Gordon Institute of Business Science
University of Pretoria

Towards an understanding of the influence of Big Data Analytics (BDA) on agility and resilience in Humanitarian Supply chains (HSCs)

Student Number: 1538 8078

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ABSTRACT

The increasing frequency and intensity of natural and human-made disasters have led to a surge in global humanitarian efforts, necessitating a deeper understanding of humanitarian supply chain management (HSCM). This sector's challenges underline the critical need for efficient and effective coordination, putting immense pressure on humanitarian non-governmental organisations (HNGOs) to improve their operational capabilities. Along with these challenges, the humanitarian sector must utilise data-driven decision-making processes, which poses an obstacle for HNGOs struggling to adopt and implement such technologies. This study aims to develop insights and a new understanding of the influence of big data analytics (BDA) on agility and resilience in humanitarian supply chains (HSCs).

Non-governmental organisations (NGOs) increasingly adopt technology to improve their operations and efficiency. However, this process has its challenges, both internally and externally. External factors such as the operating environment and technology adoption trends can significantly impact an organisation's technology integration efforts. Internally, deliberate efforts need to be made to promote technology adoption. To ensure the successful implementation of BDA, it is essential to understand the possible outcomes, inhibitors, and enablers. By doing so, NGOs can establish a clear roadmap for BDA implementation, motivating them to embrace transformative processes that build their agility and resilience.

This qualitative research study aimed to explore the enablers, inhibitors, and outcomes of implementing BDA through 18 semi-structured interviews. The participants were selected from local and global HNGOs, consultants, and donor agencies based on their expertise in BDA within HSCs. The study used thematic analysis of qualitative data to create a conceptual framework that illustrates how BDA impacts agencies' agility and resilience. The study also highlighted the challenges and enablers that affect the implementation of BDA.

The study culminated in a conceptual framework of how BDA influences the agility and resilience of HSCs. In cases where there were similarities, this research confirmed and thus added to the existing body of knowledge by potentially contributing to the literature on the agility and resilience of HSCs that implement BDA. The differences identified five potential refinements to the literature relating to the importance of *visionary leadership, lack of trust in technology, high employee turnover rates, complex donor funding structures and inadequate financial resource allocation*.

KEYWORDS
Agility, big data analytics, humanitarian logistics, humanitarian supply chain, resilience

PLAGIARISM DECLARATION

I declare that this research project is my work. It is submitted in partial fulfilment of the requirements for the degree of Master of Philosophy in Corporate Strategy at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to conduct this research.

27 November 2023

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LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation/Acronym	Full Form
AI	Artificial Intelligence
BD	Big Data
BDA	Big Data Analytics
CBDA	Cloud-Based Data Analytics
CRED	Centre for Research on the Epidemiology of Disasters
CRM	Customer Relationship Management
DSS	Decision Support Systems
ERP	Enterprise Resource Planning
ETL	Extract Transform, Load
GPS	Global Positioning System
GIBS	Gordon Institute of Business Science
HEMS	Humanitarian Emergency Management System
HIC	Humanitarian Information Centre
HO	Humanitarian Organisations
HNGOs	Humanitarian Non-Governmental Organisations
HSC	Humanitarian Supply Chains
ICT	Information and Communication Technology
ICT4D	Information and Communication Technologies for Development
IoT	Internet of Things
IT	Information Technology
KPI	Key Performance Indicator
M&E	Monitoring and Evaluation
ML	Machine Learning
NGO	Non-Governmental Organisation
PM	Project Management
QR	Quick Response
R&D	Research and Development
RFID	Radio-Frequency Identification
RQ1	Research Question 1

RQ2	Research Question 2
RQ3	Research Question 3
S&OP	Sales and Operations Planning
SC	Supply Chain
SCM	Supply Chain Management
SOP	Standard Operating Procedure
SOPs	Standard Operating Procedures
SOPs	Standard Operating Procedures
SWOT	Strengths, Weaknesses, Opportunities, Threats
UNHCR	United Nations High Commissioner for Refugees
USA	United States of America
3D Printing	Three-dimensional printing

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CHAPTER 1: INTRODUCTION

1.1 Background to the Research Problem

This qualitative research study was undertaken to explore the extant theory on humanitarian supply chains (HSCs) and explored the influence of big data analytics (BDA) on their agility and resilience. The research explored the challenges, enablers, and outcomes of implementing and adopting BDA by humanitarian non-governmental organisations (HNGOs) or agencies.

In today's complicated humanitarian landscape, non-governmental organisations (NGOs) must continuously adapt and evolve to remain relevant and effective in alleviating human suffering (Alizadeh et al., 2020; Besançon et al., 2022). By prioritising adaptability, local knowledge, innovation, accountability and advocacy, NGOs can maximise their impact and make a lasting positive difference to the lives of the people they serve (Fast & Bennett, 2020; Humanitarian Advisory group (HAG), 2023).

1.2 Business Relevance

In recent decades, natural and man-made disasters have increased, prompting increased humanitarian efforts globally to assist communities from disasters such as conflicts, wars, famine, hurricanes, earthquakes, droughts, terrorism, pandemics, and floods (United Nations- General Assembly, 2023). According to this report, in 2022, several shocking records were set, the biggest being the increase in the number of people needing humanitarian assistance and protection from 274 million to 348.7 million.

In 2022, the Emergency Event Database EM-DAT recorded 387 natural disasters globally, causing the loss of 30,704 human lives and impacting 185 million individuals (Centre for Research on the Epidemiology of Disasters (Centre for Research on the Epidemiology of Disasters (CRED), 2022). This was mainly due to the compounding drivers of conflict, climate change, disasters, the continuing effects of the coronavirus disease (COVID-19) pandemic, and a global economic slowdown (Humanitarian Programme Cycle, 2022). These record levels of suffering significantly strain the HSC systems' capacities, underscoring the need for efficient and effective humanitarian coordination. As shown below, HSCM is the process of planning, implementing, and controlling

the efficient, cost-effective flow and storage of goods, materials, and related information from origin to consumption to meet beneficiary needs (Fritz Institute, 2021).

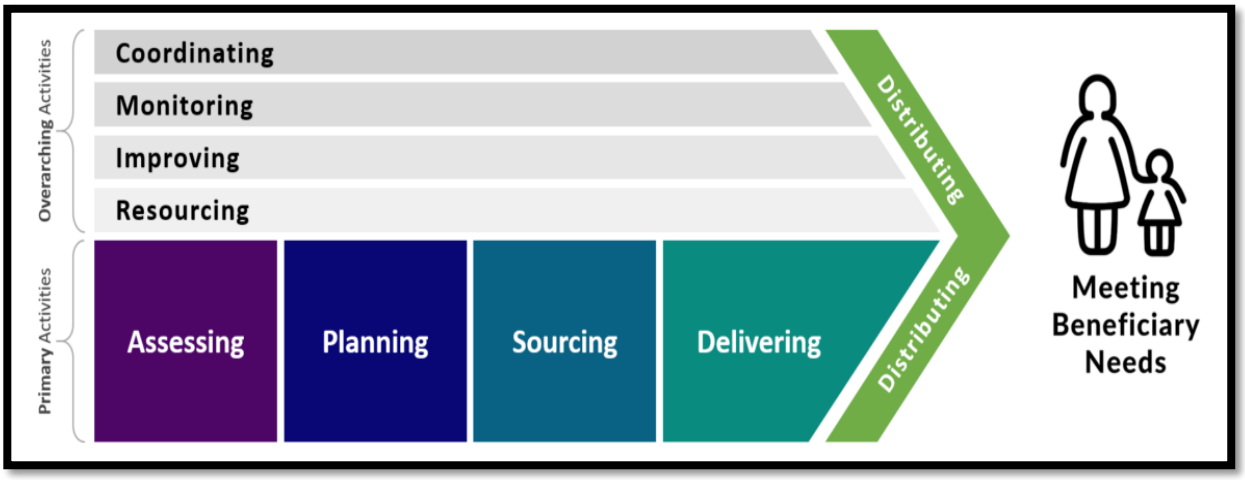

Figure 1: The Humanitarian Supply Chain (Fritz Institute, 2021).

In a report by the European Commission on Humanitarian Aid (2022), the Commissioner for Development and Humanitarian Aid states that the effects of natural disasters and conflict translate into the critical need for more and better coordinated humanitarian aid. According to O'Regan (2019) in their industry report on donor assistance and accountability, humanitarian organisations have faced challenges in efficient time and resource utilisation in their quest to be data-driven. The report states that this has subsequently reduced some of these HNGOs' ability to secure relevant donors and partners for their various prospective projects.

Data Science & Ethics Group (DSEG) (2019) states in their report on the "ethical use of advanced data science methods in the humanitarian sector" that over the past 20 years, societies have undergone a "data revolution" that has resulted in an explosion in the use of BDA, the emergence and maturation of data science methods, and increased smartphone usage. The paper continues by noting a definite and urgent need for data science, specifically for and in the humanitarian sector, despite an influx of these technologies in the corporate and public sectors.

To learn how HNGOs are utilising data, their core data competencies, and the support they require for capacity building to use data effectively, UN-OCHA's Centre for Humanitarian Data conducted a global survey in January 2019. More than 60% of respondents stated that increasing the effectiveness of humanitarian responses was their primary motivation for seeking to enhance their data abilities. Big data, predictive analytics, and statistics were selected as the top three data-related topics people are most eager to learn about Data Science & Ethics Group ((DSEG), 2019).

1.3 Theoretical Relevance

Humanitarian supply chain management (HSCM) is classified as the activities of planning, executing, and directing the efficient, profitable movement and warehousing of commodities and supplies, as well as related data, from the point of collection to the end of distribution to lessen the suffering of vulnerable beneficiaries (Behl & Dutta, 2019). Over the past decade, scholars and practitioners have given sizable attention to global humanitarian relief supply chains to improve emergency relief operations' performance (Anjomshoae et al., 2022; Jermsittiparsert & Pithuk, 2019). However, research in humanitarian contexts has not yet reached the advanced level seen in commercial supply chain (SC) contexts (Shafiq & Soratana, 2019a).

The humanitarian crisis and the need to address it was further exacerbated by the occurrence of the recent coronavirus pandemic in 2020 and its continuing influence on the global economy and healthcare structures (Elali, 2021; Ivanov & Das, 2020; Karuppiah et al., 2021; Queiroz, et al., 2022). Forecasting demand, manufacturing and supply lead times, inventory management, and sourcing tactics have all been impacted by the resultant shifting demand patterns caused by the pandemic (Kumar et al., 2022). The COVID-19 epidemic has presented HSCs with never-before-seen difficulties on a global scale. Even though wealthy nations like the United States of America (USA) and Italy have the best medical and humanitarian facilities, the current pandemic has revealed its shortcomings (Dubey et al., 2022; Dubey et al., 2019, 2021).

Besides COVID-19, continuing challenges of climate change, rising inflation, resource scarcities, and increased political instabilities around the world continue to add to the complexity, unpredictability, and uncertainty in humanitarian operations (Altay et al., 2023; Moshtari et al., 2021; Rejeb et al., 2021). These challenges and their sometimes-unwanted effects on HSCs have attracted the attention of scholars, who have advocated for the collection of data through the integration of mobile and internet technologies in emergency responses to reduce impact and restore normalcy in record time (Jamali et al., 2019; Sharma et al., 2020). The role of information technology (IT) or the need for data and communication technology in HSCs has gathered over the past decade (Behl & Dutta, 2019). In recent years, donors have also increased their calls for greater accountability and openness in the humanitarian sector (Anjomshoae et al., 2022; O'Regan, 2019). HSCs providing disaster relief in emergency operations have often been compromised due to a lack of visibility, an absence of information sharing, an absence of trust among partners and poor cooperation with stakeholders (Dubey et al., 2021; Larson & Foropon, 2018; Nurmala et al., 2018). The need for coordination in response to the volatility and instability

has created the need for agility and swift trust in HSCs, as their failure to execute timely deliveries can lead to fatalities or unnecessary suffering rather than simply reduced profits as would be the case in commercial SCs (Altay et al., 2023; Dubey et al., 2019).

