

Blockchain technology or Distributed Ledger Technology (DLT) is a decentralised technology based on peer-to-peer (P2P) transaction or information sharing, with no intermediaries. This technology runs on internet but is not dependent on a centralised system, instead it exists on many computers (called nodes) that are part of a particular blockchain network.

“Blockchain is a type of database. Whilst traditional data resides on a central infrastructure, with back-ups and redundancy measures; the blockchain technology embraces a distributed architecture” (Goudarzi, 2017).

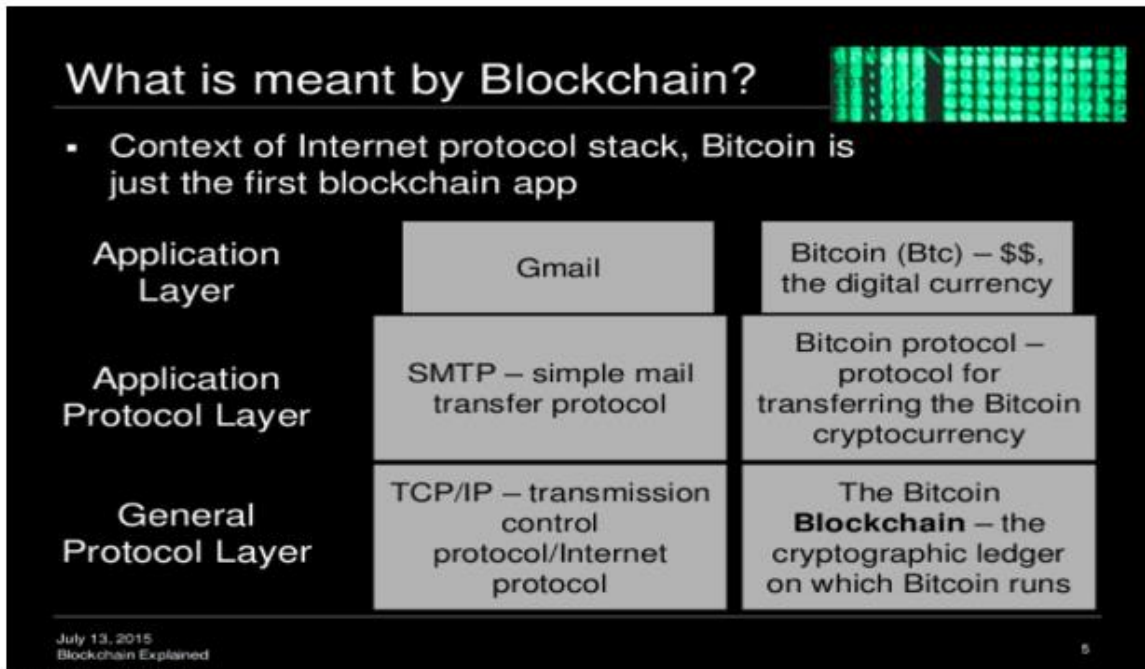
Figure 8: Metamorphosis of database



Source: Goudarzi, 2017

Founder of the Institute of Blockchain Studies, Melanie Swan (2014) compares Blockchain with the Internet with “a comprehensive information technology with tiered technical levels and multiple classes of applications.”

Figure 9: Simplified comparison of blockchain with internet



3.2 How blockchain works

In a typical blockchain, transactions or data are stored in a ‘block’, a copy of which resides on all the participating computers on the network. For each new transaction, a block is created. For a block to exist, it needs to be accepted and authenticated by the majority (called consensus) of participants called Miners, who use processing power on their computer systems. These miners are rewarded in the form of crypto-currency like bitcoin that they can save in an online or offline Wallet. These can also be converted into fiat currency using many exchanges like Binance. To add further data or transactions on that block, a new block will be created and chained to the previous block – thus the name blockchain. Once this chain of blocks is validated, it becomes almost impossible to change it, making it immutable. If anyone wants to illegitimately modify it, they will need to change all the blocks that exist on multiple computers at the same time. As the technology enables a set of data or ledgers to be distributed, it is called distributed ledger technology or DLT. Cryptography used in blockchain allows huge sets of data to be stored.

3.3 Qualities of blockchain

- Immutability
- Absence of centralised governance
- Authenticity between trust less players
- Single version of data available to multiple users

Provides proof of work, ownership and location
Quick and cheap transactions possible with cryptocurrencies
Smart contract that allow execution of transaction once business rules are met

3.4 Types of Blockchain

3.4.1 Private

Referred to as permissioned or enterprise based blockchain, it is managed by one or more organisation in terms of functionalities, rules and governance. Only invited participants join the network, with restricted level of access granted by the authority who is merely a caretaker. E.g. Hyperledger Fabric launched in 2017.

3.4.2 Public

Also called as open-sourced blockchain, it is accessible to all who join the network. Anyone can build a programme or create a blockchain community. This is where most developments are made. E.g. Ethereum launched in 2015.

3.5 Smart Contracts

Smart Contracts are self-executing contractual states, stored on the blockchain, which nobody controls and therefore can be trusted by all. The terms of the contract are written in code and are accessed via a mutually agreed data source. An example would be, once a service is consumed and verified by the user, the Smart Contract would release the payment to the service provider.

Based on the Ethereum platform, smart contracts would potentially speed up transactions, reduce underlying fee, and quite possibly make auditing unnecessary.

3.6 Blockchain in air transport

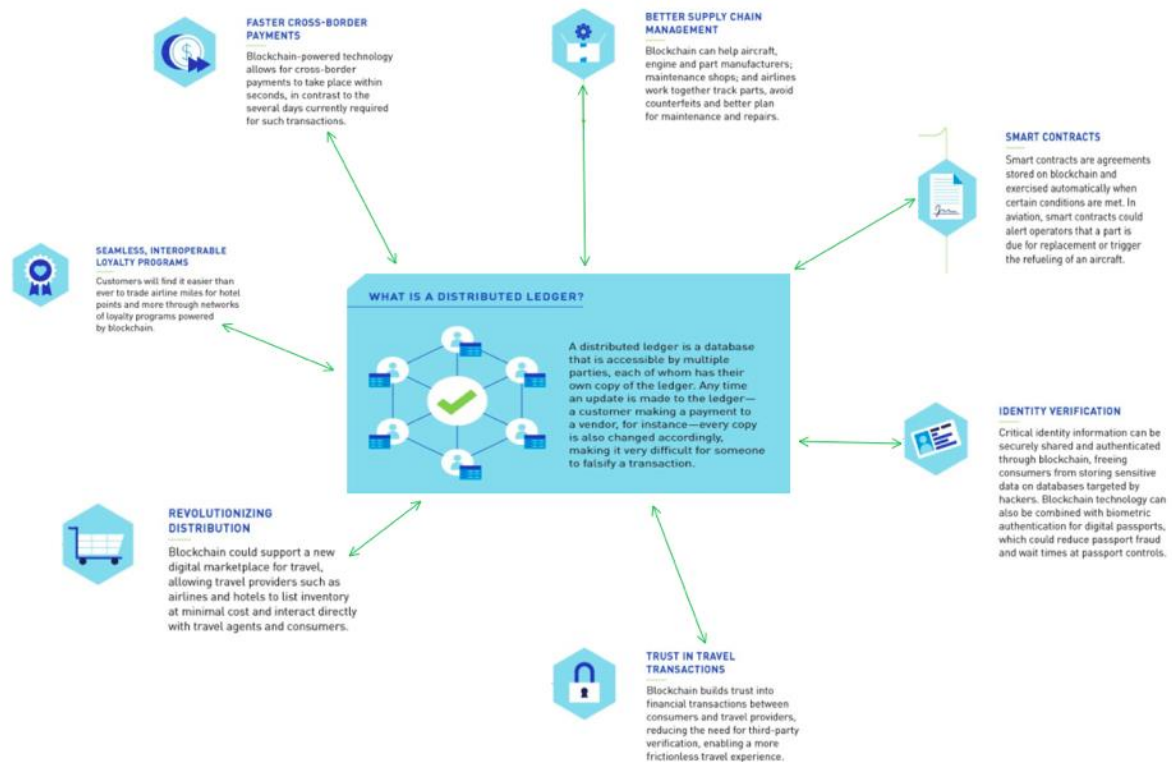
Air transport lives on a commercially distributed ecosystem, based on integration between different suppliers, partners and third parties, which makes it a potential case study for blockchain.

