Improving Service Innovation through Big Data Analytics: A Case Study of an International Air Freight Forwarder

Wu Xinmei

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Abstract

Big data is reshaping the business world and disrupting the way contemporary organizations make their strategic business decisions. Organizations, including air freight forwarders (AFFs), are finding ways to extract the values of big data analytics (BDA) to improve their service provisions. Driving service innovation enables organizations to gain an advantage over their competitors and BDA is expected to have a substantial impact on improving service innovation, if properly implemented. Air freight forwarding industry is traditional and less innovation savvy, and the significance of service innovation is slow to be appreciated. Limited empirical research has been undertaken to focus on the exploration of BDA adoption to improve service innovation at the corporate level in the air freight forwarding industry.

Based on a constructionist epistemological paradigm and an interpretive theoretical perspective, this qualitative and exploratory case study was conducted in a leading global air freight forwarder in the logistics industry. The purpose of the study was to identify the current situation and the influencing factors for BDA adoption in an air freight forwarding organization, and further to investigate how BDA can be utilized to its maximum potential in enhancing service innovation. Primary data was collected through semi-structured in-depth interviews and secondary data was collected from organizational documents. A content analysis method was employed for comprehensive analysis of the collected data. The findings suggest that in its current state, BDA application in the case organization is still in its infancy stage as a result of various factors identified through the Technology-Organization-Environment (TOE) framework as hindering BDA adoption. A set of recommendations is proposed on improving service innovation through embedding BDA applications in the business areas of air freight business from internal and external perspectives.

Air freight forwarding industry remains traditional and less innovative. Service innovation in this industry is underway leaving huge rooms for improvement. A list of influencing factors were identified under the TOE framework that affect the adoption of the BDA in the case organization. This case study has explored the interrelationship between service innovation and BDA adoption, which was, for the first time, applied in an international air freight forwarder. It is a pioneer endeavor to unpack the status and to inform management thinking and action towards service innovation through BDA in the industry, enriching and advancing the extant scholarly work in these areas. In doing so, the study also brings innovative technology like BDA closer to a less-

innovative traditional industry like the air freight forwarding industry to arouse attention and to trigger further debates.

Keywords: big data analytics (BDA), service innovation, air freight forwarders, logistics industry, case study, decision-making, Technology-Organization-Environment (TOE) framework

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**: Tashi Delek, a Tibetan all-purpose greeting, meaning "blessings and good luck"*

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Abbreviations

Abbreviation	Full Form
3S	scan, scrutinize and substantiate
4C	capture, categorize, condense and conclude
5V	volume, variety, velocity, value and veracity
AFF	air freight forwarder
APR	annual progress report
B2B	business to business
B2C	business to consumer
BD	big data
BDA	big data analytics
CCO	Chief Commercial Officer
CEO	Chief Executive Officer
CIO	Chief Information Officer
COVID-19	Coronavirus disease of 2019
DS	data scientist
EDI	electronic data interchange
HiPPO	highest-paid person's opinion
HO	head office
HREC	Human Research Ethics Committee
IATA	International Air Transport Association
ICT	information and communication technology
IT	information technology
LIIS	low innovation-intensive sectors
LSP	logistics service provider
MNC	multi-national corporation
NASA	National Aeronautics and Space Administration
PhD	Doctor of philosophy
POC	proof of concept
PPT	PowerPoint
QDA	qualitative data analysis
R&D	research and development
RFQ	request for quotation
RIM	research integrity modules
SCA	supply chain analytics
SCM	supply chain management
SME	subject matter expert
TOE	technology-organization-environment
USA	United States of America

Chapter 1 Introduction

This study concerns the improvement of service innovation through big data analytics (BDA). Big data is reshaping the business world and disrupting the way contemporary organizations make their strategic business decisions. Integration of big data analytics into the decision-making process enables decisions to be made based on facts and evidence, rather than intuition or experience (Osuszek et al., 2016). Data empowers organizations to succeed through advantageous and rigorous big data analytics (Ittmann, 2015). It affects the way people work in the organizations and impels collaboration among business units in value realization of data-based decisions and action (Davenport, 2006). Big data technologies can enable data-driven decision making to ultimately improve an organization's business performance (Provost & Fawcett, 2013). Still, this data-driven approach is a new practice for many organizations. Companies, especially those with a long history, have their own cultures, process, and capabilities. Transformation from a traditional business approach into data-driven business innovation is never a linear or easy process as generally assumed. There is strong path dependence in thinking, culture and practice; organizations cannot, nor do they have to, turn their existing structures upside down at once (Ylijoki & Porras, 2016). This study investigated the transformative process of an organization adopting big data analytics. It involves an exploratory case study in a leading global freight forwarder in the logistics industry, which unpacks the challenges in BDA adoption and identifies the service innovation opportunities through BDA utilization.

1.1 Research Background

Big data analytics is gaining increasing popularity in discussion and debates, but no consensus has been reached on its acceptance and practice in the business world. Data is processed and analyzed everywhere, and big data applications are prevalent across many industries. With

exponentially growing amounts of data being generated nowadays, many organizations have started to seek to gain benefits from BDA. Utilizing BDA to improve business performance is a new area for both scholars and industrial practitioners. As the business environment is continuously changing and BDA technology evolves, the impact of BDA on organizations deserves critical and rigorous examinations.

The BDA applications aim to generate better predictions, better decision making and ultimately better business performances (McAfee et al., 2012). Organizations benefit from more BDA-supported decisions and more consistent outcomes than ever before, and their business performance is improved by better informed decisions (Osuszek et al., 2016). However, researchers studying the impacts of BDA on organizational management and business performance have found mixed results with both benefits and challenges (Ayed et al., 2015; Ittmann, 2015; McAfee et al., 2012). Using big data is seen as a management revolution that business executives need to engage with today (McAfee et al., 2012). Yet, despite the benefits of BDA identified by organizations and the importance in adopting BDA recognized by management, many companies still encounter difficulties adopting BDA successfully in their business.

Lehrer et al. (2018) argue that BDA has a high potential to enable service innovation, which, however, has been considered as a focal business area that is increasingly the subject of intellectual and professional debates (Trigo & Vence, 2012). Innovation is a strong driver of customer satisfaction in many industries, including the logistics service industry (Cichosz et al., 2017; Grawe, 2009). It has been argued that the logistics service industry is comparatively less innovative than other service sectors (Cichosz et al., 2017); and that the significance of innovation is largely ignored (Bajec, 2011). Despite these arguments, empirical research on innovation in the logistics service industry is limited (Wagner & Sutter, 2012). These debates and the lack of empirical research leave

a considerable grey area in the knowledge and practice of BDA in the logistics service industry that call for holistic and systematic research.

Service innovation is integral to the improvement of an organization's overall performance (Gunasekaran et al., 2017), and is increasingly capitalizing on, and, on many occasions, is simply equal to, advances in new technology and its application in the business. On the basis of this understanding, BDA seems to suggest a new direction for boosting service innovation to ultimately win a business advantage. An organization may enhance its innovation capability through advanced data-driven innovations. However, little research has ever been undertaken to explore the status quo of BDA adoption at an organizational level, or to assess the potential of BDA to achieve better business performance. For this purpose, this study combines BDA discourse and service innovation discourse to explore how BDA is and can be adopted to improve service innovation in the contemporary logistics service industry. In order to do so, it employs a case study to draw new insights from real-life practices and managerial experiences.

1.2 Problem Statement

This project is situated against a backdrop in which BDA has attracted increasing attention by researchers and practitioners in the past decade. Sizeable studies on BDA have been carried out in many industries to define the concept and unpack its benefits and challenges. "Continual innovation is key to the sustained competitiveness of nations, industries and firms" (Dodgson, 2008, p. 604). More and more companies are utilizing BDA to gain competitive advantages in business services. Service innovation is extremely important to air freight forwarders (AFFs), as customer satisfaction determines the motivation for continuous customer service excellence. Those organizations fostering BDA-driven service innovations will gain competitive advantages through enhancing customer satisfaction.

Empirical studies on BDA in the logistics services industry are not much related to air freight forwarding services. These studies either focus on warehousing and trucking management (DHL, 2013), or supply chain management (Raman et al., 2018; Tiwari et al., 2018). Many real-life BDA cases relevant to the logistics service industry address specific logistics problems, such as a focus on real-time route optimization (DHL, 2013), or big data for public distribution system and tackling delivery delay reduction (Heesen, 2016). Within the logistics service industry, air freight forwarding service is unique and different from other logistics services (e.g., ocean freight forwarding, warehousing and trucking services). For instance, air freight customers have more critical service requirements, needing shorter service lead time and higher cost sensitivity compared to other logistics service industries. Therefore, the business applications of BDA in other logistics services cannot be easily replicated and adapted into the air freight forwarding service due to its different operating environments and models.

Several studies have explored the challenges that companies have encountered during the BDA adoption from different perspectives. McAfee et al. (2012) find that from a managerial perspective, leadership and cultures are extremely important in the adoption process. Katal et al. (2013) identify several technical and analytical challenges, such as data privacy, security and storage. However, these challenges and barriers are not integrated into a structured and coherent understanding. In a literature review of BDA capabilities studies conducted in recent decade, according to Arunachalam et al. (2018), the issues of adopting BDA in supply chain management were mainly related to organizational (e.g., BDA initiative is time-consuming) and technological (e.g., incapability of techniques for data deluge exploitation) challenges. Wahab et al. (2021) conducted a quantitative study investigating influencing factors in adopting BDA within the warehousing sector of logistics industry in Malaysia and their study confirmed that relative advantage and government support have a positive and critical effect on BDA adoption within

Malaysian warehousing logistics sector. Maroufkhani et al. (2022) explored the interrelationships among the TOE factors affecting BDA adoption among 171 small or medium companies, their finding confirmed the independence assumption of those factors is questionable. Existing studies of BDA adoption are ad hoc, at the expense of comprehensiveness and integrativeness. Moreover, there have been few studies that focus on challenges of BDA adoption in the air freight forwarding industry.

Today, international AFFs are handling millions of shipments for their customers, managing a massive flow of goods and creating a vast amount of data in their own network systems. The massive data can bring high potential values to the organization. However, the full benefits of exploiting BDA are yet to be confirmed (DHL, 2013). Customers with high value cargoes become more demanding in relation to real-time cargo visibility, information transparency and data prediction. International AFFs have incentives to seek innovative solutions to fulfill their customers' requirements and stay competitive in the market. BDA is seen as a technological innovation because of its advanced business intelligence and analytics features (Sun et al., 2018). According to Sun et al. (2014), business intelligence can be defined as "a framework that consists of a set of theories, methodologies, architectures, systems and technologies that support business decision making with valuable data, information, knowledge and wisdom" (p. 6). Importantly, BDA is seen as a part of "business intelligence", a term that has been used to "describe concepts and methods to improve business decision making by using fact-based support systems" (Lim et al., 2013, p. 1) with valuable data, information and knowledge. Therefore, BDA suggests a new pathway to achieve service innovation, if adopted appropriately. However, major questions remain to be answered in terms of BDA adoption in organizations to advance service innovation. The present study attempts to tackle this research problem.

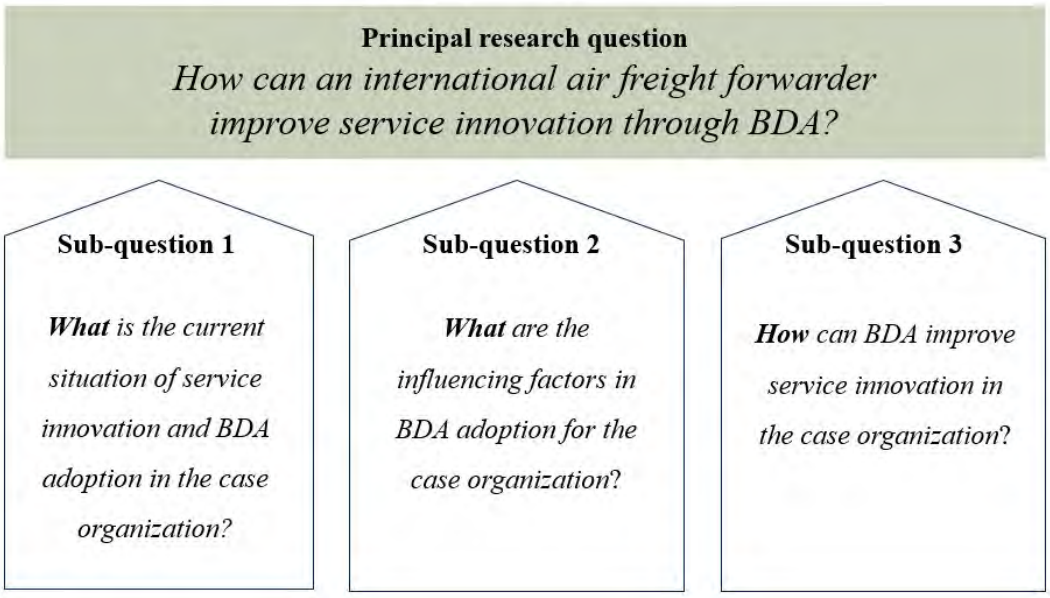
1.3 Research Aims and Research Questions

This research aims to identify the influencing factors for BDA adoption in an organization and to explore how BDA can be utilized to improve air freight service innovation in air freight forwarding industry. Guided by prevailing concepts and theories about BDA and service innovation, the study examines the adoption of BDA in a global market leader in the air freight forwarding industry to gain an understanding of how BDA can be managed to improve its service innovation. The aims of this exploratory research are:

1. to understand the current situation of service innovation and BDA adoption
2. to scrutinize the influencing factors that affect the adoption of BDA
3. to explore the prospect of improving service innovation by utilizing BDA

With the research aims identified, the researcher sought to answer the following principal research question: *How can an international air freight forwarder improve service innovation through BDA*? To address the principal research question, the researcher further subdivided the main research question into three sub-questions. Figure 1 presents the primary research question and the three sub-questions:

Figure 1 Principal Research Question and Sub-questions



To answer sub-question 1, the researcher conducted a multifaceted evaluation of the practices of service innovation and BDA adoption in the case organization, namely an international AFF. Logistics companies, including the case organization, have invested huge financial and human resources in setting up BDA technical infrastructures and establishing data analytics functions and structures. It is not uncommon to hear organizations that have adopted BDA, claiming to be data-driven companies, but the reality might not be so. Are those organizations actually doing well with this analytics technology? How do employees understand and use BDA in their daily work? What service innovations and BDA practices have been adopted in the organization and have the values of BDA been exploited as aspired? Real-life BDA business cases in the logistics industry are increasing. Have AFFs replicated these BDA business cases in their organizations? All of those questions are examined in addressing sub-question 1.

Based on the understanding about current situation of service innovation and BDA adoption in the case organization, the researcher explored various influencing factors (e.g., challenges or

barriers) that affected the adoption of the BDA. The factors affecting the BDA adoption may be transient, operating in a combination of technological, organizational and environmental contexts. The successful adoption of any technological innovation like BDA can only be secured when the challenges of the adoptions are known and managed properly by the organization. Management that knows how the organization is responding to BDA adoption is better prepared to turn the challenges into opportunities. The researcher used technological, organizational and environmental contexts as a starting point to explore a diversity of factors that may take effect.

Having identified the challenges that affected BDA adoption in the case organization, the researcher had set a solid foundation to further explore the last sub-question about how BDA can improve service innovation. Many questions related to the business transformational effects of big data remain unanswered. These include such questions as "How does big data enable innovation?" and "How shall an organization integrate BDA effectively to the existing business processes and workflows?" BDA is an enabler for data-driven innovation. However, BDA value realization is case-dependent, and each organization must find its own way to add value with data (Ylijoki & Porras, 2016).

The need to understand how BDA enables service innovation in air freight forwarding industry motivated the current study. In view of the increasing significance of big data, customers in air freight market are more demanding of their service providers to come up with innovative solutions that can solve their logistics problems. BDA has the potential to intensify the service innovation process for AFFs through tailor-made data analytics techniques. This potential needs to be exposed and exploited through case studies like this project in order to inform managers and service providers in air freight forwarding industry and address the limited research that focuses on the improvement of service innovation through BDA adoption. The research questions are based on the increasing academic and managerial interest in BDA and are established to address and

enhance our understanding real-world issues in air freight forwarding industry. The sub-questions are linked to each other, and ultimately support the answer to the principal research question, which is underpinned by, and aims to extend, the present literature on BDA and service innovation.

Finding answers to these questions has the potential to advance both knowledge and management practices in the business sector. This study of a global air freight forwarder organization and its BDA adoption contributes to the existing knowledge of service innovation and BDA adoption in logistics service industry. The findings of this exploratory study fill the knowledge gap that is identified from the research on BDA adoption practices in air freight forwarding industry. The real-life case study provides practical considerations in the integration of BDA into service innovation in organizations and promises to inspire academic and practical studies on BDA adoption. More importantly, the researcher has identified the business implications for the senior management of international air freight forwarders to support their strategic decision-making in service innovation and offer practical solutions to tackle the challenges of BDA adoption in their organizations.

1.4 Organization of the Thesis

The remainder of this study is structured as follows. Chapter 2 covers the literature review, which contextualizes and identifies the framework and the knowledge gap that underpin the research questions. Three key concepts are discussed relevant to the research problem: big data analytics, service innovation and air freight forwarding industry. BDA enables better decision making when the managers are equipped with data analytics and informed by data-driven insights. Consequently, higher customer satisfaction, internal operational efficiency and better financial results can be achieved through better decision making. However, real-life BDA adoption cases are relatively scarce for air freight logistics industry and the number of studies that focus on the

interconnections between BDA and service innovation is minimal. Driving service innovation enables organizations to gain a competitive advantage over their competitors and BDA technology is believed to bring a substantial impact to service innovation, if properly implemented.

Chapter 3 describes the methodology employed in the research project, including the qualitative research approach and design, and the underpinning philosophical and theoretical assumptions. This research is based on the epistemological paradigm of constructionism and is viewed from an interpretative theoretical perspective. A qualitative exploratory case study methodology was adopted where the in-depth interview was chosen as the primary data collection tool, and internal documents were used for secondary data collection. Content analysis was applied to the analysis of primary and secondary data, with details of the thorough step-by-step analysis process provided in the chapter. Lastly, the chapter discusses quality assurance and ethical considerations involved in the research process.

Chapter 4 discusses the findings derived from the primary data (interviews) and secondary data (documents). Demographics of interviews participants are presented, followed by three individual sections of findings that corresponding to each of the research questions respectively. The study discovers the traditional and time-sensitive nature of the air freight business related to process, people and system respectively. The findings show that service innovation and BDA adoption in the case organization are still in their infancy stages, leaving huge room for improvement. On the whole, few BDA applications related to air freight have been reported in the case organization. A comprehensive list of influencing factors affecting BDA adoption is discussed in this chapter. In the case organization, technological factors of data quality and infrastructure, and organizational factors of culture and human resource capacity are found to be critical factors for BDA adoption. This study also reveals that air freight forwarding industry is an appropriate place for BDA applications due to the potential for service improvement and to the massive data it

makes available for advanced analysis, which can add value for customers. However, not all decisions can be supported with BDA, as individual experience and gut feeling remain critical and irreplaceable in making some decisions in the air freight forwarding business nowadays. The study's recommendations for improving service innovation through BDA are presented from internal and external perspectives. The findings indicate that BDA helps improve service innovation and enables air freight management to make better decisions in air freight operations, business development and strategy. Findings of analyzed documents further corroborate and support the key findings from the interviews, which greatly enhance the trustworthiness of this study through data triangulation.

Chapter 5 discusses the major findings and research implications of the study, in great part through a dialogue with the literature, to shed new light on the understanding and practice of BDA adoption. Evidence from the current situation suggests that the case organization is not ready for BDA application due to the obstacles encountered in the adoption. The importance of having *bridge connectors* for BDA adoption in the air freight industry is emphasized and recommendations for embedding BDA in the air freight business to improve service innovation of AFFs are discussed. This study advances the understanding of BDA, service innovation and the logistics industry and serves as a pioneer study in exploring the interlinkage relationship between BDA and service innovation. The study fills the gap in translating this understanding to organizational management and in fostering a managerial culture that is able to effectively pursue service innovation, thus creating a new way of management thinking about service innovation. A summary of specific practical implications is presented for different stakeholders including business leaders, industrial practitioners (e.g., BDA adopters and data scientists) and those policy makers in the logistics industry alike.

Chapter 6 starts by recapping the research problems identified by the study, as well as its aims of the thesis and research questions for which it seeks answers. The principal findings of this study are presented, followed by a summary of the key implications for academic research and management practices that are discussed in the previous chapter. A short conclusion follows a discussion of some limitations of the study and recommendations for future research.

Chapter 2 Literature Review

2.1 Chapter Introduction

The main research question addressed in this thesis is to explore how an international air freight forwarder improve service innovation through BDA, where three main areas for literature review cover big data analytics (BDA), service innovation and air freight forwarders (AFFs). The literature review follows a sequence that logically connects BDA to service innovation in the air freight forwarding industry, as set out in the research questions. Section 2.2 starts with a conceptual section on big data and big data analytics, specifically the definition, benefits, influencing factors in BDA adoption, as well as introducing the analytical framework that was used as a starting point to evaluate the adoption of technology (i.e., BDA adoption) in this study. Section 2.3 delves deeper into the concepts of service innovation and elaborates on the relationship between BDA and service innovation, reaffirming the potential of utilizing BDA to improve service innovation. Section 2.4 introduces air freight forwarders, followed by an overview of BDA adoption and service innovation in the air freight forwarding industry.

2.2 Big Data Analytics

2.2.1 Concepts

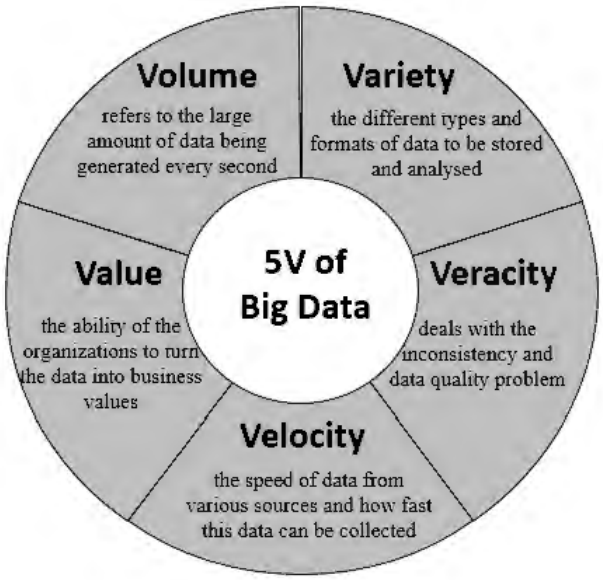
The term *big data* is a buzz word nowadays, but it is still hard to reach a common understanding what it means. Big data can mean different things to different people when being viewed through a technology lens, a business lens or industry lens (Marr, 2015). The term was first officially used in 1997 by two researchers from the National Aeronautics and Space Administration (NASA), Cox and Ellsworth, who refer to it as the visualization challenge for computer systems with huge data sets. However, this preliminary definition of big data is vague and limited. Both data itself and the technological capacity and skills for handling data have evolved so fast that a

more contemporary approach to is needed to define big data. Some researchers (Laney, 2001; Marr, 2015; Wamba et al., 2017) have started to employ different characteristics to enrich the definition of big data. A well-known combined definition refers to its *5V* characteristics: volume, variety, velocity, value and veracity (see Figure 2). For example, Laney (2001) defines big data as having three characteristics of volume, variety and velocity. The word *big* in big data obviously expresses the meaning of volume. *Volume* refers to the large amount of data being generated every second. The size of big data is reported in multiple terabytes and petabytes. With the rapid advancement of technology, the storage capacities for big data have improved and have enabled even bigger data sets to be captured by organizations. *Variety* connotes the different types and formats of data (structured, semi-structured and unstructured) that are required to be stored and analyzed together. *Velocity* implies the high speed of new data coming from various sources and how fast this data can be collected, which is highly dependent on the development of technological capacity. The expansion of digital devices such as smartphones and sensors has led to an unrivalled pace of data generation and is navigating a great need for real-time analytics and evidence-based planning (Gandomi & Haider, 2015).

Subsequently, other researchers, such as Marr (2015) and Wamba et al. (2017), have further enriched the definition of big data with two more characteristics. *Value* basically indicates the ability of organizations to turn the data into business values (Marr, 2015). Organizations need to understand what business values big data can generate for them, and these business values are vital in driving BDA adoptions constantly in the right direction. *Veracity* deals with the inconsistency and data quality problem in big data, the values of big data can be affected by data management, such as by human error in data entry and redundancy. Organizations have their own operating systems for data management and processes, but the challenge in mitigating poor data quality issues

remains critical, which ultimately may put organizations at risk of revenue loss, operational inefficiency or compliance failure in regulation within the industry (Saha & Srivastava, 2014).

Figure 2 5V Characteristics of Big Data



Source: Adapted from Laney (2001), Marr (2015) and Wamba et al. (2017)

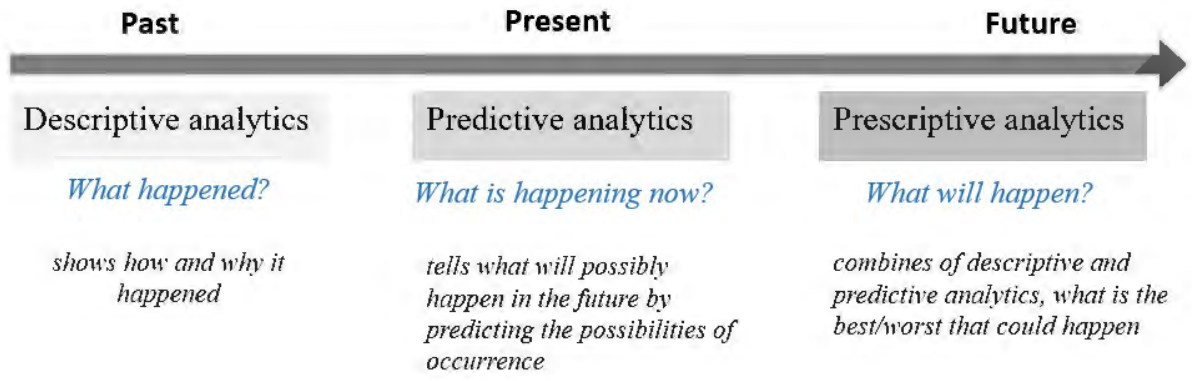
Generally speaking, the 5V characteristics are widely accepted in defining what *big data* is in the relevant field of research, and they are not considered to be solely independent of each other. However, some characteristics have attracted more attention than the others, where people tend to focus on data volume and variety, overlooking the veracity (data quality) and velocity (speed) of big data. The 5V characteristics enrich the definition of big data but also create confusion for those trying to understand this terminology. To avoid any confusions, big data, in this study, is broadly defined as *a huge amount of structured and unstructured data that grows exponentially and requires new technologies and architectures to be captured, stored and analyzed with purposive value extractions* (Katal et al., 2013; Sipahi & Timor, 2010). Research about big data is growing

and it is obvious that the evolution in the term's definition will be ongoing. More favors for or bias against big data is foreseen when more features and properties are added to define big data. More challenges in handling big data are expected due to the increased complexity of understanding big data. Purely collecting and storing data creates little business value because values can only be created meaningfully when data is analyzed, and the results are utilized by decision-makers (Watson, 2014). This is where BDA comes into place.

Big data and analytics are intertwined. BDA is defined differently by various researchers (Davenport & Harris, 2007; Raman et al., 2018; Russom, 2011; Schoenherr & Speier-Pero, 2015; Tiwari et al., 2018; Wang et al., 2016), but they do share definitional similarities. First, BDA is commonly defined as a kind of application or process. Secondly, this application or process is done by adopting advanced quantitative and qualitative analytics techniques. Thirdly, it works on vast volume of complicated structured and unstructured data and information. Lastly, the output of the application or process provides precise, clear and meaningful information and knowledge to the end users (i.e., people who use the analytics). The goal of BDA is to reveal hidden patterns, correlations and trends, which can ultimately add business value.

Heesen (2016) claims that BDA is the latest innovation in reporting and analytics of data that can analyze past and current data, and even simulate future data. To illustrate the distinctive features of BDA compared with traditional reporting, researchers such as Watson (2014), Ittmann (2015) and Heesen (2016) summarize three data analytics applications that are commonly discussed: descriptive analytics, predictive analytics and prescriptive analytics (see Figure 3). These applications are believed to provide organizations with insightful information.

Figure 3 Three Types of Data Analytics Applications from Various Authors



Source: Adapted from Watson (2014), Ittmann (2015), Heesen (2016) and Tiwari et al., (2018)

Descriptive analytics, also named *Explanatory analytics,* related to the *past*, is commonly used in many organizations showing what happened and why it happened. It looks backward at the historical data to review performance or identify the areas for improvement.

Predictive analytics, also named *Exploratory or Discovery analytics,* related to the *present*, tells what will possibly happen in the future by predicting the possibilities of occurrence. It is a forward look at the future, predicting future probabilities and trends and finding the hidden relationships in the data being analyzed.

Prescriptive analytics, related to the *future*, is the most advanced analytics method that supports decision-makers with evidence on which to base their decisions. It is also the most difficult and complicated analytics to adopt, as it involves a combination of descriptive and predictive analytics and, applies mathematical optimization, simulation or multi-criteria decision-making skills. As a result, few organizations have successfully applied prescriptive analytics in their daily business (Tiwari et al., 2018).

Descriptive analytics, compared with the other two application types, is the most basic and straightforward application used in many organizations (Ittmann, 2015). This kind of analytics is based on a historical data review of performance or of identified areas for improvement. The value of historical data analytics is limited because descriptive analytics cannot help organizations to predict future probabilities or identify hidden relationships in the data being analyzed in decision making. Predictive and prescriptive analytics, on the other hand, can have a large impact on how organizations make decisions, if adopted properly. For example, some large corporations have successfully applied prescriptive analytics in making decisions about production optimization and inventory management in their supply chains (Tiwari et al., 2018). Watson (2014) claims that organizations typically move sequentially from adopting descriptive to predictive to prescriptive analytics; however not all organizations would follow the same order in adopting three data analytics applications. One organization can apply these three analytics applications simultaneously if its technological bandwidths permit. However, the usage of these BDA applications is varied in different companies nowadays; therefore the business values and best practices of these BDA adoptions are yet to be proven with adequate evidence and empirical examples.

2.2.2 Benefits of BDA

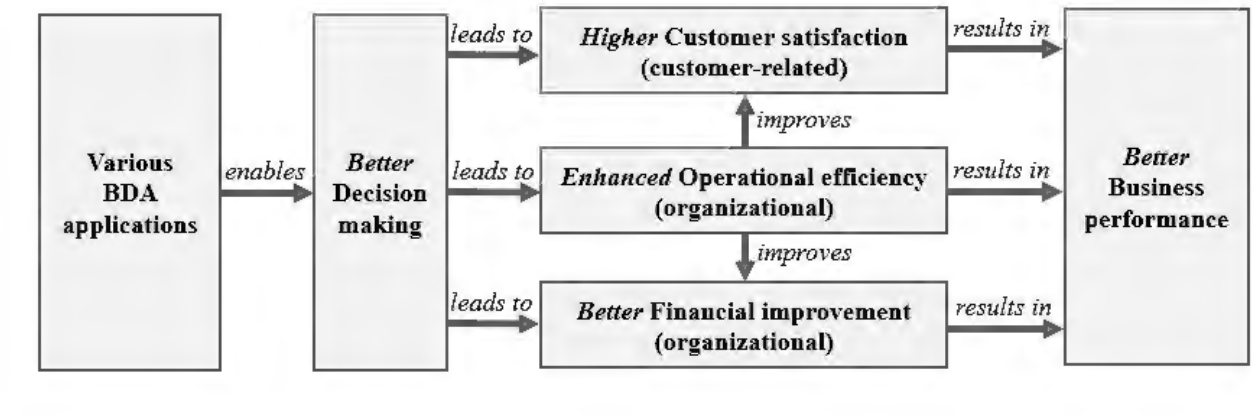
The increasing number of successful BDA adoption cases shows that the benefits of using data analytics can be diversified and extraordinary (Benabdellah et al., 2016; Raman et al., 2018). Significant BDA values may be achieved in product developments, market demand predictions and supply decisions. For instance, leading logistics companies, like DHL, UPS and Maersk, have taken some steps in the big data field to enhance their competitiveness (Benabdellah et al., 2016). However, the full realization of value in BDA in one organization can only be achieved when a comprehensive BDA strategy is put in place and a rigid execution is proceeded with.

Researchers have discussed the benefits of BDA adoption for organizations in BDA studies. One of the most common benefits mentioned is that BDA enables business executives to make better decisions. Ittmann (2015) claims that the insights obtained from big data "enable those in organizations to make better decisions" (p. 3). These decisions are made based on the application of analysis to improve operational processes or business optimization in their organizations. Valuable information can be extracted to enhance decision making and support informed decisions if organizations know how to apply analytics to big data available to them (Benabdellah et al., 2016). Decision making is an important management activity in organizations and the process of decision making is largely influenced by the respective organizational culture. People tend to make decisions with their personal experience and gut feeling when "data are scarce, expensive to obtain or not available in digital form" (McAfee et al., 2012, p. 7). According to Ylijoki & Porras (2016), embedding BDA into decision-making processes is substantial, yet it is also challenging to overcome this obstacle for various reasons, such as the scarcity of a data-driven organizational culture, the absence of a data analytics strategy as well as lack of management support. The claimed benefits of BDA can only be obtained in full when the decision makers trust the data of analytics and proactively apply BDA in their decision-making processes.

"Data-driven decisions tend to be better decisions" (McAfee et al., 2012, p. 9) because managers can use big data to make decisions on the basis of facts and figures rather than intuition and gutfeel. The outcomes of these better decisions, perceived as benefits of BDA, can bring huge impacts to both organizations and their customers. Figure 4 below illustrates how an organization may benefit from BDA applications through better decision making. Data-driven decisions can lead to higher customer satisfaction (Brown et al., 2011; Raman et al., 2018), enhanced internal operational efficiency and improved financial results (Heesen, 2016), all of which ultimately result in achieving better business performance (Ittmann, 2015; McAfee et al., 2012) for this organization.

In the logistics industry, big data helps companies to improve operational efficiency, to enhance customer experience and to introduce new business models (DHL, 2013). Business leaders believe that their companies can benefit from BDA to enhance flexibility, information visibility and integrated globalization (Wang et al., 2016). The impacts of data-driven decisions based on BDA are discussed from different perspectives, but a holistic review of BDA benefits for organizations is still missing.

Figure 4 How BDA Can Benefit an Organization



Although various BDA benefits have been reported in the research, Hopkins and Hawking (2018) claim that the actual practices of BDA in the real world are still minimal. The question, "How can organizations utilize BDA and obtain these benefits?" still remains unanswered. The translation of BDA values into business advantages can only be possible when business leaders know exactly how to deploy this technology for their organizations. Although many organizations understand the potential value of BDA, management is still struggling about how to realize these values for their companies (Hopkins & Hawking, 2017). Big data technology is still in its nascent stage, hampering BDA adoption in the supply chain industry (Raman et al., 2018).

2.2.3 Influencing Factors in BDA Adoption

More and more business executives are adopting BDA in their organizations and the discussion of the influencing factors in BDA adoption have increased in recent years (Alharthi et al., 2017; Ittmann, 2015; Katal et al., 2013; Lai et al., 2018; McAfee et al., 2012; Watson, 2014;). In these studies, different terms, such as challenges, issues, barriers, inhibitors, success factors and determinants, have been used to describe the influencing factors. Despite the variation in terminology, these terms are interlinked and express similarities in the researchers' ways of thinking. In this study, influencing factors are defined as challenges that affect BDA adoption by air freight forwarders. In the literature review, researchers discuss various categories of influencing factors, such as data, governance, culture, people and management. These factors are identified as concerns or obstacles that may influence management's intention (or desire) to adopt BDA and may not in reality be challenges to organizations adopting BDA. These categories can be further grouped into two types: technological and organizational. Technological factors include factors such as infrastructure (referring to both hardware and software), data and governance. For instance, Alharthi et al. (2017) identify *complexity of data* as a *barrier* in BDA adoption and Lai et al. (2018) mention *data quality* as *the determinants of intention* in BDA adoption. Both complexity of data and data quality are technological factors. Organizational factors include factors such as culture, management, people, strategy and financial resources. For example, Watson (2014), McAfee et al. (2012) and Alharthi et al. (2017) see *culture* as representing *requirements to succeed*, *management challenges* or *barrier* in adopting BDA, that is, factors that are related to organizational aspects. Table 1 below summarizes various influencing factors in BDA adoption that have been discussed by different researchers from technological and organizational perspectives. They are further discussed below.