Big data (BD) has transformed the face of HSC operations in a much more effective way by inspiring actors through modern technologies, which include artificial intelligence (AI) (A. Kumar et al., 2022; Roth & Luczak-Roesch, 2020) and BDA (Amaye et al., 2016a; Bhadani & Jothimani, 2016; Fan et al., 2021; Liu et al., 2023; Qadir et al., 2016). According to Gupta et al. (2021) and A. Kumar et al. (2022), HSCs' most important outcome is its ability to respond to a disaster through agility effectively (Altay et al., 2023) and timeous delivery of relief materials to victims during periods of disruption. These crises or disasters have forced HNGOs to develop systems that combine robustness, flexibility (Baharmand et al., 2019; Chari et al., 2021; Dubey et al., 2019; Jermsittiparsert & Pithuk, 2019; Kazancoglu et al., 2022), speed (Wood et al., 2017), and ability to restore normalcy (Altay & Narayanan, 2022; Gupta & George, 2016). This means HNGO's supply chains must be resilient and agile in dealing with crises and disasters (Chari et al., 2021; Ivanov et al., 2021; Mandal & Dubey, 2021; Queiroz & Fosso Wamba, 2021; Stewart & Ivanov, 2022). Furthermore, the impact and frequency of these disasters exert more pressure on humanitarian aid operations to adopt an agile and resilient response to the crises (de Camargo Fiorini et al., 2022; Queiroz & Fosso Wamba, 2021).

Managing supply chains has become particularly demanding due to business outsourcing, globalisation, short product life cycles, continuous innovation in IT, and digitalisation (Dubey et al., 2019). Furthermore, (Dubey et al., 2022) argue that humanitarian organisations face an uphill task in advancing their capability to improve the efficiency and effectiveness of their disaster relief efforts. According to Adiguzel (2019) supply chain and logistics have the highest budget in disaster relief operations. However, researchers such as Bealt et al. (2016) argue that at least 40% of the supply chain and logistics budget goes to waste because of duplicated efforts and insufficient time for adequate data analysis. In addition, a lack of coordination and collaboration adversely affects the relationship between stakeholders in humanitarian efforts (Gunasekaran et al., 2017; Wankmüller & Reiner, 2020). This is happening when other researchers such as (John et al. (2022) & Raillani et al. (2020)) are advocating for effective data processing as an essential tool for better coordination and decision-making in humanitarian relief operations. Similarly, researchers in emerging technologies, such as Dubey et al. (2019) and Nguyen et al. (2018) contend that big data analytics can enhance humanitarian coordination and improve decision-making during significant crises.

According to Goyal et al. (2020), Gupta et al. (2019) and Ittmann (2015), advancements in business analytics and data science are leading to a better understanding of large data sets. The term big data depicts an overall term for any collection of complex and large data sets that are difficult to comprehend, analyse, process and store using traditional data processing tools (De Mauro et al., 2016). However, big data analytics are now being viewed as having the potential to transform strategic humanitarian efforts to deliver at a lower cost, promptly, and with more resilience and agility than in the past (Bahrami et al., 2022). The successes of big data analytics within commercial or for-profit organisations likely impact the humanitarian sector and its ecosystem (Oncioiu et al., 2019). It is, therefore, essential for the researcher to understand the progress of BDA application in the field of HSC management through identifying barriers and enablers of the processes involved.

1.4 Research Questions

The main question was:

"How does BDA influence the agility and resilience of an HSC?" (Dubey et al., 2022; Gupta et al., 2019a)

To answer the primary research question, the following secondary research questions are posed:

What is the effect of agility and resilience on HSCs' efficiency and effectiveness? (Altay et al., 2018a; Dubey et al., 2020; Dubey, et al., 2022; Dubey et al., 2019).

What are the enabling factors of BDAs leading to the agility and resilience of HSCs? (Dubey et al., 2022; Dubey et al., 2022; Raguseo, 2018; Sheng et al., 2019).

What are the inhibiting factors of BDAs leading to a lack of agility and resilience of HSCs? (Alharthi et al., 2017; Bell et al., 2021a; Karuppiah et al., 2021; Kazancoglu et al., 2022).

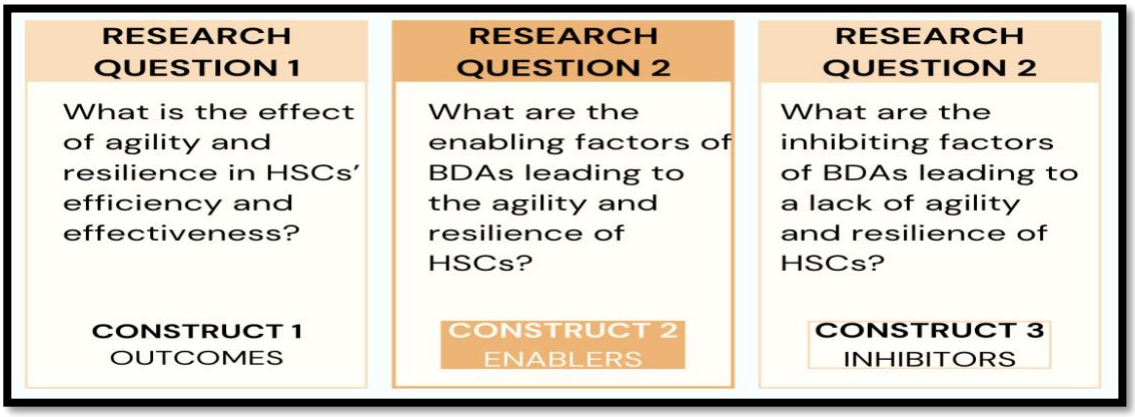

Figure 2 - Theoretical constructs as they relate to the research questions.

1.5 Research Aim

This research paper aims to explore the influence of BDA on agility and resilience in HSCs, with particular emphasis on the supply chain operations of one selected humanitarian organisation as the unit of analysis.

Additionally, a better understanding or knowledge of BDA is achieved by exploring the enabling or facilitating, inhibiting, or restrictive factors of BDA to agility and resilience in HSCs. Developing a framework at the end of the study assists policymakers, leaders, and practitioners alike in how HSCs can effectively and efficiently use BDA. Such a framework can be a valuable tool to facilitate effective plans, strategies, and implementation processes with HSCs within disaster relief scenarios.

1.6 Research Contribution

This study makes an essential contribution to understanding the impact of BDA on agility and resilience in HSCs. The investigation uncovers key challenges, enablers and barriers by examining the practical application of BDA within selected humanitarian non-governmental organisations (HNGOs). The resulting conceptual framework provides actionable insights for policymakers and practitioners to improve strategies for effective disaster response.

1.7 Research Scope

This section on the scope of this research explains the level to which the research on the effect of agility and resilience was explored. It specifies the parameters within which the study operated.

1.8 Theoretical Research Scope

This research focuses on technology relating to BDA and its effect on HSCs. This included the examination of enablers and inhibitors of BDA implementation in HSCs and finding evidence of how HNGOs are addressing these challenges.

Utilising a multi-theoretical approach, the study sought to build a conceptual model that drew on the existing literature and contributed to a deeper understanding of the influence of BDA on HSCs' agility and resilience. The literature review served as a basis for investigating barriers and facilitators and developing theoretical insights.

1.9 Physical Research Scope

The physical scope of this research is based on the following assumptions:

- The use of BDA in humanitarian organisations is a global phenomenon.
- HSCs are not bound in terms of physical country boundaries.
- HSCs are not limited by borders; hence, this study will include local and international NGOs.

1.10 Assumptions of the Study

The study assumed that BDA is being implemented in HSCs globally, and this could be easily distinguished and identified.

1.11 Research Outline

The study outline is represented as follows:

- **Chapter 1** introduces the business and theoretical problem.
- **Chapter 2** covers a literature review and culminates a conceptual framework and a summary of the presented literature.
- **Chapter 3** sets out the primary research question and the three sub-research questions designed to answer the primary question.

- **Chapter 4** justifies and explains the research methodology and design of the study.
- **Chapter 5** presents the research findings of this research.
- **Chapter 6** compares the findings of this study to academic literature.
- **Chapter 7** presents the research conclusions and the final conceptual framework developed through the research process.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents a literature review, which explores the research question based on current research and research development on the primary constructs of this study, mainly BDA, agility and resilience, and humanitarian supply chains. Using keywords like "big data analytics," "big data," "agility and resilience," "humanitarian supply chain," "agility," and "resilience," the literature review was conducted using keyword searches in academic and management databases like Web of Science, PubMed, IEEE Xplore, ScienceDirect, Emerald, and JSTOR. The chapter reviews the literature on the key ideas and places it in the context of the humanitarian sector. This section covers the function of BDA in SCs and the elements that facilitate or inhibit BDA, which are examined in relation to the research gaps. An overview of the findings from the literature concludes the chapter.

2.2 The Current State of HSCs

HSCs are an essential lifeline after disasters and crises. Disasters are unavoidable; however, the impact of a disaster can be reduced through the effective use of information and communication technologies (ICT), such as specialised decision support systems and communication and information systems for critical tasks (Kabra & Ramesh, 2015). After a disaster, people must receive the necessary help quickly and appropriately (Paciarotti et al., 2021). The current state of these supply chains, as described in recent literature, emphasises the need for agility and resilience (Altay et al., 2018b; Dubey et al., 2020; Gligor et al., 2019) due to the unpredictable and dynamic nature of emergencies (Amaye et al., 2016b; Dubey, 2022; Heaslip & Stuns, 2019; Kovacs & Spens, 2012). These characteristics determine the supply chain's ability to respond promptly to sudden changes in demand and supply conditions and to recover quickly from disruptions.

The primary objectives of aid organisations are to respond to disasters, protect human rights, provide relief services, and promote the universal desire for personal and collective safety, respect, and dignity without any profit motive (Shafiq & Soratana, 2019b). The principles of humanitarian action are that “people affected by a disaster or conflict have a right to live in dignity and therefore a right to assistance; and secondly, all possible steps should be taken to alleviate human suffering”. Furthermore, the humanitarian organisations' primary mission is to save lives and reduce human suffering (Haavisto & Goentzel, 2015). Again, Jahre and Fabbe-Costes (2015)

mention that because of the unstable environments that HNGOs operate in, they require strategies that enable them to react swiftly and respond to uncertainties in supply and demand. The article argues that this ability involves preparedness, quick deployment of resources, flexibility, resilience, and the ability to adapt efficiently in diverse local contexts.

2.3 Agility and Resilience in General SCs

Agility and resilience have been identified as essential qualities of modern-day SCs in both non-profit and for-profit sectors' transparency (Al-Khatib, 2023; Brusset, 2016; Dubey et al., 2018; Jermsittiparsert & Pithuk, 2019; O'Regan, 2019). Their contributions to assisting businesses and supply chains overcome obstacles, including globalisation, rapid change, shorter product life cycles, varied consumer requirements, and rising demand unpredictability, have been widely acknowledged (Gligor et al., 2019).

Agility is often used to describe being swift, mobile, and capable of reacting with speed and deftness when confronted by rapid environmental changes (Al Humdan et al., 2020; Jain et al., 2017; Yaqub, 2023). The significant dimensions of agility in the context of SCs include organisations' ability to change direction quickly (Calvo et al., 2020; Gligor et al., 2019; Tarigan et al., 2021), ability to speed up operation (Dubey et al., 2014, 2019; Mccann et al., 2009), ability to scan the surroundings and anticipate (Gligor et al., 2019; Tarigan et al., 2021), ability to empower customers and customise (Gligor et al., 2019), flexibility (adjust tactics and operations) (Dubey et al., 2019; Gligor et al., 2019; Jermsittiparsert & Pithuk, 2019; Kazancoglu et al., 2022) and ability to integrate processes within and across firms (Dubey et al., 2014).

Under resilience, the major themes presented by scholars include the ability to survive disruptions (Gligor et al., 2019; Tarigan et al., 2021), ability to avoid shock (Gligor et al., 2019; Mccann et al., 2009), ability to recover and return to original form following a significant disruption (Gligor et al., 2019), ability to speed up operation(Gligor et al., 2019), ability to adjust tactics (Dubey et al., 2019; Jermsittiparsert & Pithuk, 2019; Kazancoglu et al., 2022) and ability to scan and predict the environment (Tarigan et al., 2021).