One-Identity, a blockchain-based technology to replace passports, is already being tested at some airports in Europe (Zurich), the Middle East (Doha, Dubai) and elsewhere. Similarly, significant research and testing have been done with regards to baggage-ID (SITA), Frequent Flyer Programme by IAG Group (Hanger 51), cargo transportation and

maintenance, repair and overhaul ‘MRO’ (Lufthansa cargo and engineering). Pilot’s Licensing and validation by aero.com.

According to Kevin O’Sullivan, Lead Engineer of SITA Lab, “DLT is not the thing ... it’s simply the thing which enables the thing. With the help of automation, the Internet of Things, Artificial Intelligence and robotics, DLT promises a world where business can quickly contract, exchange services, record transactions, manage payment and disengage ... DLT is important because it’s a business model paradigm shift. It’s disruptive because it provides trust and transparency in information exchanged between businesses.” (Air Transport IT Review, 2017)

Figure 10: What is distributed ledger?



Source: Adapted from jetBlue Technology Ventures on Medium (2018)

Figure 10 is a modified illustration sourced from Medium (2018) which was adapted from jetBlue Technology Ventures (2017). This figure demonstrates the various progressive opportunities that blockchain offers, which hypothetically justifies the disruption of air transport industry with this emerging technology.

3.7 Projects on blockchain

There are currently many projects being tested on blockchain by numerous organisations in the air transport industry. The following are a few examples that SITA has been working on across airlines and airports based on many technologies combined, including blockchain:

FlightChain

Cargo manifests

Baggage tracking

Aircraft history and maintenance

Personalised and aggregate loyalty programmes

Smart Path™ – single token travel using e-passports (already trialled at Brisbane Airport, in the Middle East and Asia Pacific.)

Single token (which will be used for payments, and equivalent to a given amount in fiat currency) for different use cases within air transport.

3.7.1 FlightChain

Based on blockchain this is the first project that has been realistically successful in air transport industry. FlightChain was developed to investigate a single source of truth for flight data. Traditionally there has been no single version of data nor easily accessible by all parties involved. FlightChain was established by SITA Lab with Heathrow Airport Holdings Ltd (HAL) and International Airlines Group (AIG) with participation of Geneva Airport and Miami International Airport.

Security is of the utmost importance in air transport, thus FlightChain was established as a private permissioned blockchain (implemented on both Ethereum and Hyperledger-Fabric) that stored flight information on the blockchain, using a smart contract to arbitrate potentially conflicting data. British Airways, Geneva Airport, Heathrow and Miami International Airport provided flight data that is merged and stored on the blockchain. According to the report by SITA, during this project more than two million flight changes were processed by the smart contract and stored on FlightChain.

Success of FlightChain demonstrated that blockchain is a viable technology to provide a single source of truth for data for airlines and airports, especially for real-time flight information. “While there are other technologies available for sharing data, the use of blockchain, and smart contracts in particular, provides ‘shared control’ and improves the trustworthiness of the data” says Jim Peters, CTO SITA.

3.8 Blockchain in airline distribution

Bjoroy (2017) believes that “airlines need systems that speak to each other. Distribution has changed over the years, from an independent department to a collaboration with pricing, marketing, revenue management, sales, etc. therefore need a collaborative technology”. There is rising need for Airlines to be able to quickly and effectively change prices or add ancillaries without any intermediaries or delays. This would also allow travellers flexibility and lower costs for all. He also believes that there is lack of trust in the industry between suppliers and intermediaries, this is where blockchain can be trusted.

Similar to other transformational technologies and new business models, the blockchain offers prospects for travel distribution. “Assuming the community of developers or market-makers can figure out scalability and the creation of the right mix of supply and demand side incentives models, the Blockchain can potentially hit two birds with one stone”, Gaber (2017).

Blockchain may provide autonomy and access to travel content, such as availability, pricing, etc. allowing new demand-side agency models and players. It also has the potential to unleash significant multi-modal travel experience. The decentralised and distributed attribute of blockchain allows for a secure network, rather than individual application with access controlled by a few, removing barriers to new entrants and smaller players that will create competition on equal grounds.

However, they will likely face a classic innovator’s dilemma; they extract a significant amount of rent today from their privileged central trusted positions in distribution, there is no incentive for them to democratise access to content.

There are going to be a few travel blockchains or markets, the most successful being the one who will nurture and provide the right incentives for suppliers, agencies, developers and travellers alike.

Gaber is optimistic that with blockchain, airlines will ultimately triumph and regain control of their inventory and pricing whereby reshaping the distribution environment and shift the balance of power to those with the highest investment and risk in the industry.

According to the new CEO of Expedia, Mark Okerstrom “the measure of the blockchain technology is going to be whether or not it will be ‘cheaper or better’. it is simply too early to tell what the outcome will be. Why invest in a technology that potentially levels the playing field and energizes developers?” which clearly illustrates the lack of interest in IT investments by GDSs and other intermediaries (Gaber, 2017).

Two alternative airline distributions have been initiated using blockchain, called the Winding Tree and Further’s Ecosystem.

3.8.1 Winding Tree

Winding Tree claims to be the first **open-source**, decentralised autonomous marketplace for travel. It does not have the solution yet but is providing a blockchain-based platform to facilitate start-ups and developers to use their protocol to draw inventory from all participating suppliers.

Izmaylov (2018) states that the idea behind this non-profit organisation is to empower travel companies to be able to connect to each other without the need of a trusted third party by being open-source. “The goal is not to disrupt the middlemen but to enable innovation. They welcome OTA and GDS to work with Winding Tree”. He further explains that Winding Tree does not charge transaction fee for anything happening on the blockchain. However, blockchain themselves run on mining fees, and there are network fees paid to people contributing their computational power to the network and keeping it safe. Every blockchain has network fees.

Airlines including Lufthansa, Air New Zealand, Eurowings, and many more have joined the project. An important development is perhaps the incorporation of ‘state channels’, which will enable large amounts of instant transactions off-chain without incurring individual transaction fees. It will also provide ‘privacy’ for airlines or suppliers who are otherwise apprehensive of broadcasting their inventory. Additionally, with Winding Tree smart contracts, every supplier will be able to define their own business rules around cancellations, which is currently impossible with Expedia or Priceline.

3.8.2 Further’s Ecosystem

Further Network is a blockchain-based project that aims to build an ‘Autonomous Smart Travel Ecosystem’. Contrary to Winding Tree, this undertaking uses an enterprise blockchain platform Hyperledger Fabric that will foster distribution with speed, security and privacy. This venture is still in the initial stages and participation of airlines may prove its relevance.

This enterprise-based aims to resolve issues related to public-based blockchain such as performance at scale, resilience, security and confidentiality. Transactions will be carried out on a channel within the network, after it has been authenticated and authorized by certain pre-defined parties. The biggest drawback however, will be the probability of this becoming another oligopoly.

3.9 Limitations

Blockchain is still in early lifecycle, with many changes and rapid evolution which makes it complicated and error prone for implementation across many different suppliers and consumers. Private and public blockchains each has certain limitations:

3.9.1 Private

These are not self-managing and would require governance and operational oversight that ideally does not compromise the integrity of blockchain.

3.9.2 Public

Absence of central leadership or control over direction of network could lead to slow decision making. Difference and debate could arise from participants over the direction of network.

3.10 Issues with blockchain technology

Dowding (2018) lists technological limitations and issues pertaining to blockchain which makes it unsuitable for distribution such as speed and scalability. “Although transactions are being recorded successfully on distributed ledgers, the solutions are slow ... Until blockchain networks are designed without the separation of transaction and ledger validation, which can be processed at the same rate, at which transactions are generated, they will never meet the performance requirements of the financial services and other industries ... Beyond any ledger, there is the need to interpret or augment the data for financial, regulatory, credit, risk or performance reporting. If the ledger cannot be updated in real time with any ancillary downstream data, then there is, at best, a dependent process and worse, the need to API, reconcile and control the data. The solution is to redesign the Core and the Protocol layers, but most ventures don’t understand this, hope they can work around their current solutions or don’t want to admit that reality to their sponsors or investors”.

4 Chapter 4

Methodology

The methodology describes the process of how data is collected for research, with particular emphasis on the conditions under which the data was sourced. The justification of methodology used takes into account that limited research is available in the area of study of airline distribution, particularly with regards to the new disruptive technology of blockchain. The research seeks to understand the importance and relevance of an alternative and more effective distribution system, which will potentially remove or reduce the number intermediaries, and whereby reduce the cost associated with the traditional distribution.