Table 1 Influencing Factors in BDA Adoption

Type of factor	Category	Item	Term used	*Authors*	*Year*
Technological factors	Infrastructure	A strong data infrastructure	Requirements to succeed	*Watson*	*2014*
		Analytical challenges	Challenges & issues	*Katal et al.*	*2013*
		Appropriate technology usage	Success factors	*DHL*	*2013*
		Infrastructure readiness	Barriers	*Alharthi et al.*	*2017*
		IT infrastructure and capabilities	Determinants of intention	*Lai et al.*	*2018*
		Storage and processing issues	Challenges & issues	*Katal et al.*	*2013*
		Technical challenges	Challenges & issues	*Katal et al.*	*2013*
		Technology	Management challenges	*McAfee et al.*	*2012*
		Technology complexity	Determinants of intention	*Lai et al.*	*2018*
		The right analytical tools	Requirements to succeed	*Watson*	*2014*
	Data	Complexity of data	Barriers	*Alharthi et al.*	*2017*
		Data quality	Determinants of intention	*Lai et al.*	*2018*
		Data transparency and governance	Success factors	*DHL*	*2013*
	Governance	Privacy	Barriers	*Alharthi et al.*	*2017*
		Privacy and security	Challenges & issues	*Katal et al.*	*2013*
		Data Privacy	Success factors	*DHL*	*2013*
Organizational factors	Culture	A fact-based decision-making culture	Requirements to succeed	*Watson*	*2014*
		Alignment between the business and analytics strategy	Requirements to succeed	*Watson*	*2014*
		Business and IT alignment	Success factors	*DHL*	*2013*
		Company culture	Management challenges	*McAfee et al.*	*2012*
		Culture	Barriers	*Alharthi et al.*	*2017*
		Data Access and sharing of information	Challenges & issues	*Katal et al.*	*2013*
		Decision making	Management challenges	*McAfee et al.*	*2012*
		Perceived benefits	Determinants of intention	*Lai et al.*	*2018*
	Management	Leadership	Management challenges	*McAfee et al.*	*2012*

		Leadership capacity	Challenges	*Ittmann*	*2015*
		Strong, committed sponsorship	Requirements to succeed	*Watson*	*2014*
		Top management support	Determinants of intention	*Lai et al.*	*2018*
	People	Data science skills	Success factors	*DHL*	*2013*
		Lack of skills	Barriers	*Alharthi et al.*	*2017*
		People skills in the use of analytics	Requirements to succeed	*Watson*	*2014*
		Skill requirement	Challenges & issues	*Katal et al.*	*2013*
		Talent management	Management challenges	*McAfee et al.*	*2012*
	Strategy	Clear business need	Requirements to succeed	*Watson*	*2014*
	Financial	Financial readiness	Determinants of intention	*Lai et al.*	*2018*

Source: Authors cited in the table

From a technological perspective, the technology capability of an organization to a large extent determines the speed of BDA adoption. Before BDA is adopted, an organization must have equitable capability in handling high-volume, high-velocity and high-variety data expeditiously. Despite the fact that IT infrastructure and systems are becoming cheaper due to the advancement of technology these days, the development of BDA infrastructure still requires significant investment in software and hardware to support data acquisition and storage, as well as the timely analysis of massive data (Alharthi et al., 2017). In the service industry, data privacy for Business to Consumer (B2C) businesses, such as consumer goods and retail, is the most crucial and sensitive issue for data analytics, as it is related to the collection of personal data from the consumers directly (Katal et al., 2013). For other service companies that operate under a Business to Business (B2B) model, data privacy may be less critical. On the other hand, data ownership and data authorization may be more challenging for these companies to overcome.

From an organizational perspective, some researchers discuss the organizational challenges in using business analytics. Culture, management and people are three major challenges in BDA that are frequently mentioned. For example, LaValle et al. (2011) review the survey results of the MIT Sloan Management Review where more than 3,000 responses were collected worldwide. The survey reported that the biggest challenges in adopting analytics in organizations are no longer *data and technology*, but *managerial and cultural* issues. Changing the culture is never easy for any organization, especially for those long-established, large organizations with diversified business products and global coverage. Many strategic decisions must be made in an organization, and business executives need to allocate sufficient time and resources in executing these decisions. Similarly, McAfee et al. (2012) also identify *leadership* (management) and *culture* as critical challenges in value realization during BDA adoption. In addition, Ittmann (2015) indicates that organizations have failed to adapt quickly in managing adoption of the technology due to a shortage of management bandwidth. In order to secure meaningful value extraction from BDA, the major issue in BDA adoption is less about technical factors, and more related to cultural and managerial challenges (Hopkins & Hawking, 2018).

Besides culture and management, another major organizational challenge in BDA adoption is people. BDA adoption can only be driven by people, and the data scientist is the new unicorn (Del Vecchio et al., 2018). The definition of *data scientist* goes beyond the classic definitions of those of data and business analyst. According to Jones (2013), the key disciplines of the data scientist should be trained are computer science, math and statistics and the business domain knowledge. However, finding this complete set of three areas of expertise in one person is exceedingly cumbersome and that is why the data scientist is called the *new unicorn*. Data science, as described on the IBM website, encompasses "preparing data for analysis and processing, performing advanced data analysis, and presenting the results to reveal patterns and enable

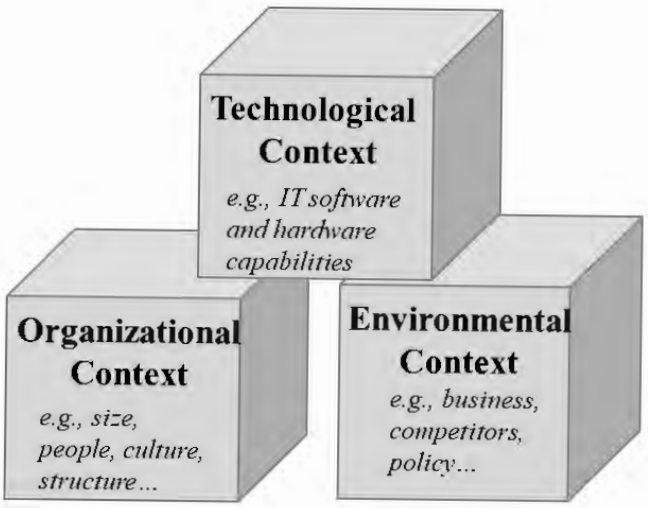
stakeholders to draw informed conclusions" (IBM, 2020, p. 1). What is more, data analysis also requires "the development and use of algorithms, analytics and AI models" to ultimately find patterns and to "transform these patterns into predictions that support business decision making" (IBM, 2020, p. 1). The scarcity of data analytical skills is one of the most challenging barriers for many organizations (Alharthi et al., 2017). Given the increasing importance of big data, a huge demand for data scientists and big data technology experts is expected.

2.2.4 Analytical Framework for BDA Adoption

Technology adoption, as defined by Garcia and Calantone (2002), refers to the technological deployment of an invention to end-users through adoption and diffusion in an organization. The literature of forty years ago indicated that organizational innovation adoption could be influenced by the characteristics of the organizational leaders, the organization itself as well as the organizational context in which the organization operates (Kimberly & Evanisko, 1981). Similarly, in order to evaluate technology adoption at the organizational level, Tornatzky and Fleischer (1990) propose a technology-organization-environment (TOE) framework that has underpinned many researchers' works to explain how any adoption decisions are influenced by the three different elements within organizational contexts. The TOE framework is an industry-free and user-friendly evaluation tool to help business executives study technology adoption (e.g., BDA) and the values the adoption may create for organizations. In this study, the TOE framework was used as a potential analytical framework to understand BDA adoption in the case organization.

Three contexts covered in this framework and shown in Figure 5 are the *technological context*, such as IT software and hardware capabilities; the *organizational context*, consisting of the organization's characteristics, such as size, people, culture and structure; and the *environmental context*, such as the type of business, competitors and government policy, as well as regulations, and so on. A brief introduction to each context is presented below.

Figure 5 The TOE Framework



Source: Tornatzky & Fleischer (1990)

The Technological Context

Baker (2012) suggests that the technological context covers technologies that are relevant to the organization including both those that are already implemented by the organization and those that have not yet been adopted but are already available in the marketplace. Numerous characteristics of a technology can influence the adoption. Data availability and data quality affect the adoption of BDA (Lai et al., 2018), and the existing technologies of an organization set the limit on the scope and pace of technological change that any organization can undertake (Collins et al., 1988). Technological factors of BDA adoption can be any hardware and software infrastructures related to big data acquisition, data storage, data management and data analysis. They also include the equipment and processes related to the adoption of BDA technology (Sun et al., 2018). According to Baker (2012), new, previously unadopted technology innovations bring incremental or erratic changes to the adoptive organizations. Innovations with incremental changes to an organization stimulate further enhancement of its existing technologies in a novel way and

the changes could be massive if the new innovation completely alerts the way people work. Organizations that plan to adopt any new innovations should carefully consider potential organizational changes that may result from adopting this innovation.

The Organizational Context

The organizational context in the TOE framework refers to the resources and other characteristics of the company. Baker (2012), Gangwar et al. (2014) and Sun et al. (2018) identify a list of organizational factors, such as firm size, organizational structure, human resources (including top management and subject matter expertise etc.) as well as organizational capability and capacity (organizational innovativeness) and financial resources. However, although the TOE framework identifies factors that contribute to technological adoption, it fails to differentiate among these factors in terms of their importance or influence. Limited studies have elaborated how these organizational factors may affect the adoption of the technology. Organizational factors take various forms in different technological adoptions and are also determined by the organizations and the industry in which the studies were situated.

The Environmental Context

The environmental context emphasizes the business operations and external factors influencing the industry. The environmental factors affecting BDA adoption in air freight forwarding industry involve the industrial structure of the air freight; industry or market uncertainty; competitors' engagement levels in BDA adoption; and regulations and policies related to data governance or data security. Gangwar et al. (2014) summarize a list of significant variables in the environmental context, such as "the customer mandate, competitive pressure, external pressure, internal pressure, environmental uncertainty, information intensity and network intensity, while government regulations are not identified as significant variables" (p. 495).

The TOE framework (Tornatzky & Fleischer, 1990) is one of the very few models that can be applied to evaluate technology adoption at the organizational level, as most technological adoptions take place at the individual level (Gangwar et al., 2014; Oliveira & Martins, 2011). This framework has been frequently adapted as a useful analytical tool for evaluating the adoption and assimilation of different types of technology at the corporate level. According to the literature review by Oliveira and Martins (2011), the TOE framework is a popular choice that can be used alone or in combination with other theories to evaluate various technology adoptions, such as electronic data interchange (EDI) application, websites and e-commerce, as well as e-business adoption. In addition, Baker (2012) reviewed the application of the TOE framework from industrial application and geographical perspectives. The TOE framework has been claimed as remaining among the most prominent and widely utilized theories for organizational adoption, because it can be applied in any industry and any organization to evaluate any technology adoption and associated challenges. The elements of technology, organization and environment have been demonstrated to affect the way that any organization seeks to adopt the new technologies (Baker, 2012; Gangwar et al., 2014).

The TOE framework has many advantages, but also some disadvantages. According to Gangwar et al. (2014), the framework itself does not represent a mature theory and has neither fixed constructs nor variables. For example, if the TOE framework is applied in different industries, different constructs or variables may be identified, which are only relevant to the particular technology adoption being evaluated. Because of these limitations, it is challenging for those organizations that intend to use the TOE framework to evaluate their own technology adoptions as an integrated conceptual framework. Another common argument about the TOE framework is that there is no single theoretical explanation that applies to the adoption and diffusion of all types of innovations. Therefore, the TOE framework is commonly employed as a generic guideline by

academic researchers and practitioners when reviewing technological adoption in organizations (Baker, 2012). The successful adoption of technology involves a mix of technological, individual, organizational, environmental and management-related factors, and the TOE framework thus provided the researcher with a practical theoretical outline with which to evaluate BDA adoption in this case study.

2.3 Service Innovation

Understanding Service Innovation

"Innovation is ubiquitous and is a management priority for a wide diversity of businesses" (Dodgson et al., 2008, p. 54). Innovation has long been defined differently by various researchers, some of whom describe innovation in general terms (Damanpour,1991; Flint et al.,2005; Grawe, 2009; Hu & Huang, 2011) or in according to a specific characteristic, such as *logistics innovation*, *technological innovation* or *customer-related innovation* (Mena et al., 2007; Rossi et al., 2013; Wallenburg, 2009). *Newness* is the most common characteristic of innovation, as it must firstly be *new* to a group of people, an organization, the customers, the industry or even to the world, although it does not need to be new to the world (Bajec, 2011; Flint et al., 2005). Our understanding of innovation has been enhanced through the evolving definitions of various authors; however these definitions are found overlap, resulting in ambiguity and a lack of clarity at the same time. Therefore, in this study, the researcher defines innovation *as any new idea, concept, product, service, practice, change, solution or project, or the application of new technical or administrative knowledge to offer something new to customers*. A summary list of definitions about innovation by various authors is presented in Appendix 5.

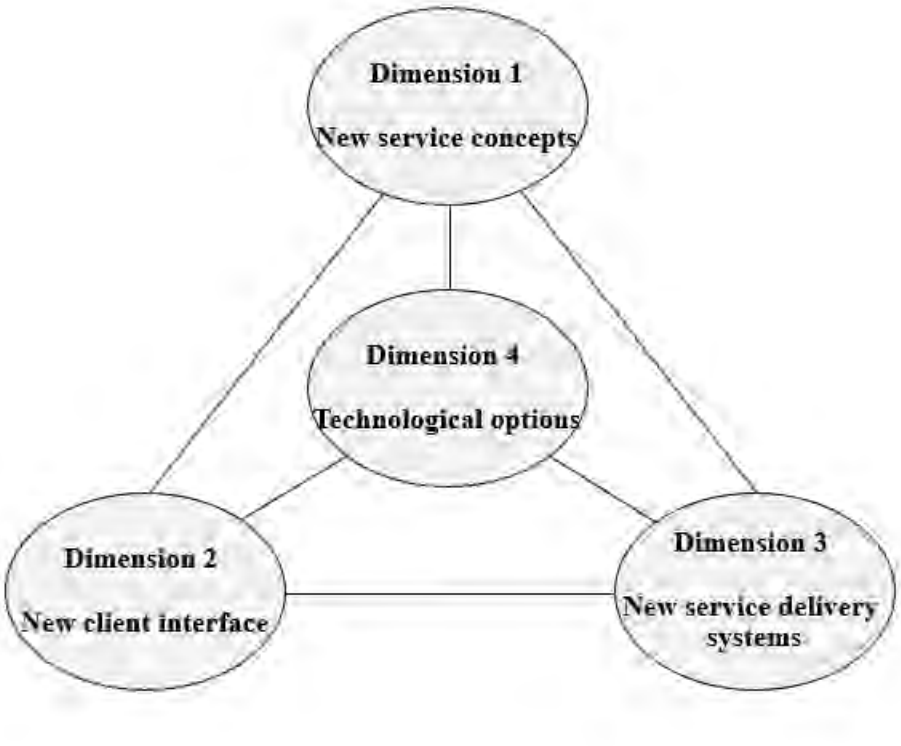
Innovation in business is commonly categorized into two types based on the commodity involved: *product innovation* and *service innovation* (Wagner, 2008; Wagner & Sutter, 2012).

Product innovation traditionally relates to tangible product development and processes rooted in conventional manufacturing. Service innovation is mainly driven either by customers' demands or management's expectations when aiming to develop innovative services for existing markets or penetrating new markets for existing services (Barrett et al., 2015). Both Garcia and Calatone (2002) and Mena et al. (2007) categorize innovation through the lens of technology into the categories of *technological innovation* and *non-technological innovation*. Mena et al. (2007) define technological innovation as "technologies for data acquisition, information management, warehousing and transportation", and non-technological innovation as referring to "changes in structures, business processes, customer and supplier relationships management and knowledge management issues that lead to innovation" (p. 14). Innovations in the logistics industry, according to Wallenburg (2009), can be classified based on their direct impacts on customers, namely, *internal innovations that do not affect customers directly* (e.g., process optimization), and *external innovations that directly impact customers* (e.g., innovative services). Different categorizations enrich the concept of innovation, but these categorizations also confuse people, which leads to different perceptions and understandings of innovations. For example, service innovation may be either an internal or external (customer-related) innovation (Wallenburg, 2009); and it may cover both technological and non-technological components (Mena et al., 2007). A list of classifications of innovation by various authors is presented in Appendix 6.

Hertog and Bilderbeek (1999) propose a four-dimensional model (see Figure 6) that explains what service innovation is. The four dimensions comprise new service concepts, a new client interface, new service delivery systems and technological options, respectively. As service innovation may be understood differently, this four-dimensional model provides a more comprehensive understanding about the diversity and complexity of service innovation, its four

dimensions being highly interactive and interdependent. These four dimensions are discussed as below.

Figure 6 A Four-dimensional Model of Service Innovation



Source: Hertog & Bilderbeek (1999)

The first dimension involves new service concepts. Unlike tangible and visible innovation in the production industry, innovations in the service industry are highly intangible and more likely to be seen as *conceptual innovations*, such as a new idea or concept about how to organize a solution to a specific business problem. The second dimension entails a new client interface. It refers to "the design of the interface between the service provider and its clients" (Hertog & Bilderbeek, 1999, p. 6). The mode of communication and the interactions between the service providers and clients have a high potential for service innovation. For example, a traditional restaurant may set up a new

digitalized channel to sell its specialties through an online platform. The third dimension, new service delivery systems, is closely linked to the first two dimensions above and refers to "internal organizational arrangements that have to be managed … to develop and offer innovative services" (Hertog & Bilderbeek, 1999, p. 7). A good example would be the macroscale development of an online shopping service (e-commerce) that significantly changes the business model and the interaction between the seller and consumers. The last dimension, technological options, has triggered some debate and discussion. This dimension reflects the close relationship between *technology* and *service innovation*. Technology plays a significant role as a facilitator, enabler or supply-pushing driver in service innovation development.

Innovation is much more than the creation of new ideas and/or reduction to practice, according to Dodgson et al. (2008), and innovation is the "*successful commercial exploitation of new ideas*" [emphasize added]. This commercial introduction of "a new or improved product or service" entails a series of "scientific, technological, organizational, financial, and business activities" (p. 2). Service innovation, in this study, can generally be defined as *any technology-enabled innovation that is newly adopted by any air freight forwarding organization with the aim of changing the way people work and, ultimately, of improving business performance and achieving financial effectiveness*. For example, service innovation of a traditional service vendor could entail a new sales channel (Dimension 2) through an online platform (Dimensions 3 & 4) where customers can obtain instant service quotations without calling the service hotline (Dimension 1). New technologies, such as BDA, are deemed potential sources of innovation and are likely to attract greater attention by organizations in future, in view of the integral role of technology and its speedy advancement of technological solutions that affect the service industry (Wallenburg, 2009; Busse & Wallenburg, 2011).

Linking BDA with Service Innovation

Although researchers talk about the importance of technology that brings big impacts to service innovation in logistics and list its substantial components, BDA is not listed. According to Barras (1986, 1990), technology has been adopted by service organizations to increase the efficiency of existing services, to improve service quality and effectiveness, as well as to generate innovative services. Chapman et al. (2003) state that technology enables service firms to improve their efficiency and effectiveness, as well as to enhance their service, and that technology will continue to be the main driving engine for innovation within the service industry. Mena et al. (2007) list some of the technological drivers that affect innovation in the logistics industry, such as visibility tools and transport technologies. The authors claim that Information and Communication Technologies (ICTs) have dominated in driving change in the logistics industry over the past 25 years, the most influential technologies that are commonly practiced in the industry being telematics, which are used to monitor and control remote devices; and information technology infrastructures that integrate information systems among supply chain providers, just to name a few. Adding to the work of Chapman et al. (2003), Grawe (2009) proposes his literature-based conceptual framework, in which the author emphasizes the importance of technology that is considered to be a key organizational factor affecting the adoption of service innovation in logistics service providers (LSPs). According to Grawe (2009), technology enables communication advances that can solve the challenges of time and distance due to operational decentralization for the employees within the organization. His article supports the conclusion reached by Chapman et al. (2003) about the necessity of new technology tools adaption to facilitate innovation in business processes. Grawe (2009) maintains that other areas of technology, such as BDA, can also have a substantial impact on the logistics industry, and can even be a game changer for the industry in the future. Yet it is rarely found in logistics innovation studies.

Customers rely on their LSPs, and innovative technological capability is a key selection criterion in the choice of an LSP. Driving for improvement and innovation is a mandate for LSPs that helps them to gain a competitive advantage over their competitors (Wagner & Sutter, 2012). Technologies can facilitate LSPs' innovations, improve their existing logistics solutions and enhance their competitive advantage in the fullness of time (Mathauer & Hofmann, 2019). Consequently, through adoption of technology-enabled innovations, these LSPs are able to offer a wider range of services that meet or even exceed customer requirements and expectations. The rapid development and widespread deployment of ICTs are indispensable to the development of service innovation in service companies. Integrated with other resources (such as skills and knowledge), ICTs allow information available and accessible in different contexts of services activities to create new possibilities for innovation (Barrett et al., 2015). There is a need for further exploration of the relationship between service innovation and technology proposed by Barrett et al., (2015), as the question of how digital technology embedded in products might enable innovation in service systems remains open and calls for more practical investigations.

Gantz and Reinsel (2011) note the straight-forward relationship between technology and BDA, since "big data technologies describe a new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling high-velocity capture, discovery, and/or analysis" (Gantz & Reinsel, 2011, p. 6). It is believed that this world is generating over 2.5 quintillion bytes of data every day with an ascending trend and that more than 90% of this data was created in the past five years (Karki, 2020). It is not possible to manage such a massive volume of data manually without the empowerment of the technology, especially where data acquisition, data storage and management are concerned, not to mention advanced data processing and analytics, where the values of BDA are extracted from for the targeted audience in many business areas.

Like other industries, the logistics industry is surrounded by new technologies. The discussion of technology-enabled transformation has fostered the strategic thinking of business executives in the logistics industry about service innovation (Busse & Wallenburg, 2011). Technology-driven service (or product) innovation is the supreme choice for many organizations (Evangelista & Sweeney, 2006). The use of BDA as an innovative technology solution has started to attract the business executives in the logistics industry as a means for improving business performance, Hopkins and Hawking (2018) believe that a valid area of investigation would be to look at how BDA can facilitate the innovation process in the volatile and agile logistics industry. Many studies on service innovation, and especially on technology-related innovation in the logistics industry, are limited to the adoption of standardized software technologies at a general level (Lai et al., 2018). Although BDA is widely recognized as an advanced innovative technology, its potential to foster service innovation has yet to be evaluated. To understand how this linkage between BDA and service innovation can be established, we approach these fields at organizational level.

2.4 Air Freight Forwarders

2.4.1 Logistics and Air Freight Forwarders

Logistics is a strategic activity that connects customers and suppliers by coordinating cargo movement, services and information from origin to destination. Logistics service providers (LSPs) broadly refer to companies that perform logistics activities on behalf of their customers. These logistics functions and activities may include transportation (e.g., carriers, couriers and freight forwarders); warehousing (e.g., warehousing companies); inventory management; and packing services (Delfmann et. al., 2002). Air cargo transportation, or air freight forwarding (Feng et al., 2015), is a specialized type of cargo transportation used in global trade. Air freight transportation

services are a more expensive mode of cargo transportation compared to land or ocean freight services. Customers choose air freight services mainly due to the specific nature of the products to be transported, such as high-value cargoes (e.g., high-end mobile phones) or cargoes that need special caring and handling (e.g., frozen meat, flowers and temperature-controlled pharmaceutical products). Stricter and higher requirements of service commitment are expected, especially in terms of speed of delivery. According to IATA (2022), global air cargo providers transport over US $6 trillion worth of goods, accounting for approximately 35% of world trade by value, but only 1% of world trade by volume. Air freight service providers play a critical role in air cargo transportation because air cargoes are trade facilitators that contribute to global economic development; and the global economy relies on air cargo transportation to deliver high-quality products at competitive prices to the customers worldwide. Integrated freight forwarders, also named air freight forwarders (AFFs), one type of air freight service provider defined by Reynolds-Feihan (2001), manage cargo movements on behalf of customers through air transportation within their operation network globally or regionally, they form the context in which this case study is situated in.

Air freight forwarding services are tedious and repetitive rather than complicated. In their study, Lai and Cheng (2004), who studied the freight forwarding industry in Hong Kong, found that the core business activities of AFFs had remained unchanged through the evolution of the industry over a number of years, and that these freight forwarders failed or lacked the capabilities to provide value-added services in the era of technology empowerment. However, with the technology innovation and advancement of technology nowadays, an updated review of customer requirements and of the service scope of AFFs is deemed necessary. An exploratory understanding of how technology innovation could be embedded into different stages of the freight transportation chain to enable service improvement would therefore be meaningful in today's digital era.

Despite the limited number of studies about air freight services available in the literature, there is one study conducted by Feng et al. (2015). According to these authors, AFFs own massive shipping data, but value extraction from this massive data in the air freight forwarding industry is still in its infancy stage. In particular, Feng et al. (2015) identify a few decision-making problems that AFFs mainly experience in procurement (e.g., capacity booking strategies for airlines) and operation (e.g., cargo loading and consolidation strategies), and they believe data-driven decision making could help solve. Although their study emphasizes the importance of utilizing BDA in decision-making problem solving, no practical solutions are provided about how AFFs can utilize BDA in decision-making processes. Nevertheless, if industrial data is utilized, BDA clearly has the potential to improve operational efficiency, enhance customer experience and form new freight forwarding business models in the industry (Mikavicaa et al., 2015).

2.4.2 BDA Adoption in Logistics

Since studies of BDA adoption purely related to air freight forwarding industry are very rare, the literature review on BDA adoption in this section refers to the logistics industry in general. The logistics industry is an applicable industry for BDA adoption, but little logistics research has focus on this subject. In those available innovation studies of the logistics industry, two terms often confuse people: supply chain management (SCM) and logistics. Supply chain activities exist in all trading companies where they are either managed by the companies themselves or outsourced to a third-party LSP (e.g., AFFs). SCM covers all information about cargo flows in great details and is organized sequentially from suppliers to customers.

The literature review undertaken for this study found that numerous logistics studies are not specific to LSPs and AFFs, but are instead related to either SCM or generic logistics topics (see Appendix 4 for details). For example, Ittmann (2015) explores BDA applications in the SCM of different industries. He examined, such features as retail predictive analytics and vendor

compliance, demand forecasting and production planning through BDA applications. Moreover, he also studied how organizations moved themselves from intuitive to data-driven decision making through BDA applications. Similarly, Tiwari et al. (2018) conducted a literature review on the importance of BDA and its application in SCM from 2010 to 2016, drawing on more than 100 journal articles and industrial papers. The authors define BDA applications in SCM as supply chain analytics (SCA) and investigated these applications in the finance, healthcare and manufacturing industries. These BDA applications, which Tiwari et al. (2018) named SCA applications, have been implemented in supply chain activities such as strategic planning, production and inventory, and supply chain network design. The authors of this study also point out the importance of third-party LSPs in BDA adoption to ensure seamless supply chain integration.

Some logistics studies provide real-life cases of BDA adoption that aimed to solve generic logistics problems in different industries, such as consumer industries and retail, e-commerce and public transportation (Heesen, 2016). For instance, DHL (2013) discusses the BDA applications in logistics where big data can be most effectively applied in the logistics industry. Those BDA applications were grouped by their benefits: operational efficiency improvement, customer experience enhancement and new business model development. According to Ayed et al. (2015), some BDA projects have been successfully executed in the logistics and transportation industries in some countries (India, Vietnam, Ireland and Norway), for example, real-time vehicle monitoring in India and the public transit system project in Ireland from 2010 to 2013. Hopkins and Hawking (2017) conducted a longitudinal case study of BDA adoption in a logistics company. They investigated how BDA could help the case organization to improve drivers' safety, lower operating costs and reduce the environmental impact of their vehicles. The study reveals the importance of establishing a BDA strategic direction (i.e., what an organization wants to achieve through BDA adoption), which should be made available before BDA is adopted in an organization.

In summary, despite the fact that BDA studies related to the logistics industry are steadily increasing, empirical studies of BDA adoptions relevant for LSPs in general, and AFFs in particular, are still very scarce nowadays. Successful BDA adoptions by other LSPs may not be applicable to AFFs due to the different business nature and practices of the latter industry. Therefore, AFFs will eventually find their own approach to BDA adoption that fits the nature and culture of their industry. BDA has great potential to improve profitability and competitiveness for organizations by offering their customers innovative solutions that were not possible in the past. There seems to be a gap in translating this understanding into effective organizational management and culture shaping to pursue service innovation. A thorough understanding of the potentials of utilizing BDA to improve service innovation of the air freight forwarders is crucial to bridge this gap.

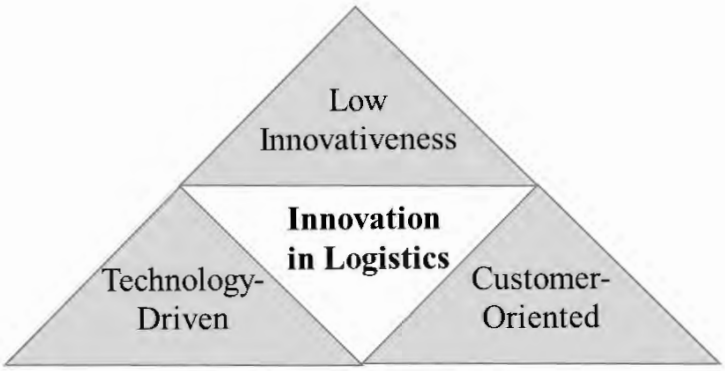
2.4.3 Service Innovation in Logistics

Different terms to describe innovation are used in a large body of innovation literature that is relevant to the logistics industry, for example, *logistics innovation*, *logistics service innovation*, *logistical innovation* and *innovation in logistics.* These terms share similar meanings within the logistics industry. Daugherty et al. (2011) define logistics service innovation as any new idea or practice in logistics operations which is different from a company's current practice. Logistics operation activities exist in both LSPs and their customers' organizations. Furthermore, innovation not only occurs in logistics operation activities, but also in other parts of the organization such as business development, procurement or finance activities (Busse & Wallenburg, 2011). Therefore, this definition is to some extent limited, and a more comprehensive definition is required. One definition that is frequently referred to states that logistics innovation is "any logistics related service from the basic to the complex that is seen as new and helpful to a particular focal audience" (Flint et al., 2005, p. 114) and, can be targeted to improve operational efficiency internally or to better serve their customers externally. Even though the authors focus on external innovation, their

description provides a precise and comprehensive foundation for understanding what logistics innovation is. Based on this definition of logistics innovation, innovations size can be small or big; adoption can be simple or complicated; and the targeted innovation receivers can be LSPs themselves (internal) or their customers (external). The most important features of logistics innovation are *newness* and *helpfulness* to any audience. To be clear, in this study logistics innovation refers to *those activities to improve business performance that are newly initiated by LSPs* (e.g., air freight forwarders).

For the past few decades, studies on services industries and their innovations have traditionally been overlooked due to the fact most innovation activities are supplier-dominated in these service firms. Although the number of studies in service innovation has increased in recent years, researchers discuss the characteristics of logistics innovation from different perspectives and with different focuses (Chapman et al., 2003; Cichosz et al., 2017; Flint et al., 2005; Lin, 2006; Trigo & Vence, 2012; Wagner & Sutter, 2012; Wallenburg, 2009). Therefore, the researcher has summarized three major characteristics of logistics innovation (see Figure 7) found in the literature reviews. Innovation in logistics is characterized according to whether: a) the innovativeness level in the logistics industry is very low; b) the innovation in logistics is mainly driven by technology and c) the innovation in logistics is very customer oriented. Details of these three characteristics are presented below.

Figure 7 Three Characteristics of Innovation in Logistics



As illustrated in Figure 7, the first characteristic of innovation in logistics is *low innovativeness*. In order to identify specific innovation patterns within the service industry, Trigo and Vence (2012) sum up three innovation patterns by analyzing four different service sectors with a wide range of innovation process attributes. The transport service sector, including logistics services, has been claimed by the authors as a *low innovation-intensive sectors* (LIIS), which means that, this sector has been ranked very low in terms of its innovative character, the relevant organizations' innovative intensity, and their innovation intensity in R&D and innovation cooperation, respectively. Wagner & Sutter (2012) explored the level of innovation in the logistics industry and found that logistics service companies are not very innovative as they neither engage in innovation management nor exploit the potential of innovation. Innovation activity and performance in logistics companies differs significantly from those of other service providers, which suggest that industry-specific studies could help to deepen the understanding of the logistics innovation from different perspectives. Compared with other industries, logistics service companies have been scored lower in innovation expenditure and innovation output, even though innovation is critical for customer relationship enhancement and achieving a competitive advantage.

Technology-driven innovativeness is the second characteristic identified in innovations developed in the logistics industry. Lin (2006) divides technological innovation into four types of innovation that relate to the logistics industry and involve data acquisition (e.g., the bar code system); information management (e.g., electronic data interchange); and warehousing and transportation technologies (e.g., artificial intelligence-aided picking and packing systems, global position systems). Obviously, technology has been playing a critical dominant role in innovation development in the logistics industry for a long time. Advance in technology and its impact in innovation in logistics will continue to grow even further. Most innovation adoptions in logistics, according to Busse and Wallenburg (2011), have dealt with technology adoption that helps organizations to deploy innovative solutions and gain advanced competitive advantages. Among the various technologies, information technologies (e.g., data acquisition technology, transportation and warehousing technologies) are the most frequently adopted new technologies in logistics. In the diffusion of technological innovation, the *knowledge required for use* is considered as a key determinant, that is, considerable formal or informal learning (or education) are required to be undertaken for the users (Dodgson et al., 2008).

The third characteristic of innovation in logistics is the extent to which it is *customer-oriented*. Chapman et al. (2003) found that LSPs were not active in driving service innovations. Moreover, many service innovations adopted are perceived as passive reactions to their customers' demands or requirements. Flint et al. (2005) point out that logistics service companies should continuously incorporate customer needs and drive customer-oriented innovations that focus on value creation for their customers. Logistics innovation, especially customer-related innovation, is considered as a key driver of customer loyalty by Wallenburg (2009), who emphasizes that the customer-oriented innovations of proactive cost improvement and proactive performance improvement greatly enhance customer loyalty. Furthermore, Cichosz et al. (2017) also emphasize

the importance of customer alignment for logistics service companies that pursue and develop any radical, tailored service innovation, ultimately achieving customer satisfaction. Proactive initialization of innovation in logistics, and especially in air freight forwarding services, is very limited and hardly reported in the literature. Companies manage their innovation processes at divergent paces and with different strategic prioritizations. Therefore, no single integrated innovation management is available and used throughout the logistics industry (Grawe, 2009).

Business historians and management researchers acknowledged innovation as a source of competitive advantage for both production and service industries, and a differentiation can be easily told between companies that have proactively prepared to innovate and those that respond reactively only when problems occur (Casson & Dodgson, 2019). Innovation plays a pivotal role in the success of many organizations, including LSPs (Flint et al., 2005), although it is very challenging to implement innovation successfully (Daugherty et al., 2011). Service innovation is a value-creating activity that ultimately achieves better business performance for any service companies (Chapman et al., 2003). Innovation in service industries, including the air freight forwarding industry, has been recognized as a prime contributor to company success to the extent that it can help organizations to bring in additional revenue from new services and achieve cost savings or the quality improvement of existing processes (Busse & Wallenburg, 2011). Due to intense pressure from their competitors, many logistics companies have been seeking innovative ways of handling their standard logistics activities. Furthermore, globalization and technology advancement are shaping the world's trading business model, while integrated commodity logistics leads to more sophisticated SCM expectations and critical customers' demands for service innovation (Bajec, 2011).