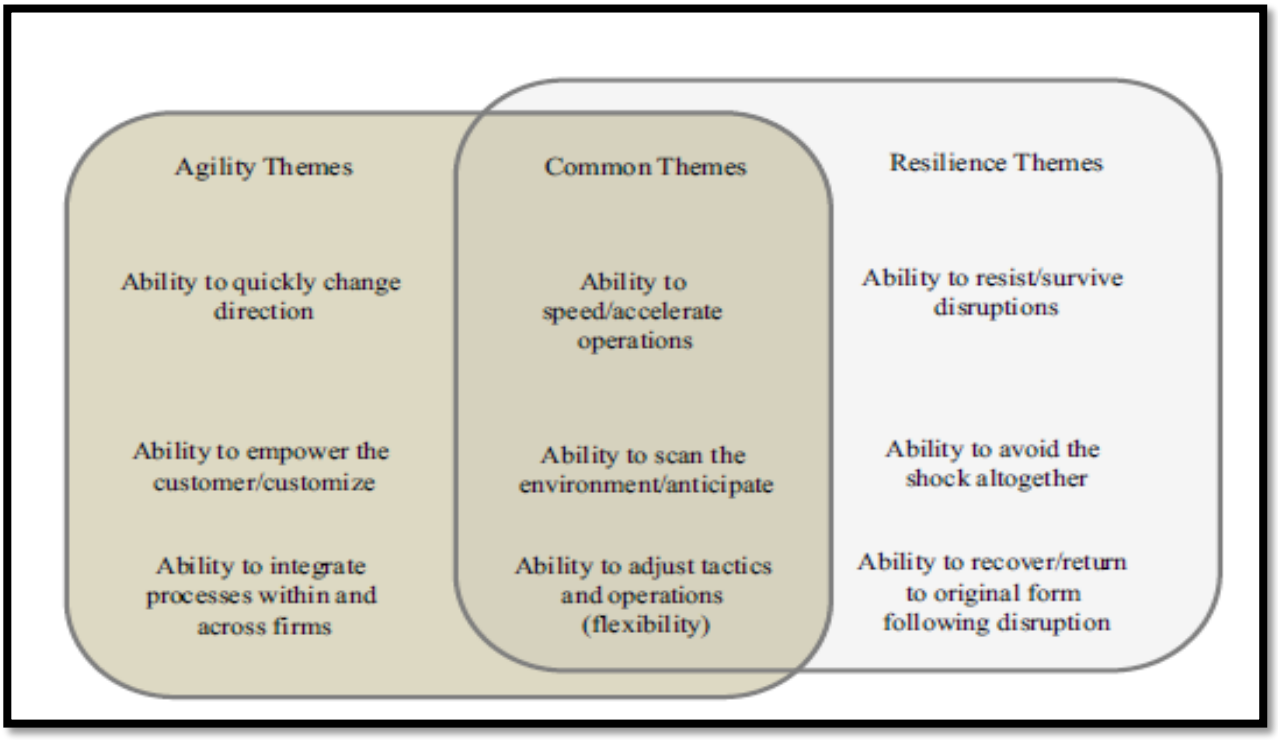

Figure 3: Common themes across agility and resilience (Gligor et al., 2019)

This multidisciplinary literature review by Gligor et al. (2019) reveals six themes for agility and resilience, emphasising their common characteristics. The article posits that the ability to accelerate processes is identified as a critical factor for both concepts, challenging conventional associations. This literature contributes to a clearer understanding of the commonalities between agility and resilience and provides insights for effective resource allocation in supply chain management (SCM).

2.4 Agility and Resilience in HSCs

The primary aim of emergency relief logistics and HSC is to preserve human lives, ease suffering, and retain human dignity (Malmir & Zobel, 2021). Altay et al. (2018) mention in their research that HSCs must extraordinarily demonstrate agility and resilience to manage highly unpredictable and extremely uncertain environments. Furthermore, HSCs are being required to ensure that their processes are practical and efficient to achieve cost-effective ways of commodity storage and their easy flow to the final recipients (Mandal & Dubey, 2021; Queiroz et al., 2022; Queiroz & Fosso Wamba, 2021; Stewart & Ivanov, 2022). Agility within SCs has gained significant attention because of high demand and supply uncertainties (Raj et al., 2023). Agility is achieved when the

SCs can prosper and thrive within the unpredictable and uncertain environments they operate (Yaqub, 2023).

Gunasekaran et al. (2019) conclude that an organisation with an agile supply chain can respond to dynamic environmental changes within the shortest possible time and show flexibility in “adjusting capabilities” to handle the situation using emerging technologies such as big data analytics. According to Dubey et al. (2019) agility's most crucial characteristic is flexibility, which is also supported by Chari et al. (2021) who also adds that finding alternatives when faced with disruptions is an added advantage. This means HSCs ought to operate within high levels of flexibility to achieve resilience and agility. However, Jermsittiparsert & Pithuk (2019) argue that agility differs from resilience, flexibility, and adaptability. This, therefore, means that what affects agility could be looked at from different lenses rather than the lens of flexibility only.

In summary, the literature reviewed in this section suggests that HSCs must operate flexibly to achieve resilience and agility to adapt to unforeseen challenges and maintain effective operations. Given humanitarian operations' complex and unpredictable nature, a nuanced understanding of agility and resilience within HSCs is critical. The literature recommends a holistic view beyond mere flexibility and recognises the multiple dimensions of agility in the specific context of emergency logistics and HSCs.

2.5 Interplay Between Agility and Resilience in SCs

Recent studies have begun to analyse the interplay between agility and resilience in humanitarian supply chains. Dubey et al. (2019) points out that while both characteristics are desirable, they may require different or conflicting skills and resources. Agility often requires a lean approach with minimal redundancies to maximise speed and flexibility, while resilience may require additional resources and capacity to absorb and adapt to disruptions.

Despite existing differences in conceptualisation, there are similarities in the literature that point out that to achieve agility and resilience simultaneously, SCs must be able to adapt, recover, execute, and maintain their operations and achieve their plans and performance regardless of facing disturbances in their environment (Fosso Wamba et al., 2019; Ivanov et al., 2021). Resilience reflects the ability of the function to move to a new desirable status or move to the original position after facing a disruption (Duffield, 2016; Ivanov & Das, 2020; Kazancoglu et al., 2022; Papadopoulos et al., 2017; Queiroz Fosso Wamba et al., 2022). This means that within the SC, the systems are designed to cope with higher risks. Strategies such as flexibility or

redundancy are commonly used to deal with risks over the stages of recovery, stabilisation, mitigation, or preparedness (Ivanov & Rozhkov, 2019). An SC with resilience must be able to avert high costs of potential disruptions such as pillowing methods of extra production capacity maintenance, having financial reserves, backup suppliers, and maintaining inventory safety stock reserves. In other words, there is a rapid and flexible response, a sense of change, and overall preparedness (Dubey et al., 2022; Dubey et al., 2019).

When emerging technologies can make SC contain vulnerability and disruptions, such technologies make them agile and resilient. As such, according to Gupta et al. (2019) and Ivanov and Rozhkov (2019) SCs can be resilient and agile when technologies give them the ability to be organised, redundant and flexible to be able to recover, stabilise and mitigate any risk pre-disruptions. Resilience strategies of commercial SCs might differ from HSCs based on the availability of resources such as financial reserves or redundant pre-disruption inventories. However, Dubey et al. (2020) argue that agility achieved through short lead time and efficient demand management is standard in commercial and humanitarian supply chains. In other words, these agile and resilient strategies can be viewed as life-support mechanisms for meeting beneficiaries of humanitarian assistance requirements with little room for mistakes (Stewart & Ivanov, 2022).

From the literature presented in this section, it is evident that there are different perspectives on agility and resilience in both HSCs and commercial SCs. In conclusion, the researcher notes that though some sources analysed above stress the importance of flexibility, others highlight differences between agility and resilience. Despite these differences, the scholars presented in this section generally agree on the significance of agility and resilience in managing uncertain environments and meeting humanitarian needs. The researcher notes that it is essential to note that the varying viewpoints of the articles presented could be attributable to the scholars' different research contexts, methodologies, or theoretical frameworks.

2.6 BDA and Integration with Advanced Technology

In recent years, there has been a growing body of research in the field of operations on the topic of the role that digital technologies (DTs) play in HSC (Marić et al., 2022). BD is one of these technologies, and it is described as a technique for gathering, managing, and analysing enormous amounts of data (Leveling et al., 2014). BDA, which involves analysing this data to obtain insights, has emerged as a crucial business capability to give firms better ways to extract value from an ever-increasing amount of data and gain a significant competitive advantage because of the

widespread usage of digital technology (Wang et al., 2016). It has been identified as a possible answer for enhancing the agility and resilience of organisations in many companies in different sectors (Benzidia et al., 2021; Dubey et al., 2019; Papadopoulos et al., 2017). Organisations collect large amounts of data, named “big data, " during everyday activities. BDA has gained strategic importance as one of the critical assets of an organisation that can be analysed to get insights and manage customers/ beneficiaries, suppliers, products, and frame business strategies (Gangwar et al., 2023). Although Benzidia et al. (2021) mention in their article that it is difficult to reach a consensus on the definition of BDA, generally, it is defined as “a new generation of technologies and architectures, designed to economically extract value from huge volumes of a wide variety of data, by enabling high-velocity capture, discovery, and analysis” (Mikalef et al., 2019).

Furthermore, this article points out that this BD hype has led firms to invest in their drive to discover how to utilise their data to create value. Nevertheless, there still needs to be more knowledge regarding the significant organisational features and constraints when implementing BDA, despite the numerous assertions that its implementation can result in economic value (Gupta & George, 2016; Wamba et al., 2017). BDA is cited as an enhancer and enabler of supply chain visibility in business operations (Al-Khatib, 2023; Leveling et al., 2014b), which helps firms control the flow of goods to their customers.

In summary, the research findings on digital technologies in humanitarian supply chains emphasise the central role of BDA in improving operational efficiency and strategic decision-making. These technologies are increasingly recognised as essential tools for extracting value from BD, providing competitive advantage, and improving the resilience and agility of supply chains. Despite the recognised potential and increasing investment in these technologies, the literature also points to a gap in understanding the specific organisational characteristics and challenges associated with implementing BDA effectively to realise its total commercial value. This emphasises the need for further research to explore these aspects in more detail.

2.7 Influence of BDA on General Supply Chains

How to handle vast amounts of data and use predictive analytics is a subject in which many SCM practitioners and scholars have shown massive interest (Kache & Seuring, 2017; Schoenherr & Speier-Pero, 2015). BDA capabilities can help with SC tasks such as SCM, manufacturing, demand management, transportation & logistics, and general SC (Raut et al., 2021a). The ease with which data can now be obtained using modern information technology has resulted in an

unparalleled volume, variety, and velocity of data, directly contributing to the challenge of analysing it and getting usable insights.

According to a study by Li & Liu (2019) "BDA can transform SCM by enabling organisations to make better, faster, and data-driven decisions". If implemented and used correctly, BDA can bring competitive advantages to an organisation that helps it improve decision-making, increase efficiency and accuracy, and provide a deeper understanding of HSC operations (Raut et al., 2021b; Wei et al., 2022). Some of these competitive advantages include agility and resilience. The use of BDA can be beneficial to the processes of logistic planning, the administration of intelligent transport systems, and the management of in-transit inventory (Raut et al., 2021a).

Because of its complexity and the significant role that SCM plays in enhancing overall business performance, BDA in SC has drawn more and more attention (Wang et al., 2016). BDA have become an increasingly important requisite for organisations across emerging and advanced economies (Ji-fan Ren et al., 2017). It provides a data-driven decision-making tool in the SCs (Gangwar et al., 2023). Some scholars have argued that organisations have mainly utilised BDA to improve SC collaboration, increase transparency and decision-making, and solve environmental challenges (Kache & Seuring, 2017; Surbakti et al., 2020).