4.1 Research Approach

The objective of this research is to examine and analyse the potential scope for an innovative technology to disrupt the traditional airline distribution system, using a qualitative approach. Industry knowledge and educated opinions were gathered by interviewing specific industry distribution experts. Many of these individuals are experts in the airline distribution or emerging technologies, or both.

4.2 Hypothesis

The hypothesis that this research aims to investigate, is whether blockchain has the potential of disrupting the traditional airline distribution, by proposing a decentralised system, which may allow clear product differentiation, reducing intermediaries and associated fees, and hence bringing the cost down associated with distribution. The research also seeks to consider the presumed high implementation cost of blockchain pertaining to research, testing and transferring data into the new platform by airlines and its various customers; as well as speculate the potential savings.

4.3 Methods of Data Collection

The research is based on mixed-methods approach to assimilate evidence from data derived from direct interviews, and secondary data, which was then analysed with reference to the literature available on the subject. Details of literature review is available in chapter 2.

4.3.1 Primary Research

The primary research entailed gathering opinions on the subject by interviewing 17 industry specialists from across the airline distribution, with expertise in blockchain and other disruptive technologies. 5 respondents hold important positions in airlines, whereas 12 respondents are from related organisations that provide services and technological expertise to the air industry. Some are expert advisors, chief researchers and primary engineers. No response was received from any distribution intermediary, such as a GDS providers, travel agency, TMC or OTA. The analysis of the primary research is used to relay the actual findings of the hypothesis.

4.3.2 Secondary Research

The secondary data collected pertains to the recurrent IT systems outage of various airlines, airports and GDS systems since 2013 till March 2018. It highlights the importance of investment in the telecommunications systems of the air transport industry. Although such projects will require huge capital investments, it will prevent any impending losses due to system outage, such as flight cancellations, readjusting passengers, or compensating them; loss of customer loyalty; bad image and reputation, etc.

4.4 Interview Structure

Research and developments in blockchain are being carried on international level. Therefore, the researcher aimed to interview experts from diverse locations, which made it impossible for the researcher to conduct face-to-face (or in-person) interviews. Telephone, Skype and email facilitated interviews were conducted. The researcher asked pre-specified questions, designed for respondent-led flow of conversation to elicit responses, which may assist in generating opinions and recommendations.

The questions for the purpose of data collection have been carefully structured in order to avoid influencing any answers by the way the question is phrased, so as to obtain unbiased primary research data for investigation. Questions covered the possibility, feasibility, quality, differentiation and cost associated with potential implementation of blockchain technology in airline product distribution.

4.5 Interview Questions

Figure 11 provides an overview of the questionnaire that was used to collect data. All respondents were asked the same questions except question 7, which is aimed to airline executives only and is directly involved with airlines cost. Some additional questions that

were tailored during the course of live interview have been added towards the end of each interview transcript in the appendices.

Figure 11: Interview Questions

QUESTIONNAIRE

Research question: "Can blockchain or Distributed Ledger Technology (DLT) disrupt the traditional airline distribution for the better? If so, what are the benefits of this new technology, and how can it be implemented?"

1. What makes DLT attractive to the air transport industry? What benefits and dis-benefits does this technology offer, and under what conditions might it work well?
2. Although the advent of the internet has had a major impact on many industries, including air transport, airlines still rely heavily on the traditional distribution system. Would this be the same after DLT, if it were implemented?
3. Do you think that DLT would disrupt the traditional distribution system by removing intermediaries? Or would the traditional distribution system evolve around the new technology, i.e. although the hierarchy may change form, the same intermediaries would continue to exist and play a role in airline distribution? If yes, what might the new role be?
4. In a decentralized, trust-less system of DLT, how would liability be managed? Who would maintain the system? Which software platform(s) based on blockchain technology would be most suitable?
5. Airlines distribute their products without broadcasting their inventory (how many seats sold, etc.). Airlines' revenue management systems are complicated, allowing different prices for different markets and travel agents. How might DLT enable this information to be transferred to selected travel agents?
6. From where might most resistance to DLT come? How willing would airlines be to switch to/trust such new systems? What factors might lead airlines to decide on implementing DLT for distribution? How would this vary by airline type? If distribution on DLT were to be implemented who would benefit the most, the network carriers, the new entrants, and/or the LCCs?
7. Approximately what percentage of the overall non-aeronautical costs does your airline have to bear specifically for product distribution? What percentage would this be with DLT-based distribution system fully implemented? (Please answer if you are involved with distribution of an airline product. This information will be kept confidential, but is essential for data analysis)
8. Approximately, how long would it take for DLT to be fully implemented in the airline product distribution, if at all?
9. With regards to DLT, what are your thoughts on: the traditional distribution system, ATPCO, IATA's NDC, ONE Order, Winding Tree, Open Blockchain, Further's Ecosystem, if known?
10. Would you like to add further comments or suggestions?

2

4.6 Choice of Questions

Question one functions as an introductory question aiming to determine the positive and negative implications of blockchain in the industry as a whole.

Question two compares blockchain with internet, which itself was a disruptive technology, and its effects on the traditional system specifically on airline product distribution.

Intermediaries are an important element of the traditional distribution ecosystem. Question three asks about the possible outcomes of these intermediaries if distribution were to be implemented on blockchain.

Absence of a centralized authority is a major concern for many, who would not trust any system otherwise. The purpose of question four is to understand how a decentralized system could possibly function effectively.

Airline inventory has always been a well-guarded trade secret, so even in traditional GDSs no one could absolutely be sure for how much and how many seats any particular airline has sold. Question five aims to find out how a decentralized platform would allow distribution on a transparent system.

Any change attracts resistance. In case of airline distribution, resistance is expected from all intermediaries, which include but is not limited to GDSs, financial service providers, aggregators, travel agents, etc. However, even airlines do not welcome change and that is what's been asked in question six.

Question seven is for respondents who are directly involved in an airline distribution, with the purpose of calculating the current average cost of distribution versus the expected cost if blockchain were to be implemented.

Data gathered from question eight will be used to calculate the average expected time scale of blockchain adoption and implementation, if at all.

Question nine is perhaps the most important question of all, which aims to determine what is expected to happen to the players of airline distribution, both traditional and disruptive.

The last question is an open-ended question which allows respondents to add in any details that they may consider important and were not asked by the researcher.

4.7 Sample

The researcher conducted research based on data collected from 'convenience sample' due to the limited number of experts in the field of distribution whereby blockchain is being considered a potential disruptor. A combination of accessibility (international location of interviewees) and purposive sampling (limited numbers of experts on the topic) is combined, to reduce the risk of bias within a small population of experts on the topic. The respondents are geographically diverse, with the majority based in the US, UK and EU. Some respondents are based in Asia/Middle East.

It is important to remember that because distribution is a sensitive topic, most airline executives and GDS providers refrained from commenting. Major GDS providers were contacted for interview but no response was received. Founder of Winding Tree responded positively but due to busy schedule and ICO coinciding at the same time as data collection, interview was postponed and was not possible within the timeframe.

Respondents include airline executives and top management in distribution department; senior IT engineers, innovation experts, advisors, analysts, researchers, writers, bloggers, and blockchain architects.

A higher number of responses was expected, yet many interviews were not conducted due to time constraints and unavailability of respondent at the time of data collection. This has been one of the contributing factors of the low strike rate. Another factor to consider for the limited participants is due to limited knowledge of blockchain.

4.7.1 Piloting and data collection through questionnaire

The questionnaire was sent to 6 individuals for piloting, and 3 were received. A few questions were removed, and some questions were combined. The updated questionnaire was then initially sent to 57 individuals on 6th February 2018 (with 20th February as deadline). Later, 13 more experts were contacted and sent questionnaire by 18th February (with deadline of 25th February).

In total 78 individuals were sent the questionnaire, who had accepted to take part in research when first contacted. By 20th February 9 typed-questionnaires were received and on 1st March the last interview was carried out. Another questionnaire was received on 21st March bringing a total of 17 responses. Many individuals who initially responded positively excused themselves due to their busy schedules. Although the strike rate is low, the number of final interviews has been higher than expected.

All respondents are unknown to researcher and were contacted through LinkedIn, except one visiting lecturer at the University. At the time of interview, all respondents were actively part of the air transport industry with expert-level knowledge of airline distribution and emerging technologies including blockchain.