2.5 Chapter Summary

The literature shows that BDA adoption can, in theory, improve decision making when managers are equipped with necessary data analytics resources and guided by data-driven insights. With better decision making, organizations can achieve higher customer satisfaction, internal operational efficiency and better financial results. However, real-life BDA adoption cases are relatively scarce in the air freight logistics industry and the values of BDA are yet to be exploited. Driving service innovation enables organizations to gain a competitive advantage over their competitors and BDA technology is expected to have a substantial impact on service innovation, if properly implemented. However, studies that focus on the interconnections between BDA and service innovation are minimal. Technological adoptions in organizations are generally influenced by a mixture of technological, organizational and environmental factors, forging a TOE framework. This analytical framework serves as the starting point to feasibly identify more influencing factors within and beyond the framework in this study.

Chapter 3 Methods

3.1 Chapter Introduction

This chapter presents the methods employed in this study to answer the principal research question, which asks how an international air freight forwarder can improve service innovation through BDA. The thesis is centered on a qualitative exploratory case study, which aims to shed light on the current state of service innovation and BDA adoption in an international air freight forwarder; to identify the influencing factors for BDA adoption; and explore the possibilities of utilizing BDA in service innovation. Chapter 3 elaborates on the research design and the data collection and analysis methods adopted to answer the research questions. The chapter is structured as follows: Section 3.2 describes the overall research design, including the epistemological paradigm, theoretical assumptions and the methodological design of case study. Section 3.3 elaborates on the use of semi-structured interviews and document analysis for primary and secondary data collection in this study. Section 3.4 presents content analysis of the primary and secondary data and two detailed data analysis processes. Sections 3.5 and 3.6 are related to research quality assurance and ethical issues. Finally, a short chapter summary is presented to end this chapter.

3.2 Research Design

The research design is a blueprint about what questions to study, what data are relevant, what data to collect, and how to analyze the results (Yin, 2018). Research starts with the identification of a problem that we want to solve and the general strategy for solving this research problem is called the *research design*. In order to increase our understanding of a phenomenon that we are interested in or concerned about, we need to have a systematic process that guides us to collect, analyze and interpret information (Leedy & Ormrod, 2015). Designing the research means

establishing a logical model of proof (Nachmias & Nachmias, 2014) that guides a researcher to walk through the research journey from the starting point (e.g., addressing a set of research questions) to the ending point where some conclusions about these questions are obtained. The research design introduces the overall processes to be used by the researcher to collect and analyze the data in order to answer the research question(s) posed in the research project. In this section, the researcher discusses the overall research design for the study, including the overall research approach, the epistemological paradigm, the theoretical perspective and the methodological design of exploratory case study.

According to Yilmaz (2013), qualitative research is "an emergent, inductive, interpretive approach to the study of people, cases, phenomena, social situations and processes in their natural settings in order to reveal in descriptive terms the meanings that people attach to their experiences of the world" (p. 312). Quantitative research, on the other hand, is "a type of empirical research into a social phenomenon or human problem, testing a theory consisting of variables which are measured with numbers and analyzed with statistics to determine if the theory explains or predicts phenomena of interests" (p. 311). Qualitative and quantitative research approaches have different considerations in terms of their epistemological, theoretical and methodological underpinnings.

In this study, given that the researcher explored a case organization, a qualitative approach was adopted for the case study. This involved a *thick description* of the selected case rather than a quantitative reductionism (Yilmaz, 2014, p. 317). The researcher believes that a qualitative research approach is deemed more appropriate for this study than a quantitative one because a qualitative study is more holistic and emerges from the specific design and methods (e.g., interviews), allowing the researcher's interpretations to be developed and possibly changed along the way. Qualitative studies examine "process, context, interpretation, meaning or understanding through inductive reasoning" (Yilmaz, 2014, p. 313) and the aim is to describe and investigate the phenomenon (e.g.,

service innovations and BDA adoption) studied by intercommunicating with experienced participants through interviews. The exploration of BDA utilization in an international AFF requires the collection, analysis and interpretation of information related to BDA adoption and service innovation. BDA adoption as the phenomenon of interest, is an emergent phenomenon that has not been empirically investigated previously. This exploratory research enables knowledge advancement about the current situation of BDA adoption and service innovation. Additionally, the process also identifies the influencing factors for BDA adoption through the lens of the technology-organization-environment framework. In particular, the research addresses a real-world business problem to address how BDA can be utilized to improve service innovation in the air freight forwarding business.

According to Crotty (1998), when developing a research proposal, researchers need to thoughtfully answer two questions: 1) *What* methodologies and methods should be adopted in the research? and 2) *How* can they justify their choice and usage of methodologies and methods? The purpose of a research project (that is, the research questions that we intend to answer) answers the second question. In order to fulfil the purpose of our research, we need to have a process that covers all these elements. Crotty (1998) proposes a framework of the research process that covers four elements: epistemology, theoretical perspective, methodology, methods. Epistemology refers to "the theory of knowledge embedded in the theoretical perspective and thereby in the methodology" (Crotty, 1998, p. 3). The theoretical perspective is the "philosophical stance informing the methodology and thus providing a context for the process and grounding its logic and criteria" (Crotty, 1998, p. 3). Methodology is "the strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes" (Crotty, 1998, p. 3); and lastly, methods refer to "the techniques or procedure used to gather and analyze data related to some research question or hypothesis" (Crotty, 1998, p. 3).

As shown in Table 2, this study is based on the epistemological paradigm of constructionism and an interpretative theoretical perspective. A qualitative exploratory case study methodology was adopted, with semi-structured in-depth interviews and document analysis chosen as the primary and secondary research methods for data collection, respectively. Content analysis guided the data analysis for both interview transcripts and documents related to the case organization. These elements of the research approach are elaborated in the upcoming sections.

Table 2 Summary of the Research Process Applied in This Study

Elements	Description
Epistemology *(philosophical grounding for deciding what kinds of knowledge should inform the research, and how we can ensure that they are both adequate and legitimate)*	**Constructionism** Research participants perceive and construct their different meanings about service innovation, BDA adoption, challenges in adopting the technology, as well as how BDA can be utilized to improve service innovation in the air freight forwarding industry.
Theoretical perspective *(philosophical stance that lies behind my chosen methodology)*	**Interpretivism** The sharing of knowledge by experienced managerial employees in the case organization about service innovation and BDA adoption and of their recommendations for improving service innovation through BDA utilization. Findings are logically interpreted by the researcher.
Methodology *(strategy or plan of action; my choice of particular methods; and their links to the desired outcomes)*	**Qualitative, exploratory case study**
Methods *(concrete techniques and procedures used to gather and analyse the data)*	
Data collection *(methods used to collect the data)*	1) Semi-structured in-depth interviews 2) Document analysis
Data analysis *(methods used to analyze the data)*	1) Content analysis

3.2.1 Epistemological Paradigm

All research starts with the selection of some philosophical assumptions about what composes justifiable research and what research methods is/are pertinent for forming the knowledge in a given study (Antwi & Hamza, 2015). Philosophy is a set or system of beliefs stemming from the study of the fundamental nature of knowledge, reality and existence (Waite & Hawker, 2009). A research philosophy is what perception of truth, reality and knowledge the researcher holds; it outlines the beliefs and values that guide the research design, data collection and data analysis in a research study, these choices complementing philosophical principles (Ryan, 2018). Collis & Hussey (1997) also define a research paradigm as "a philosophical framework that guides how scientific research should be conducted" (p. 10). Crotty (1998) describes epistemology as "a way of understanding and explaining how we know what we know" (p. 8); it deals with "the nature of knowledge, its possibility, scope and general basis" (Hamlyn, 1995, p. 242). Qualitative research is based on a constructivist epistemology and explores a socially constructed reality in a descriptive and flexible context (e.g., an in-depth description of the phenomenon from the perspectives of the engaged participants). From a qualitative perspective, reality and knowledge are psychologically and socially constructed (Yilmaz, 2013); an epistemological framework aims to understand how the knowledge is created and given meaning.

This study is situated within the epistemological paradigm of constructionism wherein the way we organize and understand our world is determined by shared experiences, meanings and interpretations (Huczynski & Buchanan, 2013). Contingent upon human practices, our knowledge and the meaning of reality are constructed through interactions between ourselves and the world, consequently transmitted within an essentially social context (Crotty, 1998). From a constructivist perspective, we see the world as constructed, interpreted and experienced by people in their interactions with each other in their social systems (Antwi & Hamza, 2015). In this study, the

participants (i.e., employees) understand and build their knowledge about service innovations and BDA adoption through their interactions with the real business world in a specific social context (i.e., the case organization), based on their own experiences. Simultaneously, it also primarily involves the researcher's understanding and interpretation, reached by collecting information about the topics (i.e., BDA and service innovation) and making meaning of that information by drawing inferences (Antwi & Hamza, 2015).

Crotty (1998, p. 43), in his book, *The Foundations of Social Research*, describes how the meanings are derived within constructionism: "*What constructionism claims is that meanings are constructed by human beings as they engage with the world they are interpreting. Before there were consciousnesses on earth capable of interpreting the world, the world held no meaning at all.*" [emphasis added]

The constructivist paradigm adopted in this study was concerned with exploring service innovation and BDA adoption in an international AFF. This goal was achieved through adopting meaning-oriented techniques such as in-depth interviews that depend on an interactive relationship between the researcher and the participants. Participants construct their meanings through their interactions with the world they are in. In the present study, feedbacks and comments were collected from experienced managers about their expertise in service innovation and BDA, and their responses were ultimately interpreted by the researcher through meaning constructions. Within the constructivist paradigm, the nature of *improving service innovation through BDA adoption* is understood and interpreted as a particular phenomenon of business management in air freight forwarding industry. Reality is only knowable through socially constructed meanings and, there is no single reality (Ritchie & Lewis, 2003). Every employee in the case organization had his or her own perspective and experience of service innovation and BDA adoption, informed by their interactions among each other and constructed by the social environment in which they worked.

More importantly, the feedback of these experienced participants was collected through interactive conversations (i.e., in-depth interviews) with the researcher's construction of meanings. These multiple realities were integrated and triangulated into an understanding that most closely reflected and represented the phenomenon being studied. This constructivist paradigm governed the design of the case study for this research.

3.2.2 Theoretical Perspective

While the epistemological paradigm discussed in the previous section relates to philosophical grounding about knowledge and how we come to know about that knowledge, the theoretical perspective reflects our way of looking at the world and making sense of it. The theoretical perspective is seen as the philosophical stance that lies behind a methodology adopted for research and provides the context and a logical basis for the research process. It is concerned with how "different ways of viewing the world shape different ways of researching the world" (Crotty, 1998, p. 66). An interpretivist sees the world as constructed, interpreted and experienced by human beings in their interplay with each other and with the broader social environment and systems, whose purpose of the inquiry is to understand a specified phenomenon, but not to recapitulate to a population (Antwi & Hamza, 2015).

With the philosophical grounding being constructionism, the theoretical perspective of this research is interpretivism. An interpretative approach is adopted by the researcher who believes that service innovation and BDA adoption are understood through the meanings that participants assign to them (Deetz, 1996), based on the subjective experiences of individuals. The interpretive paradigm is reinforced by both observation and interpretation. Observation is to collect the information about the topics while interpretation is to construct/make meaning out of the collected information within the particular context being studied. In seeking the answers to the research question, *How can an international air freight forwarder improve service innovation through BDA?*

the researcher, who follows the interpretative paradigm, utilized her experiences to construct and interpret understanding from collected data. The researcher explored BDA adoption in the case organization by interpreting the understanding of the participants, who perceived BDA adoption through their own experiences and shared their understanding and observation through descriptive expression (i.e., conversations). For the most part, it is believed that the constructivist/interpretivist paradigm is best suited to qualitative methods (Silverman, 2000; Willis, 2007), as qualitative approaches (e.g., case studies) enable researchers to understand the phenomenon with ample data. Instead of focusing on measuring social phenomena like positivism does, interpretivism focuses on exploring the complexity of social phenomena with a view to gaining interpretive understanding by adopting a range of methods that "seek to describe, translate and construct meaning in the social world" (Collis & Hussey, 1997, p. 45).

A qualitative exploratory research approach is deemed appropriate when the purpose of the research is to look into a research problem or issue where there are no earlier studies to which we can refer for information about the issue or problem (Collis & Hussey, 1997). The literature review conducted in Chapter 2 reflects the scarcity of relevant studies of BDA and service innovation in air freight forwarding industry, although some existing studies were conducted using a quantitative approach. In the past few years (2017-2018), quantitative studies of BDA adoption used surveys as primary instrument (Brock & Khan, 2017; Lai et al., 2018; Raguseo, 2018; Raman et al., 2018) have failed to interpret the complexity of the real-life business environment and comprehensiveness of BDA-related topics being studied. A few qualitative BDA studies have used content analysis or a literature review as the primary research instruments. For instance, Sun et al. (2014) and Wang et al. (2016) provide summarize overviews and observations of BDA adoptions from a generic perspective. Thus, as there are few qualitative studies in this field, the present study will strive to address this limitation.

3.2.3 The Exploratory Case Study

Justifications and Case Selection

The case study was chosen in this study to explore a contemporary phenomenon (e.g., BDA adoption) within its real-life context (e.g., air freight forwarding industry) and to address a situation in which the boundaries between the phenomenon and context are not clearly evident (Eisenhardt, 1989; Yin, 2018). The case study methodology helps in generating a large quantity of data, typically qualitative in nature, that can offer meaningful awareness into a phenomenon under development (Easton, 2010) or whose dimensions are not yet fully understood (Yin, 2018). This constructivist approach (i.e., the case study) places the researcher within the context of the phenomenon being examined (Andrew et al., 2011). The qualitative case study adopted for this project, according to Merriam (1998, p. 13), is "an intensive, holistic description and analysis of a bounded phenomenon", and this bounded phenomenon refers to BDA adoption in the case organization. The case study, as a research methodology, excels in generating new knowledge and utilizing both ongoing and past data from *real-life* situations that might not be possible to capture using alternative research methodologies (Baxter & Jack, 2008; Stake, 1995; Yin, 2018) and enables contemporary organizational phenomena to be studied in situ (Ketokivi & Choi, 2014). The researcher counts on the appropriateness of adopting the case study methodology given the early stage of research on BDA adoption in air freight forwarding industry and the complexity of the topics (BDA adoption and service innovation) being explored. The case study applied in this research entails three distinctive attributes: it is *particularistic* (focusing BDA adoption on the air freight forwarders as a particular phenomenon); *descriptive* (it yields a rich description of the BDA adoption under study) and *heuristic* (it illuminates an understanding of the BDA adoption in question).

Unlike quantitative methods that generally demand randomly selected large representative samples, qualitative research often uses purposive or theoretical sampling instead of random sampling (Miles & Huberman, 1994). The choice of samples for quantitative studies is concerned with the sample representativeness, but it is different for qualitative research. Qualitative research does not attempt to provide generalizability across samples (Collis & Hussey, 2003). In qualitative studies, samples (e.g., the case study) are deliberately rather than arbitrarily selected based on information richness (Meyer, 2001). Air freight forwarding industry is a niche logistics industry with a limited number of giant players who have dominated in market shares in the industry (see Appendix 3 for details). Additionally, these traditional giant players have seldom participated in filed studies of BDA topics, and cross-organizational collaborations have barely been observed due to business competition and sensitivity.

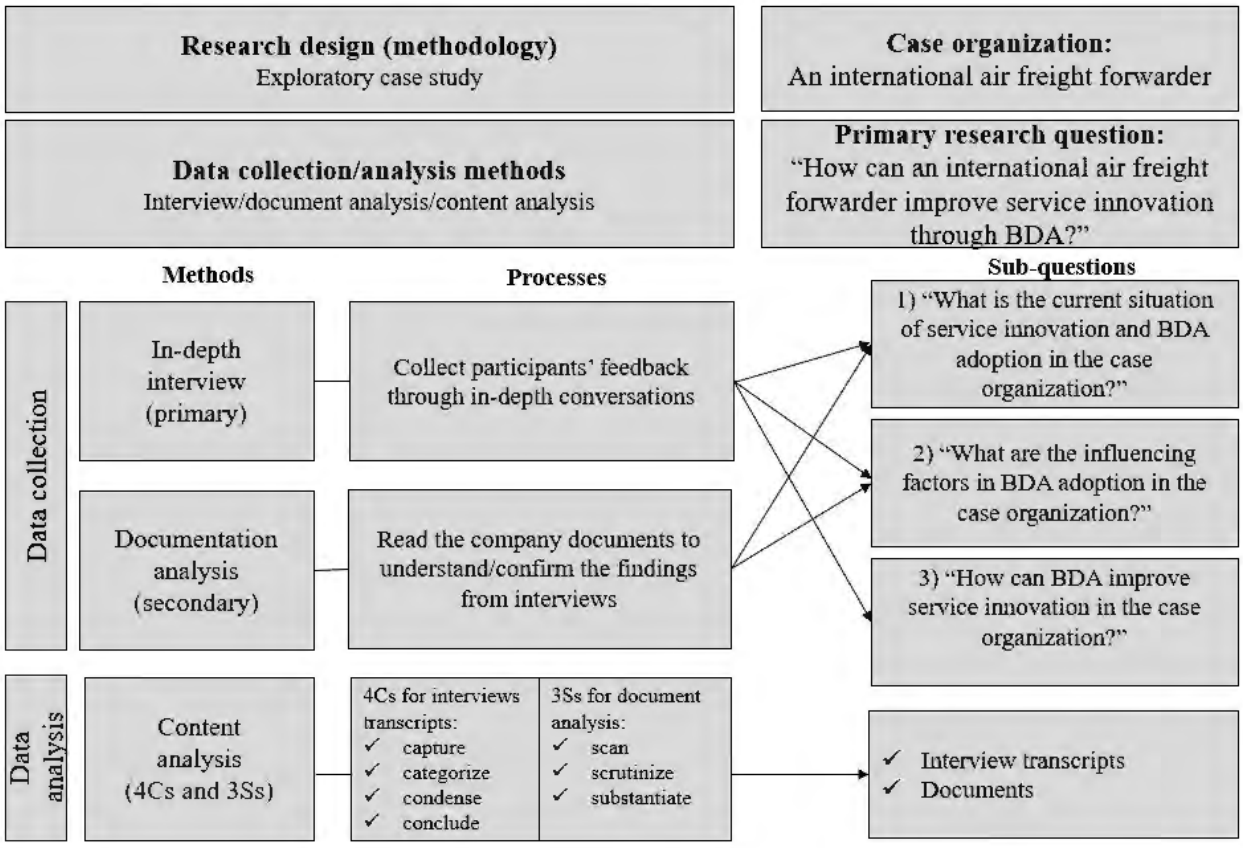
This case study was conducted in a global leader in air freight forwarding industry to explore its adoption of BDA and integration with service innovation. The case organization chosen for this study is ranked at the top of AFFs worldwide. Originating from the same country in Europe, these top-ranking market players have similar corporate cultures and organizational structures. The air freight forwarding industry is a niche market where many forwarders are serving the same customers, which results in these forwarders having homogeneous business models. In addition, the global network capacity of the case organization enables ample data to be produced and managed. The single exploratory case study was undertaken with the intent of better understanding the use of BDA and service innovation in the selected case organization and was not performed in the belief that it would necessarily represents all/any other air freight forwarders, or that it illustrates a particular trait or issue experienced by other air freight forwarders when utilizing BDA (Stake, 1995). The researcher was privileged to obtain full access to the selected case organization and conducted a comprehensive review of BDA adoption and service innovation practices in that

organization, which ultimately enriched the understanding of BDA and service innovation in the real business context. Due to the privacy protection, the identity of the case organization was not revealed. It was therefore named as *the case organization*. As such, some information was modified slightly to ensure its anonymity (Adelman et al., 1976).

Case Study Design

Although Yin (2018) and Eisenhardt (1989) have contributed very practical insights into the case study as a research strategy, many design decisions are still open to question (Meyer, 2001). The inadequate design guidance seems to be the weakness of the case study methodology, but it also makes it a strength where huge flexibility enables the researcher to design the case study and to establish the linkage among the collected data, the concluded findings and the research questions of the study (Meyer, 2001; Yin, 2018). When designing a case study, some key components should be considered such as research questions, case(s) selected, and linking collected/analyzed data to the research purpose (Yin, 2018). Figure 8 below provides a summary of the case study design, including the case selected, research questions and methods used for data collections and data analysis. It also illustrates how the methods are linked to answer the research questions posed by this study. Details of the key components listed in Figure 8 are elaborated following the figure.

Figure 8 Case Study Design and Linkage to Research Questions



The *research questions in a case study*, which could be framed as *what*, *how*, *why and where* determine the nature and relevant research strategy to be adopted by the researchers (Tellis, 1997). Case study research is most likely to be appropriate for *how* and *why* questions (Yin, 2018) as the researcher's desire is to understand an emergent phenomenon from the viewpoint of the participants by using multiple sources of data (Tellis, 1997). Service innovation and BDA adoption have to date been studied as two individual area; thus the researcher is keen to understand the linkage between service innovation and BDA and the potential of utilizing BDA technology to improve service innovation. Therefore, the research question, "*How* can an international air freight forwarder improve service innovation through BDA?" was derived for this study.

The *research propositions or purposes* should specifically identify what is to be studied, providing more concrete directions to answer the research question. Propositions might not be mandatory for an exploratory study, but the research purpose should be stated in the research design instead. To answer the research question about how an international air freight forwarder improves service through BDA, the purpose of this exploratory research is:

1. to understand the current situation of service innovation and BDA adoption
2. to scrutinize the influencing factors that affect the adoption of BDA
3. to explore the prospect of improving service innovation by utilizing BDA

Accordingly, based on the purpose of study listed above, three subsequent research questions were to help to answer the primary research question of this case study.

The case selected, as the unit of analysis in a case study, can be any individual person, community, organization, empire, or civilization (Tellis, 1997). For this study, an international air freight forwarder, the case organization, was chosen as the unit of analysis and the details of the case that were selected are presented separately in the next section.

Linking data to the research purpose reckons on the processes of data collection and analysis designed for this case study. The choice of data gathering and data analytic techniques, as well as the suitability of research methods, provides a well-grounded underpinning for the case study. The primary method of data collection used for this case study, the in-depth interview, involved the collection of participants' feedback through one-to-one conversations, and was supported by document analysis that helped to jointly answer the research questions. For data analysis, this study adopted the same content analysis techniques through two slightly different processes: the *4C* principle (capture, categorize, condense and conclude) and the *3S* principle (scan, scrutinize and substantiate), respectively. The 4C data analysis process was adopted to analyze the

contents of the interview transcripts, and the 3S data analysis process was used to analyze the contents of selected documents. The processes of data collection and data analysis are discussed in the next two sections.

3.3Data Collection

This section elaborates on data collection and its application in the present study. Data is not an absolute reality or truth. It is merely a *manifestation* of various physical, social, or psychological phenomena that we want to make better sense of (Leedy & Ormrod, 2015). Case study evidence can be collected from many sources such as documentation, interviews, observations and physical artifacts. In this study, the qualitative researcher seeks convergence and corroboration through the use of two (multiple) different data sources and methods: in-depth interviews and internal documents supplied by the case organization. No particular source has entire superiority over the others, but interrelates with all the others in serving the same intention of answering the research questions addressed by the case study (Tellis, 1997). According to Patton (1990), triangulation assists the researcher to be vigilant about the assumption that a study's findings are simply the product of a unique method or a single researcher's prejudice (Patton, 1990). Utilizing multiple sources of data advances the process of triangulation, which ultimately develops the trustworthiness and credibility of the case study (Patton, 2015; Yin, 2018).

The research questions and this exploratory case study design guided the adoption of the data collection process. The case study approach predominantly integrates a few data collection methods depending on the researcher's available time and financial resources (Meyer, 2001). Two methods of data collection were selected for this case study: *semi-structured interviews* and *document analysis*, with the main emphasis on the first method and the latter one as a supporting

method. Details about how these methods worked to answer the research questions are discussed in the following sections.

3.3.1 Semi-structured Interviews

The interview is one of the favorite methods of data collection for qualitative approaches in the social sciences, and it is commonly found in case studies (Yin, 2018) because it is especially helpful in allowing for commentaries (i.e., the *how*'s and *why*'s) of key events and on the participants' insights. A frequently deployed classification differentiates between structured, semi-structured and unstructured interviews. Given the lack of clear understanding about the adoption of BDA in the air freight forwarding industry, one-to-one semi-structured interviews were deemed appropriate for this case study as less structured styles empower the interviewees with much more flexibility of response (Robson & McCartan, 2016). The interviews were conducted with 18 managerial staff who worked at different levels of the organization and captured insights from their shared experience and practice of BDA adoption in the case organization. When conducting the semi-structured interview, the interviewer (the researcher) had an interview guide containing a checklist of topics to be covered. Additional unplanned questions were asked whenever any explanation and clarification by the interviewees was needed.

Details concerning how the interviewees were selected, the interview preparation, interview procedure and transcript finalization are provided as follows:

Sampling Interviewees

Two criteria were considered in selecting participants for the interviews, which applied a pluralist view in describing and analyzing multiple realities as seen through the lens of a variety of persons' perspectives (Meyer, 2001). The first criterion is the diversity of participants. The different types of participants were selected from different levels of the organizational matrix and from different levels of management positions. The case organization is a huge multi-national

corporation (MNC) with a complex organizational matrix. For example, the air freight business is managed at three levels of management (global, regional and country), whereby managers in different countries report functionally to the regional managers and the same line of reporting is applied from the regional level to the global level, respectively. The second criterion considered for participant selection was the knowledge and the subject expertise of the participants about the topics being studied. The length of participants' working experience in logistics industry and, specifically, the air freight forwarding industry, as well as BDA-related experience enriched the in-depth understanding of the study.

As previously noted, the case organization is a huge MNC with a matrix organizational structure at three vertical levels: the global head office; regional head offices (in Asia and the Pacific, Europe, North and South Americas, the Middle East and Africa); and local country entities (the global air freight operations network). To collect data from multiple informants, the researcher selected participants with divergent managerial positions in the case organization *vertically* (at the global, regional and country levels), and *horizontally* (general management, various departments such as air freight, sales and IT departments), respectively. The researcher originally invited 20 participants, but two participants declined the invitations due to their unavailability. A final total of 18 participants agreed to take part in the interviews. The sample consisted of four participants holding top management positions such as those of board member, Chief Executive Officer (CEO), Chief Information Officer (CIO) and Chief Commercial Officer (CCO) at global or regional head offices; ten participants who held senior managerial positions such as those of executive vice president, vice president or directors at three vertical levels in the air freight department; while the remaining four participants held various managerial positions in the information technology (IT) department at three vertical levels (see Table 3). The diversified sampling list of this case study enabled the researcher to obtain valuable data from these experienced managerial staff, who

provided multifaceted discussions and feedback on service innovation and BDA adoption topics of the case organization.

Table 3 List of Interviewees by Grouping in the Case Organization

Horizontal / Vertical	Top management*	Air Freight department	Information technology
Global head office	2	4	2
Regional head office	2	3	1
Country organizations	0	3	1
	4	10	4

* *Top management – e.g., Board member, CEO, CIO, CCO ...*

Preparation for Interviews

In the initial data collection stage, the researcher completed a number of steps in preparation for the interviews, such as drafting interview documents, sending invitations and scheduling interview appointment and preparing interview accessories. Documents prepared included a brief introduction to the research, the participant consent form (a template was obtained from the university), a short list of interview questions, an interview agenda (see Appendix 1 for details) and finally, an interview guide (to display to participants during interviews). The accessories prepared included a pen recorder, notepad and pen, as well as personal notebook. Table 4 below lists the documents prepared by the researcher for the interviews.

Table 4 Preparation List for Interviews Completed by the Researcher

No.	Preparation list	When / Who
1	Introduction to the research	First invitation email to participants
2	Participant consent form	First invitation email to participants
3	List of interview questions	Second follow-up email to participants
4	Interview agenda	For self-reference by the researcher
5	Interview guide (PPT version)	For display during the interview
6	Interviewee list and interview schedules	For self-reference by the researcher
7	Pen recorder (1)	For self-usage by the researcher
8	Notepad + pen	For self-usage by the researcher
9	Personal notebook (1)	For self-usage by the researcher

The brief introduction to the research outlined the research background and interview procedure as well as important contact details in case the participant wanted to clarify the information about the interview with the researcher or the school. This information helped the participants to decide if they would like to participate in this voluntary study or not. The participant consent form was mandatory as a means for protecting both researcher and participants' rights. No interview was conducted without the signed consent form being collected by the researcher.

To ensure the reliability of the study, a formal interview protocol (made up of interview questions) was developed. The protocol aligned closely with the research questions and research purpose and was combined with the insights gathered from the literature review. The interviews were based on a set of open-ended questions that allowed the researcher to follow up on interesting and unexpected responses and that left the participants free to elaborate on their perceptions, experiences and reflections. After the brief research background document was sent to participants in an initial email, many participants requested more detailed information, for example about interview questions or scope of the interview topics. Accordingly, the researcher decided to share the interview questions with all participants in her second confirmation email. The intention of pre-

sharing the interview questions was not to prompt participants to prepare for any answers that might satisfy the researcher. Instead, it offered convenience to participants whose working schedules were very tight and knowing interview questions in advance helped both the researcher and participants to maximize their use of the one-hour interview.

The first invitation email attaching the brief research introduction and the participant consent form (see Appendix 2 for details) was sent to 20 targeted participants in January 2021. Upon receiving his/her acceptance to participate, the second follow-up email was sent with the list of interview questions and the proposed interview schedule. Finally, a total of 18 participants agreed to attend the interviews and their signed consent forms were obtained prior to the interviews being conducted. Interviews were conducted between February and April 2021.

There are several reasons why audio/video recording was seen as a *critical* matter by the researcher. Firstly, audio/video recordings absolutely equipped the researcher with more accurate documentation of the interviews than writing down her own notes. Secondly, the researcher could focus on asking interview questions and listen carefully to the participants during the whole conversation. Thirdly, it had already been planned that the contents of the interviews would be transcribed by a professional transcription service company, therefore it was critical to obtain the approval from interviewees to use audio recordings for all the interviews. A pen recorder was purchased for face-to-face interviews, and both the pen recorder and the audio recording function of Microsoft Team tool were tested ahead of the online interviews. Notepads, ballpoint pens as well as a personal computer (for the interview guideline presentation) were prepared for the interviews in advance by the researcher.

Conducting the Interviews

Five out of eighteen interviews were conducted through face-to-face meetings in Singapore and the remaining thirteen interviews were conducted by online video-conference calls. Online

interviews were the best alternative solution to ensure the interview feasibility with participants residing outside Singapore, given the continuous global travel and country social restrictions during the COVID-19 pandemic. The face-to-face interviews were carried out in quiet meeting rooms or in the participants' individual offices in the case organization in Singapore.

Interviewing is time-consuming and the length of the interviews varied based on the participants' responses to the interview questions. According to Robson and McCartan (2016), any interview under half an hour is unlikely to be helpful, while any going much over an hour makes irritating demands on busy interviewees. It could even decrease the willingness of persons to participate. The duration of the interviews conducted varied from 45 minutes to 75 minutes with a few exceptional interviews that took longer as some additional questions were asked for further clarification.

The interview agenda proved to be very helpful to the researcher in getting ready for the interviews, and the clear interview structure helped the researcher to better control the progress and timing of the interviews. Additionally, a PowerPoint (PPT)-version interview guide was prepared and displayed for both the interviewer and interviewee during the interviews. The interview guideline was designed in accordance with the research questions to elicit information about 1) the current status of service innovation and BDA adoption, 2) current challenges in BDA adoption and 3) utilizing BDA to improve service innovation in air freight. A benefit of the guideline for the interviewees is that it helped them to better understand the interview procedure and the instructions given by the interviewer. The guideline also helped the interviewer to facilitate the interview process and better control the timing of the interviews efficiently. The interview guide was displayed on the computer during the whole interview process and found to be very helpful for the researcher's ability to complete the interviews productively and efficiently.

In the first part of the interviews, the researcher briefly introduced herself and the background to the study, as well as ethical considerations (e.g., privacy and confidentiality, anonymity). Demographic information (e.g., gender, job title, years of working experience) were collected from each participant. The interview continued with the researcher asking interview questions that related to the study in a sequential order. For instance, the researcher asked: "What do you think of 'service innovation' in the air freight in your company? Please elaborate with your own observation and understanding". Participants were free to express anything about service innovation based on their working experience and knowledge of the topics.

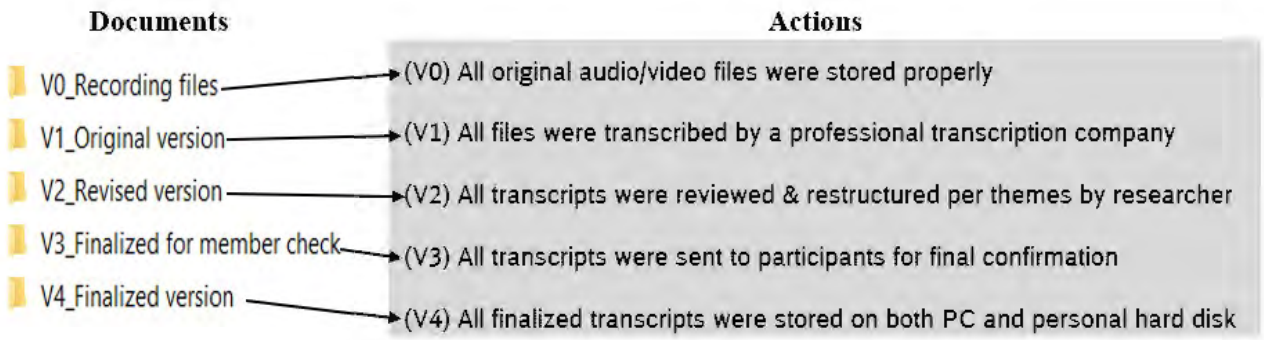
All the interviews were either audio or video recorded (either by pen recorder or the embedded recording function in Microsoft Team) with the approval of the interviewees before the interviews took place.

Finalizing Transcripts

Several steps were followed for the processing of all interview documents (see Figure 9). First, all the original audio or video files were kept on both a computer and a password-protected hard disk for transcription processing. Second, after considering the available budget and the quality of service offered by transcription companies, the researcher chose an online professional transcription service company that is located in USA. After the service fees were paid to the company, all audio/video files were uploaded to the company for transcriptions. It took about one week for the researcher to receive all completed interview transcripts in Word format. Third, the researcher reviewed all 18 audio- and/or video-recorded interviews and compared them with the transcribed documents, noting misspelled or missing words in the transcribed documents. The researcher treated this laborious review as another warmup exercise for data analysis as it considerably deepened her understanding of the interview documents. For easy reference, all the interview transcripts were theme-restructured according to the order of the interview topics. As a

fourth step, a member check was performed to enhance the trustworthiness of this research (Birt et al., 2016). Interview transcripts were sent back to the participants via email for their review and confirmation. Participants' rejections of interpretations or amendments would be allowed if necessary. It took one month to receive all confirmed transcripts from the participants. The researcher did not start any data analysis on the interview transcripts until the acknowledgement of all interview transcripts had been obtained from the participants. In the last step, all finalized transcripts were stored on both a personal computer and a password-protected hard disk.

Figure 9 Interview Transcripts Management Procedure by the Researcher



3.3.2 Document Analysis

Documents are "social facts which are produced, shared, and used in socially organized ways" (Atkinson & Coffey, 1997, p. 47) while document analysis commonly refers to a systematic procedure for document review and evaluation, including printed and electronic materials. It is often combined with other qualitative methods as a secondary method, as well as a means of triangulation in the study of the same phenomenon (Bowen, 2009). Researchers can corroborate or validate findings across different data sets and reduce the impact of potential biases that can occur in a single study. Case studies produce bountiful descriptions of a single phenomenon, event,

organization (Stake, 1995; Yin, 1994), where documents can help the researcher discover meaning, enrich understanding, and unearth insights pertaining to the research problems (Merriam, 1998).