To connect and coordinate each link in the chain, SCM has been heavily utilising a wide range of technologies, including sensors, barcodes, radio-frequency identification (RFID), internet-of-things (IoT), etc. Therefore, it should come as no surprise that BDA has revolutionised SCs, and its use in SCM has been reported in several articles by scholars (Choi et al., 2018; Fan et al., 2021; Leveling et al., 2014a; Li & Liu, 2019; Nguyen et al., 2018; Wamba et al., 2017). It is, therefore, essential to explore other sectors where organisations are applying SCM BDA, as the research question posed in this study posits.

To summarise, the literature presented highlights the critical role of BDA in the transformation of SCM. The ease of data collection and the challenges of managing large amounts of data have drawn attention to BDA as a tool to improve decision-making, efficiency and understanding of supply chain processes. The capabilities of BDA to improve logistics planning, transport management, and inventory control demonstrate its competitive advantages, such as increased flexibility and resilience. The growing importance of BDA in HSCM, emphasised by various scholars, also shows that it plays a critical role in emerging and advanced economies. This

highlights the need for a broader exploration of the applications of BDA in the Humanitarian sector, which aligns with this study's research focus.

2.8 Influence of BDA on Humanitarian Supply Chains

In the ever-evolving humanitarian aid landscape, the intersection of technology and operational strategies has become essential for HNGOs working in HSCs. The use of innovative technological tools, especially BDA, has proven to be a cornerstone for increasing the efficiency and effectiveness of humanitarian NGOs. This integration is instrumental in ensuring the sustainability of humanitarian activities and enables organisations to navigate complex scenarios characterised by resource scarcity, funding competition and challenging environments (Behl & Dutta, 2019). As HNGOs endeavour to save lives amidst these challenges, the demand for data-driven insights is paramount (Dubey et al., 2022; Vanajakumari et al., 2016).

The utilisation of innovative technological tools and technology has been crucial in enhancing the efficiency and efficacy of HNGOs, hence ensuring the sustainability of their activities in the context of HSCs (Behl & Dutta, 2019). HNGOs put forth great effort to save lives while employing limited resources, competing for donor funding, and working in challenging environments. Unsurprisingly, they require data and insights to carry out their duties efficiently and effectively (Dubey et al., 2022; Vanajakumari et al., 2016). Technologies such as Twitter, cell phone messaging, blockchain (Deepa et al., 2022; Sahebi et al., 2020), drones (Chowdhury et al., 2017; Emery, 2016; Ergun et al., 2014; Moshtari et al., 2021; Rejeb et al., 2021), and BDA (Deepa et al., 2022; Fan et al., 2021; Surbakti et al., 2020) have gained prominence in their usage within HSC contexts.

In summary, integrating innovative technological tools, especially BDA, is critical for HNGOs operating in HSCs. This strategic integration increases the efficiency and effectiveness of HNGOs and ensures the sustainability of their activities in times of resource scarcity and funding competition. The demand for data-driven insights emphasises the critical role of technologies in addressing the unique actions required to transform HSCs.

2.8.1 Transformative Nature of BDA

The transformative impact of BDA within HSCs is unmistakable, revolutionising the operational landscape of HNGOs (Amaye et al., 2016; Fan et al., 2021). BDA delivers operational efficiency and cost-effectiveness by enabling organisations to analyse large data sets, identify inefficiencies and optimise the use of resources to provide more effective assistance. BDA represents a shift

away from traditional data reporting and empowers HNGOs to make strategic decisions by utilising both structured and unstructured data, in line with advances in the for-profit sector (Altay et al., 2023; Gupta et al., 2019b). Given the dynamic and challenging humanitarian environment, BDA enables adaptability and facilitates rapid responses to changing circumstances (Dubey et al., 2022).

Researchers Gupta et al. (2019) and Talwar et al. (2021) argue that BDA usage in SCs has led to a massive transformation in the past decade. This means BDA has become a useful technological tool and solution that can improve and drive strategic decisions for operational and tactical issues within a business function, which allows organisations to be more responsive to the needs of operating in an uncertain environment.

BD in the context of HNGOs has the potential to revolutionise organisations' abilities to deliver on time, at a low cost, and to be more resilient over the long term in ways that may not have previously been imaginable (Amaye et al., 2016b; Fan et al., 2021). Most humanitarian organisations (HO) only report data rather than use it for strategic initiatives (Prasad et al., 2018). The humanitarian sector is expected to see the same transformation as the for-profit sector because of this shift, which has lately become true in that setting (Altay et al., 2023; Gupta et al., 2019a; Prasad et al., 2018).

The integration of BDA within HSCs marks a transformative shift for HNGOs. BDA's impact is evident in enhancing operational efficiency, optimising resource utilisation, and empowering strategic decision-making in response to the dynamic challenges of humanitarian operating environments. This technological advancement has the potential to revolutionise the capabilities of HNGOs by enabling timely, cost-effective, and resilient operations by leveraging strategic insights from large data sets.

2.8.2 Flexibility

According to Gupta et al. (2019) analysing structured and unstructured data is the most significant innovation in managing humanitarian supply chains HSCs. This article further suggests further research directions in BD and HSCM. Within HSCs, using BDA is believed to improve accuracy and speed in delivering aid whilst improving donor transparency and creating stakeholder trust (Dubey et al., 2019). According to Nguyen et al. (2018) BDA usage is essential to the humanitarian sector supply chain and logistics operational need to deliver aid effectively and efficiently when faced with processing, analysing, and managing high volumes of data into valuable insight.

To summarise, integrating BDA is a significant innovation in HSCM, as it enables greater accuracy, faster aid delivery, improved transparency for donors and greater stakeholder trust.

2.8.3 Visibility

Increased visibility is essential for optimising resource allocation and coordination across affected populations. Through mobile and social media data technologies, HNGOs engage in crisis mapping, enhancing their understanding of disaster areas. This subsection investigates how BDA improves visibility and decision-making in humanitarian contexts. The visibility of mission-critical resources and their allocation and coordination across affected populations challenge humanitarian organisations working in complex and dynamic situations (Prasad et al., 2018). Humanitarian organisations that use technologies often use mobile and social media data to conduct crisis mapping to deliver aid to affected disaster areas (Nazir et al., 2021). Such information can be voluminous in modes, characteristics, and content of explicit and implicit geographical information (Haworth, 2018; Senaratne et al., 2017). Yet, according to Ye et al. (2022), HSCs also receive large volumes of data in crises, which are often chaotic as survivors attempt to reach out, creating BD sets.

The section underscores the critical importance of visibility in humanitarian operations, emphasising the challenges organisations face in complex and dynamic scenarios.

2.8.4 Adaptability

The dynamic and challenging nature of humanitarian environments necessitates adaptability. BDA emerges as a critical enabler, providing the tools to analyse and interpret data rapidly, especially in crises (Dubey et al., 2022). HNGOs equipped with BDA capabilities can respond swiftly to changing circumstances, demonstrating agility in the face of operational challenges. This adaptability is crucial for maintaining the commitment to assist populations in need during disaster scenarios (Amaye et al., 2016). While BDA presents opportunities for efficiency improvement, challenges such as data reliability and rapid decision-making persist.

In essence, the section emphasises the imperative of adaptability in a dynamic and challenging humanitarian environment. BDA is a crucial factor that enables rapid data analysis and evaluation, especially in crises. HNGOs equipped with BDA capacity demonstrate their agility by promoting fast responses to operational challenges and reaffirming their commitment to supporting people in need during disasters. However, it is also evident from the discussion that despite the opportunities provided by BDA to increase efficiency, there are still challenges, including the reliability of data and the need for rapid decision-making.

2.8.5 Fostering Stakeholder Trust

In the context of HSCs, openness is of the utmost importance for establishing and retaining the trust of stakeholders. According to Dubey et al. (2019) BDA's significant contribution is to improve donor openness and accountability in HSC operations. The capacity to give real-time insights and traceability in aid distribution inspires confidence among donors, benefactors, governments, other stakeholders, and the communities being helped. This transparency improves agencies and stakeholders' ability to trust one another, making humanitarian efforts much more effective and efficient.

In summary, this section emphasises the importance of openness in HSCs for fostering stakeholder trust. The BDA is essential in improving donor openness and accountability in HSC operations. Real-time visibility and traceability of aid distribution builds trust among donors, benefactors, governments, and other stakeholders, increasing humanitarian efforts' overall effectiveness and efficiency.

2.8.6 Shifting from generic reporting to strategic decision-making

Traditionally, humanitarian organisations have been constrained by a narrow approach that primarily involves reporting on data without fully exploiting its potential for strategic decision-making (Prasad et al., 2018). However, the emergence of the BDA heralds a paradigm shift that breaks through this conventional model and enables NGOs to move beyond mere reporting into data-driven decision-making. The ability to analyse both structured and unstructured data equips these organisations with a powerful toolkit that not only enables them to understand the intricacies of their operations but also to formulate strategic initiatives that significantly increase overall efficiency (Altay et al., 2023; Gupta et al., 2019a). This shift mirrors the transformative development in the for-profit sector, where data analytics has become integral to setting strategic direction and driving organisational success (Choi et al., 2018; Fosso Wamba et al., 2018; Günther et al., 2017). BDA thus acts as a catalyst for innovation in humanitarian aid, opening new opportunities to optimise resource allocation, streamline processes and ultimately improve the efficiency of HNGOs in delivering assistance to those in need.

In conclusion, this section highlights the transformative shift facilitated by BDA in humanitarian organisations' approach to data analytics. Beyond traditional reporting, BDA enables HNGOs to make data-driven decisions that reflect developments in the for-profit sector.

2.8.7 Conclusion on the influence of BDA on HSCs

To summarise, the literature presented in this section highlights the transformative role of BDA in improving the operational capabilities of HNGOs. Using BDA and other advanced technologies is essential for improving efficiency and effectiveness and ensuring the sustainability and continuity of humanitarian efforts. The following section looks at the factors that enable the adoption and implementation of BDA by NGOs to improve their agility and resilience.

2.9 Enablers of BDA in HSCs

The introduction of BDA can transform HSCs by improving decision-making processes, optimising resource allocation, and increasing the responsiveness of aid deliveries in crises. However, the successful implementation of BDA in the complex and often unpredictable field of humanitarian aid depends on identifying and utilising key enablers. This section looks at the critical factors that contribute to the successful integration of BDA and sets the stage for a more efficient and flexible humanitarian response.

2.9.1 Integration with advanced information technology

Digital technologies and BDA efficiently influence positive change in HSC's reaction to crises and transform the methods they use from traditional to digital (Nazir et al., 2021). The primary tool used in BDA is information technology, which has moved from enabling enablers to facilitate specific tasks to being an integral part of most humanitarian agencies' operations (Talwar et al., 2021). Giannakis & Louis (2016) pointed out that it is well-recognised that IT integration is an enabler for SC flexibility, agility, and subsequently better firm performance. These operations, which hugely involve the execution of complex processes within their supply chains, involve several stakeholders who have also started relying more and more on BDA (Nazir et al., 2021). The main benefit has been the complex networks' increased visibility, making it easier to coordinate the different parts and players (Dubey et al., 2020; Talwar et al., 2021).

Information technology has also played a crucial role in encouraging the use of BDA in logistics and supply chain operations by improving inventory visibility, coordination, flexibility, and competitiveness of the agencies participating in the HNGO sector (Dubey et al., 2020). The use of BDA has been found to positively impact the efficiency and effectiveness of operations of any firm (Jeble et al., 2020). Research has also proved that BDA can improve performance and decision-making and increase transparency and traceability in logistics and supply chain operations (Zhan & Tan, 2020). However, these studies were done within commercial supply

chains. Hence, this study needs to use the same lenses to explore how enabling factors for BDA influence the agility and resilience of HSCs.

The literature reviewed in this section provides a clear understanding of the role of IT as an enabler of BDA in HSCs. The articles demonstrate a shared view on the positive influence of IT-enabled BDA in HSCs. They highlight the transformational impact of digital technologies, increased visibility of complex networks, improved coordination, and the potential benefits of BDA on efficiency, effectiveness, performance, decision-making, transparency, and traceability. While some references specifically address HSCs, others provide insights from for-profit supply chains, indicating the need for further exploration within the context of HSCs.