Strike rate: 22%

Data collection duration: 9 weeks

4.8 Ethics

To maintain consistency in the research and reduce complications no names of respondents have been included in the published research. A detailed list is separately provided to the examiner for the purpose of authentication and validation of primary data collection. However, all individuals contacted were explicitly asked if their names and details may be used in the research and were assured that the interviews' transcript were not to be published in the report. Prior to data analysis, interview transcripts were reviewed by each individual to ensure accuracy.

4.9 Interview results

Interview results have been summarised, combined and highlighted within a specific theme or theory and organised under specific headings and sub-headings. The researcher has exercised caution to ensure that all information gathered from interview data has been incorporated with minimum repetition, and the themes are categorised in a manner similar to the preceding chapters. Results are presented along with data analysis, comments of the researcher and comparison with literature review.

4.10 Data analysis

Qualitative analysis involves searching for patterns in the collected data, called coding and categorising, to enable a researcher make sense of the evidence and then relate the findings to concepts and themes in existing literature (Daymon and Holloway, 2010). Coding may be used for qualitative and quantitative data analysis and is the process of grouping interviewees' responses into categories that bring together similar ideas, concepts or themes (or scores when quantitative) that have been discovered. Coding and categorising help reduce and simplify the evidence in order to make sense of it.

Therefore, the method of coding and categorizing of data gathered from interviews has been used to analyse the primary data.

4.11 Limitations

4.11.1 Bias

It is recognized that the responses received may not truly represent the views of the majority of distribution experts in the air transport industry. Bias exist because of the low strike rate. However, because the majority of respondents do not represent any airline or intermediary, the results may be neutral.

4.11.2 Limitations of coding:

The researcher has paid special attention to minimise any 'loss of context' and has tried to incorporate all data in the additional comments in instances where data was not relevant to any specified category.

4.11.3 Absence of prior research

There is no publicly available research available on the topic of blockchain in airline distribution. A similar research available is on the uses of technology in travel distribution by LSE in 2016, which was commissioned by Amadeus, titled 'Travel Distribution. The end of the world as we know it?' However, this research does not include blockchain.

4.11.4 Emerging technology

As blockchain is an emerging technology with no successful implementation of blockchain technology in distribution, many issues remain unresolved.

4.11.5 Researcher's limitation

The researcher has carried out this research based on existing academic knowledge of airline distribution and has no hands-on experience in airline distribution and the technology involved. The researcher also does not have any technical or computer programming formal education. These rendered the researcher with some limitations in the in-depth understanding, given the limited time for research available.

5 Chapter

Part I: Interview Results and Analysis

5.1 Evaluating research data

Patton (2002) writes that qualitative analysis needs to be meaningful, useful and credible. Therefore, the interpretation needs to be an analytical process which ascribes meaning to data and aid the understanding of what has been discovered in the investigation (Daymon and Holloway, 2010). Qualitative analysis may involve participatory research by letting respondents review their own transcripts, which may then be cited rendering credibility to the research data. The following analysis involves select quotes to support findings without revealing the respondent. The researcher also refers to the literature available on the topic specified in Chapter 2.

By analysing the interview results, the researcher aims to find the answer to the hypothesis: ‘Can blockchain disrupt the traditional airline distribution for the better? If so, what are the benefits of this new technology, and how can it be implemented.’ The following six questions have been used as the framework for analysis, in order to give meaning and emphasize the necessity for this research.

1. What factors are contributing to the changes in the airline distribution ecosystem?
2. Does blockchain have the potential to disrupt the traditional system?
3. Projected timescale for blockchain adoption in airline distribution?
4. NDC – why is it relevant?
5. Different players in ecosystem. How they have involved and evolved?
6. Additional comments/Concluding notes.

5.1.1 Factors contributing to the changes in the airline distribution ecosystem:

All respondents unanimously agreed that the airline distribution system is undergoing change which has been due for some time. While there are many factors leading to this change, the majority were optimistic that it will be a positive step that will benefit the whole industry albeit a transition that will be long and complicated requiring huge investments. However, true successful transformation will only be accomplished if the traditional approach towards distribution is changed, and not just the technology-related systems that support it. According to a senior air transport technologist:

“The traditional distribution system works – millions of people are flying every year. Yet, the system has the ripe for distribution, but technology is only one part of it. The whole industry runs on very complicated business model – it will be disrupting that which is the main trick.”

It is inevitable that business and distribution models of airlines transform. Subsequently, all players of the distribution ecosystem will have to revise their business models to stay relevant. Respondents cited growth in passenger numbers as a key factor, as well as the need of cost reduction and increased competition particularly after the proliferation of LCCs.

Because the business model of LCCs focuses on unbundling of fares and cost reductions, traditional airlines have had to change their business model accordingly. As a result, legacy airlines have started focusing more on direct distribution to lower the cost involved with intermediaries such as a GDS. This has been referred to as ‘financial restructuring’ by a senior technology analyst:

“We are in midst of financial restructuring. The three major airline groups in Europe have imposed GDS surcharges. Some large TMCs and travel agencies have agreed to a ‘private channel’ which eliminates payments derived from the airlines to GDS and then given to the TMCs or travel agencies. That’s what private channel is – it’s a financial restructuring.”

Vinod (2011) denoted that airlines are moving forward towards digital distribution channels, whether its direct distribution on the internet through its website or using paid advertisements on search engines; or indirect distribution using OTAs, TMCs and traditional travel agents using NDC. Web-based communities such as social media bring traffic to online vendors.

The sale of airline products has become more complicated, especially with the unbundling of offers and sale of ancillaries. Non-airline concepts have long entered the pricing and sale mechanisms of the airline industry, such as dynamic pricing and product differentiation. Although the archaic IT systems have been reliable for so many years, they were not designed for such functions. As business models are evolving, so is the technology to support it. All respondents concurred that it is imperative that the IT systems are adapted accordingly, simplified, and synergized across different departments of airlines and different entities within the distribution ecosystem. A leading researcher indicated that:

“Airlines have moved towards an environment of selling products such as branded fares and extensive ancillary products ... these technology systems that airlines rely on to host their reservations were originally written in technology software languages that are no longer even taught in computer science programmes. They have had components bolted on, they had functionalities extracted and reapplied. Airlines have had to do a massive

work to make these systems work in selling the things they want to sell and more. It makes it more difficult for airlines to sell their products and experiences because the GDSs are unable to comply”

Airlines are taking control of their sales and distribution, moving towards dynamic pricing. According to Atmosphere Research Group (2016) airlines cite dynamic pricing as the top influencer of their future distribution strategies, ahead of predictive analytics, de-commoditization, and even NDC. Most airline executives and analysts believe that this change in business model is driving away the airlines away from the traditional processes of filing fares with ATPCo and then to GDSs.

This change is reflected in the recent ATPCo partnering with Farelogix to offer airlines the ability to control their fares through dynamic pricing and give transparency of their product through NDC implementation on ATPCo. (Jonas, 2017, 2018), and was highlighted by senior analyst explaining:

“In an era of dynamic pricing, an airline will assemble all the base fare and any optional component, create a price discount of air fares.”

All respondents agreed that the air transport Industry is very fragmented, with many different and often non-connected IT systems that makes synergy challenging. Each GDS has an independent IT system, whereas banks and payments function on different systems. Even internally within airlines, different departments are divided into silos, running independently. Many systems are in use which complicates distribution and increases costs. All the respondents strongly believe that the whole industry needs integration, and the many complicated IT infrastructure need to be streamlined, whether they are at the front end or in the back office. Analysts believed that airlines themselves tend to under-invest in IT compared to other industries. A leading researcher affirmed that:

“SITA estimates that globally in 2017 when airline was doing their best, 3% of revenues in IT which was up from 2016 levels, but far below the 4-6% average that you see in other industries. I also know that the largest airlines don’t spend anything close to even 3% of their total revenue to IT”

Whilst, resistance to IT innovation is attributed to intermediaries such as GDSs, travel agents, etc., many researchers and consultants held airlines accountable for under-investment in IT as compared to other industries, which in turn hold backs innovation. Airline managements are very short-term focused in wanting to show investors growth in sales and reduction in costs, desisting from massive technology projects that require capital investments and prolonged completion. Historical thin profit margin is also regarded as the main reason airlines essentially choose to invest depending on return on investment. According to a senior analyst:

“Massive long term complex strategic IT projects always tend to be pushed out because the airlines are afraid that it’ll have a negative impact on earnings. The irony is that in pushing these projects out airlines only undermine their ability to compete, dilute their ability to become retailers and increase the likelihood of increasing the frustration of customers, as they’re trying to shop or find what the best value is in a given journey.”