Analyzed documents can be very helpful to research, if utilized appropriately by the researcher. Bowen (2009) lists some specific functions of documentary materials that the researcher also agrees with. One function is that documents can provide ancillary data on the background and environment in which the research participants operate. Insights and awareness derived from documents can help investigators understand the historical radicle of particular organizational behaviors (e.g., BDA adoption) and can specify the situations that affect the phenomena currently under investigation. The research can use data drawn from documents, for example, to contextualize data collected during in-depth interviews. In this study, a thorough review of documents provided useful background information on BDA resources, strategies, and applications that helped the researcher to understand the organizational background where service innovation and BDA are managed. Another function is that documents can be used to *verify findings* or *corroborate evidence* from other sources (e.g., interviews). Data culled from the documents helped the researcher to check the information collected from the interviews. According to Bowen (2009), convergence of information from different sources gives readers greater confidence in the trustworthiness of the findings. In case of any contradictory rather than corroboratory results are derived, the researcher should either investigate further (if time permits) or take the contradictions into consideration for future study. Despite the functions of documents as described above, it is important to note that information obtained from documentation is undeniably restricted by what is available and its quality. No matter how imperfect and biased the documents were, the reviewed documents enriched the interview data and thus served a useful purpose in the present study.

Documents take various forms, such as minutes of meetings, background papers, books and brochures, letters and memoranda, organizational reports, which may come in WORD, EXCEL,

PPT and PDF formats etc. Collecting documents in a large organization might be overwhelming and time-consuming for analysis afterwards, therefore it is the researcher's responsibility to determine the relevance of the documents to the research problem and purpose. This study aims to explore how BDA could improve service innovation in the case organization and to identify the influencing factors that affect the adoption of BDA from organizational perspectives. The researcher searched for any documents that might be either related to specific topics such as BDA and service innovation or that might provide important contextual and background information for the case study.

In the initial documents collection stage, a researcher should not be overly concerned about the quantity of documents (i.e., how many documents are to be collected). Rather, the quality of the documents and evidence they contain should be taken into serious consideration in terms of the purpose and design of the study (Bowen, 2009). Therefore, even a few documents can provide an effective means of completing the research. In addition, the absence or incompleteness of documents (e.g., certain topics may have been given little attention) can provide insightful information from an alternate perspective. For instance, the researcher failed to obtain (collect) any official global policies and specific procedures about BDA adoption for air freight department of the case organization. This absence of documents further confirmed the organizational challenges in identifying information about BDA adoption within the organization. More details about verification for different data sets can be found in the Findings chapter (Chapter 4).

At the beginning of the documents search, the researcher managed to collect a total of 22 documents. The number of documents was reduced to 16 after the first document selection because of duplications or because some documents had little/no relevance to the study. Table 5 below provides an overview of documents collected in this study. Documents included 2 PPT presentations, 2 WORD documents and 12 PDF files, each of which was assigned a short code (e.g.,

DOC001). Documents collected had various forms, such as organizational background papers, annual report, organizational charts, organizational reports, brochures, procedures and public records. While six documents were shared by the research participants, the remaining 16 documents were downloaded directly from the organizational intranet. All documents collected were kept in a separate folder on both a personal computer and password-protected hard disk drive that were only accessible by the researcher.

Table 5 List of Organizational Documents Collected

Document code	Document format	Document name	Document form	Topics involved	Data source
DOC001	*PPT*	Data quality control	Procedure	Procedure	Shared by employee
DOC002	*PDF*	*Data Science Report* (comprehensive version)	Organizational report	BDA related	Company intranet
DOC003	*PDF*	*Introduction of Operation Research* (internal use) (Version July 2021)	Brochure	BDA related	Company intranet
DOC004	*PDF*	*Introduction of Supply Chain Optimization* (internal use) (Version July 2021)	Brochure	BDA related	Company intranet
DOC005	*PDF*	Online Data Analytics Seminar (Version February 2020) Air forecast project	Organizational report	BDA related	Shared by employee
DOC006	*PDF*	Overview of data analytics in case organization (for external)	Background papers	BDA related	Shared by employee
DOC007	*PPT*	Introduction of IT system	Background papers	Company Info	Shared by employee
DOC008	*PDF*	*Annual Integrated Report 2019*	Annual report	Company Info	Company Intranet
DOC009	*PDF*	*Global Freight Forwarding Market Report* (Version December 2019)	Organizational report	Market Report	Shared by employee

DOC010	*PDF*	IATA cargo statistics 2019	Public records	Air Freight development	Shared by employee
DOC011	*PDF*	*Introduction of Innovation Management* in case organization	Organizational report	Service innovation related	Company intranet
DOC012	*WORD*	Organization key figures and data	Background papers	Company info	Company intranet
DOC013	*PDF*	Organizational structure (matrix report) - air freight	Chart	Company info	Company intranet
DOC014	*PDF*	Organizational structure (matrix report) - global matrix	Chart	Company info	Company intranet
DOC015	*PDF*	Organizational structure (matrix report) - IT	Chart	Company info	Company intranet
DOC016	*WORD*	Strategy & transformation (Global)	Background papers	Company info	Company intranet

Documents are a useful source of evidence but are not always accurate and may contain some bias. As a rich source of data, documents should be treated with a critical eye; the researcher should be cautious in using documents in her study. Documents should be used rigorously to cross-validate information gathered from interviews, given that sometimes how people behave maybe different from what they say (Yin, 2018). Therefore, in this study, documentary evidence was typically combined with the data from interviews to minimize the bias and establish the study's credibility. Moreover, documents should not be treated as necessarily precise, accurate or complete recordings of events that have occurred (Bowen, 2009). The researcher was mindful of the above statement in using the findings of analyzed documents in her study. The document analysis process is presented in the next section, with some examples given for illustration purposes.

3.4 Data Analysis

This section discusses the method adopted for data analysis in this research. The purpose of data analysis is to interpret the various sources of evidence collected and use the findings to answer research questions (Merriam, 1998). The choice of method for analyzing any research relies on the philosophical paradigm adopted and the types of data being collected, either quantitative or qualitative, or both (Collis & Hussey, 2003). Data analysis methods in published studies have not been discussed as much as data collection methods (Eisenhardt, 1989; Meyer, 2001) and researchers need to find their own ways of arriving at their final conclusions due to the lack of adequate guidelines and theories obtained from the literature (Miles & Huberman, 1994; Meyer, 2001). In this section, the researcher firstly introduces the content analysis method that was chosen for the data analysis of both primary data (interviews) and secondary data (documents), followed by the overall analysis strategy adopted in this study. Guided by the same analysis strategy, the data analysis processes for interview transcripts and the documents involved similar, but slightly different approaches. The researcher spent five months completing the data analysis process for the study and details of this process are presented below.

Content analysis is deemed to be an appropriate method of data analysis for this qualitative exploratory case study as the researcher holds the constructivist view that reality can be interpreted in different ways and that understanding relies on constructivist meaning interpretation. The qualitative research data was collected mainly through in-depth interviews with research participants. These conversations and observations were transcribed into text-based documents afterwards. A text, according to Graneheim and Lundman (2003), can always involve multiple meanings and be interpreted differently by different people.

In this study, content analysis was used to analyze both primary data (from interviews) and secondary data (from existing document sources). The data analysis process entails three stages, which include skimming (superficial examination), reading (thorough examination) and interpretation (Bowen, 2009). Known as a research technique for making replicable and valid inferences from data to their context (Krippendorff, 2018), content analysis, which involves a systematic and qualitative approach, was used for this research. This meaning-oriented analytical approach enables us to capture meaning by disaggregating the interview transcripts or other documents into constituent parts and subsequently describing the contents of each component to increase understanding of what is communicated and how (Collis & Hussey, 2003).

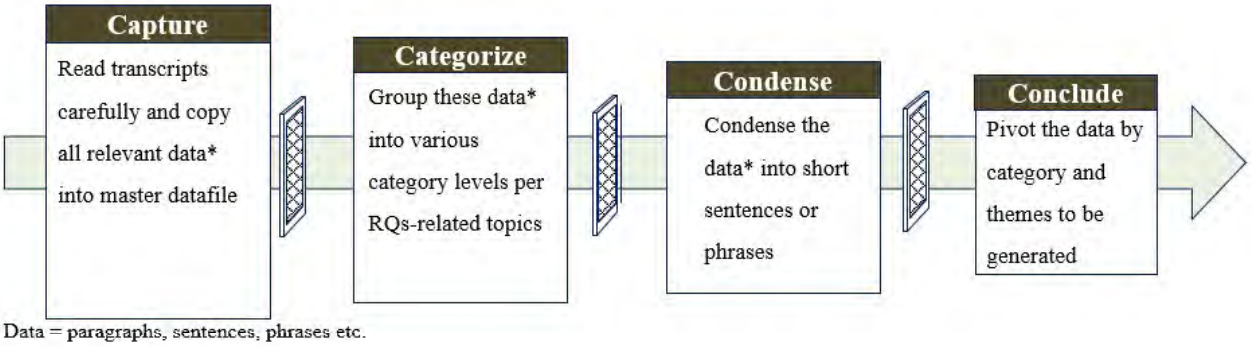
Every investigation will have general analytic strategies that answer the questions of what is to be analyzed and why (Yin, 2018). For qualitative case studies, very little fixed guidance from the literature could be found to guide researchers about how to analyze massive qualitative data. Instead, data analysis largely depends on the different, systematic and pragmatic thinking styles of researchers and how they present their findings efficiently (Yin, 2018). Analytic tools are useful, but researchers should never rely too much on analytic tools, as the tools can *assist* them to code and categorize large amounts of data, but the tools will not do the finished analysis on their own. Researchers need to study the outputs themselves to determine if any meaningful patterns are emerging. Qualitative data analysis (QDA) software, such as NVivo is widely available to analyze large amounts of qualitative data. In the initial stage of data analysis, the researcher installed the NVivo software on her computer and planned to use NVivo for her data analysis. However, she found the software too complicated to work with. Instead of spending great deal of time and effort to master the tool, the researcher used Microsoft Excel, one of her favorite software applications, to analyze her data. No matter what computer-assisted software is used, it is always good to *play*

with your data as a first starting point and having an analysis strategy makes your *play with data* more fun in a systematic way.

In the work of Graneheim and Lundman (2004), important concepts, such as *meaning unit*, *condensation*, *category* and *theme*, are discussed in relation to qualitative content analysis. A meaning unit is simply defined as "words, sentences or paragraphs containing aspects related to…context" (Graneheim & Lundman, 2004, p. 106) and this definition helped the researcher greatly in identifying insightful information during her transcript reading stage. At the same time, the authors also illustrate with some practical examples the process of conducting qualitative content analysis. Enlightened by the ideas of Graneheim and Lundman (2004), the researcher proposed her data analysis strategy, developing the 4C principle for analysing the primary data (the interviews). The 4C principle represent the four actions to be performed by the researcher at different stages of the data analysis: *Capture, Categorize, Condense* and *Conclude*.

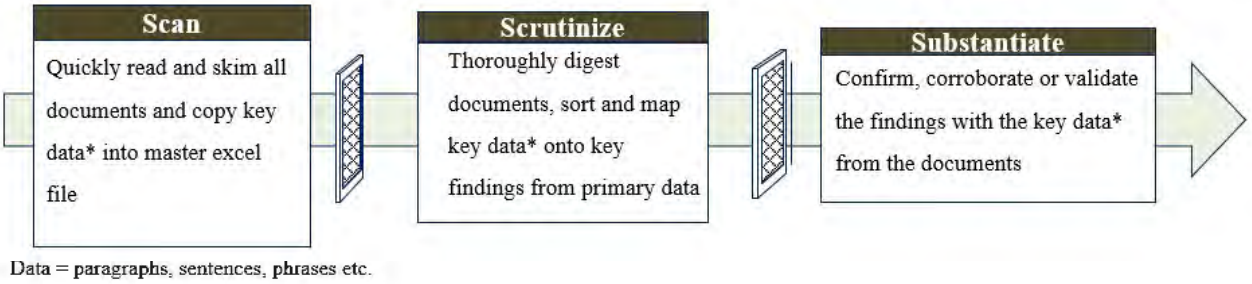
The researcher has designed a slightly different analysis process for secondary data collected in this study (i.e., the 16 organizational documents), which requires finding, selecting, informing (making sense of), and synthesizing data contained in documents (Bowen, 2009). Document analysis generates data (excerpts, quotations, entire passages), then organizes it into major themes, categories and cases, specifically through content analysis (Labuschagne, 2003). As the subjective interpreter of data comprised in documents, the researcher made the process of analysis as rigorous and as transparent as possible. Based on Bowen's (2009) analysis process of skimming, reading and interpretation, the researcher developed a three-step process of document analysis which she named as 3S principle: *Scan*, *Scrutinize* and *Substantiate*. These two strategic processes of content analysis, the 4Cs and 3S's are respectively presented in Figure 10 and 11 below, and then detailed in the following sections.

Figure 10 4C-analysis Process of Content Analysis



Source: Adapted from Graneheim & Lundman (2004)

Figure 11 3S-analysis Process of Content Analysis



Source: Adapted from Bowen (2009)

3.4.1 Analysis Process for Interviews

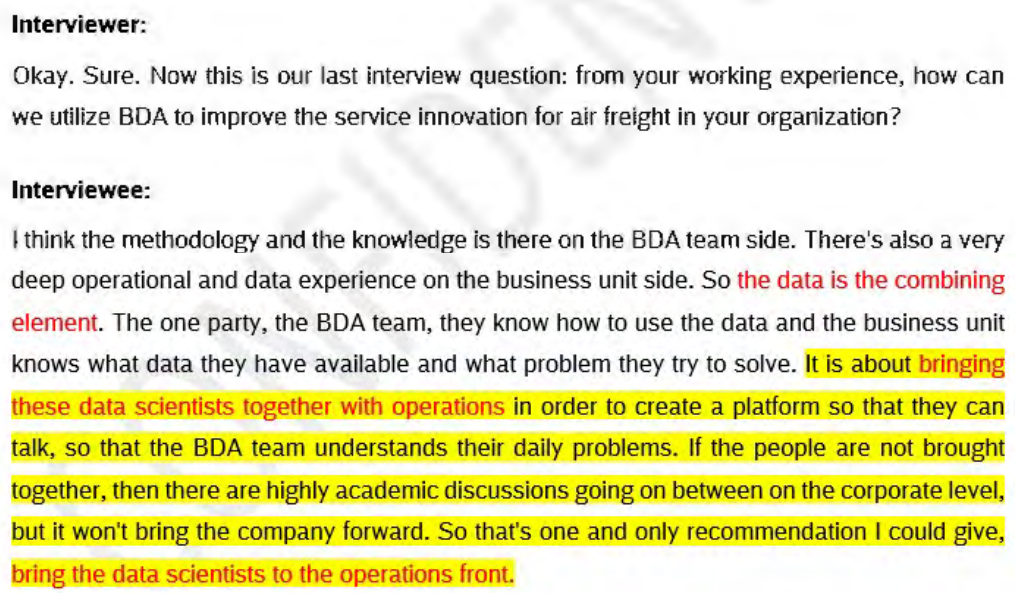
The 4C principal, embedded in the strategic analysis process, guided the researcher in the different stages of the data analysis. The analysis process was specifically applied for the analysis of primary data collected in this study, namely the 18 transcribed interview documents. This analysis process covered four stages, with the actions described as the 4Cs.

Stage 1 – Capture

In this first stage, the researcher started by obtaining a comprehensive understanding of all interview transcripts by reading and rereading the scripts. Data rejuvenation was necessary for the researcher, as there was a short interval between data collection, when the interviews were

conducted, and the availability of the interview transcripts for analysis. Reading those 18 interview transcripts (15–22 pages for each script) was a tedious but constructive starting point for the first stage of the analysis. When reading the transcripts, the researcher highlighted all meaning units, such as a few words, a large sentence, several sentences or even paragraphs (Erlingsson & Brysiewicz, 2013). A meaning unit that always carries one essential denotation is directly or indirectly relevant to the research questions addressed in the study (Erlingsson & Brysiewicz, 2013). For instance, from the example shown in Figure 12, one interviewee was asked how he/she would utilize BDA to improve service innovation. The interviewee noted the importance of connecting data scientists to air freight operations as part of BDA adoption in the air freight business. The interviewee explained that data scientists are subject matter experts in advanced data analytics, but they are sitting far away from air freight operations. People working in air freight can help data scientists better understand what real-life business problems they encounter in adopting BDA. Therefore, this whole paragraph was treated as one meaning unit and was captured into the master file for further analysis.

Figure 12 Screenshot from Interview Transcripts



Interviewer:

Okay. Sure. Now this is our last interview question: from your working experience, how can we utilize BDA to improve the service innovation for air freight in your organization?

Interviewee:

I think the methodology and the knowledge is there on the BDA team side. There's also a very deep operational and data experience on the business unit side. So the data is the combining element. The one party, the BDA team, they know how to use the data and the business unit knows what data they have available and what problem they try to solve. It is about bringing these data scientists together with operations in order to create a platform so that they can talk, so that the BDA team understands their daily problems. If the people are not brought together, then there are highly academic discussions going on between on the corporate level, but it won't bring the company forward. So that's one and only recommendation I could give, bring the data scientists to the operations front.

All meaning units captured from the transcribed documents were copied by the researcher into the master file (in Excel format) for next step of data analysis. Additional comments from the researcher, if any, were also noted down in the master file.

Stage 2 – Categorize

In the master file, a meaning unit was treated as one single line of record (in Excel format), with a total of 399 records (meaning units) captured in Stage 1. Categorization helped the researcher to firstly establish a logical structure for the massive data available, and then prioritized her limited time and effort to focusing on important data that needed deeper analysis. Foreseeing the potential significance of some categorizations (e.g., customer demand, decision making, business culture), the researcher created separate worksheets for these topics and conducted more rigorous analysis to generate critical insights, which merged with other findings to collectively answer the research questions.

In Stage 2, before any themes could be derived out of these meaning units, the key action by the researcher was to sort these meaning units into three levels of categories. The aim of doing the data analysis was to obtain findings that answered the three research questions posed by this study. During the process of creating *Category level 1*, the researcher sorted all the meaning units according to their relevance to the respective research questions, based on her interpretations. As a result, three words were derived and placed under Category level 1: *current status* (corresponding to the first research sub-question); *challenges* (corresponding to the second research sub-question); and *utilization* (corresponding to the third research sub-question). For instance, a total of 99 records (meaning units) were grouped under *challenges* at the Category level 1.

The researcher proceeded to further sort these 99 meaning units related to *challenges* into three main areas, classifying them within *Category level 2* based on the TOE framework. Any meaning units that were not related to these three areas were grouped under *Other* for further clarification. A similar grouping was carried out to all records (meaning units) according to their core meaning, such as BDA adoption, air freight business nature or BDA values etc., based on the researcher's understanding and interpretation. When the grouping of Category level 2 items was completed, a total of 11 categories had been identified (five related to the current status of service innovation and BDA adoption, and three reach related to challenges and utilization, respectively).

Category level 3 was a more specific categorization of the meaning units, compared to the first two levels. Let's take *challenges* as an example again. One type of challenge in Category level 2 concerned *organizational factors* affecting BDA adoption in the case organization. The researcher identified 46 meaning units that were related to organizational factors, guided either by the literature or her own interpretations. Some typical organizational factors include organizational culture and leadership or human resource capacity. Thus, the researcher sorted those meaning units

according to their areas of relevance. Table 6 represents a screenshot captured from the master file, showing how the meaning units were sorted into different category levels.

Table 6 Excerpts of Master File Showing Categorization of Meaning Units

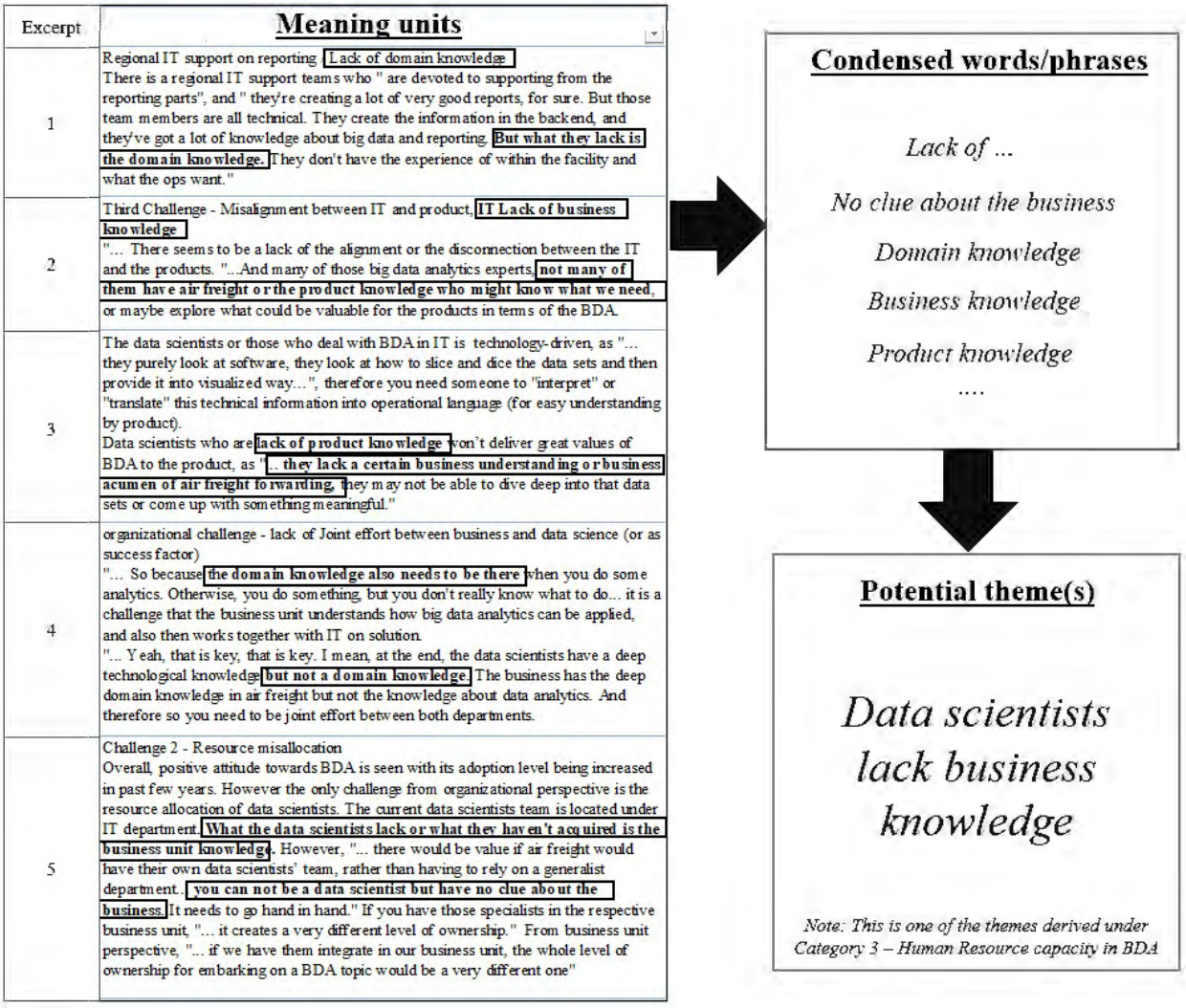
Category level 1	Category level 2	Category level 3	Theme	Meaning units
Challenges	Organizational challenges	Human resource capacity in BDA	Lacking people to drive BDA in air freight	Fourth challenge: ack of resources, e.g., "data stewards" as data owners in the business unit "So for your research, you probably came across these concepts of data stewards and things like that. And this is something that we don't really have, at least not to my knowledge in our company. We have here and there some teams that deal with data. We have master data management. We have other data-related teams…".
Challenges	Organizational challenges	Human resource capacity in BDA	BDA expertise shortage	People (data scientists who know the air freight business as well) who know how to analyze the data and also to recommend how to utilize the data from a business perspective: "We need skilled people to do this. It's not only to have systems in place, but you also need people such as Big Data Science analysts. These people can retrieve the information we want out of the data. Having internal system is not enough…".
Challenges	Organizational challenges	Human resource capacity in BDA	Data Scientists lack business knowledge in IT	Regional IT support on reporting / Lack of domain knowledge There are regional IT support teams who "are devoted to supporting from the reporting parts", and "they're creating a lot of very good reports, for sure. But those team members are all technical. They create the information in the backend, and they've got a lot of knowledge about big data and reporting…".

Stage 3 – Condense

By the time Stage 2 was completed, all meaning units had been sorted accordingly into three levels of category. The derived sentences or phrases under Category level 3 were considered as an initial form of condensation, where the *meaning units* had been shortened to a few words or short phrases. In this Stage 3 of the process (Erlingsson & Brysiewicz, 2013), several actions were performed on all the meaning units. Based on the categorization levels, separate datafiles were created by the researcher for purposive analysis. Each meaning unit was reviewed by the researcher, with the aim of identifying key words that contained core meanings or were relevant to the research questions. Those key words that occurred in different meaning units repetitively ultimately formed a theme that was considered as a train of fundamental meanings that links the data together, or *as a red thread of underlying meanings that ties the data together* (Erlingsson & Brysiewicz, 2013).

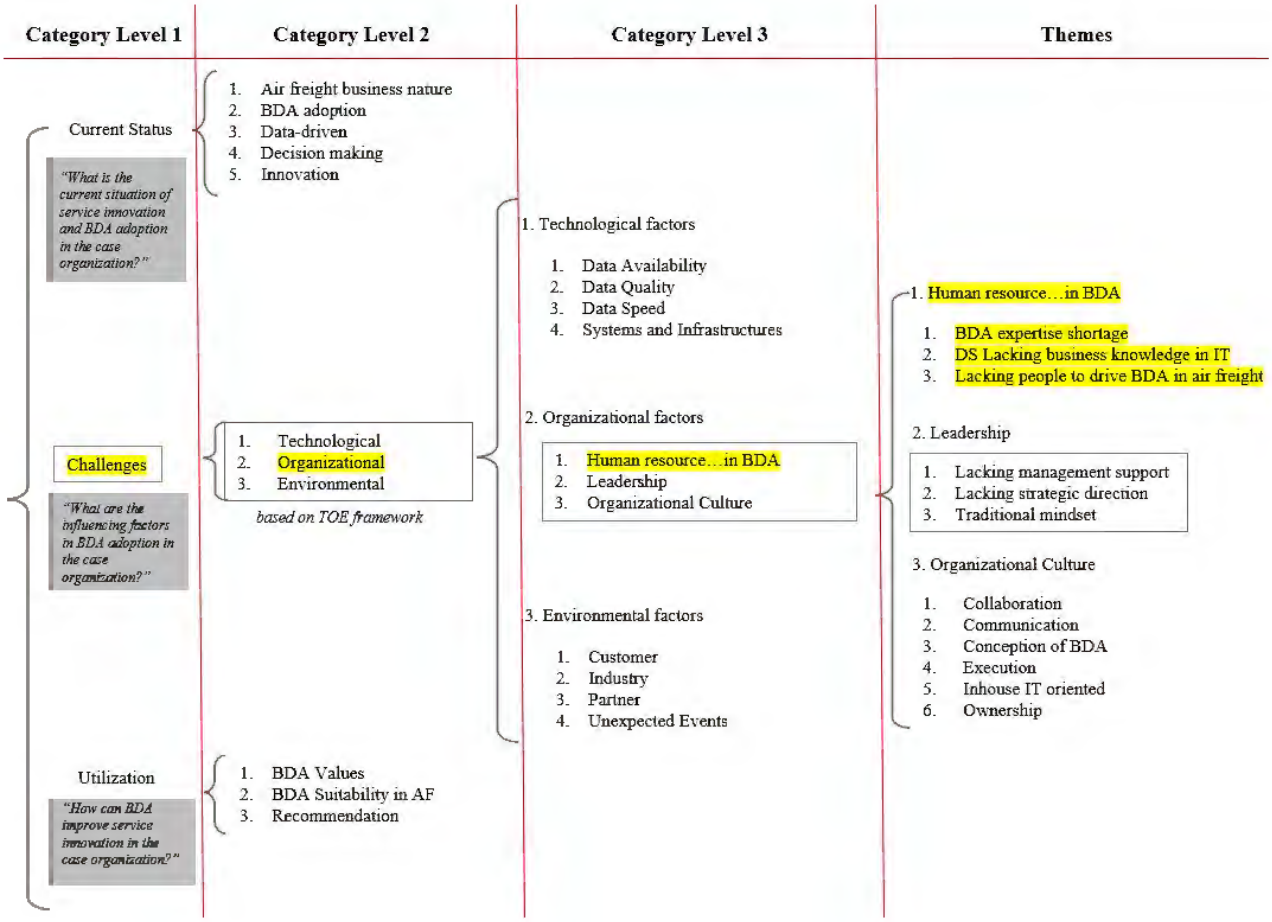
An example is displayed in Figure 13 to show how the researcher condensed some meaning units and how a theme was ultimately derived through the Stage 3 condensation process. The five meaning units listed in the table on the left were captured from responses of the interviewees who talked about the challenges in BDA adoption related to the human resource capacity in the case organization. Condensed words or phrases were identified by the researcher, for example, domain knowledge, business knowledge or product knowledge were mentioned frequently by various interviewees, but basically referred to the same thing. By interpreting what these interviewees described, the researcher derived the theme of "*Data scientists are lacking business knowledge*", which was one aspect of findings that related to human resource capacity in BDA for this study.

Figure 13 Different Levels of Category Derived from Meaning Units



The researcher saw Stages 2 and 3 as two important parts of the analysis process, since all the themes related to the research questions were derived through in-depth interpretation of the meaning units. To show the close links between these two stages, the researcher created a chart (see Figure 14) to illustrate how different category levels were derived from the meaning units, and ultimately generated themes to answer the respective research questions.

Figure 14 Themes Generation From Categories/Meaning Units



Stage 4 – Conclude

The last stage of the content analysis process was much easier than the previous three as, by this time, majority of the data analysis had already been completed. However, this stage also involved an important process, that of drawing conclusions from the data analysis. The data display is "a summary of data in diagrammatic form that allows users to draw valid conclusions" (Collis & Hussey, 2003, p. 159); in this study, the data display enabled the researcher to organize her data in a structured, logical way, as in the next two chapters, Chapter 4 on Finding and Chapter 5, the Discussion. Data display is one aspect of the analytical process, and the conclusions are arrived at through the researcher's interpretation of the data. In the present study, the researcher utilized a

number of tables, charts and figures to illustrate the data, as these facilitated the organization of her thought processes and her ability to reach conclusions. At the same time, visualization of the data can provide readers with directions and hints, enabling them to follow the thought flow of the researcher more easily.

3.4.2 Document Analysis Process

The 3S principle, embedded in the strategic analysis process for secondary data (documents), guided the researcher in the different stages of the document analysis. The analysis process was specifically applied to the analysis of secondary data, the 16 organizational documents collected for this study. This analysis process entailed three steps, with the actions described as the 3S's.

Step 1 – Scan

Scanning means that secondary data (documents) are skimmed and read quickly. The researcher looked at all parts of the documents in order to obtain an initial understanding of their contents. Special or important messages or information may be detected as well. As for the data analysis of primary data (interview transcripts), a master Excel file (see Table 7) was created with the details of the documents to be analyzed, such as the document code, document name, document form and source of document etc. A ranking of *relevance level to the study* was carried out by the researcher based on her understanding of the documents, which proved to be helpful for the researcher to prioritize her time and efforts in analyzing the documents. Based on the ranking of relevance level to the study, six documents ranked as *High* were related to data analytics topics and one document ranked as *Medium* was related to information management. The remaining nine documents were ranked as *Low*, as these documents provided mainly contextual and background

information about the case organization, such as its organizational structure or annual integrated report.

While scanning each document, the researcher identified key words, information or paragraphs in the document, extracted them and added them to the master file. Additionally, the researcher noted her thoughts and comments in the adjoining column in the master file. The information extraction was a preliminary step in the document scrutinizing process.

Table 7 Excerpts of Document Scanning and Key Information Extraction

Document code	Document format	Document name	Relevance level	Key information	Comments by the researcher	Potential themes linked
DOC002	*PDF*	*Data Science Report* (comprehensive version)	High	Data science team supports the business by delivering data-driven insights and proposing analytics solutions across the company. Our data experts apply a broad range of data acquisition, visualization and state-of-the-art predictive modeling techniques, e.g. machine learning, AI etc.	To obtain a complete list of existing BDA pilots related to data science.	Communication ➔ BDA pilot projects are not known to local organizations Collaboration ➔ joint effort between BDA team and air freight department Execution ➔ BDA pilot projects of Air freight were not scaled up (only a one-time exercise)
DOC011	*PDF*	Introduction of Innovation Management in case organization	Low	It provides a generic overview of what innovation means for the organization; some pilot projects in innovations	No specific service innovation is clearly defined for air freight. The organization is an integrated logistics company which covers not only the air freight forwarding business but also other freight forwarding, logistics and warehouse business.	Finding 1 ➔ Current situation ➔ Service innovation
DOC016	*WORD*	Strategy & Transformation (Global)	Low	Introduction of "Strategy and Transformation" team who drives company's strategy in head office (HO)	The document listed the 10-years strategy map for the case organization in data science area. And the mission of the global data analysis team is to turn the case organization into a data-driven company in long run. The existence of these documents shows the existence of a data strategy on top level, but this strategy has not been well communicated from top down to the local organizations, where the participants commented about the lack of strategic direction from the top.	Finding 2 ➔ Organizational challenge ➔ Leadership: Alignment missing

Step 2 – Scrutinize

Scrutinizing basically refers to the process of thoroughly studying and digesting the documents, where all individual records of key information (or paragraphs) are further sorted and mapped onto the major findings (i.e., themes) that are derived from the primary data (interviews). Unlike the data analysis of interviews transcripts, the researcher did not perform *meaning unit* categorization in the document analysis. Instead, the condensed meaning units and those themes derived out of the interview transcripts were mapped onto the key information extracted from these documents.

Firstly, the researcher examined the documents carefully and extracted insightful words, sentences or paragraphs from the documents. Under some circumstances, the researcher summarized a whole paragraph or the contents of the documents in her own words. For instance, the document DOC006 is about an overview of BDA applications in the case organization. Figure 15 below demonstrates how document analysis (DOC006) helped to corroborate the findings from the interviews. The document DOC006 introduced the data analysis team and a list of BDA pilot projects that were done in the past years etc. The researcher summarized all the key points (or paragraphs) of document DOC006 in the master file accordingly. Some key information indicated that a great number of BDA pilot projects were done in the case organization, but only less than 20% of which were related to air freight business. Moreover, none of BDA pilot projects was further implemented in the air freight department (Box A).

Secondly, the researcher mapped the key information onto the major findings (e.g., themes) of the analysis of primary data (interviews). For example, one theme reported in the Finding 1 section (regarding the BDA adoption in air freight of the case organization) was “very few BDA initiatives related to air freight were done” (Box no. 1). Another two themes reported in the Finding 2 section (regarding the organizational challenges in BDA adoption) were “BDA adoption topic

had not been communicated efficiently from head office down to local organizations" (Box no. 2), and "absence of joint effort in working together among different business units within the same organization" (Box no. 3), respectively. The researcher linked this key information of document analysis (Box A) with the three reported themes (Boxes no. 1, 2 and 3) because they were all related to BDA adoption in the case organization.