2.9.2 Integration with advanced technology that supports BDA.

In recent times, the term “big data” has increasingly been used by scholars to explore the impact of both commercial SCs and HSCs(Chen et al., 2015; Deepa et al., 2022; Dubey et al., 2019; Gupta et al., 2019a; Nguyen et al., 2018; Tiwari et al., 2018; Wei et al., 2022). Akter and Wamba (2019) and Dubey et al. (2022) point out that because of the dynamic nature of computing technology and capabilities, the term “big data” may not make sense soon. Likewise, with no application of AI, BDA will have no usage (Akter et al., 2021; Kankanamge et al., 2021). BDA enables commercial and humanitarian organisations to shift from instinctual to data-driven decision-making (Duan et al., 2019). Organisations will utilise BDA to help create value by swiftly focusing on complex issues and obstacles at a minimal cost (Dwivedi et al., 2021).

Because of this, AI's crucial role in BDA is to generate value by giving organisations intelligent insights from large data sets and to assist in the capture of structured interpretations of large unstructured data sets, which make up nearly 85% of the total volume of big datasets (Dubey et al., 2019). According to (Dubey et al., 2022), the humanitarian sector has a lot of chances to use digital technology to improve its operations. The use of mobile phones, social media platforms, geospatial technologies, and various crowdsourcing tools in recent disaster relief efforts has wholly changed how humanitarian crises are recognised and addressed, as well as how information is gathered, analysed, and shared among the various humanitarian actors (Behl & Dutta, 2020; Fan et al., 2021; Ivanov et al., 2021; Kankanamge et al., 2021).

Despite growing confidence in using digital technology in the HNGO sector, this has led to initiatives to address the challenges faced during humanitarian relief operations using multidisciplinary approaches (Fan et al., 2021). According to Behl and Dutta (2020), however,

humanitarian organisations take a while to realise how much digital technology may improve their decision-making capacity. Thus, there is a need for this research to explore the enabling factors of BDA's effect on agility and resilience in HSCs.

The success of BDA and its accuracy depend immensely on the tools and methods used to analyse the data (Ranjan & Foropon, 2021). Hence, more work is being done to give HSCs more useful managerial support based on data. This study further points out that the capacity to utilise and fully exploit the benefits of BDA tools and techniques is vital to unlocking an enabling environment in BDA-driven organisations. Adopting tools and techniques such as IoT and cloud computing technologies leads to better value creation for both the customers and the organisation (Ranjan & Foropon, 2021; Rehman et al., 2016).

To summarise, the increasing importance of BDA in both commercial and humanitarian supply chains marks a shift towards data-driven decision-making. This transformation is particularly evident in the humanitarian sector, where digital technologies have revolutionised crisis detection and response. While confidence in the use of digital technologies in humanitarian organisations is growing, the literature reviewed in this section highlights the need to explore the factors that favour the impact of BDA on the agility and resilience of HSCs.

2.9.3 The need for data-driven decision-making.

In HSC operations, data-driven decision-making is paramount, and BDA is a key enabler (Fan et al., 2021; Zwitter & Gstrein, 2020). The complexity of humanitarian operations, often in crises, requires real-time insights from large and diverse data sets to improve decision-making processes. BDA gives HNGOs the tools and methods they need to turn large amounts of changing data into helpful information that can be used to make humanitarian logistics more proactive and well-informed (Arunrat et al., 2022; Dubey et al., 2019). The need for data-driven decision-making is underscored by the multiple challenges HSCs face, including resource allocation, optimisation of crisis response and overall operational efficiency (Altay et al., 2018b; Shafiq & Soratana, 2019b). Through using BDA and technology in HSCs, organisations can improve their ability to quickly analyse and interpret information from various sources, facilitating timely and informed decision-making in humanitarian assistance (Ivanov & Dolgui, 2021; Nazir et al., 2021). Integrating data-driven processes through BDA increases the agility and responsiveness of HSCs and contributes to more effective resource utilisation and better outcomes in crises (Altay et al.,

2018b; Fan et al., 2021). So, adding BDA to HSCs is necessary and shows how important technology is for encouraging decisions based on facts to improve humanitarian outcomes.

Overall, this section emphasises the research focus on identifying how BDA influences the agility and resilience of humanitarian operations through data-driven decision-making processes. The literature presented puts a lot of emphasis on the use of technology in humanitarian logistics, which fits with the study of research's exploration of enablers and inhibitors of BDA in the specific context of HSCs. Organisations need decision frameworks or support systems that help them address complex problems in this sector.

2.9.4 Decision Support systems

The importance of decision support systems (DSS) in HSCs as enablers of BDA adoption and implementation is well documented in the literature. DSS provide a structured framework to support decision-makers in tackling complex problems and facilitate using BDA for informed decision-making in humanitarian operations. Scholars emphasise the need for integrated decision-support mechanisms to improve the effectiveness and efficiency of HSCs (Talwar et al., 2021). Decision support systems play a crucial role in managing the complexity of humanitarian logistics by processing and analysing large amounts of data, which aligns with BDA's objectives (Nazir et al., 2021). The synergy between DSS and BDA is highlighted as essential for optimising resource allocation, improving decision-making processes, and increasing the responsiveness of aid delivery in crises (Nazir et al., 2021; Talwar et al., 2021). The literature emphasises that integrating advanced information technology, including DSS, is essential for successfully implementing BDA in HSCs (Giannakis & Louis, 2016). The way that decision support systems and BDA work together makes sense when looking at the things that make HSCs flexible and robust through the lens of BDA.

The identified literature supports the exploration of enablers that foster agility and resilience in HSCs through the lens of BDA, emphasising the interconnectedness between decision support systems and the transformative potential of BDA in humanitarian contexts. With suitable decision support systems, the leaders of organisations can make the right call regarding investments in pursuing BDA as a technology to enable agility and resilience.

2.9.5 Visionary leadership

Visionary leadership is critical in implementing and adopting BDA in HSCs and ultimately contributes to agility and resilience. Research highlights that visionary leaders are instrumental in steering agencies towards technological advances such as BDA and recognising its potential

impact on decision-making, operational efficiency, and overall performance (Ateş et al., 2020; Uhr, 2017). Visionary leaders foster a culture of innovation and encourage the exploration and integration of advanced technologies to address the unique challenges HSCs face. Studies by Nazir et al. (2021) and Dubey et al. (2022) emphasise the importance of leaders in promoting digital transformation, with a particular focus on BDA in the humanitarian context. Visionary leaders champion the strategic adoption of BDA and create a favourable environment for learning and adapting to technological advances. This literature backs up the quest to explore if visionary leadership is an enabler for maximising BDA's benefits in HSCs, ultimately making humanitarian operations more agile and resilient.

2.9.6 Conclusion on enablers of BDA in HSCs

To summarise, the literature in this section highlights the key factors contributing to the successful integration of BDA into HSCs. The first key factor is integration with advanced information technology, emphasising the transformative impact of digital technologies, increased transparency, and improved coordination. The second key enabler is the integration of advanced technologies to support BDA, emphasising the role of artificial intelligence and various digital tools in enhancing decision-making processes. The third factor is the need for data-driven decision-making, which highlights the paramount importance of BDA in providing real-time insights for better decision-making, especially in crises. The fourth factor is Decision Support Systems (DSS), which give the decision-makers a structured framework for utilising BDA for informed decision-making in humanitarian operations. Finally, visionary leadership is cited as a critical factor that highlights the role of leaders in steering organisations towards technological advances and fostering a culture of innovation for the successful implementation of BDA in HSCs. Overall, these factors contribute to improving the agility and resilience of humanitarian operations through the effective integration of BDA.

2.10 Inhibitors of BDA in HSCs

Although the potential of BDA is widely recognised, there are significant challenges to its adoption and implementation. Technological barriers are frequently cited in the literature, such as the lack of infrastructure and data management capacity (Bell et al., 2021a; Bhadani & Jothimani, 2016; Dwivedi et al., 2021; Jagadish et al., 2014). Organisational challenges also play a role, with issues relating to governance, data-sharing protocols, and the need for specialist skills at the forefront (Altay et al., 2018). Besides BDA, scholars have identified several challenges commonly encountered in HSC. These challenges encompass issues related to evaluation and planning, limited use of technology, operations in remote and underdeveloped areas, and inadequate

infrastructure (Shafiq & Soratana, 2019). This article by Shafiq & Soratana (2019) says one major challenge identified is the tendency of donors to exhibit short-sighted and shallow spending practices.

These challenges, ranging from technological barriers to organisational issues and broader HSC-related concerns, underscore the complexity of integrating BDA into humanitarian operations. Notably, addressing these inhibitors is crucial for unlocking the transformative potential of BDA in enhancing the efficiency and effectiveness of HSCs.

2.10.1 Lack of IT skills and knowledge

The lack of sound knowledge and expertise in digital technology is one of the key reasons why AI-driven BDA is being adopted slowly (Bag et al., 2020; Karuppiah et al., 2021; Zanon et al., 2021). The authors continue by saying that this is made worse by a need for more sophisticated methods to address humanitarian issues. According to Pizzi et al. (2020) one factor that may hinder the effective adoption of emerging technologies to improve the effectiveness of humanitarian relief activities is the need for digital technology. Furthermore, according to Kunz & Gold (2017), humanitarian organisations need more data analytics professionals capable of processing and analysing vast amounts of data to extract further relevant conclusions and information (Alharthi et al., 2017).

Akter et al. (2016) advocate for developing reliable human resources with BDA capabilities to align extensive data analytics capability with strategic goals. HSCs must develop employee skills in data optimisation, data mining, machine learning and statistics (Choi et al., 2018). Similarly, Kunz & Gold (2017) argue that HSC must develop employee capability in skills, experience, knowledge, processes, and routines to sustain BDAs. However, given this reliance on people and strategic alignment, Pizzi et al. (2020) argue that there may be additional challenges in HSC scenarios where environmental instability makes alignment more challenging. Hence, this exploration aims to understand if employee IT skill factors inhibit BDA from influencing agility and resilience in HSCs.

A key challenge preventing the full potential of BDA in HSCs is inadequate staff training and education. The existing literature identifies this skills gap as a significant obstacle to using BDA effectively. The current BDA workforce needs more training and education due to a lack of ongoing professional growth (Bag et al., 2020). HNGOs often work under extreme pressure and

are focused on immediate disaster relief. This environment can lead to a need for more systematic investment in education and training, especially in specialised areas such as BDA. Kunz and Gold (2017) argue that humanitarian logistics staff typically receive training focusing on operational skills rather than analytical competencies. The rapid development of technology in HSCs needs to catch up to current training programmes in these organisations, resulting in a mismatch between workforce skills and available technologies (Heaslip et al., 2019). More training and education in BDA and other technologies represent a fundamental challenge that undermines the operational effectiveness of HSCs.

In conclusion, the reviewed literature unanimously agrees that the lack of IT skills, insufficient training, and education in digital technology and BDA are significant inhibitors to implementing BDA in HSCs, affecting their agility and operational effectiveness.

2.10.2 High cost of BDA technology

The significant investment required to implement BDA technology is a primary consideration in the business landscape. In addition to the initial investment in BDA infrastructure, management and skilled personnel, there are ongoing and sometimes escalating costs to maintain and update the technology. Organisations often face the challenge of managing the high cost of BDA implementation, including the purchase of advanced hardware and software and the expense of data storage, processing, and security. The complexity of managing large datasets and ensuring their accessibility further adds to the financial burden (Manyika et al., 2011). As BDA evolves, organisations must keep pace with technological advances, which require ongoing investment to remain competitive and harness the full potential of BDA to make informed decisions (Sharma et al., 2021). The financial commitment required for BDA underscores the need for companies to carefully evaluate the cost-benefit dynamics and develop strategic approaches to optimise the return on their investment (Akter et al., 2016; Lai et al., 2018).

To summarise, implementing BDA in HSCs poses a significant financial challenge. In addition to the initial investment in infrastructure and specialised staff, there are ongoing costs for maintenance, updates, data storage, processing, and security. This financial commitment underlines the importance for HSCs to thoroughly assess the cost-benefit dynamics and develop strategic approaches to optimise returns to ensure that the potential benefits of BDA can be realised in humanitarian operations.