Other reasons for the lack of motivation in IT investment owes to many people who do not like change, including many airline and airport executives who are scared of becoming redundant. Travel agents and agencies also seem to be reluctant to adopt new technology because a technology that simplifies procedures will make them exchangeable and obsolete (Strauss, 2016).

5.1.2 Blockchain as a disruptor for the traditional distribution system:

Whilst some respondents were optimistic of the possible disruption of the industry by blockchain, they believe that it is too early to be sure and there are many obstacles in the technology that needs to be solved for it to be a viable solution. Many believe that blockchain is feasible for other use cases, but not airline distribution.

A few senior blockchain experts consider the technology as “superficially attractive” due to the many promises of “decentralisation, disintermediation, expectation and hopes to reduce costs by bypassing GDS and going direct”, however, they believe that that’s not where blockchain’s strength particularly lies.

Some respondents believe that blockchain is the technology that will simplify the airline distribution by changing how the system operates. They look at blockchain as the technology that will provide the platform and offer a market place like never before. The promise of blockchain will allow airline distribution to be fair and transparent, without anyone controlling the system, where airlines may directly sell their tickets out of their in-house systems. A senior executive maintains that:

“The global interconnected nature of the air transport industry makes it a perfect candidate for blockchain or Distributed Ledger Technology, coupled with the fact that thousands of transactions take place on a daily basis not just between airlines and passengers, but between airlines-airlines, airlines-airports, airlines-regulators, etc.”

An airline executive, who is optimistic about blockchain and the various attributes it offers the industry listed down many use-cases. According to him/her, Smart contracts on blockchain will simplify payments and transactions by removing intermediaries and associated costs, low cross-border settlements. 4-5% of total expense is cost, which may be reduced to 1% with blockchain-based transactions. Use of cryptocurrency will aid

payments in certain countries and perhaps allow reconnecting fragmented industry, with a common standard platform. Reduced intermediaries will enable closer link between airline and customers leading to better customer service. A central location to store certain data that needs to be exchanged between different entities across the value chain, e.g. passenger information, preferences, loyalty points, purchases, etc. As an emerging technology, it is open to innovation, and thus remove barriers for new entrants by allowing both established companies like large OTAs and GDS and new start-ups on equal terms. But it is yet to be figured out how shopping will be done on blockchain for a ticket or ancillaries. Nevertheless, a senior analyst believed that the technology is too immature and that:

“The benefit that this technology offers is that it creates a common, standardized platform across the world, creating uniformity & seamlessness. However, we need to keep in mind that this technology is still in its infancy – and could be vulnerable to hackers, flaws and other vulnerabilities. Cooperation and open communication between all segments of the industry from technology providers, airlines, airports & regulators to create one consistent global standard will be key to making it a success.”

The same was reiterated by an expert technologist that:

‘DLTs present the drawbacks of all emerging technologies. Although the blockchain was born 9 years ago, current networks are still not very mature. Several proof-of-concepts in the airline industry are based on the Ethereum blockchain, which is still at an infancy stage. The network is regularly clogged because of high loads of traffic, and we are still far from mass adoption.’

Most respondents from airlines as well as non-airlines representatives, agreed that because blockchain is still an evolving technology, it is prone to all issues related to emerging technologies. But immature technology, issues with resilience, scalability, vulnerability, trust, security. Gaber (2017) considers blockchain to create the perfect breeding ground for a travel distribution. He believes that if the community of developers or market-makers can figure out scalability and the creation of the right mix of supply and demand side incentives models, the blockchain can potentially hit two birds with one stone.

Whilst some respondents believed that blockchain promises to potentially lower costs by removing intermediaries, some respondents were apprehensive about it being costlier with each transaction on the block that will have to be paid. Another factor is the uncertainty of the continued relevance of any particular cryptocurrency that a distribution ecosystem is based on. Also, for an airline with long history the process of system integration and

process change of internal legacy systems will be too costly and cumbersome. Senior technology experts advised caution:

“Blockchain supposedly eliminates the trusted intermediaries, e.g. GDS, credit card companies, clearing houses and possibly a few more. So theoretically, all this can be eliminated and replaced by ‘smart contracts’. However, practically I’m still not sure if people wouldn’t want to have somebody to turn to in order to regulate if all of a sudden something goes wrong.”

“In a truly decentralised network, everything will stop unless there is incentive for people to keep on mining, which can happen if the cryptocurrency supporting that particular blockchain drop to zero in value.”

As air transport is a very regulated industry, the use of cryptocurrency for transactions and tokens to run a blockchain-based platform may pose much criticism from regulators. Worldwide adoption along with some regulation of cryptocurrencies is required before they may be considered as a payment method in the airline industry. A few respondents were looking at the use-case of a distribution system that accepts cryptocurrencies for allowing ease of payment for certain (in-conflict) countries.

Another major concern that many seem to ignore is regarding how public blockchains function. Permissionless, open-sourced blockchain based distribution solution could potentially disrupt the current oligopoly with distribution, provided they could draw enough partners to gain the traction needed, maintained a senior advisor and further stated that:

“If users don’t trust blockchain technology, including passengers, it will fail. It is depended upon the systems it is built around for blockchain to be able to work. We need consumer interfaces, acceptance by existing travel retailers, and OTAs. We also need suppliers buying into the blockchain by providing inventory. There may be new OTAs emerging, so I think distribution is only as good as who’s using the system. But I think the potential is to have a more dynamic direct relationship with supplier and buyer and to have settlement automated and while the discounts are done through smart contracts.”

Most respondents mainly from airlines stated that inventories are “highly confidential, sensitive information” with sellers such as airlines or intermediaries and sharing it even with trusted partners require “massive and extensive” legal contracts and security protocol. Others believe that “transparency will not be a problem in the future because in the future, every single ‘offer’ will be unique based on customer profile’.

Conversely, many respondents believed that blockchain will not be able to disrupt the industry if a permissioned or private blockchain infrastructure is pursued. Although it could help streamline certain business processes, provide anonymity, high transaction speed and reduced fee, it may be controlled by a single entity leading to another oligopoly and it will not do much to change the status quo. According to a senior technologist:

“It is going to be some mixture of private and public blockchain. It could be a private blockchain set up for private transactions, and that is then recorded on the public blockchain it is accounted for. If a public blockchain has enough inventory and have enough people hooking into it, then we’re going to see it grow to a point where it’s going to be more dominant than the private.”

Some IT technologists did not anticipate for blockchain to initially disrupt the distribution system, except in the payment of reservations and perhaps the documentation of travel, i.e. passports, ID used to clear security or biometrics. The business process and business model around distribution, e-commerce and sales is much more complicated, and merely moving onto a blockchain platform will not solve any problems.

Several respondents believe that the airline distribution is too complicated, and an immature technology cannot be relied upon. The same respondents are of the opinion that blockchain has the potential to solve many issues in air transport, but distribution is not one of them yet.

“Non-commercial areas such as technical, operation and maintenance may be quicker to adopt, since there is no predominant system or approach, rather very fragmented industry supplying largely bespoke systems... DLT may have more immediate applications on the operation side of airlines. It may be more useful right now in maintenance and supply chain management, potentially other areas like payroll, training and so on... Commercial side would d be on the service aspect or service delivery.”

Blockchain use-cases suggested by respondents included low frequency transactions, non-commercial areas such as flight data, operational data or passenger information and preference data. Blockchain was considered to bring innovative approaches to loyalty programmes, baggage tracking, interline settlements, boarding process, etc. Blockchain was suggested to be used for service-related operational data for airlines to keep track of the services that a passenger purchases and consumes resulting in the service provider being automatically paid through smart contracts. Identity management was another promising use case, allowing one version of the truth on a decentralised blockchain to be accessed by airport agencies and airline. This will allow travellers profiles to be saved on one location, rendering feeding data multiple times unnecessary, and reduce any mistakes/discrepancies. According to a report by Amadeus (LSE, 2016), Blockchain is harnessing its potential in travel, and it is likely that as blockchain technology continues to develop, it will gradually make its way into existing industry applications.

5.1.3 Projected timescale for blockchain adoption in airline distribution:

The estimated timescale projection for the possible blockchain adoption in the airline distribution by respondents varied between 2 to 20 years in general. Although the majority of respondents stated that it is very unlikely for blockchain in its current state to be adopted in distribution, in the event of positive developments, blockchain-based distribution may be implemented within 3-5 years according to 60% of respondents, while 40% predicted 10 years or more.