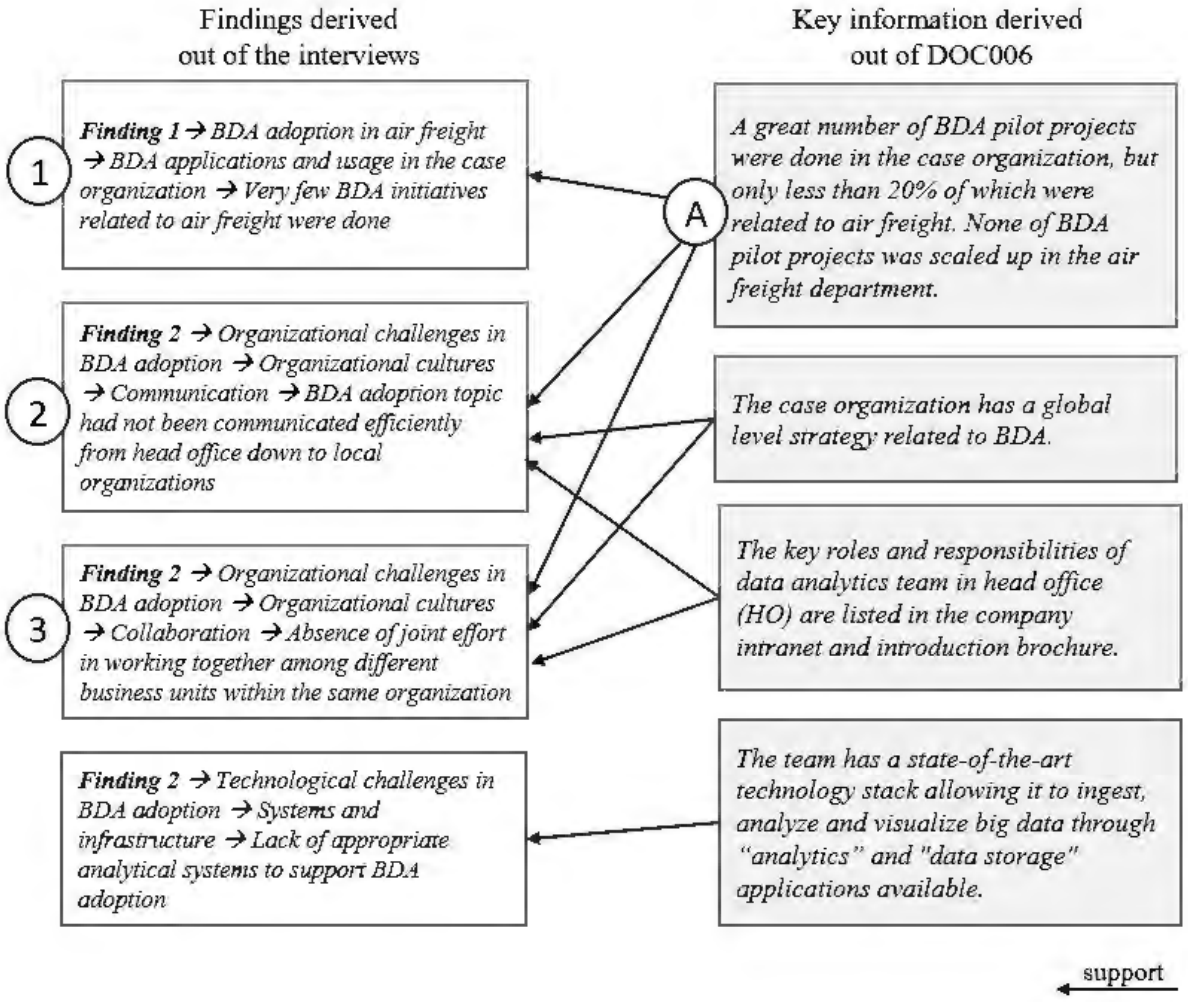
Step 3 – Substantiate

As mentioned in the previous section, the major function of the document analysis in this study was to corroborate, verify, converge or support the findings derived from the in-depth interviews. The final step in the document analysis, *substantiate*, performed this function exactly. However, some background information contained in the documents only served to provide the researcher and the readers with the context or the background of the case organization; therefore, not all key information extracted from the document analysis was used in the study. Once the mapping of key information onto respective findings (of the interviews) had been completed, the researcher substantiated the findings with the key information derived from the document analysis. If any key information from the document analysis was contradictory to the interview findings, the researcher marked it as a potential area for future study, rather than taking further investigation.

One theme reported in the Finding 2 section (regarding the organizational challenges in BDA adoption) was "the topic of BDA adoption had not been communicated efficiently from head office down to local organizations" (Box no. 2). Some interviewees claimed that they had not seen any BDA applications implemented in the air freight department. Yet the analyzed document (DOC006) lists a great number of BDA pilot projects, but only less than 20% of which were related to air freight business. Moreover, none of BDA pilot projects was scaled up in the air freight department (Box A). This document has, obviously, not been widely distributed within the organization, but was posted on the company's internal website. This document analysis finding

corroborated the interview finding (Boxes no. 1, 2 and 3) that few number of BDA pilot projects are relevant to air freight; BDA adoption topics (e.g., availability of data analytics resources, relevant BDA applications) had not been communicated efficiently from head office to the local organizations. Not much joint efforts were seen among different business units within the same organization (e.g., air freight department and IT department).

Figure 15 Illustration on Document Analysis Supporting Findings of Interviews



Despite seeing the benefits of document analysis as a good secondary method to supplement the interviews, the researcher has to acknowledge that the mined data from some of the documents was incomplete and fragmentary. In many cases, the documents contained limited information, with extensive information on some topics and virtually nothing in others. Nevertheless, analyzed documents were useful in providing a behind-the-scenes look at some topics that were collected from the interviews.

3.5 Quality Assurance

Qualitative researchers do not necessarily use the term *validity* in describing their research; rather they refer to its quality, trustworthiness, credibility, transferability, dependability and/or confirmability. For ensuring the trustworthiness of this qualitative research project, the following strategies proposed by Shenton (2004) were applied. According to Merriam (1998), ensuring *credibility* (in preference to internal validity) is one of most important factors in establishing trustworthiness.

Firstly, this project adopted appropriate and well-recognized research methods such as semi-structured in-depth interviews and documentation for data collection and qualitative content analysis for data analysis. *Triangulation*, particularly data triangulation and methodological triangulation were of great help in improving the trustworthiness of the case study (Patton, 2015; Yin, 2018). In this research, data triangulation set up the rationale for using multiple sources of evidence, while methodological triangulation was supported by adopting the two data collection methods of documentation review and interviews. The researcher utilized the supporting data from documents to provide a background, which helped to explain the attitudes and behaviors of the participants in the case organization and verified or proved particular details supplied by the participants and some of the themes generated by the data analysis. *Member checks*, as indicated

in the data collection section, was another strategy for improving the quality of qualitative data that included the *voices* of participants in the analysis and interpretation of the data. Doing member checks helped greatly in eliminating researcher bias when analyzing and interpreting the data collected.

Secondly, the findings of this qualitative study were specific to a particular environment, which is air freight forwarding industry. It is challenging to demonstrate that the findings and conclusions could be applicable to other situations, a quality criterion that is been commonly understood as *transferability* (in preference to external validity/generalizability). The researcher ensured the maximum level of transferability by providing sufficient contextual information about the case study. This information included the number of participants involved in the fieldwork, the data collection and analysis methods employed, as well as the duration of these procedures. In doing so, the readers are enabled to make such a *transfer* to their own situations if they believe their situations are similar to that being described in this case study.

Another two criteria, *dependability* (in preference to reliability) and *confirmability* (in preference to objectivity) were also considered, in pursuit of a trustworthy study in this research process. For the purpose of ensuring dependability, the researcher undertook a rigorous and detailed research process, including making an in-depth methodological description available, so that a future researcher or industrial practitioner can repeat the work, if not necessarily to gain the same results. In addition to the role of triangulation, the availability of the detailed research process further enhanced the confirmability of the findings, allowing the reader to determine to what extent the data are acceptable. The consideration of practical research strategies and tactics to achieve the objective of demonstrating the rigor and trustworthiness of this case study formed an integral part of the research proposal.

Two more tips were considered by the researcher for quality assurance in this study: The first one is the availability of a thick description. The researcher has described a situation in sufficiently rich *thick* detail that readers can draw their own conclusions from the data presented. The second one is the collection of feedback from others. The researcher actively sought the opinions of colleagues and friends in the same field to determine whether they agreed or disagreed that she has made appropriate interpretations and drawn valid conclusions from the data.

3.6 Ethical Considerations

This research followed a qualitative approach that involved human *subjects*, that is, the people who participated in this study. The aim of the study was to document the experiences and opinions of the participants through the semi-structured in-depth interviews. Before any data collection was started for this study, a research ethics online application, with supporting documents, was submitted to the Human Research Ethics Committee (HREC) of the University of Canberra. Ethical approval was obtained from the HREC in December 2020 (Project ID: 6850). Any amendments to the project completion timeline and other project revisions were submitted for acknowledgement to the HREC through the online platform. As a researcher, it is critical to understand one's role and responsibility and how to best deal with any research integrity matters. To this end, the researcher had completed the relevant research integrity modules (RIM) that were provided by the university and formed part of the mandatory prerequisites to conduct this research. Annual Progress Reports (APR) were submitted to the university by the researcher and bi-monthly interactive meetings for discussion of research topics and progress updates were conducted between the researchers and her two supervisors. To address ethics issues, the researcher also took a number of measures to ensure the informed consent, privacy and confidentiality, anonymity of participants respectively.

Voluntary Participation and Informed Consent

Researchers are responsible for conducting the research with special care and sensitivity to protect human subjects. To fulfil this responsibility, a participant information form was sent to all participants who were involved in this case study. The form outlined the project background and explained what participation in the project entailed. A consent form was also prepared to be signed by all participants and sent back to the researcher prior to the collection of data. All participants who agreed to participate in the research understood that their participation was completely voluntary, and they could withdraw anytime if they wished. Samples of these two documents are provided in Appendix 2.

Privacy and Confidentiality

The privacy and confidentiality of all participants in this study were protected. Anonymity was guaranteed if the case organization and the participants of the study were not willing to be identified. For participant selection, the researcher equitably identified the interviewees so that no groups of people were unfairly included or excluded from the research. All individual face-to-face interviews were conducted in meeting rooms of the case organization for the safety of both researcher and participants. The researcher honestly reported the research data collected; analyzed it with rigor; kept the promises and agreements made with participants; and acted with sincerity through the whole period of this study. For example, it was agreed that no individual would be identified in the reports and publications of the research, and that all information would be kept in the strictest confidence.

Data Storage

Data storage is critical for any research because of the massiveness of data that is collected and processed. All data collected and analyzed from the in-depth interviews and documentation

was stored securely in two locations: i.e., the researcher's password protected personal computer and hard disk.

3.7 Chapter Summary

This chapter presented and justified the methodology employed in this research. This study followed an explorative qualitative approach with the aim of identifying the influencing factors affecting BDA adoption and exploring how BDA can improve service innovation in air freight forwarding industry. The research was situated within the epistemological paradigm of constructionism and adopted an interpretative theoretical perspective. A qualitative exploratory case study methodology was adopted, where the in-depth interview was chosen for the primary data collection, and internal documents for the secondary data collection, with content analysis applied to both sets of data. The primary and secondary data were analyzed using the 4C (i.e., capture, categorize, condense, and conclude) analysis model and the 3S (i.e., scan, scrutinize, substantiate) analysis models developed by the researcher. The detailed processes by which the researcher conducted her data collection and data analysis were presented in this chapter. Lastly, the quality assurance and ethical considerations factored into carrying out this study were discussed, including the detailed steps taken by the researcher to ensure that the research is ethical and of high quality. The following chapter will elaborate the key findings derived from the methods of data collection and data analysis described in this chapter.

Chapter 4 Findings

4.1 Chapter Introduction

Literature review chapter indicated the lack of real-life BDA adoption cases and studies that focus on the interconnections between BDA and service innovation in the air freight forwarding industry. To further address the theoretical gaps and the research questions, this chapter reports the major findings derived from the analysis and interpretation of primary data (interviews) and secondary data (documents) respectively. The chapter is organized as follows: section 4.2 provides a brief overview of the demographics of the interview participants. The next three sections present the findings aligning with each of the three sub research questions: section 4.3 describes the current situation of service innovation and BDA adoption in the air freight department of the case organization; section 4.4 highlights the challenges of BDA adoption in the case organization's air freight business through analysis based on the TOE framework; and section 4.5 makes recommendations about how BDA can be utilized to improve service innovation in the air freight operation of the case organization.

4.2 Profiles of the Participants

Demographic and professional information was collected including the participant's current position, business function, years of experience with the current employer and in related business fields. The case organization is a multi-national corporation, with participants coming from different parts of the world (Singapore, Germany, Hong Kong, the Philippines, Malaysia and Taiwan). The participants have been selected using purposive sampling to achieve a good balance of interviewees invited to take part in the study that would enrich the overall understanding of service innovation and BDA adoption in the case organization. Tables 8 – 11 provide more detailed overviews of the participants' profiles.

Participant Position in the Case Organization

To gain an understanding of their backgrounds, the research participants were asked about their current job positions in the case organization. Table 8 shows that 33% (6 out of 18) participants held the senior management positions of Board Member or C-level Officers; 50% (9 out of 18) participants held middle management positions, such as those of Vice President or Director; while the remaining 17% (3 out of 18) participants worked as project managers or data analysts in the case organization. The statistics show that 83% of participants (directors or above) were from high level management and had comprehensive understanding of the organizational strategies and approaches related to service innovation and BDA adoption. Moreover, they were also potential end users of BDA applications. Therefore, they were the right informants to provide answers to the research questions.

Table 8 Positions of Participants

Position	Number of participants
Board Member / C-level Officer (CEO, CIO, CCO)	22%
Executive Vice President	11%
Vice President	11%
Director	39%
Project Manager	11%
Data Analyst	6%

n=18

Participant Matrix Level in the Case Organization

The researcher collected details from each participant about their matrix level. Table 9 shows that 44% (8 out of 18) participants worked in the global head office; 33% (6 out of 18) participants worked in a regional head office; and the remaining 23% (4 out of 18) participants worked in local branches of the case organization within the Asia Pacific region. As the case

organization has a complex organizational matrix structure, feedback collected from participants at different matrix levels helped to provide a multi-faceted understanding about BDA adoption and service innovation through a balanced vertical lens, for example, in terms of corporate strategy communication and execution.

Table 9 Matrix Levels of Participants

Matrix levels	Number of participants
working in the global head office	44%
working in a regional head office	33%
working in a local branch (country)	23%

n=18

Participant Business Function in the Case Organization

Information about the participants business function in the case organization was also collected. Table 10 indicates that 56% (10 out of 18) of participants worked in the air freight business unit; 28% (5 out of 18) of participants worked in IT (e.g., the data analytics team); while the remaining 16% (3 out of 18) of participants were employed in general management or in the sales department. This study aimed to understand BDA adoption and service innovation in the air freight business, and thus collecting feedback from people working in the air freight department was important. It was also beneficial for employees from other business units, such as the top management (e.g., CEO, CIO) and technology information departments (e.g., data experts) to be included in this study. This diversity of business functions enabled the researcher to obtain a holistic understanding of BDA and its adoption from different stakeholders in the organization.

Table 10 Business Function of Participants

Business function	Number of participants
Air freight	56%
IT	28%
General management	11%
Others	5%

n=18

Participants' Years of Working Experience

The participants provided details about the length of time they had been working in the case organization and relevant business fields (e.g., logistics, air freight and BDA). From Table 11 below, it can be observed that 55% (10 out of 18) of participants had worked in the logistics industry for over 20 years; and that 55% (10 out of 18) of participants had worked in the air freight business for more than 10 years. The long years of work experience in logistics and air freight operations help to gain insightful information about the adoption of BDA in this industry. Participants' understandings about BDA varied depending on their years of service in the organization. For instance, 55% (10 out of 18) of participants had worked for over 5 years in the case organization. However, more than 67% (12 out of 18) participants had either zero or less than 5 years of experience in dealing with BDA. This high percentage indicated that despite BDA being an emerging technological innovation with huge potential, its potential had not been fully harnessed in the case organization.

Table 11 Years of Working Experience

Year of experience	Working in logistics industry	Working in air freight forwarding	Working in current employer	Working with BDA
0-5 years	17%	28%	44%	67%
6-10 years	22%	17%	22%	11%
11-20 years	6%	16%	17%	22%
above 20 years	55%	39%	17%	0%

n=18

4.3 Findings 1 – Current Status

This section answers the first research sub-question*, What is the current situation of service innovation and BDA adoption in the case organization?* In this section, five themes are presented to elaborate the current status of service innovation and BDA adoption in the case organization: 1) the business nature of the air freight forwarding business in general; 2) the management decision-making approach in the case organization; 3) evolving customers' demands in air freight forwarding industry; 4) service innovation practice; and 5) BDA adoption status in the case organization.

4.3.1 The Nature of the Air freight Forwarding Business

The nature of the air freight forwarding business can be described in two words: *traditional* and *time-sensitive*. Air freight forwarding industry is a traditional business that has remained unchanged for ages. Air freight forwarders (AFFs) have much shorter service lead time requirements than other freight forwarders (e.g., ocean freight forwarders), making it necessary for shipments to be processed with urgency and agility, and this makes the air freight business time sensitive. The nature of air freight forwarding industry is further unpacked from *process, person* and *system* perspectives below.

From *a process* perspective, air freight forwarding services are still operated manually which discourages process standardization. Manual operations offer high flexibility to customers, but also entail high risks of data entry error. Operational staff tend to use *shortcuts* in data entry for catching shipment deadlines, which ultimately leads to data of poor quality. "The culture of doing the business in air freight is still quite traditional and the way to handle the customer is more related on the relationship with the customer" (Interviewee SG10). This traditional business nature offers "high flexibility to our customers, which leads to high non-standardized way of moving cargoes for the customers" (Interviewee SG10). Therefore, this non-standardized way also "limits the BDA adoption in the traditional air freight where a lot of flexibility is required in order to move customers' cargoes efficiently"(Interviewee SG10). Time is very critical to both air freight forwarders and their customers. For example, cross-country air freight transportation can be done within three days, starting from the shipper's location in the country of origin, where the cargoes are picked up to the final consignee in the destination country, where the cargoes are delivered. Due to the time sensitivity, the operational staff tend to utilize *shortcuts* in systems to *skip* some mandatory steps of the data entry process. This *step-skipping* behavior weakens the data quality and triggers high risks of data incompletion (missing data). The spoiled data cannot be used for analysis before it is cleaned, requiring massive extra human effort.

From *a person* perspective, the customer relationship is based on personal relationships which show people's *values*. As a result, "little force can be seen behind the service innovation in the air freight forwarding industry as a whole" (Interviewee SG08). The air freight industry is dominated by a few key players, "initiatives that usually drive standardization…are not that important because there is only a limited number of companies involved anyhow" (Interviewee SG08). Air freight is "done much based on personal relationships that leaves no way for digitalization" (Interviewee SG08). For example, digital technologies reduce business reliance on

personal relationships heavily in a B2B context. Market players are happy with what they are doing now because "there is currently no incentive for them to move away from the status quo, and it will always mean a loss of power for the people who are currently working in the industry, they have no incentive to move into this direction" (Interviewee SG08). Therefore, it is *"*very hard to push for service innovation" (Interviewee SG08). Additionally, people in air freight are "not technologically savvy", but "more operationally focused" (Interviewee SG05), which leaves limited time and effort to drive service innovations in their work.

From *a system* perspective, the case organization is still operated using diversified systems that engender a high potential for risks to data quality. These systems and applications "are very old and isolated", and because these isolated systems are "not linked to each other", "huge challenges in offering an integrated supply chain visibility to customers" are created (Interviewee SG05). According to Interviewee SG08, data quality is one of the key obstacles to developing service innovations and BDA adoption in the air freight industry. Data quality is challenging because human typographical errors are unavoidable.

In summary, the findings reported in this section emphasize the traditional and time-sensitive nature of air freight forwarding industry. Data entry in air freight is still performed manually using isolated and diversified systems, and this endangers the quality of data entry. People working in this industry are very operationally-driven and thus less sensitive to innovations in technology. The traditional air freight business still relies heavily on personal relationships, further hindering the air freight forwarders from driving service innovation proactively within the industry.

4.3.2 Management Decision-making Approach in the Case Organization

Decision making is one of the key activities for effective business management. BDA is believed to enable better informed decisions, greater understanding about the different types of management decisions, and decision-making behaviors. Furthermore, identifying the challenges in

using data for decision making in air freight business can help to evaluate the potential of adopting BDA in decision-making processes in the air freight industry.

Types of Management Decisions

Six types of management decisions were categorized based on the nature of the decisions (see Table 12). Based on the ranking by a frequency count, the participants predominantly dealt with *commercial* (26%) and *strategic* decisions (19%), in other words, decisions that are related to customers, pricing and business strategies. Samples of decisions in the table indicated that many management decisions are highly relevant to data, except for a few administrative decisions (e.g., those related to human resources). Data can be used either to help managers in decision making (e.g., financial data in strategic decisions) or to support managers to verify decisions they make based on personal experience. Finding from the participants interviews show that data, which is available and appropriate, can be very valuable in management decision making in the air freight industry.

Table 12 Types of Management Decisions

Decision type	Frequency count	Share %	Decision examples from participants
Commercial	7	26	1) customer-hunting decision (specific customer onboard) 2) customer selling rates 3) investment-related 4) price-related decisions (RFQs, quotations, tender prices etc.) 5) customer fronting (different options offered to a customer) 6) price level, discounts to customers, write-off
Strategic	5	19	1) strategical decisions in regard to new services or product development 2) long-term strategic decisions, e.g., what customers to focus on hunting, how to funnel the right business into the channel 3) strategic decisions around platforms 4) strategic decisions (future digital platform deployment decision)
Administrative	4	15	1) people (staff) 2) resource utilization 3) salary, cost effectiveness, structure etc.
Financial	4	15	1) profit margin (P/L owner) 2) profit and loss of the shipments 3) bad debt
Procurement capacity	4	15	1) such as carrier contracts (capacity, procurement) 2) on charter contracts and capacity 3) capacity and procurement 4) buying capacity or charters for procurement 5) sourcing strategies
Operational	3	10	1) air freight operational decisions in the country 2) a lot of operational decisions from flight operations to securing space, to warehouse leases to all these kinds of things
Total	**27**	**100**	

Decision-Making Behaviors

The participants shared about their experiences how they make decisions in daily work. Decisions were made either based on personal experience or data at hand. The findings showed that 72.2% participants (13 out of 18) made their decisions using a combination of personal experience, gut feeling and data. Two participants (Interviewee SG10 and SG17) admitted that they made most of their decisions by personal experience. Although "different people have different ways to make decisions", Interviewee SG14 tended to make decisions with any "facts that are supported by data". However, all participants agreed that past experience was important, and the best way was to have "all information together and do a pros-and-cons analysis and decide."

Most decisions in air freight need to be made quickly due to the urgency of shipment handling. Managers have to react to the market and their customers by making swift decisions. Using personal experience or data in decision making depends on various factors, such as types of decisions, personal preferences and data availability. Business leaders tend to make critical strategic decisions based on personal experience or gut feeling, especially in dealing with unexpected events. A typical example is the COVID-19 pandemic in early 2020, which unexpectedly caused most aircraft (especially passenger flights) to cease being operated. The global shutdown of aircraft operations largely reduced freight capacity across the entire air freight market. The pandemic came like a shot and left little time for the business leaders to think, react and make strategic decision based on data. Although many companies and industries were hit hard by the COVID-19 pandemic, AFFs including the case organization demonstrated outstanding financial performance. One of the senior executives (Interviewee SG07) shared how the air freight senior management team made critical decisions during the challenging time of the COVID-19 pandemic:

> When COVID started and China stopped flying to Europe, we decided very quickly on charter aircrafts. Did I have any facts on hand? No. Has it been a risk? Yes. Did I know it will fly? No. Have I believed it will fly? Yes. There was no data available because nobody could tell will the demand collapse or not because decisions are for the future, we learned that the volatility is so big that prediction from the past does not fly. (Interviewee SG07)

Challenges in Using Data in the Decision-Making Process

Two major concerns the participants had in using data for decision making were *lack of a trust in data* and the *unavailability of data*. In a real business world, people make their decisions based on experiences with insecurity. Building trust in data in decision making is not easy, as it "takes time to trust the system and it might take several years" (Interviewee SG06). You cannot *force* people to trust data that may be against any instinct they have already saved for years. This includes not only external data that is hard to obtain due to competition, data protection and

sensitivity, but also internal data that needs to be extracted from diversified systems because of low data integration.

In summary, decision making is one of the core activities in the management of AFFs. Managers in air freight need *data* to support decision making. In reality, management decisions need to be acted upon quickly. People tend to make decisions through a combination of individual experience and any data available to them. However, the lack of trust in data and the unavailability of data are two key challenges in data-based decision making within the air freight industry today.

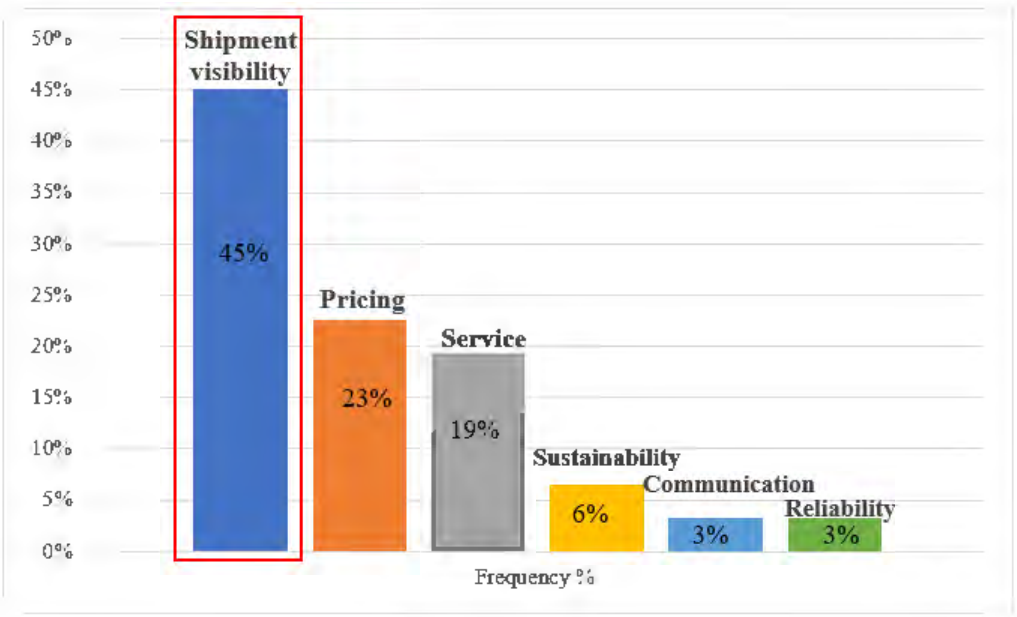
4.3.3 Customer Demands of Air Freight Forwarders

Air freight forwarding is a service-oriented industry. Customer satisfaction motivates air freight forwarders towards continuous business improvement. For many years, air freight customers have been "traditional and risk-averse" and "low demanding" to their LSPs (Interviewee SG08). These modern customers are only concerned about their shipments and the price involved because they "really do not care if their goods are transported by forwarder A, B, C; they just want their goods to be transported on time at a reasonable price" (Interviewee SG08). Air freight customers do not see service innovation as the most important criterion in selecting their service providers.

The participants were asked how they understood air freight customers' demands nowadays and the findings indicated that customers are more demanding than before. Figure 16 below shows information about evolving air freight customers' demands that was collected from 14 participants (78%). Calculated by a frequency count, *shipment visibility*, with highest rank of 45% (14 out of 31), was the most important demand for customers, followed by *pricing* at 23% (7 out of 31). Customers' expectations have steadily evolved from *price-focused* to *shipment visibility-focused*; while pricing remains a major consideration to customers, it is no longer the most critical one. "The transparency of an air freight service" with real-time notifications of "any hold ups or delays that

occur at customs …" (Interviewee SG08) can ultimately achieve higher customer satisfaction to stay ahead of their competitors. This identified customers' focus on shipment visibility falls squarely into the research scope and objects of this study – BDA adoption and how it can improve service innovation to meet customers' demands.

Figure 16 Evolving Customers' Demands in Air Freight Forwarding



n=31

In short, the participants' interview data indicates that customers' priority have shifted from price-focused to data visibility-focused and they are expecting more innovative solutions to be offered by AFFs. Shipment visibility was ranked by participants as the highest customer demand in air freight. The need to understand and meet customers' demands motivates AFFs to proactively drive service innovations that are beneficial to their customers, and that ultimately help to increase customer satisfaction and achieve better business performance.

4.3.4 Service Innovation Practice in the Case Organization

This section sheds light on how service innovation is managed in the case organization. The feedbacks collected from the participants highlighted the existence of two contrasting views about experiencing service innovation practices, and also led to a discussion of a few factors that affect the service innovation.

Some participants (Interviewees SG04, SG06, SG10, SG14) recognized the benefits of service innovation. Service innovation has been well managed in the past five years and the company has consistently been looking for solutions to improve existing services or to develop new products for their customers. New customer-interacted service innovations have been introduced, such as digital booking platforms and sustainability initiatives of CO_2 neutral flights in collaboration with industrial partners. The recently launched digital booking platform is a new service innovation that offers digital interactions with customers for instant freight quotations and shipment booking. The case organization has implemented more advanced measures than other competitors in driving service innovation. Nevertheless, service innovation processes are tedious and complicated due to the industrial nature of AFF, especially in terms of changing people's mindset in this industry.

Nevertheless, there were also some views expressed in oppositions to the above positive observations. A number of participants (Interviewee SG09, SG15, SG16) reported such notions as "not much innovation or fundamental changes have been seen in past years and overall air freight process remains the same although partially being digitalized" (Interviewee SG09). This data indicated that while the company has been pursuing service innovation more actively than its peers in the market, its impact remains limited and there is huge room for improvement. The air freight industry is still "a little behind the innovation compared with other industries" (Interviewee SG16). According to Interviewee SG15, "there haven't been many new ideas or new technology infused

in our day-to-day operations" and "not much fundamental changes had been noticed in the past years within the organization, especially the way air freight team process their shipments remains almost the same and the speed in driving service innovation within air freight was very slow". Adding support to these views, only one organizational document (DOC011) was related to service innovation. Moreover, air freight service innovation was seldomly discussed among the employees and there was hardly any systematic reporting available about service innovations driven by the organization. The unavailability of documents on service innovation implies that little attention was paid to service innovation in the organization.

Innovativeness of services differs among industries due to the nature of the business and industry. The freight forwarding industry is dominated by a few big players, who have no *sense of urgency* to drive digitalization within the industry. As indicated earlier, air freight business relies heavily on personal relationship. Digitalization (e.g., online sales channel) largely reduces human interactions and threatens to reduce employees' power in decision making. The fear of *power loss* halts service innovation "because it will always mean a loss of power for the people currently working in the industry, and they have no incentives to move in this direction." (Interviewee SG08)

Management support or its absence influences the adoption of service innovation in an organization. The findings indicated a lack of local management buy-in and support in driving service innovation in the case organization. Interviewee SG05, who works in a country organization, talked about the challenges he encountered in driving service innovation in the country: "the local management is interested in BDA innovation projects, but they didn't want to invest time and resources into these projects because of the limited return on investment." Service innovation is an important management topic, but it is never urgent because "it was not on the list of the management priority. It's one of those *nice to have* things so it was deprioritized." This example

may not reflect the same situation for another country organization; however it suggests the missing alignment on service innovation between the head office and local country management.

The interview data analysis revealed that service innovation is under way in air freight forwarding industry. The findings point to two contrasting views in participants' experiences of service innovation. Manual data entry brings potential risks in data quality that could have held back the adoption of big data analytics and innovative solutions in a timely fashion in the air freight business. Service innovation is mainly driven from head office in the case organization, and management alignment between global and middle/local management teams seems to be missing on this issue and will need to be looked into sooner or later.

4.3.5 BDA Adoption in the Case Organization

This section elaborates on three aspects of the cultural factors affecting BDA adoption in the case organization: first, it examines how BDA was understood and accepted by employees in the case organization; second, it provides an overview of the BDA applications in the case organization and BDA resources available in driving BDA adoption; last, a few unexpected factors that affect the current adoption of BDA in the organization are presented.

Staff Awareness and Acceptance

The global head office has a more proactive and open attitude towards BDA adoption than the regional and country entities. The top air freight management in global head office recognized the values of BDA and drive BDA adoption proactively. People in the case organization, especially those in the middle and local management teams, are "quite cautious and conservative towards to innovation and BDA related topics" and "the business units are much focused on achieving short-term goals and reluctant to adopt those innovative solutions recommended from IT" (Interviewee SG08 and SG11). Top management are aggressively driving BDA adoption, but the force is

"already slowed down when it goes down to the countries", as there seems to be "a lack of connection among the different levels in terms of BDA utilization" (Interviewee SG12 and SG17).

According to the interview data, staff awareness and acceptance of BDA has steadily increased in the past few years. However, discussions about BDA seldom took place among employees in the organization. The participants' observations suggest that people in air freight operations are reluctant to use technology innovation for three reasons:

1) Air freight people are "pragmatic, time-sensitive" and "too focused on daily business, so they are hesitant to adopt new technologies with the fear that these technologies might not work properly" (Interviewee SG12).

2) Air freight people do not fully trust the data generated internally because they know the data is "entered manually under great pressure… and people are not paying 100% attention on the accuracy of what they have entered" (Interviewee SG12).

3) Air freight people may not understand the analytics logic behind BDA (Interviewee SG11).

One participant shared the experience of working with xx (the name was not disclosed). He proposed a few BDA applications to the business, but they were rejected by the management team because "they personally didn't trust the algorithms". Most employees do not understand how BDA works behind the data and therefore "they would rather go by their own gut feeling as opposed to using the predictions that were created by the machines". Furthermore, people initially want to "understand where data decisions come from", but after understanding the logic behind this information, nervousness and panic come up about "why machines can do things in the way they do" (Interviewee SG11).

BDA Applications and Resources

This study also revealed that there is limited BDA application use in the case organization. According to Interviewee SG02, "although the company has a lot of data, the application of BDA is completely under-utilized potential". This is how he described BDA adoption: "we're basically sitting on a gold mine, but we don't even know how to use the shovel kit… to exaggerate a bit." A global data analytics team was set up in 2016 with more than 30 full-time PhD data scientists and operation research experts working on BDA topics. A few participants commented that they seldom engaged in any BDA projects with this team, while more than 50% of the participants admitted that they were not aware of this team. To create more awareness of BDA technology in the organization, the global data analytics team have arranged regular online basic BDA training for employees on a voluntary basis. According to the statistics (as of July 2021), the air freight staff participation rate was only 4.3% (43 out of 1000 participants), which was much lower compared with other business units. Two possible reasons for the low participation rate can be identified: 1) inefficient communication about the BDA training from the global office, meaning that air freight people were not aware of the training sessions; and 2) air freight people were aware of the training opportunity, but there were not motivated or interested in BDA.

Other Factors Affecting BDA Adoption

BDA adoption in an organization could be influenced by various factors. A few unexpected factors, such as the COVID-19 pandemic, have affected BDA adoption in the air freight forwarding industry. "It is the first time happened in modern times" and people "didn't think that any predictive analysis helped them in this unpredictable event" (Interviewee SG10). Business was the priority for air freight management, who had to slow down or even suspend any ongoing technology innovations (e.g., BDA adoption in this case) temporarily due to the pandemic. The efficiency of BDA adoption within an organization could be affected by the industry it is in. The readiness of an industry to embrace BDA is another critical external factor to be considered by those business

leaders who want to adopt BDA for their organizations. “BDA might bring a lot of values to air freight industry in long run, but at current moment, our industry is not ready for BDA yet… as we do not have the data in a systematic and integrated way to be able to use it” (Interviewee SG14). Massive data is available in different systems; however utilizing these data for advanced analytics is very limited as the data is not ready for analytics. Data is a challenging showstopper in BDA adoption in air freight forwarding industry, as described by Interviewee SG01:

> The quality of the data is lacking, the data capture quality is also lacking... and once you can get that data, it is fantastic because you can then predict trends, pricing, movement and flows…that’s what big data is about: predictive analytics. (Interviewee SG01)

In brief, the Finding 1 section has provided a picture of the current status of service innovation and BDA adoption in the case organization from five perspectives, addressing the first research sub-question posed in this study. Air freight is a traditional and time-sensitive business that operates manually. People in air freight are focused more on operations and less on service innovation. The data quality is affected by manual data entry and diversified aged systems in the case organization. The findings presented in this section related to management decision making, including types of management decisions, managers’ decision-making approaches, and the challenges involved in using data in decision-making processes. Customer satisfaction motivates AFFs to maintain continuous business improvement. The analysis of the interview data also indicated that customers’ demands in air freight have been evolving, with service innovations such as shipment visibility ranked at the top of customer demands. Lastly, the current status of service innovation management and BDA adoption in the case organizations were reported. The participants gave both positive and negative feedbacks on service innovation, pointing to huge room for improvement in this area. Topics related to BDA adoption in the case organization, such as the staff awareness, BDA applications, and resources in driving BDA adoption, were also examined. This exploration revealed that overall, limited BDA applications in air freight operations

were available or reported in the case organization. The next section uses the TOE framework to discuss the challenges for BDA adoption by the case organization.