2.10.3 Lack of finance and investment in technology

According to Sharma et al. (2018) extensive data analysis comes at a cost. Small organisations and a significant part of vulnerable populations in disasters cannot afford to use new technologies that generate big data. HOs allocate resources and offer essential products and services to individuals facing adversity, utilising financial contributions from donors who endorse their philanthropic objectives. The importance of funding methods, money, and their characteristics on the success of HNGOs in meeting their goals and the needs of donors is significant (Burkart et al., 2016). This article mentions that aid agencies must allocate their limited resources to many disasters and development programmes needing help. The allocation of limited resources is therefore associated with opportunity costs in the form of unmet and urgent demand for activities that cannot be carried out simultaneously.

A diverse range of scholarly publications exists on HSCM and the administration and procurement of donations. Studies such as that by Kabra et al. (2023) emphasise that limited financial resources are a significant barrier to technological progress in this sector. Besiou et al. (2011) explore how competition in funding humanitarian work affects technology adoption, often favouring immediate relief efforts over long-term technological investments. These constraints are related to more than resource scarcity and the prioritisation of funding.

The link between underinvestment in technology and the slow uptake of BDA in HSCs has been highlighted in several studies. Oloruntoba & Gray (2006) examined how limited technological investment hinders the development of HSCs, proposing that agility in the context of these operations must address the unstable nature of funding. Gupta & George (2016) reinforce this notion by highlighting how funding positively influences the efficiency and efficacy of humanitarian organisations in their relief operations. This article also highlights that insufficient funding for technology hinders the ability of HSCs to utilise BDA for fully improved decision-making and efficiency.

The challenge of prioritising investment in technology in humanitarian organisations is complex. (Kovacs & Spens, 2012) Discuss the difficulty of prioritising funding for technological advances given the urgency of disaster response. Balcik et al. (2010) offer an organisational perspective in which they analyse the dilemma of balancing immediate operational requirements with the need for long-term technological development. The authors note that donors are not obligated to provide funding for any disaster scenario. Furthermore, if donors do choose to provide funding,

they can only withdraw their support if the agencies fulfil the requirements outlined in their contractual agreements.

Kunz & Reiner (2012) provide empirical evidence of the link between financial constraints and the slow adoption of technology in humanitarian organisations. In response to these financial barriers, scholars (Nurmala et al., 2017) suggest strategies such as forming partnerships with the private sector and developing innovative financing models. Van Wassenhove (2006) emphasised the role of external funding and donations in facilitating technology adoption and highlighted these avenues as potential solutions to mitigate financial challenges in HSCs.

In summary, the literature reviewed highlights the need to overcome financial and investment challenges to exploit the potential of BDA in HSCs fully. The evidence suggests that overcoming these financial constraints is critical for the humanitarian sector to fully realise the benefits of technological advancement.

2.10.4 Data incompatibility

According to Akter and Wamba (2019), the vast amounts of data generated by disaster-related events are too large to fit into typical data storage and processing systems. This points to the need to build an infrastructure to accommodate big data into the system for processing and visualisation. Other issues include more value unlocking and data capacity (Alharthi et al., 2017). According to Griffith et al. (2019), the biggest challenge for supply chain leaders is that they have a wealth of data but must utilise its full potential. The article points out that data sources can include any data from social networks, remote sensing data, multimedia data, and areas that have just experienced a disaster.

Self-service analytics capabilities need to be enabled by streamlining all aspects of the system, including how data is collected and fed into the BDA platform (Alharthi et al., 2017). However, the challenges of centralising the management of BDA operations remain due to the volume of data generated from multiple disparate data sources (Griffith et al., 2019). It is critical to understand whether data incompatibility hinders BDA's ability to impact the agility and resilience of HSCs.

The literature in this section highlights the challenges posed by the vast amounts of data generated by disaster events, which require dedicated infrastructure for storage, processing, and visualisation. Issues such as underutilisation of the full potential of data, lack of value unlocking and difficulties in centralising BDA operations management are highlighted. The importance of enabling self-service analytics capabilities and addressing data incompatibilities is highlighted as a critical factor in determining the impact of BDA on the agility and resilience of HSCs.

2.10.5 Lack of data-driven culture

A "big data" culture, according to Gupta and George (2016) and Dubey et al. (2019), has a substantial influence on how quickly people adopt new technologies. A data-driven culture is necessary within HSC to develop a better environment for BDA application in HSC operations (Dubey et al., 2019). This means the mindset of employees must change to permit the practical application of BDA in HSCs with motivated employees (Alharthi et al., 2017). This article further points out that employees should be motivated to embrace the not-so-user-friendly BDA process comprised of data visualisation techniques, advanced data analysis and integration techniques. Hence, this study needs to explore whether a data-driven culture or lack thereof inhibits BDA's influence on the agility and resilience of HSCs.

From the references provided, there is agreement among scholars regarding the importance of a data-driven culture in the context of BDA adoption in HSCs.

2.10.6 Big data attributes

According to a study by Qadir et al. (2016) big data needs help with validity, verification, veracity, velocity, variety, and volume. In another study by Osinga et al. (2022) velocity and variety were the most essential prominent data characteristics. The problems of big data include the need for adequate translation, the focus of attention, deception, performance quantification, and reliability (Sheng et al., 2019). Qadir et al. (2016) further point out that, sometimes, large amounts of data can obscure critical information and is not a good thing during a disaster when the time to react is short, as with most HSC efforts during crises.

According to Sharma & Joshi (2020) data is generated from numerous sources in multiple, unstructured, and structured formats, making data interpretation and processing complicated. Sources that BDA must use in HSC include global positioning system (GPS) data, multimedia data, social network platforms, and websites (Alharthi et al., 2017). Any information overflow could lead to HSC's poor decision-making and disaster response under time limitations. Hence, this study must understand if prominent data attributes inhibit BDA's influence on HSC agility and resilience.

To summarise, the challenges of big data, including validity, verification, veracity, velocity, variety, and volume, highlight the complexity of interpreting different data formats. Understanding the potential inhibiting factors of these significant data attributes is critical to assessing the impact of big data analytics on the agility and resilience of humanitarian supply chains.

2.10.7 Data privacy and security

Within humanitarian aid and crisis management, the ongoing issue of striking a careful balance between the benefits of BDA and the safeguarding of personal privacy continues to be a significant concern. Multiple research investigations, such as those conducted by Salah (2021), Bell et al. (2021) and Gupta et al. (2019) underscore the importance of implementing strong protective measures. These measures must be implemented to preserve sensitive information effectively while facilitating efficient data interchange among authorities. The significance of ethical considerations, as highlighted by Roberts and Faith (2021) lies in HNGOs' focus on transparency, informed consent, and accountability. Moreover, it has been argued by Alvarez et al. (2016) and other scholars that data breaches significantly impact populations particularly susceptible to harm. The role of technology remains essential today, motivating researchers like Sandvik et al. (2017) and Zomignani Barboza et al. (2019) to explore fresh ideas, such as safe channels of communication and data governance frameworks, to address emerging challenges. Bag et al. (2022) and Gazi and Gazis (2020) provide valuable insights and practical recommendations for effectively implementing resilient methods within complex settings. The humanitarian sector must effectively navigate this complex landscape to fulfil its goal and respect the privacy rights of the individuals it assists.

In summary, the literature reviewed in this section suggests a delicate balance between harnessing the benefits of BDA and protecting privacy, which is a significant challenge for HNGOs. Robust safeguards are critical to preserving sensitive information and facilitating efficient data sharing. Ethical considerations, transparency, and accountability play a central role, while innovative ideas and practical recommendations contribute to effectively implementing resilient practices in this complex environment. The humanitarian sector must overcome these challenges to achieve its goals while respecting data protection rights.

2.10.8 Conclusion on inhibitors of BDA in HSCs

In conclusion, the literature presented identifies that the integration of BDA into humanitarian supply chains holds immense potential to transform the delivery of humanitarian aid by enhancing agility and resilience. However, its adoption is hindered by significant challenges, including technological barriers, organisational issues, and ethical concerns regarding empirical studies with human participants. To overcome these hurdles, aid organisations need to invest in staff training, recruit data analytics professionals, build reliable human resources with BDA skills and implement robust policies to protect consent, anonymity, and confidentiality. By overcoming these

challenges, HSCs can harness the transformative power of BDA to improve the effectiveness of humanitarian aid.

2.11 Research Gap/Opportunity

A study by Sharma and Joshi (2020) reviewed the challenges of BDA in HSC, while the other by (Gupta et al. (2019) carried out a literature review on the use of BDAs in supply chains. Despite a deep look into these areas of importance, this researcher notes that none of these studies explored how BDA influences the agility and resilience of HSC. Abdul Rahman et al. (2022) in their research on HSC trends, prescribed that future research could explore how technology could help in the swift execution of HSC activities.

Other past studies have found the importance of emerging technologies in commercial supply chains, such as three-dimensional printing (3D printing) (Holmström et al., 2019) the IoT (Boehmer et al., 2020) AI (Dwivedi et al., 2021) and BDA (Kinra et al., 2020). However, Dubey et al. (2021) argued that commercial supply chains differ from humanitarian supply chains in proactiveness, disruption likelihood and demand. In addition, past literature (Giannakis & Louis, 2016; Papadopoulos et al., 2017; Prasad et al., 2018), analysed the concepts of agility and resilience separately, yet it can be argued that these two attributes together are critical in the effectiveness of humanitarian supply chain operations (Altay et al., 2018b). Therefore, this study seeks to understand how BDA influences supply chains' agility and resilience within the humanitarian sector. This will be done by exploring the role of BDA in affecting the agility and resilience of HSC through a focus on both enablers and inhibitors of technology and BDA within HSCs.

2.12 Conclusion on literature review

In summary, the literature review in this chapter provided insight into the use of BDA in enhancing agility and resilience in HSCs, covering enablers, inhibitors, and associated outcomes. The section addressed the factors that facilitate or hinder the integration of BDA and emphasised its transformative potential to improve agility and resilience in humanitarian operations. The challenges discussed, including technological barriers, organisational issues, and broader concerns in HSCs, highlight the multifaceted nature of BDA adoption. Skills shortages, financial constraints, data-related challenges, and the delicate balance between utilising BDA benefits and protecting privacy are highlighted as critical issues. This comprehensive overview lays the groundwork for further empirical research into the nuanced dynamics of BDA implementation in HSCs and its impact on operational outcomes.

2.13 Conceptual framework

The literature reviewed in this section identified the key constructs and themes relevant to a deeper understanding of the topic and what has already been written about it in literature. The critical constructs identified were enablers, inhibitors and HSCM outcomes. In concluding this chapter, these key constructs and themes discussed in the extant literature were incorporated into the conceptual framework as illustrated in Figure 4 below:

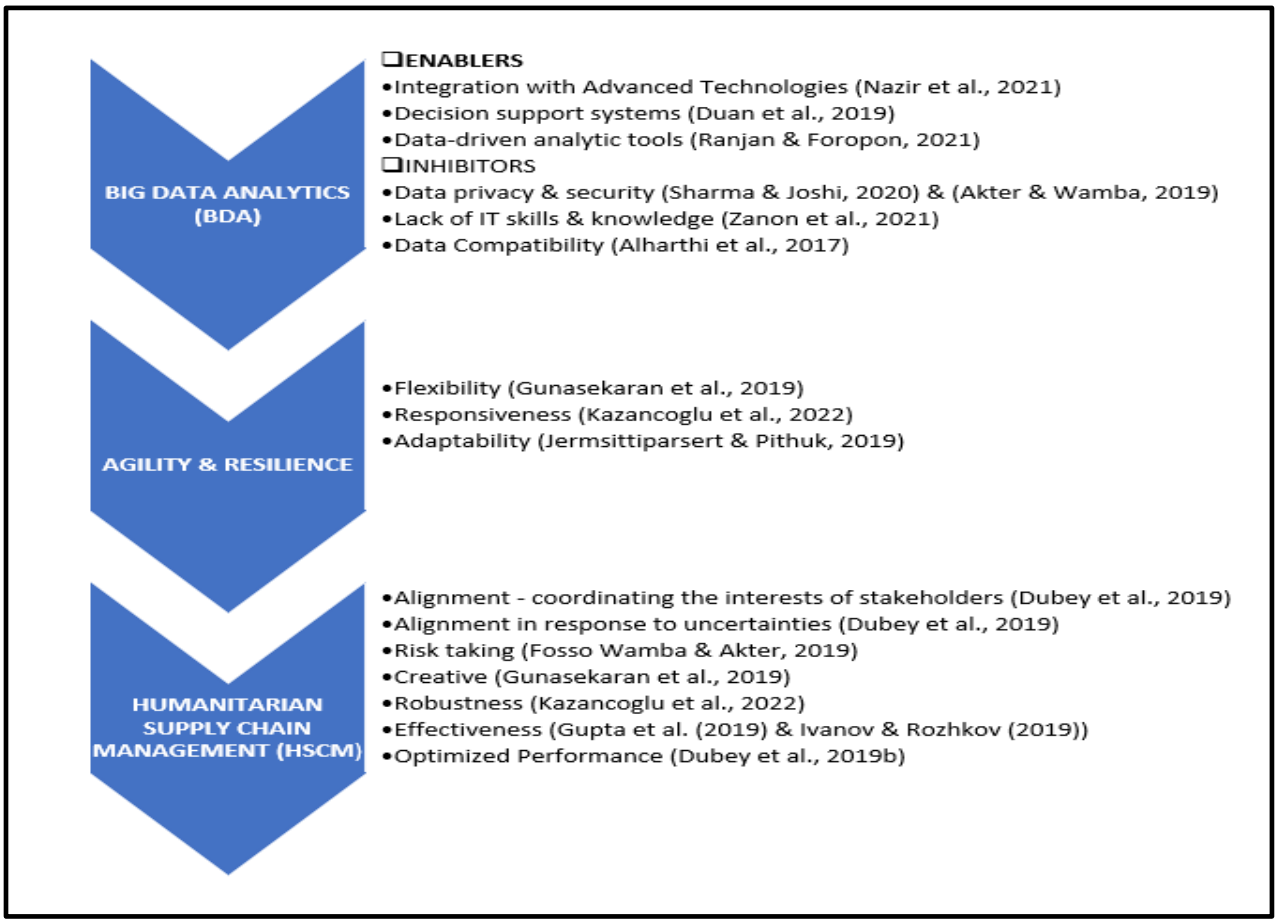

Figure 4 - Conceptual framework from the literature (Source: Author)

CHAPTER 3: RESEARCH QUESTIONS

3.1 Introduction

This chapter explores and explains the research questions arising after the literature review. These questions assist in exploring the research problem and help to guide the research process of gathering primary data. The literature review in the previous chapter led to the following conceptual framework, which the author has formulated in the figure below:

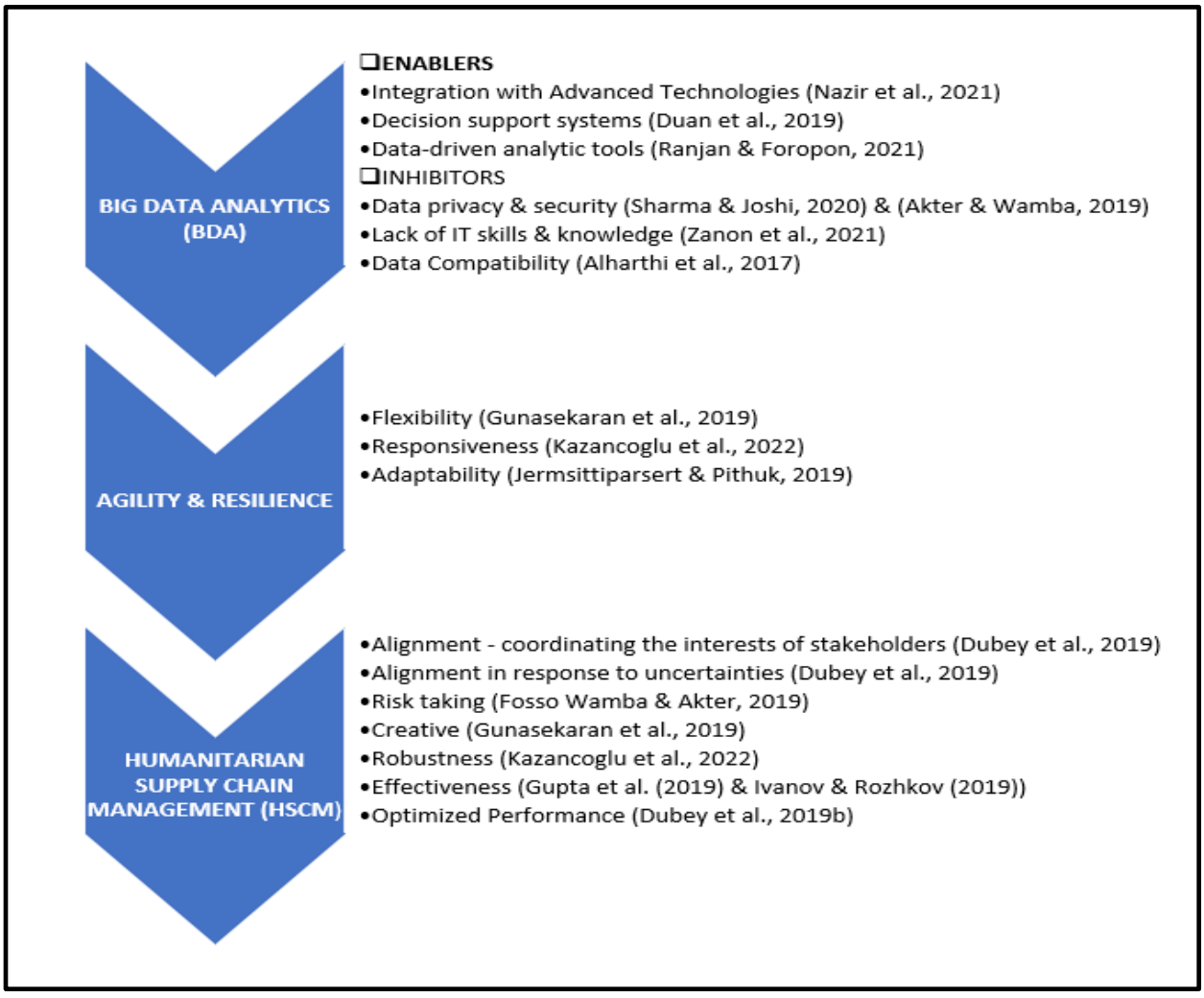

Figure 5: Conceptual Framework (Source: Author)

3.2 Research questions

3.2.1 RQ1: How do agility and resilience affect HSC's effectiveness and efficiency?

According to Altay et al. (2018) SCs must extraordinarily demonstrate agility and resilience to manage the highly unpredictable and extremely uncertain environment in which they operate to ensure effective and efficient processes of cost-effective storage and flow of materials and goods, logistics and transportation information from the point of origin to the point of consumption to meet the populace humanitarian needs. Agility is achieved when the supply chain can prosper and thrive within the unpredictable and uncertain environment in which it operates (Elali, 2021). Consequently, an organisation with an agile supply chain can respond to dynamic environmental changes within the shortest possible time and show flexibility in adjusting capabilities to handle the situation using emerging technologies such as big data analytics (Gunasekaran et al., 2019).

Resilience reflects the ability of the function to move to a new desirable status or the original status after facing a disruption (Pavlov et al., 2022). This article further points out that HSCs can be resilient and agile when technologies enable them to be organised, redundant, and flexible to recover, stabilise, and mitigate any risk pre-disruptions. In other words, the technologies allow an SC to maintain its integrity, bottom line, market share and service level after disruptions occur (Gao et al., 2021; Wieland & Durach, 2021). However, some of these studies were done within commercial SC. Hence, this study aims to explore the effect on agility and resilience within an HSC to answer the above question.

3.2.2 RQ2: What are the enabling factors in BDAs leading to the agility and resilience of an HSC?

Functional managers such as supply chain managers often seek ways to exploit gathered information within the entity and produced by external stakeholders to identify process change opportunities, operations effectiveness, and efficiency and to improve operations visibility (Richey et al., 2022). However, BDAs have various powerful information technologies and analytical techniques that enable organisations to capitalise on big data (Fosso Wamba et al., 2019). The primary tool used in BDA is IT, which has moved from enabling enablers to facilitate specific tasks to being an integral part of most humanitarian agencies' operations (Talwar et al., 2021). The use of information technology has also played a crucial role in encouraging the use of BDA in logistics and supply chain operations through improving inventory visibility, coordination, flexibility, and competitiveness of the agencies participating in the humanitarian sector (Dubey et al., 2020;

Mandal & Dubey, 2021). According to Akter et al. (2016); Kankanamge et al. (2021) BD will have no usage without the application of AI. BD enables commercial and non-profit organisations to move from intuitive to data-driven decision-making (Bhadani & Jothimani, 2016; Günther et al., 2017; Li & Liu, 2019; Liu et al., 2023).

3.2.3 RQ3: What are the inhibiting factors of BDAs leading to a lack of agility and resilience of an HSC?

The absence of a thorough grasp of the technology is one of the critical reasons for the sluggish adoption of AI-driven BDA (Zanon et al., 2021). One of the problems hindering the effective application of emerging technology to enhance humanitarian relief efforts may be the need for proper understanding (Pizzi et al., 2020). A "big data" culture, according to Gupta & George (2016) and Dubey et al. (2019), has a substantial influence on how quickly people adopt new technologies. Numerous academics have thoroughly researched the impact of culture on operations management (Altay et al., 2018b; Dubey et al., 2019; Gupta et al., 2019a; Zanon et al., 2021).

Other inhibiting factors, as found in the literature, include data incompatibility, big data attributes, data security and ethical (Ghadge et al., 2020) costs and funding (Agrawal & Prabakaran, 2020; P. Sharma & Joshi, 2020) and misinformation and poor information sharing (Devitt et al., 2023; Tran et al., 2020). Hence, this study needs to explore what inhibiting factors in BDA influence the agility and resilience of HSCs to answer the above question.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

This chapter presents the research methodology that guided the research inquiry on how BDA influences the agility and resilience of HSCs. It was an exploratory question, and the decisions made in this research design depended on it.

Considering that the research question was how BDA affects HSCs, it was an exploratory question that favoured several different perspectives or views to conclude. In this section, the research methodology used is described, explained, and justified in terms of the research approach, research design, population, sampling method, data collection method, data analysis method and quality controls.

4.2 Research paradigm

The research paradigm chosen for this study was interpretivist. Interpretivism promotes understanding the differences between individuals in their roles as “social actors” (Bell et al., 2019). Therefore, the interpretivist paradigm was appropriate and well-suited for the exploratory nature of this research on the influence of BDA on HSCs' agility and resilience.

The use of semi-structured interviews helped to explore the research question using a variety of themes to provide a balanced account of the findings. This approach emphasised the need to conduct a study that respects the differences between people and objects of study. The term 'social actor' suggests that people play a role in the stages of human life by taking on a part in line with this interpretation.

Moreover, the interpretive approach allowed the observation of an incident in a real and natural setting and allowed the development of a more accurate understanding of the phenomena (Pervin & Mokhtar, 2022).

4.3 Research Design & Approach

The study adopted an exploratory case study research approach. Yin (2018) defined an exploratory research approach as a vital manner of exploring "what is happening; seeking new insights; asking questions and assessing phenomena in a new light." In this approach, clarity was achieved when facing a problem.

This study sought to understand and seek new insights into the phenomenon of BDA's influence on the agility and resilience of HSCs. The researcher sought clarity on how BDA influenced efficiency and effectiveness within the HSCs. An intensive and holistic approach using interviews was aimed at real-life, multiple HSC cases to understand in-depth.

4.4 Setting

The scope of this study was the globally and locally operating HNGO supply chains. The HNGOs studied were international and local organisations that have been working for several years and are present on most continents to aid millions of people in many countries. These non-governmental organisations have fully developed HSC departments that have extensively used BDA in their humanitarian operations and projects over the last five years. The organisations work under the humanitarian pressure of artificial and natural disasters with limited donor-funded resources.