Respondents asserted that as blockchain-based distribution already exists, perhaps some bookings and payments will be possible within 5 years, and approximately 10 years for it to become the standard. Some respondents predicted that although trials will start within the next few years, the time scale would mimic the conversion from paper to electronic ticketing, as there are many unresolved issues associated with the technology that needs to be solved before it goes mainstream.

5.1.4 NDC as the main disruptor to the traditional distribution system:

IATA's NDC is considered by many, as the first form of disruption to the traditional distribution. Some respondents perceived the current technology to evolve around technologies like NDC and OneOrder.

"The main issue today is that not all airlines have API capability for exposing their inventories. This is the first hurdle that needs to be overcome before further streamlining process by any technology. This is a major issue that NDC is addressing"

Many recognised NDC as an opportunity for GDS expansion. According to LSE report (2016) NDC could be viewed either as an alternative to GDS or an opportunity for expansion. Some airlines interviewed by LSE suggested that NDC could bypass the GDS allowing airlines to connect directly with travel agents and other players in distribution, but the likelihood of airlines agreeing the detailed standards necessary for direct connect to operate at scale is very low and expected to take many years. Other industry experts expected NDC to create new opportunities for GDS companies and other aggregators, as the complexity of information will require more sophisticated aggregation, which is stated as:

"Booking a travel with some XML interface which is connected via NDC to airlines that doesn't change the way airlines settle, gets the money or where the record is maintained, things like that. NDC Its simply a platform to

allows the message to go back and forth and allow for a rich media associated with it... The aspect of NDC which is very difficult is how do you do comparisons? How do you compare airlines with different products? No one has the answers yet. They want to create these personalised offers but then how does a consumer or intermediary evaluate the offer to make sure which is the best one for individual's best value."

NDC technology lacks many important components. NDC APIs are only standards, it does not offer many features that are offered by GDS. An agent using NDC cannot compare different airlines product and may still need an aggregator to do it. XML, the technology NDC is based on, is said to be restrictive and 'old' by some respondents. Most respondents from airlines and many analysts believed that NDC programme is not centred on the technology but the whole idea behind it what will fuel innovation and disruption. The technology could eventually change and may even become blockchain based. According to a senior consultant:

"While I applaud any attempt to introduce industry wide standards, IATA's approach, with top-down development, is too slow, too closed, and too narrow. We need travel industry wide standards, not one limited to selected airlines."

Although all respondents appreciated the NDC programme as an initiative to move away from the traditional systems dependency on GDSs, many believe that it has taken too long for the programme to develop and be implemented by airlines and various industry players. Yet the success of NDC implementation as a disruption is evident with the adoption of the programme by the leading GDSs. Amadeus, Sabre and Travelport have all adopted the programme and plan to deliver NDC capabilities by 2019 (Jonas, 2017, 2018).

5.1.5 Different players in distribution ecosystem - how they have involved and evolved:

The future of distribution intermediaries does not appear ominous. According to many respondents, all intermediaries will not disappear, but they will change forms; evolve around technologies; bring something distinctly more relevant or different. There will be acquisitions, mergers and new entrants. According to a senior airline executive:

"We'll always have travel agents, for people who for whatever reason, want to deal with human agents. At the end of the day, those agents might be working on Winding Tree solution or Amadeus or an NDC exchange talking to multiple airlines directly."

Respondents had conflicting views on GDS and other intermediaries of the distribution ecosystem. Some respondents believed that GDSs are charging them high fee with very limited facilities, yet many respondents believe that GDSs provide many benefits:

“Anyone who does want a middleman in the ecosystem can feel threatened, which includes the OTA and the GDSs. So, it’s really a question of does the middleman add value or just add costs? And if it’s only adding costs, that they’re subject to being displaced by the blockchain.”

“It would be utopian to think that everything can run without a single intermediary. Intermediaries aren’t necessarily a bad thing. Sometimes they deliver good value. We will always have middlemen, but I think we’ll have a fair market where there is not a monopoly.”

“The potential of blockchain to remove intermediaries is over exaggerated. If there’s value in any type of intermediary, a travel agent, or tour operator packaging flights and hotels, or aggregators and/or comparison platforms, they will exist irrespective of technology.”

GDSs have platform relevance. Respondents from airlines as well as independent analysts highlighted that GDSs have world-wide presence, with travel agents all over the world who are connected to them. As airlines are generally global companies, requiring the need to reach to customers worldwide, GDSs provide booking platforms, so where there’s limited technological capabilities, travel agents will have a system where they can book and process tickets. GDSs are looked at as facilitators, allowing airlines to market and sell their products are places which are not inherently the local market of the airlines. If airlines were to sell tickets individually to so many locations, their cost would go much higher.

One of the primary reasons that airlines continue to distribute through GDS is to reach the corporate travel market. The other reason is to reach leisure and other travels in areas where internet is not widely adopted or where people may not necessarily have traditional banking accounts, in which case they will use travel agents as intermediaries to book tickets and pay cash.

The majority believed that GDSs have multiple functions, so their importance remains. The role of GDS is going to change, but they will exist, without being able to extort high fees. There will be fewer airlines transactions going through them. Yet, current distribution players or GDS could benefit from private blockchain solutions to improve their own internal processes.

According to Vinod (2011) “the distribution vendors deliver higher yielding tickets than supplier websites in exchange for long-term assurance of full content and a broad set of protection”. However, a major advantage of GDS is the fact that they distribute for many airlines simultaneously, reaching out to areas where a particular airline is not the main

provider in the market. GDS is indispensable to areas where customers, for various reasons, still heavily rely on brick-and-mortar travel agencies.

OTA and metasearch were expected to continue consolidation and form a market force that airlines have to work with. Also, new intermediaries will emerge such as retail shopping platforms, something similar to Google Flights. Even in a decentralised booking platform, such as a blockchain-based distribution system, airlines would fall back on third party services, for IT and data management services. OTA and aggregators will still need to exist, who will take data from blockchain platforms.

ATPCo's fare distribution was expected to decrease significantly when airlines will remove fare rules and simplify their processes. Therefore, ATPCo is reinventing their processes, and employing technologies that facilitate bookings, which is evident from the partnership with Farelogix to implement NDC. Some respondents say that ATPCo will remain as the industry's standardisation layer, maintain certain value. It is a body serving the industry for the common needs e.g. publishing fares to governments; it will continue as facilitator and remain as the industry's standardisation layer, such as creating certain standard as to how to put up rules, how to name certain things, how to define a bag, etc.

Another development highlighted was the acquisition of 'Routehappy' which according to an analyst will act as "the clearing house for all multimedia content relevant to airlines." This will enable airlines, who have been trying for years to get away from the cryptic format GDS screens, to more multimedia cell.

"ATPCo has partnered with both SITA, and acquired route happy, they are trying to find partners and assets that increase their utility and viability, recognising that it is inevitable airlines will file fewer fares through their old system. ATPCo's partnership with Farelogix using NDC will allow airlines directly deciding what price they're offering the passenger or the passenger's agent."

Some respondents questioned the need for two costly industry bodies: IATA and ATPCo. Airlines may eventually bypass ATPCo, but respondents believe that it will not be the first thing to happen. They will still be around as long as they are providing benefits and functions.

Distribution is a complex process and reaching every single potential customer with direct channel is not an easy task, so intermediaries were expected to continue to survive in many forms, playing a role and evolving with technology. Although intermediary business models were expected to change, new entries to the industry were also believed to appear with new players likely to challenge the existing incumbents. GDS reach and influence is not based on technology, because of the amount of money that they spend on marketing and

getting the airline brand out there. Many passenger requirements are more sophisticated than simply point-to-point. A leading consultant explains:

“There will always be a fee for distribution. However, any new distribution is expected to be less than traditional intermediaries take today, but nobody seems to understand that traditional intermediaries could just reduce the fee and add services to it.”

More than half of distribution goes to traditional agents worldwide, heavy dependency on GDS specially in the corporate travel market. GDSs themselves are evolving, e.g. Amadeus and Travelport have been certified on the highest level for NDC.

5.1.6 Additional comments by respondents:

Whilst many believed blockchain to solve many issues in the traditional distribution systems, many others considered blockchain unnecessary and inappropriate unless a viable successful venture produces good results. Another concern is the possibility of a blockchain-based platform turning into a new oligopoly much like the GDSs in the current ecosystem.