4.4 Findings 2 – Influencing Factors in BDA Adoption

The findings presented in this section answer the second research sub-question, *What are the influencing factors in BDA adoption for the case organization*? In this study, the TOE framework (Tornatzky & Fleischer, 1990) was used to identify all the influencing factors in BDA adoption. Table 13 below summarizes the influencing factors that are grouped according to the TOE framework. The frequency count (FC) carried out shows that most of the influencing factors identified in this study are related to organizational factors (51%) and technological factors (40%). These factors are further analyzed in following sections respectively.

Table 13 Influencing Factors in BDA Adoption Identified in the Study

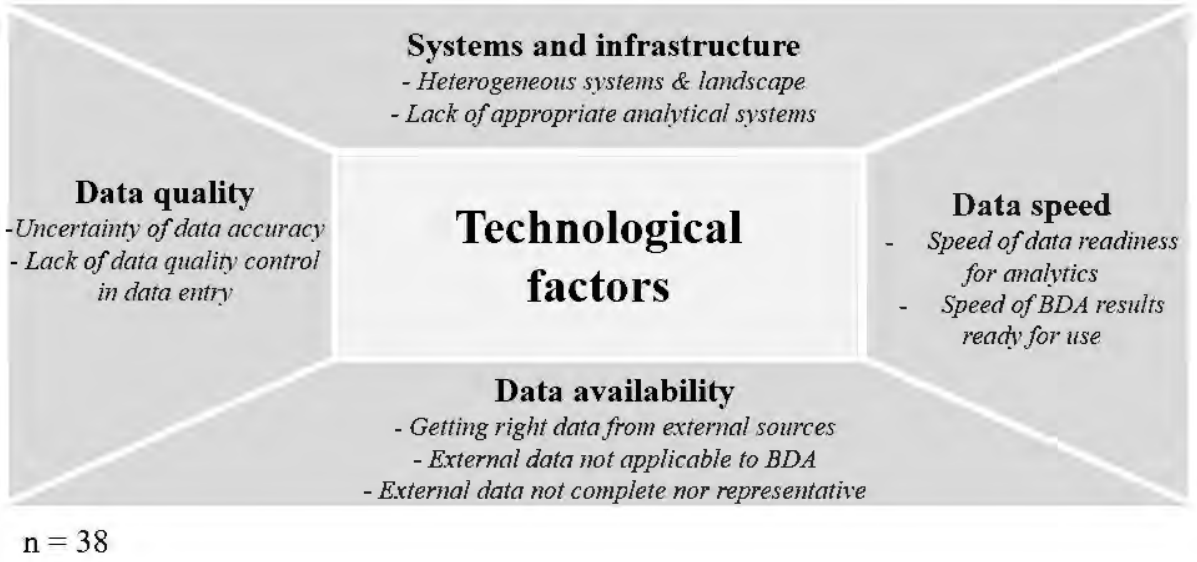
TOE context	Frequency count	Share %	Types of factors	Details
Technological factors	**38**	**40**	Systems and infrastructure	*Hetergeneous systems and landscapes*
				Lack of appropriate analytical systems to support BDA adotpion in the organziation
			Data qauality	*Uncertainty about data accuracy*
				Lack of data quality control in data entry
			Data availability	*Difficult getting right data from external sources*
			Data speed	*Speed of data collection for analytics - challenge to get instant data*
				Speed of data analytics results - challenge to get data analytics ready for use
Organizational factors	**49**	**51**	Organizational culture	*Lack of communication on BDA within the organization from global to country level*
				Challenging in execution of BDA adoption due to conservative risk-averse culture and lacking translation layer for converting BDA theory into BDA practice
				Limited collaboration seen among silo-departments and with external partners in the industry
				Conception of BDA - low awareness, little understanding and misperception of BDA
				Unclear ownership of data and BDA adoption
			Human resource capacity in BDA	*Weakness of existing BDA resources available in the organization (DSs' lack of business knowledge)*
				Lack of dedicated resources to drive BDA in air freight (lean structure in air freight)
			Leadership	*Younger generation of managers tends to use more data in decision-making than older manangers*
				Top management has ambitious goals to drivie BDA, but middle management focus more on daily operations (lack of alignment)
Environmental factors	**9**	**9**	Unexpected events	*Negative impacts from unexpected events (e.g., COVID pandemic) have distracted the management attention and slowed down the innovation development.*
			Partner	*Lack of data integration among logistics partners, different parties are concerned and hesitant in data sharing with others under competition*
			Industry	*Low data transparency in air freight industry due to compliance with govermental laws and regulations, competition laws and the need for data protection*

4.4.1 Technological Influencing Factors

Technological influencing factors identified in this study, were mainly related to infrastructure capabilities for *data management* (see Figure 17). Apart from *systems and*

infrastructure (32%), other three types of technological factors are specifically related to how *data* is currently managed in the case organization, including *data quality* (32%), *data availability* (26%) and *data speed* (10%).

Figure 17 Summary of Technological Factors



1) Systems and infrastructure refer to capabilities such as the air freight operation systems available and data analytical tools and applications recruited by the case organization. The finding from the TOE framework analysis of the interview data reflected that *heterogeneous systems and landscapes* for data management are operated in different business units that have existed for decades. The core operation systems in the air freight industry were adopted in the 1980's, and the speed of data entry is largely slowed down due to the complexity of these aged systems. Although infrastructural transformation has been under way, it is thought that the full deployment of the new systems will take longer than expected (Interviewee SG09 and SG11).

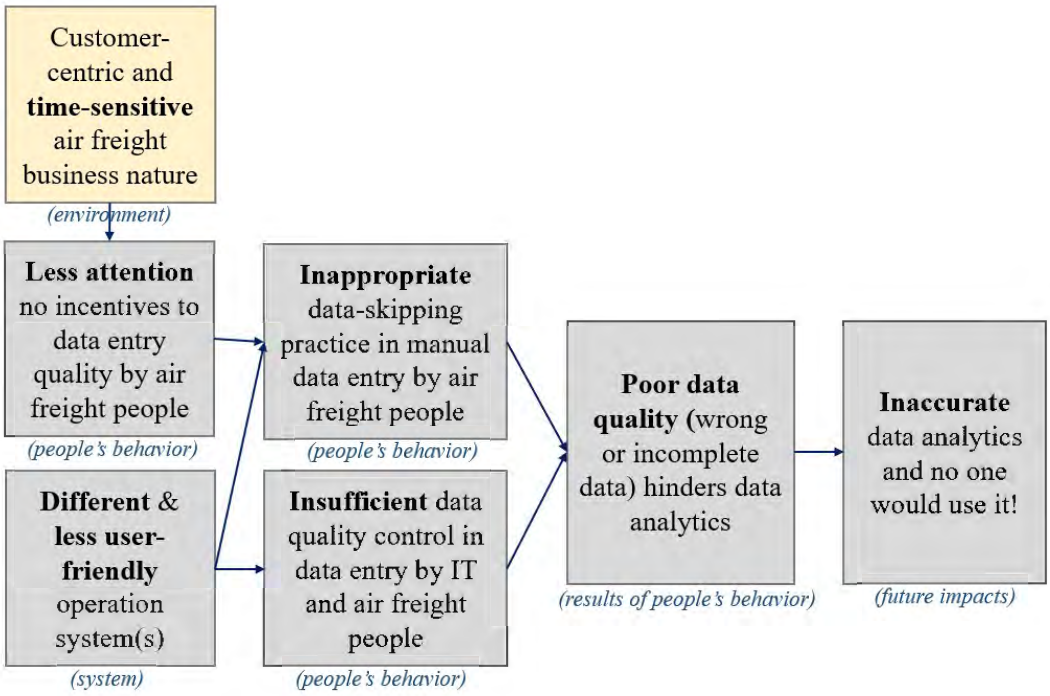
Physical data crunching is inevitable if data does not tally after being extracted from various systems. According to Interviewee SG16, many customer reports were done manually because shipment data need to be "retrieved and compiled from different systems". The findings derived from document analysis (DOC001) further corroborated the above statement. The document outlines how customer service teams prepare customer reports through a tedious data quality checking process. Data, after being pulled out from the systems, has to be crunched before data reporting and advanced analysis. First, shipment data are extracted from various isolated systems. Then, the team check and verify missing or abnormal data with internal stakeholders via email communication. Data integration is imperative for BDA adoption that "allows us to add further values to our customers in terms of improving and offering new products" (Interviewee SG16).

In the interviews, most participants commented that there was a *lack of an appropriate analytical system to support BDA adoption* in the organization, at least not that they were aware of. In contrast, the document analysis (DOC006 and DOC007) indicated that the case organization had a full *state-of-the-art* bucket of advanced systems for data storage and data analytics (e.g., ORACLE, Postgre, AWS and Hadoop); and that the IT department was equipped with sufficient advanced technology to support data management and data analytics (DOC006). However, the overall use of technology remained very low, as BDA applications were still in their infancy stage and focused on descriptive analysis of historical data. The contradictory findings also pointed to a communication disconnection between the IT and business units, another organizational challenge in BDA adoption that is discussed in section 4.4.2.

2) Data quality covers the *uncertainty of data accuracy* and *lack of data quality control in data entry*. Accuracy of data is most critical to managers when using data for decision making. Performing analytics with the wrong data could create huge disasters for business. People in the air freight business are concerned about data accuracy because they know how data are *entered* in

systems nowadays, and that quality governance of data entry in the air freight industry seems to be missing. Figure 18 below illustrates how data-entry behaviors affect data quality and ultimately affect BDA adoption in air freight operations. Less user-friendly systems, less efficient data quality governance and people's behaviors in data-entry lead to poor data quality that hinders the accuracy of data analytics. "*Garbage in, garbage out*", as mentioned by Interviewee SG13, "…if you don't have the right data, the information that we analyze out of the data would not be accurate at the end." Air freight forwarding is a time-sensitive business where "people rush to complete the shipment and intend to skip some mandatory data entry in the less user-friendly systems" (Interviewee SG08). Data skipping is a common shortcut used by data entry staff as "it brings them short-term benefits of speeding up the process", although "they don't recognize that their active entry-skipping behaviors make it impossible for the data afterwards". Governance of data entry in the organization is not efficient because "different systems in different countries have different standards, and no standard effective controlling and monitoring of data is currently in place" (Interviewee SG02). Inappropriate data-skipping and insufficient governance of data entry greatly affect the quality of data, which may be inappropriate or incomplete for advanced analytics. Consequently, no one would trust BDA applications based on the data that are most likely to be wrong or incomplete.

Figure 18 Garbage in, Garbage out?



During the document collection, the researcher failed to identify any governance policy for data quality which indicated two possible scenarios: either the data governance policy exists but has not been implemented; or the governance policy does not even exist.

3) Data availability refers to getting the right data from external sources such as customers, the market or industry. Internal data are comparatively easier to manage than external data. "The challenge is more about obtaining external data…" (Interviewee SG11) that relies heavily on a "willingness to share, the openness of the data" (Interviewee SG09). Data is most useful if it is complete or representative. Market and industrial data would be easy to obtain (available), but not applicable (meaningful) to data analytics. For example, trading data extracted from governmental authorities in different countries are generally recorded by *cargo values* instead of by *kilogram* or *number of shipments*, whereas the latter two units of measurement are commonly used in the air freight industry. Additionally, the definitions of commodities used by different countries are

inconsistent and impractical to AFFs. “For laptops or computers cargoes, Indonesia might define it as ‘electronics’ while Singapore might define it as a ‘consumer good’, so there is lack of integrated data from various data sources” (Interviewee SG14). Various airlines statistics reports are available on the IATA website however those reports might not be representative for the whole industry because not all airlines are currently associated with the IATA network.

4) Data speed refers to *the speed of data readiness* in terms of the *speed of data collection for analytics* and the *speed of data analytics results for use*. Managers need to get data in time to make decisions, so that getting instant shipping data is vital for AFFs. The technology capacity of an organization can either limit or facilitate BDA adoption. Managing huge data sets counts on the solid foundation of IT infrastructures in air freight. Technological influencing factors identified in this study are closely linked with data acquisition, data collection and data analytics.

4.4.2 Organizational Influencing Factors

Organizational influencing factors refer to the resources and the characteristics of the company, such as firm size, organizational structure, human resources, and organizational capability and capacity (Baker, 2012; Gangwar et al. 2014; Sun et al.,2018). Three types of organizational factors in BDA adoption were identified in this study (see Figure 19). The findings show that *organizational culture* (65%) was the most important organizational factor in BDA adoption and mainly concerns BDA-related communication, collaboration and implementation in the case organization. Organizational culture is related to people; it reflects *how people behave*, such as how they understand BDA, and how they communicate and collaborate among departments in BDA adoption in the organization. Analysis of the participant responses revealed two additional organizational factors in BDA adoption were *resource capacity in BDA* (22%) and *leadership* (13%), which is also related to people and their behaviors. More details of these organizational factors are presented in this section.

Figure 19 Summary of Organizational Factors

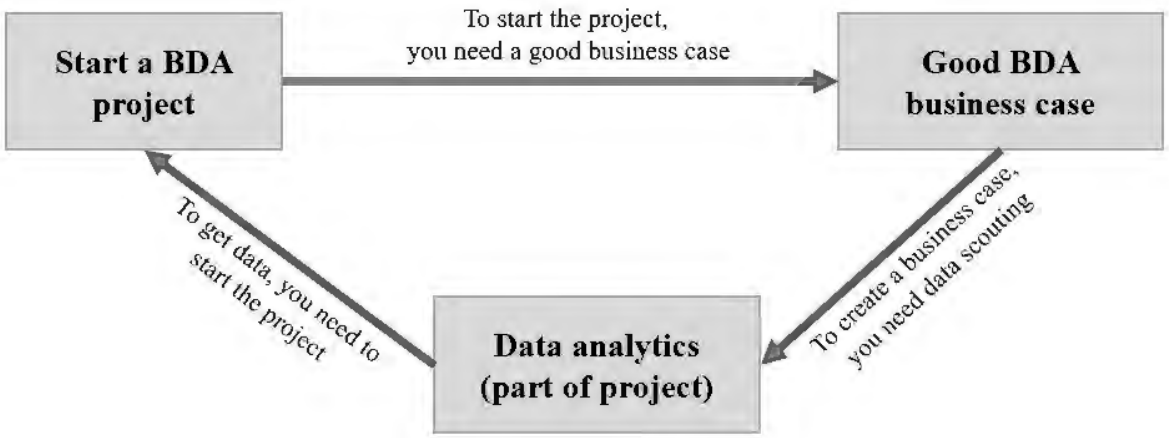
1) ***Organizational culture*** broadly defines how an organization behaves in a proper way internally and externally. Organizational culture was ranked highest (65%) and discussed by all participants in the interviews as a factor affecting BDA adoption. Five aspects of this cultural factor can be further elaborated namely, *communication*, *execution*, *collaboration, conception of BDA* and *ownership in driving BDA.*

Communication has huge impacts on BDA adoption. The findings indicated that the topic of BDA adoption had not been communicated efficiently from the top management down to local country organizations. It was obvious that "BDA-related topics were not widely discussed within the organization at all" (Interviewee SG03), although the top management team recognized the benefits and the values that BDA that could bring to the organization. "There is something happening within the organization", but "the knowledge is basically centered only in one spot and

not been brought closer to the business and into the regions" (Interviewee SG10). Limited communications were seen to be related to the corporate strategic direction in BDA adoption, such as organizational BDA capability, BDA benefits and BDA adoption guidelines. Additionally, the document analysis showed that no specific guidelines in BDA adoption are available in the case organization.

Execution in BDA adoption was affected by the conservative risk-averse culture of the case organization that often create an *BDA approach dilemma* (see Figure 20) between the BDA team and business units in the case organization. In general before a BDA project is kicked off, the BDA team needs a *good* business case with BDA Proof of Concepts (POCs) for business management approval. However, the BDA team cannot start any POCs (e.g., collecting data) without the support of the business unit, because the business case needs to be approved first. From a business perspective, a good business case (how BDA could benefit the business) needed to be provided before the air freight management team of the case organization could decide if they would proceed; from an analytics perspective, the BDA team needed to collect data (in order to start the analytics) to prepare the business case. Ultimately, it ran into an endless vicious circle or *chicken or the egg* situation, where the BDA team "couldn't start because it's expected to have a business case before doing so…they can't create a business case because they can't start data analytics" (Interviewee SG08).

Figure 20 The BDA Approach Dilemma



BDA theories need to be converted into actual applications before any values are extracted. There is too much *theory talk* but no actual practice of BDA in this organization (Interviewee SG04). The translation layer was missing from transforming BDA concepts into business practices and "…the biggest challenge lies in implementation that brings the BDA ideas from theory to execution" (Interviewee SG08). Clear direction on implementation is deemed necessary communication to employees for any innovation adoptions. According to Interviewee SG02, the organization is "…still missing the strategic direction in utilizing big data…and the data scientists, but that's not really part of the strategy yet" (Interviewee SG08).

Collaboration refers to the joint efforts among different parties within the case organization. Technology adoptions can be facilitated through "big collaboration between the departments to get the full potential out of BDA". However, not much joint effort was observed among these silo-departments and "… that is something we don't have it today" in the organization (Interviewee SG06). The silo-working pattern is not particular to BDA adoption but applies to all technological projects. Interviewee SG08 shared his working experience of cross-department collaboration. Various departments did not "share the same view of a customer, although they are both serving

the same customer". Data analytics on customer behaviors is valuable but "it doesn't work if the same customer is treated differently in different business units".

Conception of BDA is a term that describes the awareness, understanding and perception of BDA in the case organization. BDA awareness varies at different levels of the case organization. People working in head office are more open-minded and proactive in regard to BDA, while people working in the countries are operationally-focused and less interested in innovative technology. Employees often saw BDA as *rocket science* and those data scientists sitting in head office as *rocket scientists who only do theory*. Various BDA terms such as *big data* or *big data analytics* confused employees. BDA technology is like a "black magical box ... but not knowing the details of the process and what to do with it" (Interviewee SG08). The concern about using the data available in public is "the accuracy of the data and the objectives behind the data presented, such as data neutrality", and it greatly reduces trust of data from external sources (Interviewee SG03).

Ownership about who was driving BDA adoption was not clearly defined in the case organization. Participants (Interviewee SG11 and SG18) claimed that the air freight department should be the owner of the data and the key driver in BDA adoption. Air freight people are *closest to their customers,* and they work in "the place where the heartbeat of the machine is happening" and "usually this is where the pain is felt strongest".

2) Resource capacity in BDA adoption refers to the weakness of existing BDA resources, the lack of dedicated resources to drive BDA within air freight, and the overall shortage of BDA expertise in the case organization.

The global BDA team was formed in the head office and consisted of data scientists who "purely look at software, slice and dice the data sets and then provide it into a visualized way" (Interviewee SG01), but had little (or no) freight forwarding experience. Data scientists are specialized in technical skills of data analysis without knowing details of the air freight business:

they “don’t know what end users really need” (Interviewee SG05) and may not “be able to dive deep into that data sets or come up with something meaningful” (Interviewee SG17). Technical information about BDA application is not translated into operational language that can be easily understood by business. In the case organization, no dedicated team or people were assigned to drive BDA adoption in air freight “where people have hardly any time to think of innovation” (Interviewee SG18). Underutilization of existing data scientists and a lack of dedicated resources to drive BDA in air freight means that the company lacks BDA subject matter experts (SMEs). Interviewee SG17, who has been leading a local air freight organization for many years, stated the urgency of having BDA expertise with *dual-knowledge* to drive BDA in air freight:

> Many colleagues in our air freight have been working for years in the company, they are not proactive to receive data reports telling them what they need to do in their daily work, because they are using their experience most of the time in the decision making or in their daily operation. We need to have some people who know the IT knowledge to deal with those big data. We don’t have people who know both IT and product knowledge at the same time, that is one of the challenges, but we need to have these skilled people to get BDA adopted. (Interviewee SG17)

3) Leadership, in this study, relates to the different decision-making styles of traditional and young generations leaders. According to the findings, senior managers who have been working in the industry for a long period of time in the air freight business tend to make their decisions based on their experience or gut feeling (and no evidence indicated that they were wrong in taking that approach). They are less reliant on data in decision making. In comparison, the younger generation of managers are more likely to be driven by data in business decision making. Differences in decision-making styles may lead to different attitudes towards BDA and influence the willingness of decision-makers to use data in making decisions. Alignment among different levels of management teams of the case organization seems to be missing where BDA adoption is concerned. The senior management were ambitious to drive BDA, while the middle management “were too focusing on firefighting in their daily operation.” The strategic direction for driving BDA

was not "cascaded down properly from the top to their next levels of management" through efficient alignment and communication within the case organization (Interviewee SG01).

Participants' feedback about most of these organizational influencing factors such as insufficient execution, limited collaboration, and misalignment between managerial levels in BDA adoption were supported by the analyzed documents. Figure 21 gives some examples how document analysis supported the influencing factors in BDA adoption identified through the interviews. For example, document analysis (DOC002, DOC003, DOC004, DOC005 and DOC006) revealed reports of a great number of BDA POCs being conducted by the BDA team related to data science and operational research supply chain optimization. The figure shows that only 20% of POCs were applicable to air freight (e.g., cargo optimization, customer churn analysis and volume prediction). Furthermore, none of these POCs was implemented in air freight operations (Box A). These two findings from the document analysis corroborated those from the interview data in relation to four cultural factors (Box a, b, c and d) influencing BDA adoption. These factors are listed below:

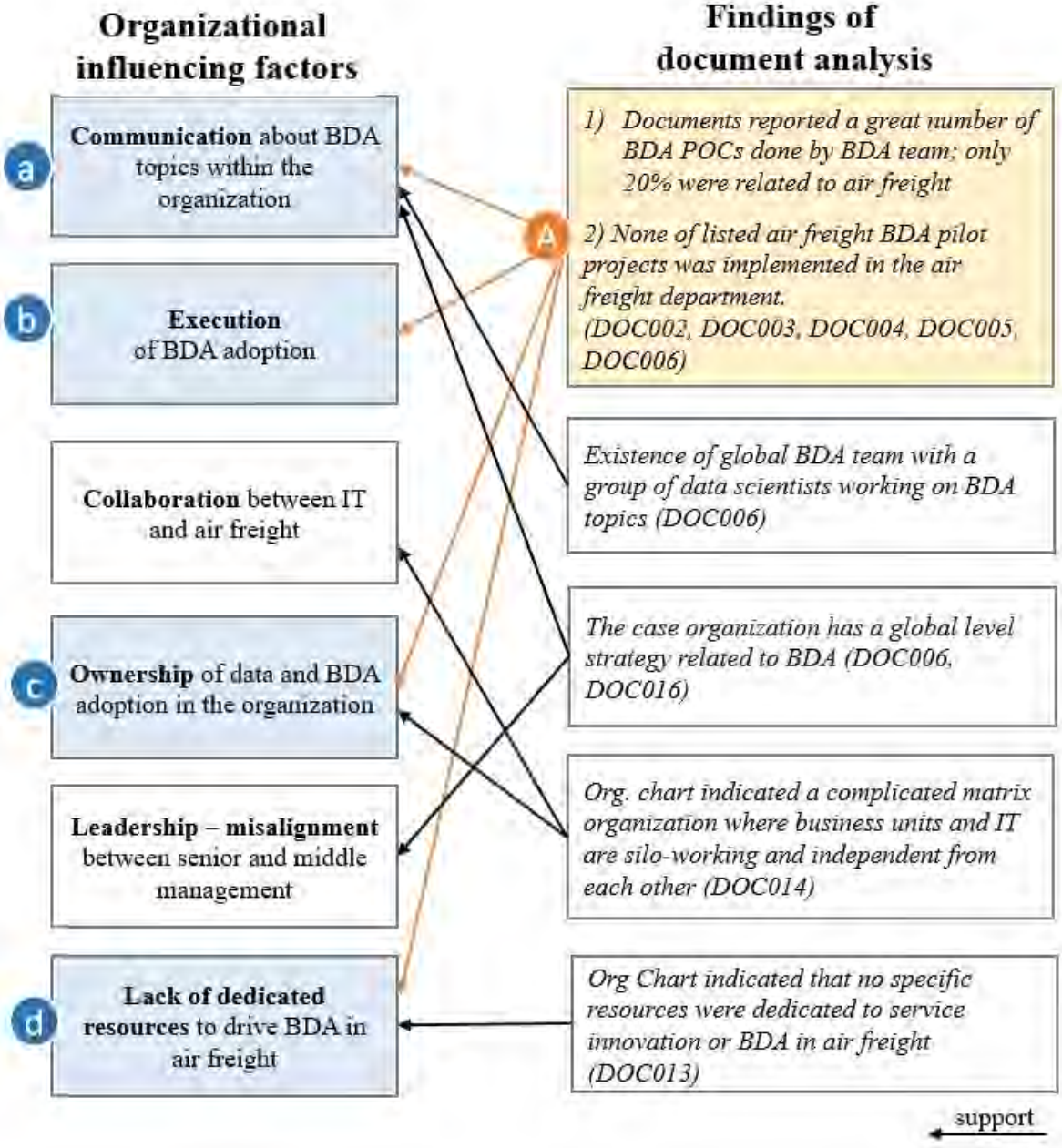
1) Little (or no) information on these BDA POCs was communicated within the organization; and nobody knew/talked about these BDA projects in air freight reflecting the poor communication about BDA topics within the organization (Box a).

2) Twenty per cent (20%) of BDA POCs were related to air freight, but none of these POCs was scaled up within air freight operations of the case organization (Box b).

3) This pointed to the fact that there was insufficient execution of BDA adoption and unclear ownership in driving BDA adoption within the organization (Box c).

4) The fact that no BDA POCs was scaled up in air freight operations of the case organization indicated that a lack of dedicated resources in driving BDA applications in air freight operations (Box d) .

Figure 21 Analyzed Documents Supported the Findings of Organizational Influencing Factors

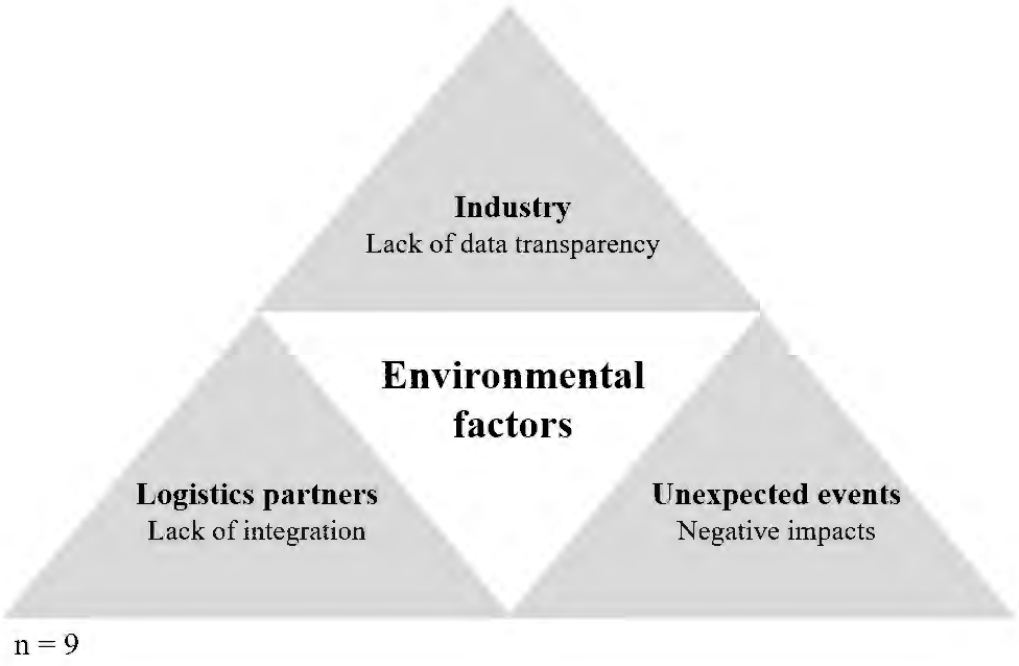


4.4.3 Environmental Influencing Factors

Environmental factors refer to those external elements outside the organization that impact on the adoption of BDA, such as the respective industrial environment, competitors' engagement

levels in adopting BDA technology and information intensity (Gangwar et al., 2014). Compared with technological and organizational factors, environmental factors featured less in this study. Three environmental factors raised in this study and discussed briefly below are *low data transparency* in the air freight industry, the *lack of integration among logistics partners* and the *impact of unexpected events* (see Figure 22).

Figure 22 Summary of Environmental Factors



The first environmental factor is the *low data transparency* in the air freight forwarding industry, due to the compliance and governance of laws and regulations, such as the competition laws in the logistics industry (Interviewees SG16 and SG07). Data transparency is treated as an environmental factor because of its scope of influence. It is linked with data availability of external sources, another technological factor identified in the previous section.

The second factor is the *lack of integration and data sharing* between partners. Yet, data integration is integral to BDA adoption in the air freight industry because "…parties are involved in the entire supply chain: the freight forwarders, airlines, the shippers, the consignees, various customs authorities", said Interviewee SG16, and "there's the need for the entire processes to be integrated, which is not existing today unfortunately". These parties are hesitant about sharing data with each other "for the good reason because they are not in a socialistic monopoly, but in a competitive environment where people don't want to share" (Interviewee SG02).

The COVID-19 pandemic is one example third environmental factor, namely the impact of unexpected social events on BDA adoption in air freight. The pandemic has distracted the organization's drive for technology innovation over the past three years. Predictive analytics did not help much during the pandemic, as it was hard to predict what would happen and this brought much uncertainty for the air freight business. Innovations such as BDA were intentionally slowed down because the team concentrated on operational activities. The disruption that the pandemic brought to BDA was, Interviewee SG09 believed, "a pause in the development rather than an abandonment"; and the drive for change would be picked up again sooner or later.

The Findings 2 section of the thesis has reported on the results of this research project relating to research sub-question 2, identifying factors influencing BDA adoption in the air freight industry from technological, organizational and environmental perspectives. All identified influencing factors are important to BDA adoption, although some have a greater influence than others. From a business perspective, it is not feasible to assess all the influencing factors due to the resource capability of the case organization (i.e., time, money and people). These findings indicate that management's attention should be given to more critical influencing factors, such as infrastructure and data quality (technological), and culture and resource capacity (organizational) as these factors may significantly hinder BDA adoption if they are not managed properly. The

findings pertaining to cultural factors such as communication, execution, collaboration and ownership of data, were further supported by those obtained from the document analysis.

4.5 Findings 3 – Utilizing BDA to Improve Service Innovation

The findings reported in this section answer the last research sub-question, *How can BDA improve service innovation in air freight of the case organization*? The findings are divided into three components: 1) the suitability of BDA adoption for air freight forwarders; 2) the benefits of BDA adoption for air freight forwarders and 3) utilizing BDA to improve service innovation for air freight forwarders from technological, organizational and business application perspectives.

4.5.1 Suitability of BDA Adoption for Air Freight Forwarders

Interviewees were asked the same question, "Do you think BDA can improve service innovation for air freight operations in your company?" and they all answered with "Yes, it can". All participants agreed that air freight forwarding industry was an appropriate place for BDA application for the following reasons: *firstly*, because traditional air freight forwarding services have largely remained the same in past decades and would otherwise probably continue to do so. This situation opens up many possibilities for exploration and indicates high potential for BDA utilization. *Secondly*, the enormous data being generated and processed by AFFs would provide data analytics with a sufficient data base. For example, BDA adoption could make it possible to provide customers with accurate and resilient predictions about shipments, such as about flight punctuality at different airports. Real-time data visibility strengthens the precision of estimated time of arrival information. AFFs dealing with a lot of high value and time-sensitive products would have the advantage of utilizing shipment data for advanced analytics and trend/development predictions. Such information could bring valuable insights into strategic planning and decision making. *Thirdly*, undiscovered values of data analytics might bring potential unknown values to

the air freight market and other industries as well. This point is well described by Interviewee SG18: "air freight is an early indicator and air freight forwarders have massive data which are extremely powerful such as providing macroeconomics insights".

4.5.2 Benefits of BDA Adoption for Air Freight Forwarders

BDA can bring significant benefits to air freight forwarders, if adopted properly. The findings from the interview data analysis suggest that data analytics helps AFFs in two major areas:

- *BDA helps improve decision making*
- *BDA helps improve service innovation*

BDA helps in making improved decisions in the air freight business. BDA enables air freight management to make better decisions for air freight operations and business development and strategy. Table 14 below provides a list of examples where BDA can result in better decision making for air freight forwarders. In air freight *operations*, many predictive analytics can provide insightful information about future trends or possibilities based on a combination of historical and current data. For example, capacity procurement is the biggest cost component in the air freight forwarding business. BDA helps AFFs in managing costs and ensuring a good quality of service delivery to customers. Various predictive analytics can support decision-makers evaluating the demand and supply of capacity in specific markets before they decide how much capacity to procure from airlines for the upcoming months (or year). BDA-generated information can provide insights on market demands, trade lane development trends, air freight service prices development trends and customers' behavior. Based on the information available, decision-makers can therefore procure freight capacity as per expected demand: it ultimately "helps us in terms of preparing ourselves to make sure that we secure enough solutions or capacity to meet our customers' demands" (Interviewee SG03). Another statement from Interviewee SG16 demonstrated how real time

visibility of shipment movement provided by BDA can achieve better service quality and efficiency for customers:

> …Big data helps us track our shipments from production to destinations and enable us to see if there are deviations in these shipments in terms of temperature, humidity, or shock. so that we can monitor the quality level of our transport chain. We can identify certain patterns to improve our quality of our transport chain. I think Big Data helps. (Interviewee SG16)

BDA also helps management team make better *business development* and *strategy*-related decisions. For example, in the process of customer quotations and Requests For Quotations (RFQs) submissions, BDA helps air freight managers verify the accuracy of information, reducing potential decision errors. Data-based predictions of customers' behavior facilitates sales planning in business development. From a strategy perspective, BDA helps in projecting comprehensive business trends, so that the air freight management can make quicker decisions and take faster actions.

Table 14 Summarized Benefits of BDA in the Air Freight Forwarding Business

Type of value/benefit	Value/benefit of BDA application
Operations	helps assess cost competitiveness to improve procurement planning enables small tools and applications to optimize procurement process enhances efficiency and achieve financial savings predicts demand/supply to improve procurement planning predicts operational abnormality predicts service deviation and potential risk predicts volume forecast which ultimately improves procurement accuracy provides real time visualized information replaces routing repetitive decision makings
Business development	improves service/product user experience predicts customer behavior and customer churn predicts the future looks in customer targeting strategy supports customer hunting/focus strategy supports pricing negotiation with insightful customer information verifies facts and figures before customer quotations to reduce decision errors verifies the accuracy of customers' information with customer analytics data
Strategy	helps to project industry trends and outlook etc. helps with strategic recommendations for service improvement

However, not all decisions can be supported with BDA, as individual experience and gut feeling remain critical and irreplaceable in making some decisions. “Having the data will tell a story but there’s no downside to having the data”, said Interviewee SG09, but “don’t let the data decide for you”; the decision-makers should “use their critical thinking and the brains to do that.”

The majority of participants in this study believed that *service innovation can be improved through BDA*, if adopted properly. Broadly speaking, air freight forwarding remains a traditional price-driven business, and most AFFs perform homogeneous services. If any company thinks of innovations, BDA should be brought in as “BDA allows company to see things which have not been visible in the past”, such as data prediction or data forecast that “opens completely new fields of monetization for the company” in the long run (Interviewee SG02).

BDA applications can be applied in the three broad areas of operations, business development and strategy as identified in this study and featured in Table 12 (above). This was the

general consensus among the managers interviewed. The benefits of BDA in decision making and service innovation improvement are yet to be proved through the achievement of more successful real business practices. The next sub-section based on analysis of the interview data suggests how BDA can be utilized to improve service innovation in the air freight industry.