Yet, most respondents unanimously agreed that realignment whether driven by NDC or ONE Order or any other emerging technology such as blockchain, is long overdue and change is imminent in the distribution sector. Experts cited blockchain-based projects like Winding Tree to be “foundational” because they’re trying to approach the marketplace with a different angle versus IATA or enterprise-based-private-blockchain, who are more “situational” trying to work within the system. According to a senior technologist:

“We are currently seeing the gradual adoption of the New Distribution Capability (NDC) standard by airline, agents, TMCs, OTA, IT companies. Once NDC adoption has gained traction, and there is a competitive landscape in terms of content aggregators; that would already be a big disruption. None of that requires blockchain technology. Blockchain comes in handy when you want to establish trust; when the parties involved don’t trust each other. To me distribution is not suffering from a trust issue, but rather lack of connectivity.”

The blockchain development projects around airline distribution promise to address issues at high level, but many respondents did not consider it to necessarily solve problems and rebalance the value chain unless details are worked out. In order to be successful, a wide adoption of a small amount of solutions would need to be achieved on a global scale, which is highly unlikely at this point with little to none successful blockchain. It was expected that

any new technology or system may be easier for LCCs to implement as they do not have historical burden to care about, e.g. yield management and finance systems.

“Basic structural changes like blockchain has the opportunity as the internet did so kind of changed the dynamics of the way buyers and sellers and intermediaries play. Winding Tree has an early start, but they have to execute, I mean IATA has a lot of market strength, so does OTA and so on.”

Respondents considered the air transport industry as being historically traditional, resisting from timely adoption of new technologies, comparing it to the era when internet came along, and the airlines did not react in time, which led to metasearch and other web-based aggregators to take control of the content. Similarly, the slow move to mobile technology was criticized, as most of the players in the value chain specially in the corporate market are still lagging. Developing, testing and implementing new technologies, cooperation and maintaining open communication between all segments of the industry, from airlines, airports, technology providers, and regulators were considered indispensable in creating one consistent global standard which will be the key to making blockchain or any new distribution system successful. A senior analyst stated that:

“A larger airline company or group may be far more proficient and far more advanced in its technology infrastructure, but that airline might have something that goes on in the system that supports it, can only work in EDIFACT. Or the airline itself or group may have moved off EDIFACT or any older technologies, but it has important partner or ground handler or some other commercial entity with which it works that are based on EDIFACT. So that’s why they have to maintain this backward environment, but there’s no question that airlines want to move away from systems with limited value such as EDIFACT. This is the reason why NDC was begun, with a more flexible language that is better suited for the industry as a set of standards.”

The majority looked at IATA for solution and support. IATA was considered to play the role of the ‘manager’ for the system as most resistance is expected from big carriers, but if standards are developed by IATA and once the small-sized airlines implement blockchain without any problems, they can become mainstream in the industry. An airline executive added that:

“In general, decentralized systems still need to have a strong governance around them to be able to function properly on a long-term. The governance framework should cover all aspects related to liability and change management. Usually it makes sense to have a neutral and non-profit body acting as the secretary of the governance framework.”

Størner and Heller (2016) suggest the use of Blockchain technology with IATA’s NDC and ONE Order to make it more efficient, generic and transparent than the current proposed messaging system. Heller advocates that since the process of implementation is still underway, it could be adjusted. Størner believes that the shared ledger by IATA will make the traditional interline settlement obsolete. Blockchain provides a payment audit trail

which cannot be tampered with, whereby reducing the time and costs of payments in multiple currencies and geographical areas.

In 2017, IATA Senior Vice President for Financial and Distribution Services, Aleks Popovich declared that IATA is looking to be either a first mover, or certainly a fast follower by effectively managing some of the risk and developing a blockchain system on behalf of its members. However, undertaking such a transformational innovation of the industry would require more resources and more willingness to take risk. “Implementation of blockchain requires a complete change of philosophy as well as a change of technology”. Although “financial technologies have reconfigured the shop-front, by contrast blockchain is a complete revolution in the back-office, and airlines typically do not do revolutions.”

Ultimately if blockchain proves to be a better distribution channel, respondents believed that airlines will shift, but for that to happen, blockchain solution will have to be significantly better to justify moving away from the traditional solutions which are tried and tested and with a lot of investment already gone into. The traditional distribution system works, according to a technologist, which is evident by millions of people flying every year. Anyone aiming to disrupt the traditional system will have to do a significantly better service than a GDS to replace it.

“There are 3 dominant GDS with hundreds of airlines relying on for distribution. If blockchain is viable, it will first scale up to GDS. It took the industry 15 years to implement E-ticket and IATA is still developing NDC after 7 years, so it’s a long way.”

Part II: Secondary Data Analysis

5.2 Investment related to blockchain implementation, and anticipated savings:

The researcher's objective to collect secondary data was to calculate airline costs for distribution and compare it with the approximate initial cost of investment required on blockchain and the savings expected after its potential application (Question 6 on the data-collection/interview questionnaire). However, due to the sensitive nature of this data, only the publicly available distribution costs were available from airline websites, but no data was available on the estimated investment on blockchain and the expected cost cutback after blockchain implementation, which is crucial to have an effective analysis of the cost efficiency that blockchain promises to bring. Also, from interviews, only one respondent indicated the prospective cost reduction from blockchain-based distribution. Thus, no reliable data could be gathered.

5.3 Major IT system outages in air transport industry:

The traditional IT systems in the air transport industry has been modified and upgraded continuously over the years as a response to the needs of the industry. However, there has been an increase in the recurrent IT system outage in the air transport since 2016, which can be seen in Figure 12. In general, a common IT outage is caused by incorporated IT system with cutting-edge technology alongside legacy elements and processes that are prehistoric in computing terms (The Independent, 2017).

Such occurrences have major repercussion for airlines, airports and agencies involved. Apart from reputation damage for an airline or airport, the costs associated with passenger care, compensation and increased workload of staff is enormous. British Airways' 15 minutes downtime in 2017 costed the airline GBP 150 million (Metro News, 2017). Although it was a human error and not an IT malfunction, it does underpin the cost pertaining to such an IT outage.

Figure 12: Major IT systems outages worldwide in the last 5 years

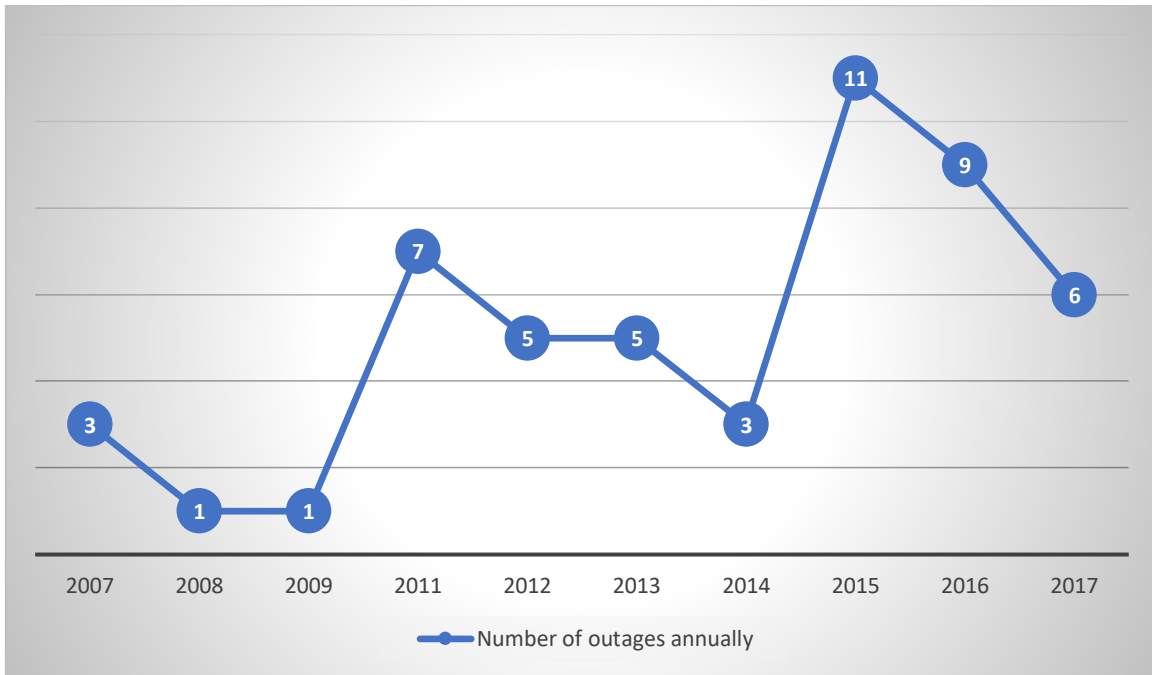
Date	System outage	Affected organisations
12 th March 2018	IT system	Air Canada domestic and international flights
27 th February 2018	IT system	Air Canada system outage at check-in, call centres causing delays
3 rd February 2018	IT system	Alaska Airlines computer reservation system outage, delays but no flight cancellations
28 th September 2017	IT system	Amadeus system glitch, affecting many airports including London Heathrow, London Gatwick, Paris Charles de Gaulle, Zurich, Frankfurt, Melbourne, Johannesburg, Hong Kong, Singapore Changi, Washington DC's Reagan Airports and many others.
28 th June 2017	IT system	Amadeus, mainly affecting Qantas booking service
27 th May 2017	Power supply/IT	British Airways computer system down for 15 mins due to human error
29 th January 2017	IT system	Delta Airlines
11 th November 2016	IT system	Sabre
8 th August 2016	IT system	Delta Airlines
20 th July 2016	IT system	Southwest Airlines
6 th August 2013	IT system	Sabre
17 th April 2013	IT system	American Airlines