4.5.3 Utilizing BDA to Improve Service Innovation for Air Freight Forwarders

This section presents recommendations made by interviewees about how AFFs can utilize BDA to improve service innovation. The findings are grouped into three categories: 1) *technological recommendations* on data quality, data acquisition and system integration; 2) *organizational recommendations* about culture, human resources and leadership and 3) *recommendations for utilizing BDA* in various business aspects of the air freight forwarding services, including services and solutions, operational efficiency, business development and quotation enhancement, as well as procurement optimization. Technological and organizational recommendations were based on the findings related to the respective technological and organizational influencing factors in BDA adoption discussed in the previous section (4.4), which constitute necessary organizational foundations to be considered in adopting BDA. Integrating BDA into the air freight business can help AFFs to improve their service innovations internally and externally. Internally, operational efficiency and process optimization are enhanced through adapting BDA-driven business models and practices. Externally, customer retention ratio and customer satisfaction level are elevated through continuously offering data-driven innovative products and solutions to their customers. More details of these recommendations are presented below.

Technological Recommendations

From a technological point of view, data and infrastructure are two key elements in BDA adoption. Recommendations were made that relate to *data quality, data acquisition and system*

integration. Maintaining decent data quality is a perquisite for BDA adoption. Operational standardization in air freight business processes helps to improve BDA quality: "more standardization in operation and processes will help to improve data quality", according to Interviewee SG12. Why is it very difficult for organizations to obtain certain external data? It is commonly due to purposive data protection by other parties or potential technical roadblocks in data exchange. Data acquisition comes before data analytics, since "BDA is based on the assumption that all data is available" (Interviewee SG07). Hence evaluation should be firstly conducted to identify what data are available (and worthy) to collect before any BDA application is adopted. Both internal and external data are valuable; however an organization should focus on its internal data as "internal data is something that makes the company unique and gives it a competitive advantage", while external data is normally public information that may "be obtained by other competitors easily" (Interviewee SG11).

Diversified transportation management systems hinder an integrated freight forwarder from offering out-and-out shipment visibility to their customers. The interview data analysis results indicate that individual systems of different logistics services in the case organization should either be closely interlinked to each other or be integrated within a neutral platform. An integrated platform receives data from various isolated systems and stores it for advanced data analytics. It is a cost-effective alternative solution for organizations whose diversified systems are hard to replace. Finally, at the present time, shipping data in air freight operations are largely maintained in a manual way. However, the findings point to the need to replace manual data entry by automation to eliminate chances of human errors.

Organizational Recommendations

From an organizational perspective, analysis of the interview data points to recommendations concerning the case organization's culture, human resources and leadership in

BDA adoption of air freight business. Two culture-related recommendations involve *improving in-depth communication* and *enhancing cross-department collaboration.* In-depth communication to raise awareness of BDA should be carried out at different levels in the air freight operations of the case organization, especially in middle management of the country organizations. The BDA adoption strategy should be passed down from head office to the ground level through proper communication. As mentioned by Interviewee SG08, the first step would be "to create awareness and create understanding; it is the first thing to overcome these challenges in BDA adoption." To obtain the *buy-in* and supports from middle management, it is critical to make them aware of the value and the success stories of BDA adoption in the air freight industry. BDA concepts, especially methodologies and analytics methods behind the screen, remain quite conceptual to many people in the air freight business.

Adopting BDA is a change management topic, as Interviewee SG04 stated: "introducing data-based decision making in an organization is a massive transformation for people" because it is about "*changing behavior"* and "*making people trust the data*". The data analytics team (IT department) can increase BDA awareness of people in the air freight business through initiatives, such as conducting basic BDA training, inviting air freight to carry out BDA pilot tests and sharing more success stories about BDA adoption in other freight services. People would be more convinced and open-minded about embracing BDA if they know more about the topic and if there was more communication about policies and implementation guidelines in BDA adoption.

As noted earlier, the air freight industry is falling behind in innovation and BDA utilization. One reason for this is the lack of collaboration between data scientists and air freight department. Comprehensive cross-department collaboration would facilitate the utilization of BDA in the air freight industry. *Collaboration* has two layers of meanings: the first meaning is that air freight forwarders should collaborate with other freight forwarders (e.g., ocean freight forwarders) in terms

of data source integration and BDA practice sharing. BDA needs to be cross-disciplinary to work in any part of a business, as "it needs to be an alignment between the different parts of the business, because it's one topic but directly benefiting all business units" (Interviewee SG05). The second meaning is that air freight forwarders should collaborate with the data scientists for joint discussion of BDA initiatives and push for BDA adoption in its business field, because "data is the combining element and the connection between product and data scientists". However, the findings of this study indicate that, in the case organization, "these data scientists in global head offices are too far away from the countries" (Interviewee SG04). Therefore, Interviewee SG05 proposed that "an open community of data-driven people in the air freight department should be built up and BDA evangelists are appointed either in big countries or on regional levels, which will be supported by the data analytics team in head office." Similarly, Interviewee SG18 emphasized the necessity of collaboration between air freight and data scientists:

> … It is about bringing these data scientists together with operations to create a platform for collaboration, and the BDA team understands their daily problems. If the people are not brought together, then there are highly academic discussions going on between on the corporate level, but it won't bring the company forward. So that's one and only recommendation I could give, bring the data scientists to the operations front. (Interviewee SG18)

Two recommendations related to human resources are to *improve air freight knowledge of existing data scientists* and to *build a BDA center of excellence in air freight*. The current set up of data analytics team in the HO is a good start of the case organization, but it does not guarantee the full success of BDA utilization. The full extraction of BDA value appears to be restricted by data scientists who have little or no business knowledge. Data scientists cannot work in silo. They should know "how to extract the useful information from the data, what to analyze, and the ultimate results of data analytics should be something that they consult and collaborate very closely with the air freight department" (Interviewee SG03). To equip themselves with business knowledge, data scientists should "sit close to the air freight department and understand the customer problems"

(Interviewee SG18). At the same time, building up a "*center of excellence*" community in air freight organizations is deemed appropriate, where these dedicated resources can "help the line functions to build analytics, the dashboards, KPIs which are really triggering actions that leads to more data-driven decision making in air freight" (Interviewee SG04). The availability of both data scientists who know BDA methodologies and the dedicated air freight resources for driving BDA adoption are fundamental to *translating* BDA from concept to practice. Additionally, data quality governance should be set up properly in the air freight operations. In particular, dedicated data stewards should be available to take care of the data quality at different levels of the air freight organization.

Leadership, in terms of management support and commitment, are the most powerful forces in driving organizational change (in this case, BDA adoption) for an organization. Strategic directions, such as transformation in data-driven decision making and data quality governance in air freight, should be set up by top management before it is further cascaded down to the regional and country organizations for execution. However, little findings were identified particularly related to leadership in this study.

Utilizing BDA

There are two broad types of BDA utilization in the air freight business — external, and internal uses. Within each type, utilization is further divided into categories. Within external use, BDA can be used for *services and solutions* and *business development*; internal BDA use involves *operational efficiency, quotation enhancement* and *procurement optimization*. Table 15 below summarizes these categories with specific recommendations given by the interview participants.

Externally, BDA can be utilized in air freight operations to offer innovative value-added services and solutions to the customers. Given that visibility and prediction of cargo movements are important to customers, data-driven services that offer shipment visibility and predictive

information can be commercialized as new innovative products for customers. Business development applications of BDA include developing a new customer hunting strategy and better understanding customers' demands through a series of data analytics. BDA optimizes the customer hunting process by helping the organization to target new customers precisely. The quality of customer service can be improved when customers' demands are acknowledged and properly met by the organization.

Internally, BDA can be applied in the areas of operational efficiency, quotation enhancement and procurement optimization. Data visibility and data transparency improve operational efficiency in air freight operations. For instance, air freight managers can obtain computerized proposals of shipment consolidation through data-driven artificial intelligence on digitalized platforms. Higher profits can be yielded through such optimized consolidation, which would enable an organization to offer more competitive rates to their customers. These five categories are further discussed in following sub-sections.

Table 15 Summary of Areas of BDA Utilization in Air Freight Business

Type	Share %	Category	Areas of BDA utilization
External	**35**	**Services and solutions**	Data-driven supply chain visibility
			Omniscient control tower
			Partnership with customers
			Data-driven sustainability
	12	**Business development**	Identify new potential customers with customer data analytics
			Analyze customers' demands of different vertical markets
Internal	**35**	**Operational efficiency**	Improve shipment consolidation efficiency through big data platform
			Improve air freight network planning through gateway optimization
			Enhance air freight network collaboration through data transparency
			Improve air freight hub process optimization to relieve the congestion issue
			Provide historical data transparency to reduce operational errors
			Evaluate customer loyalty in digital connection with customers
	9	**Quotation enhancement**	Support RFQs or customer quotations with big data
	9	**Procurement optimization**	Improve procurement decision-making process

Services and Solutions

BDA can be utilized to offer various innovative solutions to customers, enhancing the service innovation capability of the case organization. Four innovative solutions can be driven by BDA adoption: *data-driven supply chain visibility; an omniscient control tower, partnership with customer* and *data-driven sustainability.* Taking omniscient all-knowing control tower as an example, Interviewee SG11 explained how predictive data analytics help customers in choose alternative, better flight routing solutions with immediacy in unexpected weather situations:

> For example, knowing there is a thunderstorm in Shanghai right now, let's fly to Nanjing instead and directly book a truck from Nanjing airport to Shanghai warehouse according to the data. And this is technically possible but extremely complex. I don't see anyone right now being able to do that. But if you want to have a long-term vision, then this omniscient control tower is the long-term vision of what you can achieve with leveraging big data. (Interviewee SG11)

Business development

Recommendations for business development apply to both existing and new customers. BDA can support business development activities of AFFs in *two* ways, as described below:

Identifying potential customers with customer data analytics

Advanced analytics of customer data, such as customer behaviors and vertical market trends development, can help AFFs to target the *right* customers. Apart from historical shipment data that can be obtained internally, much external data is hard to collect. For example, data related to competitors and emerging markets are beneficial to AFFs, because the information allows business leaders to know what is happening in the market and how competitors are behaving.

Analyzing customers' demands in different vertical markets

AFFs have their individual vertical customer portfolios based on their respective operational strengths and advancement (e.g., AFF 1 specializes in handling pharmaceutical customers, while AFF 2 dominates in handling automotive customers). Different vertical markets have different patterns, and these different customer demands subsequently affect freight capacity planning during the peak season. Sustainable customer relationships are properly maintained through fulfilling customers' demands, and BDA can support AFFs in procurement planning to achieve customer demand fulfilment.

Operational efficiency

Improving operational efficiency internally leads to service improvement externally in the long run. Participants recommended a great number of areas where BDA can be embedded to improve the operational efficiency of air freight forwarders. BDA can help to improve shipment

consolidation efficiency, enhance air freight network planning and collaboration, and achieve air freight hub operation optimization. The six recommendations discussed below indicated how BDA adoption may improve operational efficiency in the air freight industry:

a. Improving shipment consolidation efficiency through a big data platform

Air freight shipment consolidation is mainly done manually in the case organization at present. It is a tedious but important activity in air freight operation. A digital platform that integrates all shipment data ready for consolidation supports air freight managers to make better decisions about cargo consolidation. Theoretically, "if you have the dimensions of every single package coming in, you could calculate how you can load your pallet best" (Interviewee SG07). In the end, this BDA-driven cargo consolidation improves operational productivity level in air freight operations by reducing tedious manual calculation and coordination in shipment planning.

b. Improving air freight network planning through gateway optimization

Gateway optimization refers to air freight operation network planning and shipment flow visibility and prediction. Utilization of gateway operations improves internal air freight network planning. The bargaining power of the AFF with respective airlines is increased because of its capacity commitment through better gateway utilization. BDA-enabled cargo tracking and prediction of arrival time in destination airports help AFFs and their customers in better business planning. Another example is crowd-based pickup and delivery. AFFs can determine pickup/delivery routings based on available real-time data and respond instantly to customers' demands. BDA-driven routing decisions ultimately help to achieve cost saving and time saving for both AFFs and their customers.

c. Enhancing air freight network collaboration through data transparency

Visibility on shipment arrival in destination countries is currently very limited due to the diversified systems of the case organization. A lot of time and effort could be saved for destination offices if such visibility was available to them. Activities such as calling overseas counterparts, sending emails back and forth, investigating and clarifying shipment details could be eliminated considerably. As the current backbone systems in the case organization do not provide this data transparency, a *cloud-based solution* where shipment information could be shared in a timely fashion may solve this challenge instead.

d. Improving air freight hub optimization to relieve the congestion pressures

According to Interviewee SG10, "BDA can help with air freight hub optimization in air freight". Since the COVID-19 pandemic started in 2020, a number of large air freight hubs (e.g., Frankfurt, Chicago, Hong Kong and Shanghai) have been completely congested due to the reduced available capacity of secondary hubs. One reason for this has been that many of these secondary hubs or airports relied heavily on passenger airline operations. In addition, ground handling capacity has been an issue for these large air freight hubs for a long time. By obtaining the latest visibility of local situations in these hubs through BDA, AFFs could actively communicate with ground handling agents and take preventive actions earlier and before the situation worsens, which would ultimately avoid potential shipments being withheld or delayed due to hub congestion.

e. Providing historical data transparency to reduce operational errors

BDA can analyze historical data for AFFs to identify areas where mistakes were made and propose areas for improvements. BDA helps air freight management to "focus on making the past much more transparent with the data exchanged and learn in terms of mistakes" (Interviewee SG07). For example, if data analysis reports of selected shipment routings show a high number of repeated damages in the past six months, further investigation could be carried out to find out the root causes

of the damage, and accordingly corrective actions could be proposed to avoid the same damage from happening again in future shipments.

f. Evaluating customer loyalty through digital connections with customers

AFFs have started to develop and launch different digitalized platforms in the market in recent years. Many of these new digital products are beneficial to freight forwarders in offering new sales channels or generating new revenues, but they also weaken customer bonding as customers are connected through online platforms and not through personal relationships anymore (as air freight forwarding business has done in the past). To maintain more stable and long-lasting customer relationships, BDA analytics can help AFFs to assess customer satisfaction with the use of these digital products and focus on areas for improvement accordingly.

Quotation enhancement

Quotation involves ad hoc customer quotations and regular RFQs. BDA can support air freight management in improving the quotation process and enhancing quotation accuracy. RFQs are service contracts between customers and AFFs that entails quotations for relevant air freight services. Efficient RFQs management is critical to AFFs because the quotations determine the profit margin of the air freight business. The findings indicated that most of the air freight RFQs in the case organization were managed by human effort. Data was normally entered into an Excel worksheet and exchanged repeatedly among various persons before the final RFQ file was submitted to the customer. Limited data transparency was available to RFQ managers as no digital database was shared. Interviewees SG04, SG09 and SG16 proposed that BDA should be integrated into the RFQ process, improving the efficiency of RFQ handling internally as well as of quotation accuracy for customers externally.

Procurement optimization

As one of the key operational activities in air freight, capacity procurement determines the level of business profit margins and the level of customer satisfaction. BDA can help to improve the procurement process through data visibility and predictive analysis. The more accurate the procurement, the higher the chance of fulfilling customers' demands in cargo movement, and the lower the risk of potential financial loss. The findings revealed that majority capacity procurement decisions in air freight are primarily based on personal experience and gut feeling. Based on available data, BDA helps to forecast customers' capacity demands and analyze the freight capacity supply of the airlines. Such insightful information can help the business leaders to make proper procurement decisions. Optimized BDA-driven procurement guarantees shipment uplift, improved customer service quality and, as a consequence, customer satisfaction.

The Finding 3 section has reported the findings, predominately from the interview data analysis, that answer the third research sub-question, *How can BDA improve service innovation in air freight of the case organization?* Based on its study of the case organization, the section suggests the suitability of BDA adoption for the AFF industry because its traditional business model has the need and potential for service innovation and because of the availability of massive data for advanced data analytics. The findings indicate that BDA enables air freight management to make better decisions and improves service innovation by providing data-driven services to customers. Lastly, technological and organizational recommendations are made, followed by recommendations for embedding BDA applications into various business areas that could ultimately help to improve the service innovation capability of the case organization and, by extension, of AFF more broadly.

4.6 Chapter Summary

This study explored BDA adoption and its integration with service innovation through a qualitative case study that was conducted in a global air freight forwarding organization. Derived from in-depth interviews and document analysis, the major findings were organized in three sections that answered each of the research sub-questions posed in this study. The *Finding 1* section elaborated the current situation of service innovation and BDA adoption in the case organization through five perspectives. The study revealed that the traditional and time-sensitive nature of the air freight business is closely related to processes, people, and systems, respectively. Decision making is one of the key activities for effective business management. This first set of findings related to decision types, management decision-making approaches and challenges in using data in decision-making process. Customer satisfaction motivates AFFs towards continuous business improvement, making it vital to understand customer demands. The findings showed that data visibility and analytics ranked highest among the listed customer demands of air freight forwarders, which indicated the increasing importance of BDA in creating added value for customers. Lastly, the current status of service innovation management and BDA adoption in the case organization were reported. The participants provided both positive and negative feedbacks on service innovation that emphasized there is huge room for improvement in this area. Topics related to BDA adoption in the case organization, such as the staff awareness, BDA applications, resources in driving BDA adoption, were examined. Overall, limited BDA applications in air freight operations in the case organization were available and reported.

The *Finding 2* section reported on various factors found to influence BDA adoption based on application of the TOE framework to the data analysis. Four technological influencing factors were identified in the areas of systems and infrastructures, data quality, data availability and data

speed. Also found to influence BDA adoption were three organizational factors, namely, organizational culture, resource capacity and leadership. Examining of the organizational culture of the case organization allowed the researcher to further identify five areas that affected BDA adoption: insufficient communication on BDA topics from the top to the bottom level of the organization; execution and lack of collaboration in driving BDA between silo-working departments; verifying BDA awareness and perceptions at different levels of the organization; and lastly, lack of clarity for the IT and business units about ownership for BDA driving and execution. The document analysis findings indicated that organizational documents about relevant BDA POCs were not communicated within the organization and people seldom knew or talked about these BDA projects in air freight operations. This reflected the poor communication about BDA topics within the organization. Although few environmental influencing factors were identified in this study, one main factor to be considered and that emerged from the interview data analysis was the negative impact of unexpected social events (e.g., COVID-19 pandemic). Such events were shown to have affected the way the case organization managed service innovation and BDA adoption, particularly in the areas of strategic direction and execution prioritization.

The third set of findings reported in this chapter, *Findings 3*, highlighted the fact that the air freight forwarding industry is a mature industry for BDA applications due to its potential for service improvement and its massive data available for advanced analysis that can add value for customers. The findings indicated that BDA adoption can help to improve decision making and service innovation. BDA enables air freight management to make better decisions in air freight operations, business development and strategy. However, analysis of interview participants' responses also showed that not all decisions can be supported by BDA, as individual experience and gut feeling remain critical and irreplaceable in making some decisions in air freight forwarding business nowadays. A set of recommendations to improve service innovation through BDA were

presented from internal and external perspectives. The recommendations were drawn based on comprehensive analysis of the case organization and the air freight forwarding industry as a whole. The next chapter discusses these findings to shed light on how knowledge about and practice of BDA utilization can contribute to improving service innovation in air freight forwarding industry.

Chapter 5 Discussions

5.1 Chapter Introduction

This chapter discusses the findings of the research project, in great part through a dialogue with the literature, to shed new light on the present-day understanding and practice of BDA in air freight forwarding industry. Service innovation is critical to business performance (Gunasekaran et al., 2017) and BDA suggests a new direction for enhancing service innovation to achieve a business advantage. However, few empirical studies on BDA adoption in the logistics industry are related to air freight forwarders. This research aimed to obtain a better understanding of the current status of BDA adoption and service innovation in an international air freight forwarder, to identify influencing factors for BDA adoption and to explore the linkage between BDA and service innovation in air freight forwarding industry. Based on an evaluation of the current situation, the study findings revealed that the nature of the air freight forwarding business remains traditional, less innovative and time sensitive. The structured review of influencing factors in BDA adoption guided by the TOE framework indicated the importance of influencing factors such as data quality, infrastructure, cultural and resource capacity in BDA adoption. In light of this updated understanding of the air freight business and of challenges in BDA adoption, the study proposes a series of practical recommendations for improving service innovation through BDA utilization by air freight forwarders in the industry. This study not only advances academic knowledge in the research fields of service innovation, BDA adoption and the logistics industry; it also has insightful, practical implications for business leaders and industrial practitioners in utilizing BDA to drive service innovation in the air freight forwarding industry.

The structure of the present chapter is organized as follows: section 5.2 starts with a brief recap of research problem and research aim; section 5.2 discusses how the study findings advance

the current knowledge base about service innovation, BDA and the logistics industry; and section 5.3 draws on the knowledge advancement represented by this study to elaborate the practical implications that can contribute to air freight forwarders improving BDA adoption and service innovation.

5.2 Advancement of Knowledge

This study has advanced new knowledge in understanding BDA adoption in the logistics industry, particularly in the air freight forwarding industry, in following four areas. *First*, it is the first experiential case study to have been conducted in a global leading air freight forwarder and to have extensively evaluated BDA adoption and service innovation in the logistics industry, thus helping to advance knowledge in the fields of BDA, service innovation and logistics research. Little empirical research and few case studies have to date purely focused on BDA adoption in the air freight forwarding industry. Despite the increasing research on BDA user cases in the logistics industry, these studies are mainly associated with SCM or logistics services in general (e.g., ocean freight and warehouse management services), but are not relevant to air freight forwarders. Those reported successful BDA user cases in the logistics industry may not be applicable to air freight forwarders due to differences in business nature and practices among LSPs. The speed of raw data collection and the level of urgency in data analytics readiness are varied in decision-making processes among different LSPs. More AFF-focused BDA studies, like the present case study, are needed in order to differentiate air freight forwarding services from the general logistics services.

Second, this research has explored the interrelationship between service innovation and BDA adoption, enriching the scholarly work in these areas through empirically applying them in the air freight forwarding industry. Theoretically, technology enables service innovation, so that the business performance of organizations can be further enhanced through offering BDA-driven

innovative solutions to their customers, which was not possible in the past. However, researchers have tended to focus on either BDA or service innovation in their studies, rarely linking these two topics together or exploring the interconnection between the two. Minimal research has explored the potential of utilizing BDA in service innovation at the organizational level, and there are hardly any studies about the actual practice of BDA adoption in the *real* business world (Hopkins & Hawking, 2018). A gap was identified regarding the need to translate this understanding about the use of BDA to pursue service innovation into effective organizational management. More management attention should be given to BDA as a potential source of innovation for organizations (Wallenburg, 2009). The findings of this study deepen existing understanding about BDA's values and its potential for improving service innovation in the logistics service industry, including logistics industry. The potentials of BDA for fostering service innovation in AFFs that was reaffirmed by this study serves as a practical pilot study for exploring the significance of technology adoption in business performance improvement in the business world more broadly.

Third, the findings further enrich interpretations of the nature of the air freight forwarding industry and of the industry's experience-oriented decision-making approach. The current status of BDA and service innovation revealed in this study restates the low innovativeness of air freight forwarding industry. The logistics industry in general is less innovative and more traditional, with LSPs seldom proactively engaged in innovation nor exploiting innovation potential (Wagner & Sutter, 2012). It has been noted that integrated innovation management is not widespread within the logistics industry (Grawe, 2009). Some researchers claim that BDA helps organizations make better decisions (Benabdellah et al.,2016; Raman et al., 2018;). The results of the research project reported in this thesis reaffirm the potential of BDA in improving decision making and also acknowledge the criticality of personal experience and gut feeling in making decisions in air freight forwarding industry, where business still heavily relies on personal relationships in customers'

engagement. The experience-based decision-making pattern identified in this study corresponds to the statement of McAfee et al. (2012), who argue that many organizations still make most of their important decisions by relying on "*HiPPO*" – the highest-paid person's opinion. The findings of the present study emphasize that BDA may not be applicable for all kinds of management decisions, and that the efficiency of BDA value extraction for organizations therefore depends on the nature of the business itself and on decision-making preferences, which may vary from one organization to another.

The study shows that BDA value extraction in the logistics industry is still in its infancy stage and the case organization is not yet ready for BDA adoption. The findings from this study are consistent with the claim by McAfee et al. (2012) who states that many organizations are not ready to embrace BDA for improving business performance. The findings provide a holistic understanding of BDA adoption and the need to suggest tailor-made solutions to management about corporate strategy prioritization and execution, an idea which is substantiated by Mikavicaa et al. (2015) in their research on the emerging potential of BDA and its applications. Additionally, this study has taken further steps to show why the case organization is not ready for BDA adoption from three perspectives (process, people and system), confirming and/or extending understandings about BDA adoption in the existing literature. Successful BDA adoption in the air freight forwarding business is largely determined by the overall openness of AFFs to BDA technology, the availability of its industrial data and the strong engagement of AFFs within the industry. Once the industry is practically ready for BDA adoption, AFFs can proactively speed up the adoption process to place themselves ahead of their competitors. BDA adoption depends on the overall readiness of AFFs, including the readiness of their integrated systems and the availability of good quality data, as well as the strong engagements of both management and employees within the organization.

Last, this study extends current knowledge about influencing factors in real-life BDA adoption through the TOE framework, which made visible salient factors that affect BDA adoption in the air freight forwarders in a systematic way. The study confirms existing knowledge about technological factors, such as data quality and infrastructures, and organizational factors, such as culture, remaining important factors that influence BDA adoption. It also extends current understandings about human resource capacity from a new perspective. Impact by unexpected social events is one newly identified environmental factor in this study that enriches the existing coverage of influencing factors included in the TOE framework.

Some scholars (Hopkins & Hawking, 2018; LaValle et al., 2011) claim that cultural and management challenges remain the most critical factors in BDA adoption. These findings are only partially supported by the study reported here, which found that cultural challenges remain critical in BDA adoption, but that managerial issues such as leadership, management commitment and support are less critical factors. Additionally, cultural factors were further evaluated through five organizational behaviors (communication, collaboration, execution, perception and ownership of BDA) providing a deeper understanding of cultural challenges from different investigation lenses. Human resource capacity, such as data scientists, is crucial to BDA adoption. One of the commonly discussed challenges for human resource capacity is the shortage of data scientists (Alharthi et al., 2017). However, while the case organization was equipped with adequate data scientists, the greatest human resource challenge was that these data scientists were lacking in business knowledge. This study has identified a new environmental factor, namely, unexpected social events (e.g., COVID-19 pandemic) that have significantly slowed down BDA adoption in recent years. Coping with unexpected events has emerged as an environmental influencing factor for inclusion in the TOE framework, and, as such, needs to be taken consideration by organizations in technology adoption.

5.3 Advancement of Practice

In many studies, the advancement of knowledge and implications for practices are interlinked, as practical implications are further derived based on the understanding of knowledge gained. This section starts by discussing the most significant practical implication of this study, which proposes a new way for management to think about and approach service innovation and explores its interlinkage with BDA technology. Next, it elaborates another practical implication of the study, which helps to bring innovative technology (e.g., BDA) closer to a less-innovative traditional industry (e.g., air freight forwarding industry) based on the discovery of new knowledge that was discussed in the previous section. Finally, the section presents a summary of specific practical implications for different stakeholders, including business leaders, industrial practitioners (e.g., BDA adopters and data scientists) and policy makers in the logistics industry alike. For business leaders and industrial practitioners, this study offers a strategic checklist to assess the organizational suitability and readiness for BDA adoption. At the same time, the comprehensiveness of influencing factors in BDA adoption and the BDA-embedded service innovation approach also provides them with an insightful guide to challenges in technology implementation for air freight forwarder management. Additionally, the findings of this study will benefit relevant policy makers and industrial associations in the logistics industry with constructive suggestions to improve and ensure industrial readiness for technology innovation as well as for diffusion.

A New way of Management Thinking about and Approaching service innovation

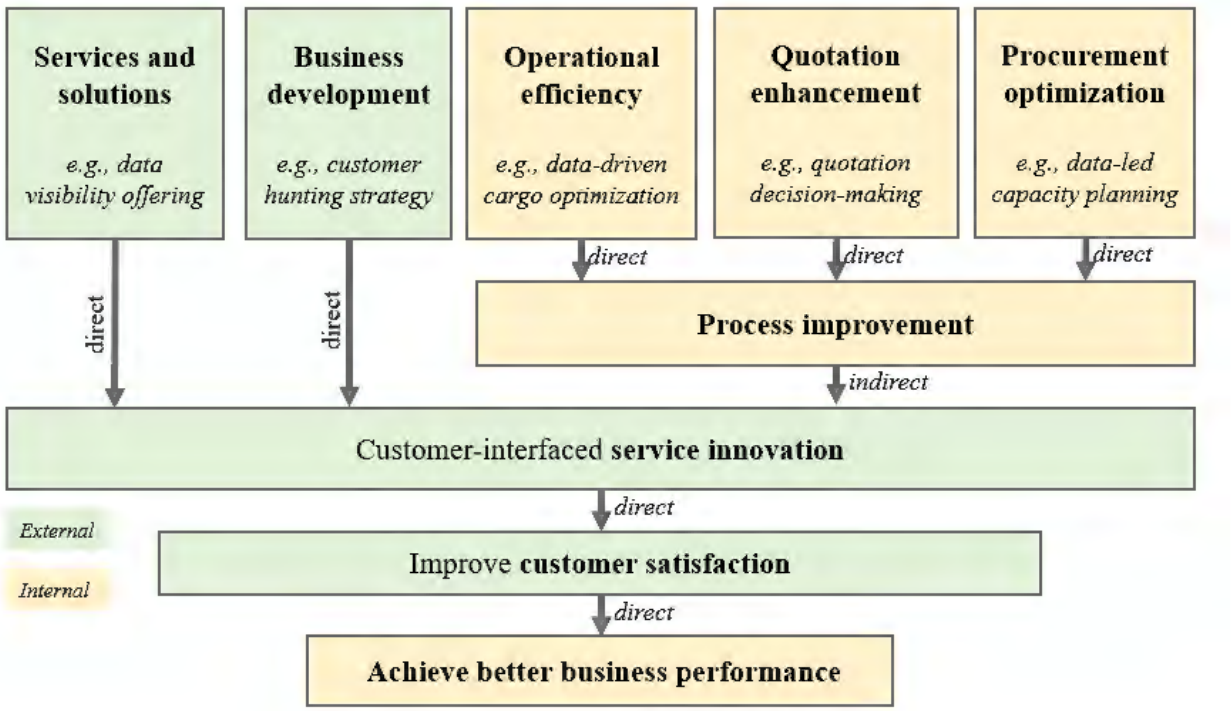
Service innovation has been widely defined and understood differently by various researchers and business executives. Service innovation does not only refer to external innovations that directly impact customers. Service innovation should not be limited to new services offerings

and internal service innovations related to operational efficiency; decision-making quality can also contribute to customer satisfaction. The purpose of service innovation is to fulfill customers' requirements in ways that ultimately improves the business performance of organizations. Service innovations can be achieved through embedding BDA applications in different business processes of the air freight forwarding services, such as air freight service solutions, business development, operational efficiency and procurement activities. BDA, as a new technology, is deemed a high potential source of innovation and should receive more attention by organizations (Busse & Wallenburg, 2011; Wallenburg, 2009). The findings of this study not only acknowledge the increasing attention to and supports of BDA technology by senior management in the case organization, but also reveal a deficiency of communication about the strategic direction required to move forward with BDA technology. Technology enables service providers to improve their efficiency and effectiveness and continues to be the main driving engine for innovation within the service industry (Chapman et al., 2003). As a popular innovative technology, BDA helps to make better informed decisions and improve the operational efficiency of an organization internally, which eventually leads to service quality enhancement and business performance reinforcement.

This study provided a practical investigation and helped to answer the pending question from Barrett et al. (2015) that how digital technology could be embedded in products to enable innovation in service systems. Recommendations for embedding BDA into different business areas of air freight and how this might be done were discussed in this study. Specifically, five business areas where BDA can be utilized were identified in this study. They range from services and solutions, operational efficiency, business development, and quotation enhancement to procurement optimization. Many researchers state that BDA enables business executives to make better, smarter decisions (Hopkins & Hawking, 2018; Ittmann, 2015; Wang et al., 2016; Watson, 2014). Appropriate BDA applications support business leaders in making more informed decisions

that eventually lead to greater financial results for organizations. This study explored the potential of embedding BDA in business activities and specified the business areas in the air freight business where BDA could be utilized in supporting better decision making in AFFs. Figure 23 proposes a BDA-embedded service innovation approach from an operational perspective and demonstrates how the approach can help to enhance customer satisfaction and ultimately achieve better business performance for the organization. From an external perspective, customer-interfaced service innovation capabilities can be directly enhanced through offering innovative services to customers, such as full data visibility of supply chain activities, and through a data-driven business development approach that is adopted in strategic customer hunting. From an internal perspective, BDA applications can be embedded into air freight business processes, such as operational, quotation and procurement activities. Eventually, air freight service processes are further improved in terms of operational efficiency, quotation accuracy and procurement optimization, and this internal service process improvement indirectly enhances customer-interfaced service innovation capabilities. Ultimately, customer satisfaction can be improved, and better business performance can be achieved through BDA-driven service innovations.

Figure 23 BDA-embedded Service Innovation Approach for AFFs



Technological and Organizational Readiness for BDA adoption

Technological and organizational recommendations that were proposed in this study serve as a strategic checklist for organizations to evaluate the readiness of air freight forwarders before adopting BDA. From a technological perspective, data quality and infrastructure are two critical challenges for BDA adoption by the case organization. Data is the key, and a decent quality of data is of the essence for advanced data analytics. No data scientists can conduct top-notch data analytics without the availability of superior data. Moreover, data needs to come with correctness and completeness, otherwise data analytics is just a "*garbage in, garbage out*" exercise. However, many organizations have legacy IT systems and, as such, it is more practicable to merge the present- day big data platform with their existing infrastructures, instead of building entirely new systems (Alharthi et al., 2017; Davenport & Dyche, 2013).

From an organizational perspective, this study reaffirms the importance of cultural change in service innovation and technology adoption for an organization, as the desire to innovate stems from its organizational culture. The efficiency of communication greatly affects other cultural factors such as collaboration and execution of BDA in AFFs. Strategically, a strong desire and willingness to drive innovations is crucial for AFFs to fulfil customers' evolving demands (e.g., for shipment visibility). For that reason, AFFs should closely align with their customers in cooperating and implementing innovations, as this alignment will fuel the future business growth of AFFs. BDA-driven services and solutions, in the form of service innovation, help to tighten relationships between AFFs and their customers, enhance customer retention, and improve customer satisfaction in long run.

Another cultural factor, human resource capacity, was found in this case study to be highly important in BDA adoption. This finding emphasizes the critical role of data scientists in BDA adoption, corroborating the views of other authors (Alharthi et al., 2017; Del Vecchio et al., 2018; Jones, 2013). However, the researcher has provided two new insights for understanding this factor: 1) the case organization lacks *experienced data scientists* who have knowledge about both data analytics skills and the air freight business; and 2) the case organization lacks *dedicated resources in air freight operations* to act as *bridge connectors* between the data analytics team and air freight business. Watson (2014) recommends that organizations hire sufficient data scientists to work on data analytics. These data experts are supposed to discover unseen patterns and relationships through analytical tools, and further turn these discoveries into actionable information for the organization. The findings from the interview and document analyses both showed that the case organization set up a team of data scientists in global head office in 2016, where more than thirty PhD-educated data scientists were hired to work on BDA for the entire organization. However, the findings also reflected that most of these data scientists majored in Mathematics, Physics,

Computer Science and Engineering, and had little (or no) air freight business knowledge. In other words, the case organization had adequate data scientists who know *how to analyze data*; however these data scientists do not have business knowledge of *how air freight business is run*.