Source: Compiled from various online news sources

5.3.1 IT system outages in the U.S.

Figure 13 demonstrates the number of airline systems outage within the U.S. Global IT service solution providers, Sungard AS (2017) highlight the periodic outage in the US domestic airline in the last ten years, which shows an increase in the numbers of such incidents. Perhaps there are many such outages occurrences in the industry worldwide, details of which are not publicly available.

Figure 13: Major U.S. Airlines outages between 2007-2017



Source: Sungard AS (2017)

According to a study conducted by Qualtrics on behalf of Sungard AS in 2017, more than one-third passengers said that they would not book another ticket on an airline with a technology-related service disruption.

“Carriers that have been through multiple mergers are most likely to suffer an IT outage. This is due to the patchwork of systems, components and staffing that is prone to error” (Heidi in Elliot, 2018).

Reliability of the traditional airlines’ telecommunication system has been questioned in recent times. Multiple and recurrent system malfunctions in the last few years is navigating the industry towards adopting a new system based on a more current or advanced technology.

6 Chapter

Conclusion and Further Recommendations

6.1 Conclusion:

The purpose of this research was to examine the potential of blockchain technology in disrupting the traditional airline distribution system, and whether this technology will facilitate the evolving environment of the air transport industry, which till now has been reliant on a system that is more than 50 years old. Whilst the traditional system has been reliable, it impedes many new business models such as dynamic pricing, revenue management, sales, etc. that require collaborative technologies. Blockchain was considered for this research as it conceptually had the promise of an alternative platform which may effectively complement the new business models entering the air transport industry. This hypothesis is based on the presumptions by many technologists that blockchain has already caused disruption in other various industries, including banking, supply-chain, etc.

It is evident from the result of this research that the majority of respondents believed that blockchain cannot replace the traditional distribution system. There were many reasons highlighted why they believed so, but mainly because the technology is still in early stages, and unless there is evidence of a successful and reliable venture, airlines will not adopt or shift to blockchain.

All respondents unanimously agreed that the traditional air transport system is undergoing massive transformation. This change is not limited to distribution, but the overall functionality of the industry. Increasing competition from LCCs and their business models based on low costs and low price, has led the industry towards unbundling of products and fares, sale of ancillaries, revenue management, dynamic pricing, predictive analysis, etc. Yet the full potential of these developments is being held back by the lack of appropriate technology to support such systems, which in turn is the accumulated outcome of deficient telecommunication enhancement and investments, as well as the oligopoly of GDSs. All respondents believed that the fragmented air transport industry needs to adopt a more flexible IT infrastructure that will allow seamless connection between different players of the industry.

Many respondents indicated that airlines are also trying to take back control of pricing and distribution. Airlines are moving towards digital distribution, through their websites, mobile apps, etc. and indirectly through travel agents using NDC's APIs. Airlines are not

only competing with GDSs but with OTAs, TMCs, gatekeepers and metasearch companies, etc.

Some respondents affirmed that airlines do not invest in IT, which is plausible given the thin profit margins of airlines. Respondents also cited airlines to be resistant to change as airline executives are very short-term focused. The panacea proposed by some respondents was for an 'intermediary' to offer a disruptive alternative to replace the archaic distribution system, with support from airlines in the form of sharing a portion of their inventory, allowing testing /piloting of different technologies and coordinating with feedback, etc.

Whilst all respondents agreed that change is imminent in the distribution sector, disagreement abounded among respondents regarding NDC versus a blockchain-based-distribution. Many respondents considered NDC to be the disruptive factor that is driving the industry away from the traditional system, while other respondents believed NDC to be a set of API or standards based on a relatively old technology, in lieu of which any innovative technology could potentially drive development further. Respondents claimed that NDC can well be run on top of a blockchain based platform.

Some respondents believed that blockchain will provide a decentralised unique platform where different players including new entrants could compete on level playing field; remove the myriad of IT systems that have been historically pertinent; and simplify the distribution environment by minimizing intermediaries whereby reducing costs. Yet, some respondents argued that the fee required for each transaction on blockchain may further increase costs.

The use of cryptocurrencies in a blockchain-based distribution platform has been another cause of controversy. While some respondents believed that cryptocurrency will be instrumental in transactions in certain countries, others contended on its legitimacy and volatility.

Moreover, as with any emerging technology, blockchain has its flaws and limitations, which manifested as disagreement among respondents with regards to the use, adoption or application of blockchain in distribution. Distribution has always been a sensitive issue and is considered the 'driving force' of the air transport industry, and hence any new technology such as blockchain will not be trusted unless proven. Security, resilience, speed, scalability, regulations of cryptocurrency, etc. are many factors hindering the adoption of blockchain.

Several respondents advocated implementation of blockchain for low frequency transactions, operational and non-commercial areas, such as passenger information, flight data, etc. where the true benefits of blockchain may be utilized.

Finally, all airline-based respondents and a few industry experts looked up to IATA to disrupt the airline distribution system, which they believe has already been partially established with the implementation of NDC. Respondents believed that an industry-wide set of standards were needed for distribution, which benefits all without any oligopoly of any intermediate. They also believed that because IATA is a neutral body, it will be encouraged by the majority and may be adopted with the least resistance.

6.2 Further Recommendations:

Within the air transport industry, each individual body needs to contribute and collaborate to pave the way for any innovative or disruptive technology to fully enjoy its benefits and lessen any potential issues or resistance. This includes emerging technologies such as blockchain, artificial intelligence, augmented reality, etc. New business models based on collaborative innovation is a requisite for better understanding of customers' expectations as the air industry is considered a consumer driven market. Respondents recommended the following actions to be taken by the industry which may mitigate the arduous shift to any new technology including blockchain:

6.2.1 Research

Research is fundamentally an ongoing process. Airlines particularly should investigate the need and profitability of various internal traditional processes and departments that may be unnecessary as technologies evolve and new business models are adopted. Incumbents in the air transport industry need to explore all emerging technologies if they wish to remain relevant.

6.2.2 Invest

The air transport industry has limited willingness to invest in emerging technologies compared to other industries. Investment is needed by airlines, and all incumbents if they want to stay relevant and move forward.

6.2.3 Collaborate

Adoption of non-traditional business models has made distribution complicated and reliant on the collaboration of different departments internally within an airline, among industry partners, and competitors. For the true value to be realised for blockchain or any technology, information sharing, and collaboration is crucial.

6.2.4 Experiment

Many trials are generally required for any technology to achieve precision. However, unless airlines and related organisations open up to technology-providers, experiments will not be possible. Support is needed from airlines in the form of sharing a portion of their inventory, allowing testing of technologies, coordinating and sharing feedback, etc.

6.2.5 Employ and upskill

The industry needs to recruit experts, such as blockchain specialists, etc. to better understand the technology. Encouraging and training employees will allow airlines and intermediaries to seamlessly adapt with least resistance.

6.2.6 Adapt

GDSs and other intermediaries could maintain their relevance if they reduce their fee or invest in IT research. They may move their platform to an innovative technology and help everyone in their network to do so.

6.2.7 Moderate

There is need for industry bodies to be involved and take the role of moderators to recognize constructive and competitive environment to allow any emerging technology to mature and be adopted by suppliers and consumers. Organisations like IATA and ACI could design standards to ensure consistency across all players of the ecosystem.

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