Having skilled data scientists onboard does not guarantee successful BDA applications. Good data scientists are those who speak the language of business and help leaders reformulate their challenges in ways that big data can tackle (McAfee et al., 2012). Data scientists without relevant business knowledge may not understand the real problems of the business and what the end users really need. In the long run, they fail to deliver practical and constructive BDA solutions to the end users in air freight business. Given the importance of BDA in air freight industry, a mixture of business and data analytics expertise is needed to succeed in BDA adoption (Watson, 2014). Many organizations have an unfulfilled demand for data technology experts with a business background (Alharthi et al., 2017). To conclude, getting the right resources onboard with dual knowledge (technical and business) is critical for an organization's successful BDA adoption. However, the biggest challenge is not the imbalance of supply and demand of data scientists in the market, but the shortage of data scientists with dual-knowledge of technical data analytics skills and relevant business domain knowledge (of any industry that the hiring employer is in). Data scientists with dual-knowledge are hard to find and in short supply (McAfee et al., 2012). Because of the shortage of data scientists in the market, organizations tend to hire data scientists who have no mandatory business knowledge or experience. As an alternative solution, the study proposes to nominate a group of dedicated *bridge-connectors*, i.e., individuals who provide a virtual bridge whereby communication and coordination between data scientists and air freight employees can occur. Working in air freight and understanding the business very well, *bridge-connectors* could connect and communicate between the data scientists (in IT) and their air freight management (in business)in relation to all BDA topics. The existence of these *bridge-connectors* in air freight would

be critical in making sure the requirements of BDA applications are understood by the data scientists and eventually, the finished products (of BDA applications) are accepted and utilized by the end users. For example, a huge amount of data is produced in various systems in air freight every day and selecting useful data sets (i.e., data filtering) is the first critical step before any data analytics mechanism is established technically. These *bridge connectors* could clarify the business needs with air freight managers, and then work with data scientists closely in choosing appropriate data sets for advanced analytics. The finished products of BDA applications (e.g., analysis reports or results) would be translated into simple operational language by the *bridge connectors* so that information derived out of BDA can be understood by the end users in air freight.

A translation layer is found to be missing from converting BDA theory into BDA practice in the execution process of BDA adoption. This translation layer could be filled by the *bridge connectors* who would support the data scientists transforming BDA theories into practices. Additionally, the alignment between the air freight and IT department is one of the superior success factors of BDA adoption (DHL, 2013). The collaboration between silo-departments (IT and air freight) would be enhanced by the joint-efforts of the *bridge connectors* and data scientists. Deliberately, this alignment for BDA adoption could be greatly reinforced by the availability of both data scientists with dual-knowledge and the *bridge connectors* in air freight. Data scientists are essential resources needed for BDA applications in organizations. It is recommended that attention should be focused on identifying qualified data scientists with adequate business knowledge. At the same time, the findings of the document analysis revealed an absence of communication from the global level down to the country level of the case organization. For instance, information about a relevant BDA strategy and about the latest status of BDA POCs pilot testing that were conducted by the BDA team failed to be communicated properly within the organization. *Bridge connectors* would, therefore, be the appropriate communication ambassadors

between BDA adopters (in this case, the BDA team in head office) and employees. Onboarding *bridge connectors*, who can bring analytics-savvy data scientists closer to the business, is a practical alternative solution for organizations whose data scientists are not business equipped. An organization cannot tackle all challenges in BDA adoption at one time, due to its priorities, and limited available time, money and resources. Therefore, a strategic approach is needed to address, and control the most critical challenges in order for the company to move forward.

Management Implications for Stakeholders in the Logistics Industry

For business leaders and industrial practitioners in air freight forwarding industry, this study provides pragmatic guidance and solutions in three areas: 1) *assessment* of organizational readiness for BDA adoption; 2) strategic *planning and execution* of technology adoption and 3) BDA *utilization* to improve service innovation. Before making any decisions for technology adoption (e.g., BDA), business leaders of AFFs can utilize the study's findings, such as the list of influencing factors and technological and organizational recommendations to assess the organizational readiness and capabilities in adopting BDA. For example, systems and infrastructure is a critical factor to AFFs because many of them are still operated using diversified aged systems where data is not integrated. Thus, an evaluation of the technological readiness for BDA adoption can provide the management team with a clear picture of changes that need to be introduced before proceeding with the BDA implementation. The study reaffirms the suitability of air freight forwarding industry in BDA adoption, since mass data available in the industry would provide advanced data analytics with a solid data base.

The findings of the study emphasize the values of BDA and the great potential of BDA in improving the decision-making process and fostering service innovation for AFFs, reassuring those decision-makers who are planning BDA adoption for their organizations. A clear strategic vision of how BDA fits with the overall corporate strategy should be developed from the top management

team, as it helps to foster and congeal positive BDA acceptance within the organizational culture (Alharthi et al., 2017). Such a vision would need to start with a clear definition of the ownership of or responsibility for BDA adoption within the organization. Sufficient time and resources should be invested by business leaders in aligning managers, especially middle management across the organization in support of the mission and execution of the adoption process (Barton & Court, 2012). Proper in-depth communications on BDA related topics must be carried out from the top management to their middle-management and eventually, filter down to the ground staff. The findings of this study yield a better understanding of the nature of the air freight business, of management's decision-making behaviors and of evolving customer demands in the air freight business. This understanding provides insightful information for BDA adopters and data scientists who are adopting BDA in air freight, especially in designing customized BDA solutions from a business perspective. One of the most critical influencing organizational factors identified concerns the organizational culture. This finding elucidates the necessity of enhancing cross-department collaborations between data scientists and the air freight department to secure successful BDA adoption for air freight. Understanding the challenges in BDA adoption and knowing how to tackle them prevent organizations from being stuck or failing in the adoption due to unexpected challenges that may occur during the implementation. The service innovation approach (see Figure 25 above) proposed in this study is a comprehensive framework that closely connects BDA with service innovation. The proposal provides an intuitive demonstration of how BDA can improve service innovations that ultimately achieve better business performance for the organization.

For industrial policymakers in the air freight forwarding industry, the findings of this study offer an opportunity to obtain a rigorous understanding of influencing factors in BDA adoption. These policymakers can make use of the findings to formulate policies and regulations to achieve industrial data transparency and availability with the consideration of data sharing and data privacy.

The findings of this study show that major industrial players in air freight forwarding industry are hesitant and cautious to share their own data, possibly due to reasons such as data sensitivity, conflicts of interest, legalities and the potential destruction of their existing business models. The findings of this study provide valid corroborations for logistics associations such as IATA (International Air Transport Association) who aim to work out impartial and righteous data sharing regulations for industrial players, which would ultimately facilitate coherent BDA diffusion within the air freight forwarding industry.

5.4 Chapter Summary

This chapter has discussed the correlation between key findings of the research and the literature review that was presented in Chapter 2. The discussion shows how the study has advanced knowledge in the areas of BDA adoption, service innovation and the logistics industry and has practical implications for different stakeholders in air freight forwarding industry. The study is the first pragmatic case study focusing on BDA situated in a large air freight forwarding organization. At the same time, it represents a pioneer research project that explores the interconnection of BDA adoption and service innovation in the air freight forwarding industry. BDA improves service innovation. The study fills the gap in translating this understanding into effective organizational management and culture reshaping to pursue service innovation, providing a new way of thinking about service innovation. The chapter also presents a summary of specific practical implications for business leaders, industrial practitioners (e.g., BDA adopters and data scientists) and policy makers in the air freight forwarding industry alike.

Chapter 6 Conclusion

6.1 Chapter Introduction

An organization's competitiveness and profitability can be increased by adopting a data analytics strategy. The ability to use big data analytics in business enables organizations to access various information sources that contribute to better decision making (Ittmann, 2015). However, many organizations face challenges or difficulties in extracting the value out of BDA. The potential of using BDA for business decisions is case-dependent, and each organization needs to find out how they can utilize BDA to navigate their business (Ylijoki & Porras, 2016). The logistics service industry is comparatively less innovative than other industries (Cichosz et al., 2017) and the significance of innovation has been largely ignored (Bajec, 2011). Limited research has been undertaken to explore the status quo of BDA adoption at the corporate level in the logistics service industry. This research project aimed to evaluate the current status of BDA in the air freight forwarding industry, to identify the influencing factors for BDA adoption, and to explore the relationship between BDA and service innovation. The principal research question and its three sub-questions that guided the study were:

How can an international air freight forwarder improve service innovation through BDA?

1) *What is the current situation of service innovation and BDA adoption in the case organization?*
2) *What are the organizational challenges in BDA adoption in the case organization?*
3) *How can BDA improve service innovation in the case organization?*

To achieve the aims, an exploratory qualitative case study of a global leading air freight forwarder was adopted. In-depth interviews were conducted with a number of experienced managerial staff in the case organization to gather their feedback and suggestions on BDA adoption related topics. The findings of the study not only advance the knowledge about BDA, service

innovation and the logistics industry, but also contribute to practical implications that are beneficial to the logistics industry including the air freight forwarding industry.

This chapter starts with a brief recapitulation of the study, restating the research problems, research aims and research questions, respectively. Key findings of the study (Chapter 4) are presented in section 6.2 below and followed by section 6.3, a summary of its principal implications, which are discussed in the previous Chapter 5. The researcher then acknowledges the research limitations of the study and proposes some recommendations for future research in sections 6.4 and 6.5, respectively. Lastly, section 6.6 presents a short conclusion for the study as a whole to end the chapter.

6.2 Key Findings

The key findings of this study presented in Chapter 4 are summarized as below:

- Air freight forwarding industry is traditional, less innovative and time sensitive; the air freight business in the case organization is relationship-driven and operated with a lot of manual effort.
- Decision making in the air freight business still relies heavily on personal experience and gut feeling due to data unavailability or a lack of trust in data, which further hinders air freight forwarders from driving service innovation.
- The priority of air freight customers has steadily shifted from being price-focused to visibility-focused.
- Service innovation is underway in air freight forwarding industry, with contrasting positive and negative responses noticed; service innovation development in the case organization remains very limited, leaving huge room for improvement.

- BDA adoption in the air freight department of the case organization is still in its infancy stage; hardly any air freight BDA applications were implemented broadly within the case organization.
- A list of influencing factors for BDA adoption in the air freight industry was identified and examined through an analytical TOE framework. The findings from the interview and document analysis indicate that data quality, infrastructure, organizational culture and resource capacity remain critical factors in BDA adoption.
- BDA enables air freight management to make better decisions and service innovation can be further improved through offering innovative data-driven services and solutions to customers.

6.3 Key Implications

Key implications of this study, namely the advancement of scholarly knowledge and advancement of practice that were discussed in Chapter 5, are summarized as below:

Advancement of Knowledge

- This research represents a case study of BDA and service innovation, which was, for the first time, undertaken for a large air freight forwarder. The study has extensively examined and evaluated the status of BDA adoption and service innovation in the logistics industry, contributing to the advancement of knowledge in the fields of BDA, service innovation and logistics research.
- This research has explored the interrelationship between service innovation and BDA adoption, enriching the scholarly work in these two areas through empirically applying them in the air freight forwarding industry.
- The findings of this study also enrich interpretations of the business nature of the air freight forwarding industry and of its experience-oriented decision-making approach.

- The findings of this study extend existing knowledge about influencing factors in real-life BDA adoption through application of the TOE framework to data analysis, making visible salient factors that affect BDA adoption in the air freight forwarders in a systematic way.

Advancement of Practice

- This study proposes a new way of management thinking about and approaching service innovation and exploring its interlinkage with BDA technology.
- This study brings innovative technology (e.g., BDA) closer to a less-innovative traditional industry (e.g., air freight forwarding industry) based on the discovery of knowledge.
- This study offers business leaders and industrial practitioners in the logistics industry with a strategic checklist to assess the suitability and readiness for BDA adoption of their organizations. At the same time, the comprehensive identification of influencing factors in BDA adoption and the proposed BDA-embedded service innovation approach provide managers with an insightful guide to managing challenges and technology implementation in the air freight forwarding industry.
- The findings of the study offer relevant policy makers and industrial associations in the logistics industry recommendations on improving and ensuring the readiness of organizations for technology innovation and diffusion.

6.4 Limitations

Like every study, this one has its limitations. One limitation the researcher has considered is the generalizability of the findings. One main feature of qualitative approaches is that their findings are not expected to be extended to wider populations with the same degree of certainty that quantitative analysis can. “Qualitative research occurs in the natural setting, and it is extremely difficult to replicate studies” (Wiersma, 2000, p. 212). This is because the findings of the research

cannot be tested to determine whether they are statistically significant or due to chance (Ochieng, 2009). The focus of qualitative analysis is on providing a complete and detailed description of a phenomenon or object. In many cases, qualitative case studies investigate the behavior of one individual, group or an organization. This behavior of the unit of analysis may or may not reflect the same behavior of similar persons or organizations. Thus, the findings of this case study may suggest that similar findings could be found in homogeneous organizations or contexts, but additional studies would need to be undertaken in other similar air freight forwarders in the logistics industry to verify whether any findings of this study can be generalized.

Another inevitable limitation that needs to be acknowledged is that of the researcher's personal involvement in the case study. This qualitative research was conducted based on a constructivist epistemology and explored a socially constructed reality in a thick-described and flexible context. An interpretative approach was adopted by the researcher, who believes that service innovation and BDA adoption can be understood through the meanings that participants assign to them (Deetz, 1996), based on their subjective experiences. Like other qualitative researchers, the researcher was interested in meaning, that is, how people make sense of their lives, experiences, and their constructs of the world. The researcher herself was the primary instrument for data collection and analysis. Data was mediated through this human instrument, rather than through questionnaires or machines (Ochieng, 2009). Therefore, the quality of the research was heavily dependent on the individual skills of the researcher and could have been influenced by her personal attributes. The researcher's presence during data gathering, which is often unavoidable in qualitative research, could also have affected the subjects' responses (Anderson, 2010). Even so, a qualitative approach is deemed appropriate for this research as qualitative research is good at disentangling and getting massive data out of a phenomenon without destroying its complexity and context (Ochieng, 2009).

6.5 Recommendations for Future Research

The limitations discussed in previous section highlight significant prospects for future research. This research adopted a qualitative case study to understand the status of BDA adoption in air freight forwarding industry and a global air freight forwarder was selected as the case organization. The data was collected and analyzed within a single case organization. Along the same track of undertaking case studies as a comprehensive data-rich methodology for understanding a new phenomenon, it is recommended that future studies include multiple cases, and engage multiple stakeholders such as customers and airlines partners. Customers are important end users who are directly affected by the BDA adoption and service innovations of the AFFs. As airlines partners collaborate closely with AFFs on daily business, such an investigation promises to open the new insights on BDA adoption and service innovation for air freight forwarders.

This research used the TOE framework systematically to explore the various influencing factors affecting BDA adoption. A list of major influencing factors under technological, organizational and environmental contexts were identified in the study. However, the findings did not further validate the level of significance among these factors in BDA adoption in particular. Future empirical research is recommended to validate the relationships among these factors and their levels of significance in BDA adoption. The validation would be much more helpful and insightful for business leaders in prioritizing their efforts and time to solve those more critical challenges to secure a successful BDA adoption. Quantitative research, such as using surveys, can be a good methodology for testing the relationship among these factors influencing BDA adoption at the organizational level. While the purposive selection of the case organization and the participants for the study was limited by the choice of a qualitative research approach, a greater

number and wider range of participants and organizations in the same industry could be considered and included if a positivist research approach using a survey method is adopted.

The primary research question of this study aimed to understand how organizations can utilize BDA to improve service innovation. The findings have provided a list of recommendations, including technological recommendations, organizational recommendations and the proposed BDA service innovation approach. These recommendations have beneficial practical implications for business leaders and industrial practitioners. However, these proposals about how an AFF can improve service innovation through BDA adoption remain theoretical. Action research, a methodology used in applied research, may be an effective way of bringing about a conscious change in a partly controlled environment (Collis & Hussey, 1997). By conducting action research within AFF organizations, the recommendations of BDA adoption presented in this study could be further examined and monitored for its practicality and feasibility.

This research was conducted during the time where the COVID-19 pandemic started. It was noted that environmental factor as such did bring impacts to various business sectors, including air freight forwarding business. The pandemic shifted strategic priority to secure business continuity and survival that ultimately slowed down the ongoing BDA adoption temporarily. It is worthwhile for researchers to take those unexpected environmental factors (i.e. COVID-19 pandemic in this case) into the consideration, such as comparing the differences on the organizational strategies and management's decision-making on adopting BDA and service innovation before and after the pandemic.

6.6 Conclusion

It is believed that the objectives of this research—which were to understand the current status of service innovation and BDA adoption, to identify the organizational challenges in

adopting BDA and to explore the potential for utilizing BDA to improve service innovation in an international air freight forwarder have been achieved. The study provides appreciable insights into the operations of a leading global air freight forwarder and recommends a number of proposals in air freight business areas where BDA could be utilized to improve service innovation for an international air freight forwarder. The researcher believes that the findings make a significant contribution to knowledge about BDA adoption in air freight forwarding industry that is currently lacking in academic research. The study has practical implications for industrial practitioners. The researcher hopes that the study helps bridge certain gap between practice and theory about BDA adoption in the industry; and that the research adds to current discussions on the topic in the industry through the contribution of new insights. As an exploratory case study on BDA adoption and service innovation in the air freight forwarder industry, it also points to a few valuable areas for future studies. It is hoped that this research helps advance existing knowledge about BDA, service innovation and logistics industry, and further, it helps improve practice, arouse attention, trigger debates, and inform future research.

Appendix 1 Interview Agenda

Interview Agenda

Estimated time of completion: ***60 minutes***

Opening: self-introduction of researcher (interviewer), the brief background information and the purpose of the study. Explain the consent form, ethical consideration, usage of recording devices and all "house-keeping" rules of the interview.

Interview Questions:

Total seven (7) open-ended questions will be asked by sequence order. In the case of non-availability of the answers/feedbacks from the interviews or rejection by the interviewees due to special reasons, we will skip the question and jump into the next.

1) *Can you please share with us what you think about "**service innovation**"? please elaborate your understanding of the concept from your own understanding/knowledge.*

2) *Please tell us what you know about the **current situation of service innovation** in your organization and use some examples to illustrate your comments.*

3) *Can you please share with us what you think about "**Big Data(BD)**" and "**Big Data Analytics (BDA)"**? please elaborate your understanding of the concept from your own understanding/knowledge.*

4) *Please tell us what you know about the **current situation of BDA adoption** in your organization and use some examples to illustrate your comments.*

5) *Based on your working experiences and practices, may you please share with us, what are the **(potential/existing) challenges** in BDA adoption in your organization and why.*

6) *Can you share with us your thoughts or suggestions **how BDA can be utilized to improve the service innovation** for your organization?*

7) *Do you have any **other thoughts or ideas** that you would like to share with us about BDA adoption in your organization? Please elaborate accordingly.*

Clarification is expected and we will end the interview when both parties once all questions are completed. The interview transcripts will be shared to some selected interviewees for confirmation.

Closing: Thank you very much for your participations in this interview. Your inputs are valuable to our study. In case any questions, please feel free to contact me or our school with the contact information stated in the invitation letter.

Appendix 2 Participant Information Form

UNIVERSITY OF CANBERRA

DISTINCTIVE BY DESIGN

Participant Information Form

Project Title

Improving service innovation through big data analytics (BDA): a case study of an international air freight forwarder

Researcher

Name: Wu Xinmei, Cindy

Faculty: Faculty of Business, Government & Law, University of Canberra

Phone: (65) 9663 7780

Email: u3212767@uni.canberra.edu.au

Supervisor

Name: Dr. Richard Hu

Phone: (61) 6201 2051

Email: richard.hu@canberra.edu.au

Project Aim

The aim of this research is to identify the influencing factors for BDA adoption in an organization and to explore how BDA can be utilized to improve air freight service innovation in air freight forwarding industry

Benefits of the Project

The information gained from the research will be used to contribute to the existing knowledge of service innovation and BDA adoption in logistics service industry. It will guide future theory development in the integration of BDA into service innovation and inspire academic and practical studies on BDA adoption. More importantly, we will develop business implications for the senior managements of international air freight forwarders to support their strategic decision-makings in service innovation and offer practical solutions to tackle the challenges of BDA adoption in their organizations.

General Outline of the Project

The project will be conducted in a market-leader in the international air freight forwarding industry. Guided by prevailing concepts and theories on BDA and service innovation, the research will examine the adoption of BDA in the case organization to gain an understanding of how BDA can be managed to improve its service innovation. Semi-structured interviews will be arranged to various levels of managerial staff to obtain their feedbacks, opinions and comments about the topics related to our research.

Participant Involvement

Participants who agree to participate in the research will be asked to:

1. Participate in the interview
2. Share your experiences, opinions and feedbacks with honesty and objectivity
3. Verify your interview transcript as per request

Participation in the research is completely voluntary and participants may, without any penalty, decline to take part or withdraw at any time without providing an explanation or refuse to answer a question.

Confidentiality

Only the researcher/s will have access to the individual information provided by participants. Privacy and confidentiality will be assured at all times. The research outcomes may be presented at conferences and written up for publication. However, in all these publications, the privacy and confidentiality of individuals will be protected.

Anonymity

All reports and publications of the research will contain no information that can identify any individual and all information will be kept in the strictest confidence.

Data Storage

The information collected will be stored securely on a password protected computer throughout the project and then stored at the University of Canberra for the required five year period after which it will be destroyed according to university protocols.

Ethics Committee Clearance

The project has been approved by the Human Research Ethics Committee of the University of Canberra (HREC – insert number 20206850) on November 24, 2020.

Queries and Concerns

Queries or concerns regarding the research can be directed to the researcher and/or supervisor.
Contact details are at the top of this form.
If you have any complaints or reservations about the ethical conduct of this research, you may contact the University of Canberra's Research Ethics & Integrity Unit team via telephone 02 6206 3916 or email humanethicscommittee@canberra.edu.au or researchethicsandintegrity@canberra.edu.au

If you would like some guidance on the questions you could ask about your participation please refer to the Participants' Guide located at http://www.canberra.edu.au/ucresearch/attachments/pdf/a-m/Agreeing-to-participate-in-research.pdf

Consent Form

Project Title

Improving service innovation through big data analytics: a case study of an international air freight forwarder

Consent Statement

I have read and understood the information about the research. I am not aware of any condition that would prevent my participation, and I agree to participate in this project. I have had the opportunity to ask questions about my participation in the research. All the questions I have asked, have been answered to my satisfaction.

Please indicate whether you agree to participate in each of the following parts of the research (please indicate which parts you agree to by putting a cross in the relevant box):

☐ Complete a questionnaire.

☐ Participate in an interview with the researcher.

☐ Agree to the information being used in future research

Name.....

Signature.....

Date .....

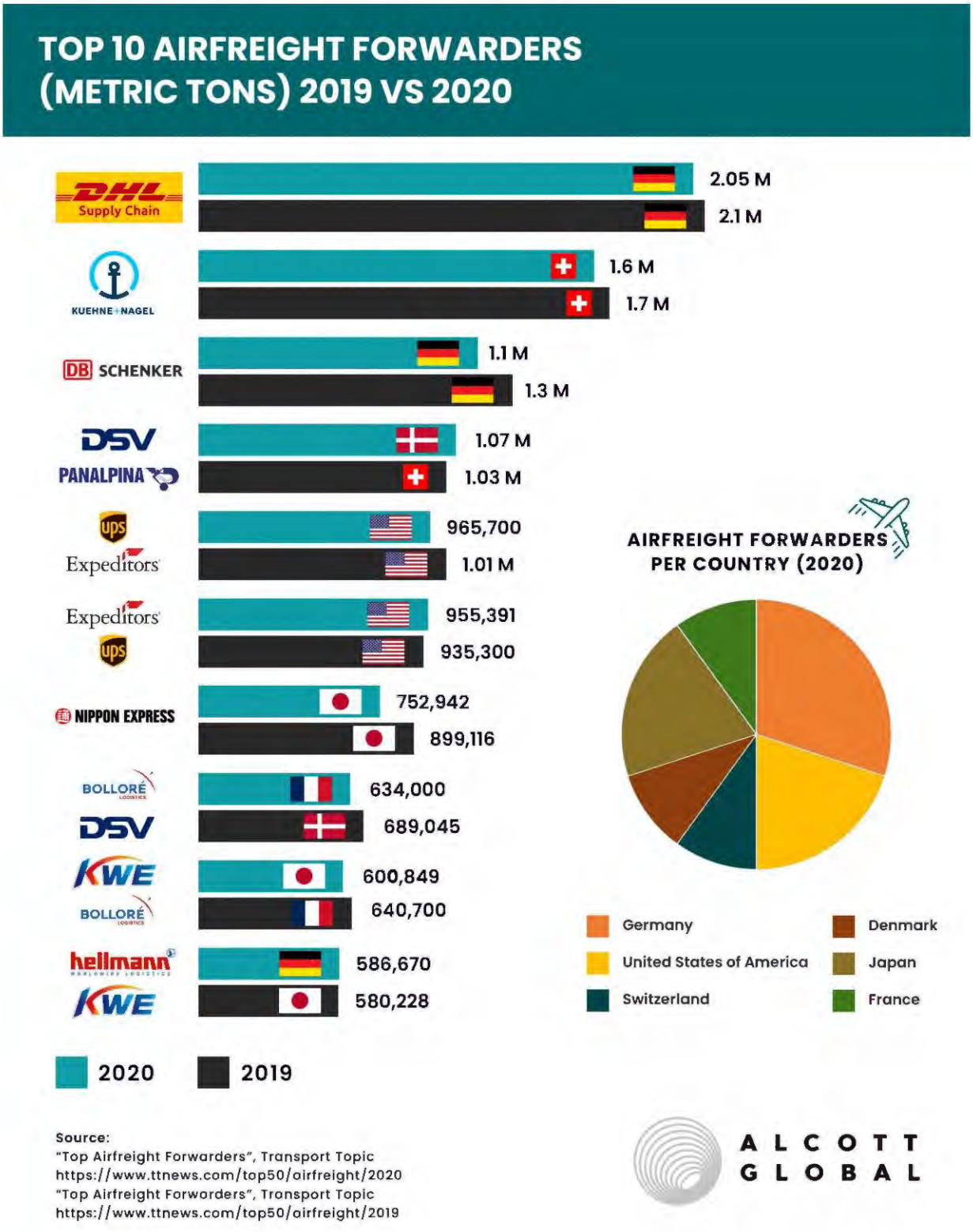
A summary of the research report can be forwarded to you when published. If you would like to receive a copy of the report, please include your mailing (or email) address below.

Name.....

Address.....

.....

Appendix 3 Top 10 Air Freight Forwarders 2019 VS 2020



Appendix 4 Examples of BDA User Cases by Various Authors

Authors	Year	Examples of BDA User Cases	Industry
1. DHL	2013	(1) Use Cases - Operational Efficiency (1.1) Last-mile optimization (1.1.1) Real-time route optimization (1.1.2) Crowd-based pick-up and delivery (1.2) Predictive network and capacity planning (1.2.1) Strategic network planning (1.2.2) Operational capacity planning (2) Use Cases - Customer Experience (2.1) Customer Value Management (2.1.1) Customer Loyalty management (2.1.2) Continuous service improvement and product innovation (2.2) Supply chain risk management (2.2.1) Risk evaluation and resilience planning (3) Use cases - New business models (3.1) B2B demand and supply chain forecast (3.1.1) Market intelligence for small and medium-sized enterprises (3.1.2) Financial demand and supply chain analytics (3.2) Real-time local intelligence (3.2.1) Address verification (3.2.2.) Environmental intelligence	*Logistics & Transportation*
2. Ayed et al.	2015	1) Real-time vehicles monitoring in India - to improve operational efficiency for logistics and transportation firms, helping firms' managers to make better business decisions. 2) City of Dublin, Public Transit System - reduce congestion in the city of Dublin in its public bus transport network without making modification for the city historic infrastructure. 3) City of Da Nang, Vietnam, Traffic Management System - to build water and transportation traffic management system able to deal with the city fast-growing population of a city of more than a million population. 4) British Airway's Know Me Program - improve the quality of British Airways services for its customers, the objective is to understand client's needs better than any competitive airline company. 5) City of Stockholm Real-Time Intelligent Transportation Services - to improve the quality of the transportation network in the city of Stockholm. 6) Cloud-Enhanced System Architecture for Logistics Tracking Services - to set up an efficient real-time monitoring system of customers cargoes	*Logistics & Transportation*

3. Ittmann	2015	1) Retail predictive analytics and vendor compliance 2) E-Commerce and market intelligence 3) IBM - applying analytics to the supply chain 4) End-to-End Analytics in Supply Chain in Forecasting reality check, Pricing and Supply chain planning	*Supply Chain in various industries Logistics & Transportation*
4. Heesen	2016	1) Big data in merchandising 2) How Big Data helps a bus company 3) Utilizing digital media at Piano 4) Manufacturing intelligence at Villeroy and Boch 5) Big Data for the Public Distribution Systems in Tamil Nadu	*Consumer & Retail Transportation eCommerce*
5. Tiwari et al.	2018	1) Strategic sourcing - support supplier management decision, investment indication 2) Supply chain network design - strategic decision in supply chain physical configuration 3) Product design and development - improve product adaptability 4) Demand planning - demand forecasting and production planning with BDA 5) Procurement - supply risks and suppliers performance management 6) Production - BDA application in improving production processes 7) Inventory - interrelationship gathering in inventory ordering decision optimization 8) Logistics and distribution - planning optimization for maritime companies 9) Supply chain agility and sustainability	*Supply Chain in various industries Logistics & Transportation*

Sources: Authors cited in the table

Appendix 5 Definitions of "Innovation" by Various Authors

Category	Name	Definition	Proposed by Authors
General	Innovation	An innovation does not need to be new to the world, merely new in the eyes of beholder	*Flint et al. (2005)* *Bajec (2012)*
General	Innovation	Innovation is the use of new technical and administrative knowledge to offer a new product or service to customers. The innovation is any practice that are new to organizations, including new equipments, products, services, processes, policies and projects	*Kimberly & Evanisko (1981)* *Damanpour (1999)* *Lin (2006)* *Bajec (2012)*
General	Innovation	An idea, practice, or object that is perceived as new by an individual or other unit of adoption	*Rogers (1995)* *Grawe (2009)*
General	Innovation	Innovation is not only limited to innovation of technology or product, as it also involves process, strategy, organization architecture and so forth	*Hu and Huang (2011)*
General	Innovation	Innovation is not an exclusive terminology for technology and it should also be a vocabulary for economics and society and its scope includes changes in management knowledge or economic systems.	*Drucker (1974)* *Hu and Huang (2011)*
General	Innovation	Innovation is a new and useful solution to satisfy customer's needs	*Schumpeter (1934)* *Wagner and Sutter (2012)*
Specific	Innovation in Supply Chain	is a broad process of learning and implementing new ideas, procedures and technlogies.	*Panayides and So (2005)* *Rossi et al. (2013)*
Specific	Logistics Innovation	Any logistics related service from the basic to the complex that is seen as new and helpful to a partner focal audience. The audience could be internal where innovation improve operational efficiency or external where innovations better serve customers.	*Flint et al. (2005)* *Mena et al. (2007)*
Specific	Logistics Innovation	Any logistics-related service that is seen as new and helpful to particular focal audience; Logistics can be very basic to very complex and can be applied to internal operations or services with business partners	*Flint et al. (2005)* *Grawe (2009)* *Cichosz et al. (2017)*
Specific	Logistics Innovation	as the development of new logistics services and products that are different from what has been offered in the past and that create greater value for customers. It can be applied to internal operations or service with business partners.	*Flint et al. (2005)* *Rossi et al. (2013)* *Cichosz et al. (2017)*
Specific	Non-Technological Innovation	Changes in structures, business processes, customer and supplier relationships and knowledge management issues that lead to innovation.	*Mena et al. (2007)*
Specific	Pure internal innovation	Innovations that are not noticeable from outside the LSP and do not affect customers directly; increase efficiency and operations	*Wallenburg (2009)*
Specific	Technological Innovation	Data acquisition, information management, warehousing and transportation	*Mena et al. (2007)*
Specific	Customer-related innovation	Innovations that are noticeable by customers and have a direct impact on them (cost reductions/performance improvement)	*Wallenburg (2009)*

Source: Authors cited in the table

Appendix 6 Classifications of Innovation by Various Authors

Category	Description	Classification Criteria	Proposed by Authors
Innovation	1. Product innovation 2. Service innovation	commodity /industry	*Wagner (2008)* *Wagner & Sutter (2012)*
Innovation	1. Radical innovation 2. Improvement innovation 3. Incremental innovation 4. Ad hoc innovation 5. Re-combinative innovation 6. Formalization innovation	degree and nature	*Gallouj et al. (2017)*
Innovation	1. Technological innovations: products, services and production process technology 2. Administrative innovations: organizational structure and administrative processes	nature	*Garcia and Calantone (2002)* *Lin (2006)*
Innovation	1. Low Innovation-Intensive Sector (LIIS): wholesale and communication trade, transport and communication 2. Technology Intensive and Moderately Innovation-Intensive Sector (TIMIIS): financial intermediation 3. Knowledge and Innovation-Intensive Sector (KIBS): business services	industry according to the innovation process attribute	*Trigo and Vence (2012)*
Innovation	1. Incremental innovation: small changes or further optimization 2. Radical innovations: “breakthrough” innovations or disruptive innovations, significant changes(have direct impact on customers)	degree of novelty of the innovation	*Garcia and Calantone (2002)* *Wagner & Sutter (2012)* *Cichosz et al. (2017)*
Innovation	1. Innovations “new to the firm”: already known in the industry, but have not been introduced by the firm 2. Innovations “new to the industry”: have not been introduced by another firm in the industry 3. Innovations “new to the world”: seldom available in the market that is “totally new”	degree of newness to a service innovation	*Wagner & Sutter (2012)*
Innovation	1. Technological innovations: data acquisition, information management, warehousing and transportation 2. Non-technological innovations: changes in structures, business processes, customer and supplier relationships management and knowledge management issues	technology	*Mena et al. (2007)*

Innovation	1. Technical innovation 2. System innovation 3. Knowledge innovation 4. Organizational innovation	nature	*Hu and Huang (2011)*
Innovation in Logistics Technologies	1. Data acquisition technologies 2. Information technologies 3. Warehousing technologies 4. Transportation technologies	n.a.	*Lin (2006)*
Innovation in LSP	1. Pure internal innovations: not noticeable from outside the LSP and do not affect customers directly 2. Customer-related innovations: noticeable by customers and have a direct impact on them	scope	*Wallenburg (2009)*
Innovation in LSP	1. First classification: technical/technological innovation, administrative innovation 2. Second classification: radical, semi-radical, and incremental innovations	nature/degree of impacts	*Bajec (2011)*
Logistics Innovation	1. Process: lower costs and higher service provided 2. Product/service offering: the response to new market needs 3. Network / relationships innovation: offer news of working across company boundaries	nature	*Lin and Ho (2008)* *Panayides (2009)* *Rossie et al. (2013)*
Service Innovation	1. Supplier-dominated innovation 2. Innovation within services 3. Client-led innovation 4. Innovation through services 5. Paradigmatic innovations 6. Innovation in a firm's internalized service function 7. Innovation in an outsourced service function	n.a.	*Hertog & Bilderbeek (1999)*
Service Innovation	1. Internal processes without a specific project 2. Internal innovation projects 3. Innovation projects with a pilot customer 4. Innovation projects tailored for a customer 5. External funded innovation projects	degree of formality and pattern of collaboration	*Miles (2015)*
Service Innovation	1. The service concepts 2. The client interfaces 3. The service delivery system / organization 4. Technological options	dimensions of novelty	*Hertog & Bilderbeek (1999)* *Miles (2015)*
Service Innovation	1. Service concepts 2. Client interface 3. Intra-organizational service delivery system 4. Interorganizational service delivery system Technology	IS research stream	*Barrett et al. (2015)*

Service Innovation	1. Supplier-dominated: small firms with little in-house R&D 2. Scale-intensive physical information networks: large firms such as "transport and travel 3. Science-based and specialized supplier: analogous to small, high-tech manufacturer, firms, business services 4. Professional knowledge-based style: accountancy, legal etc. 5. Public service style: also as supplier-dominated, such as education, healthcare 6. Interactive style: T-KIBS, consultancy services, very closely involved with their clients in the production of innovation	industry	*Soete and Miozzo Miles (2015)*

Source: Authors cited in the table

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