4.5 Level and unit of analysis

According to Creswell (2014) the level of analysis was the scale, size, or location of the research target. However, Yin (2018) argued that the analysis level differs from the analysis unit, as the unit of analysis refers to the distinct team from which data are to be drawn, while the level of analysis relates only to the scale of the research objective. Thus, in this study, the level of analysis was the humanitarian supply chain. The decision to select more than one HSC case helped to increase the depth of the study (Yin, 2018). It allowed for observing and understanding variations between individuals in their roles as 'social actors' (Ryan, 2018).

The unit of analysis is a crucial factor in a case study that determines what and who is studied (Patnaik & Pandey, 2019). The unit of analysis in this study was the interviewees. Therefore, the study used an embedded design to utilise a multi-unit analysis Yin (2018) whereby semi-structured interviews were conducted.

4.6 Sampling Method and Sampling Frame and Criteria

The sampling method is the systematic process of selecting a representative subset of individuals or elements from a larger population to study them and draw conclusions about the population. The choice of sampling method for the study was crucial as it directly impacted the validity and generalisability of the results of the exploratory research.

Purposive sampling, or judgement sampling, was used for the study (Etikan, 2016). Purposive sampling is a method in which respondents are intentionally selected based on their ability to

shed light on a particular phenomenon, concept, or theme (Bhardwaj, 2019). According to Etikan (2016) this non-random method does not require a theory or a predefined number of participants. Simply put, the researcher determined what they wanted to know and sought out individuals with knowledge or experience who could provide that information. For this reason, the researcher found this method to be the most appropriate way to obtain information about BDA in HSCs from knowledgeable and well-informed individuals.

4.7 Sampling method for selecting Organisations.

Maximum variation sampling was used to select the five HNGO cases used for the study. This choice aligned with the interpretivist paradigm chosen for this exploratory work. Interpretivism promotes an understanding of variation between individuals in their roles as “social actors” (Ryan, 2018). This sampling method achieved diversity by collecting responses from consultants within HSCs, international HNGOs and local HNGOs. Supply chain professionals who focus on implementing data analytics projects and IT systems were also selected for their expertise and knowledge of BDA in HSC operations.

4.8 Sampling Criteria

The sampling criteria for the study included humanitarian organisations active in the supply chain, such as non-governmental organisations or humanitarian aid organisations. By applying these sampling criteria, the research was expected to gather insights from relevant organisations that have actively used big data analytics in their supply chain processes in the humanitarian sector. This approach helped explore BDA's impact on the agility and resilience of humanitarian supply chains, gaining valuable insights and contributing knowledge in the field. The criteria for selecting the individuals who were interviewed are listed below:

4.9 Criteria for primary data

The individuals selected for the study had to fulfil the following requirements:

- They had to have worked in HNGOs/humanitarian organisations or in organisations that support HNGOs in the areas of data analytics and technology.
- They had to hold senior decision-making or leadership positions in the sector.
- They had to be competent, well-informed, and knowledgeable about BDA in HSCs.

4.10 Sample size

In determining the sample size for the research, which involved five organisations and eighteen respondents, it was crucial to consider both the practical constraints and the aim of achieving sufficient data richness and diversity. Given the specific context of investigating the impact of BDA on the agility and resilience of humanitarian supply chains, the relatively small sample size was deemed appropriate. The five organisations selected provided a focused insight into the application of BDA in humanitarian supply chains and allowed for an in-depth exploration of their practises and experiences.

4.11 Data collection method

The data collected in this study was mainly in words, as it is a qualitative method. According to Ishtiaq (2019) the main aim of qualitative data analysis was to uncover new understanding, insights, concepts, patterns, and themes in line with the research questions. The transcribed data was coded, categorised, and grouped into common themes using Atlas.ti software. The inductive approach ensured that common themes emerged from the data analysis rather than presenting theories (Bell et al., 2019). Themes were explained using direct quotes from the transcripts and were summarised and grouped for each research question in word clouds, tables and reports created using Atlas.ti to enhance understanding of the findings.

4.12 Data collection process

Data collection for the study comprised semi-structured interviews with key supply chain actors within the selected HNGOs. The semi-structured interviews were used to capture the experiences and perceptions of the stakeholders regarding the use of digital BDA technology in the supply chain. The data collection process is explained in more detail in the following sections.

4.13 Semi-structured interviews

The data collected through the semi-structured interviews was analysed using "thematic analysis" (Castleberry & Nolen, 2018) to identify common themes and patterns in the interviewees' experiences and perceptions. Thematic analysis (TA) has been defined in the literature as "a method of analysis for systematically identifying, organising and gaining insight into patterns of meaning referred to as 'themes' in a data set" (Castleberry & Nolen, 2018). Thematic analysis enabled the researcher to visualise and understand collective or shared conclusions and meanings.

All interviews were recorded using otter.ai recording and transcription software so that the conversations could be transcribed verbatim. The researcher edited the transcriptions in cases where the software could not recognise the correct words spoken. Due to location and time constraints, the interviews were conducted on MS Teams, an online platform that allowed direct recording by otter.ai. Transcribing the data and recording the interviews ensured that the data collection occurred in a natural environment so that the research could capture what the interviewees were saying and sharing about the research topic. This was in line with Ebneyamini & Sadeghi Moghadam's (2018) assertion that qualitative researchers need to be interested in what interviewees say and how they communicate it to capitalise on their findings.

4.14 Research Instrument

According to Ishtiaq (2019) the interview questions are methodically prepared and guided by the central research theme, with questions designed to elicit more complex responses. An interview guide was defined as "a list of mnemonic devices for the research topics at the centre of attention that enabled the exploration of the interviewees' social world" (Bell et al., 2019). Furthermore, the article pointed out that the questions in semi-structured interviews must be carefully crafted to achieve the specific objectives of the research investigation.

Therefore, the interviews in the study were guided by pre-designed open-ended questions to obtain further detailed answers and perspectives on the research questions. These interview guide questions were derived from the literature review and the study questions.

4.15 Data analysis methods

Data analysis methods were crucial in extracting meaningful insights and generating robust conclusions in several case studies focused on the "Effect of BDA on the agility and resilience of humanitarian supply chains."

4.16 Primary Data – Interview Results

The data collected in this study was mainly in words, as it is a qualitative method. According to Ishtiaq (2019) qualitative data analysis aims to uncover new understandings, insights, concepts, patterns, and themes in line with the research questions. The transcribed data was coded, categorised, and grouped into common themes using Atlas. ti software. The inductive approach ensured that common themes emerged from the data analysis rather than presenting theories (Bell et al., 2019). Themes were explained using direct quotes from the transcripts and were

summarised and grouped for each research question in word clouds, tables and reports created using Atlas. ti to enhance understanding of the findings.

4.17 Quality controls

Kunz (2019) notes that there are several risks associated with the use of content analysis in the context of HSC research. The quality and the trustworthiness of the data origin often need to be improved, especially when using big data from social media platforms. To ensure that the research process is valid, reliable, and trustworthy, the following considerations were made:

4.18 Validity

According to Bryman & Bell (2015) validity has been defined as "the extent to which research measures what it is intended to measure." Validity can be either internal or external validity. Internal validity was concerned with the accuracy of the measured variable. In contrast, external validity revealed how the results described the population from which the sample was drawn (Creswell, 2014). The researcher utilised face validity by involving HSC and IT experts to review the instrument and confirm its ability to measure the research interest accurately. In this way, content validity was achieved when the research instrument could assess and measure the measurements of interest (Yin, 2018).

4.19 Reliability

Reliability was the stability and consistency of the data collection methods (Bell et al., 2019). The regularity of the data ensured accuracy in the measurement results. According to Creswell (2014) a reliable research instrument usually yielded the same answers when different respondents were used. The article further states that the generalisability of the study results determines the degree of correctness or accuracy of the numerous roles in the study. Therefore, a purposive sample was used in this study to ensure reliable results.

4.20 Trustworthiness

According to Yin (2018) trustworthiness ensured the study results were transferable, confirmable, credible, and reliable. Credibility ensured that the study's results were honest and accurate (Leedy & Ormrod, 2013). Transferability confirmed that the study results contained detailed descriptions to maintain relevance to comparable populations, events, or situations (Creswell, 2014).

4.21 Limitations

According to Leedy and Ormrod (2013) limitations are controllable and unknown biases within a research process that could influence the results. The methodology proposed above had potential limitations that could have affected the study results. Using a combination of semi-structured interviews and document analysis could provide rich and in-depth data for case study research (Bowen, 2009; Qu & Dumay, 2011). However, potential limitations included the potential for subjectivity in the interview process, and time and resource constraints that could have limited the number of interviews conducted.

4.22 Ethical considerations

The GIBS Research Ethics Committee granted authorisation to conduct the study to respect and safeguard the freedom and rights of the research subjects. Among the many moral considerations in this study were informed consent, preservation of participant privacy, and avoidance of injury (Badampudi et al., 2022). When conducting this study, several ethical considerations were considered to ensure the protection and welfare of the participants involved. No organisation had been selected, but any organisation meeting the criteria outlined in section 4.3.3 was considered for identifying potential participants. The organisations chosen for this study met the research criteria outlined in section 4.3.3.

First and foremost, informed consent was obtained from all individuals before participating in the study. They received a clear explanation of the research purpose, procedures, potential risks, and benefits and were informed of their right to withdraw from the study at any time without consequence. Confidentiality and anonymity were strictly maintained throughout the study. No names of individuals or organisations were mentioned, and all data were stored without identifiers to protect the participants' privacy. The ethical guidelines and regulations of the Gordon Institute of Business Science (GIBS), the organisation responsible for the study, were adhered to in conducting the study. These guidelines ensured the integrity and ethical soundness of the research process by upholding the principles of respect, beneficence, and justice in treating research participants.

4.23 Data Storage

In this study, which examines the impact of BDA on agility and resilience in humanitarian supply chains, the data collected will be securely stored in an accessible format for ten years. A specialised database such as iCloud was used during the research and allowed the researcher

access to the data for the entire research period and for other interested parties in the future. Storage prioritised data security and compliance with legal and ethical requirements to ensure the integrity and confidentiality of the information stored.

4.24 Chapter Conclusion

Chapter 4 of this research report presented the research methodology used to explore the impact of BDA on the agility and resilience of humanitarian supply chains using an interpretivist paradigm and an exploratory case study approach. The chosen paradigm allowed for a comprehensive examination of the research question and emphasised the role of individuals as "social actors".

The study included global and local HNGO supply chains, donor employees, and consultants known for extensive use of big data analytics. The scope, level and unit of analysis, purposive sampling, data collection methods and quality controls were discussed in detail, forming the basis for the subsequent presentation and analysis of findings in Chapter 5.

CHAPTER 5: RESULTS/FINDINGS

5.1 Introduction

This chapter presents the research process results to understand the complex interaction between BDA and the adaptability and resilience of humanitarian supply chains. The insights gained from examining multiple viewpoints are revealed in this chapter, illuminating BDA's transformative potential in humanitarian operations. This chapter spans the landscape of real-world experiences, presenting views of how BDA influences the qualities of agility and resilience by analysing the data gathered through document analysis and semi-structured interviews. This chapter advances the researcher's grasp of the complex effects of BDA in reshaping the field of HSC now and in future.

The chapter comprises a description of the leading emerging themes based on the main research question as mentioned in Chapter One, namely, what were the effects of agility and resilience in HSC's efficiency and effectiveness, enabling factors of BDAs leading to agility and resilience and the inhibiting factors of BDAs leading to a lack of agility and resilience. Additionally, the chapter includes a narration of the arising antecedents and outcomes of BDA as part of the study's conceptual framework.

5.2 Presentation of Findings

The chapter summarises the findings derived from the analysis of the data gathered throughout the research, as outlined in the methodology section (refer to Chapter 4). The findings are derived from the systematic organisation and analysis of material obtained from 18 semi-structured interviews.

After analysing the data, 27 themes were identified, including six potentially new themes. The new themes identified in the study were categorised and added to the conceptual framework that was presented at the end of Chapter 2. The new themes were identified across all three enablers, inhibitors and outcomes constructs. The researcher concluded that the enablers were external and internal, adding an extra category to outcomes, which were new categories that the researcher decided to add to the original framework. The updated conceptual framework is depicted in Figure 6 below.

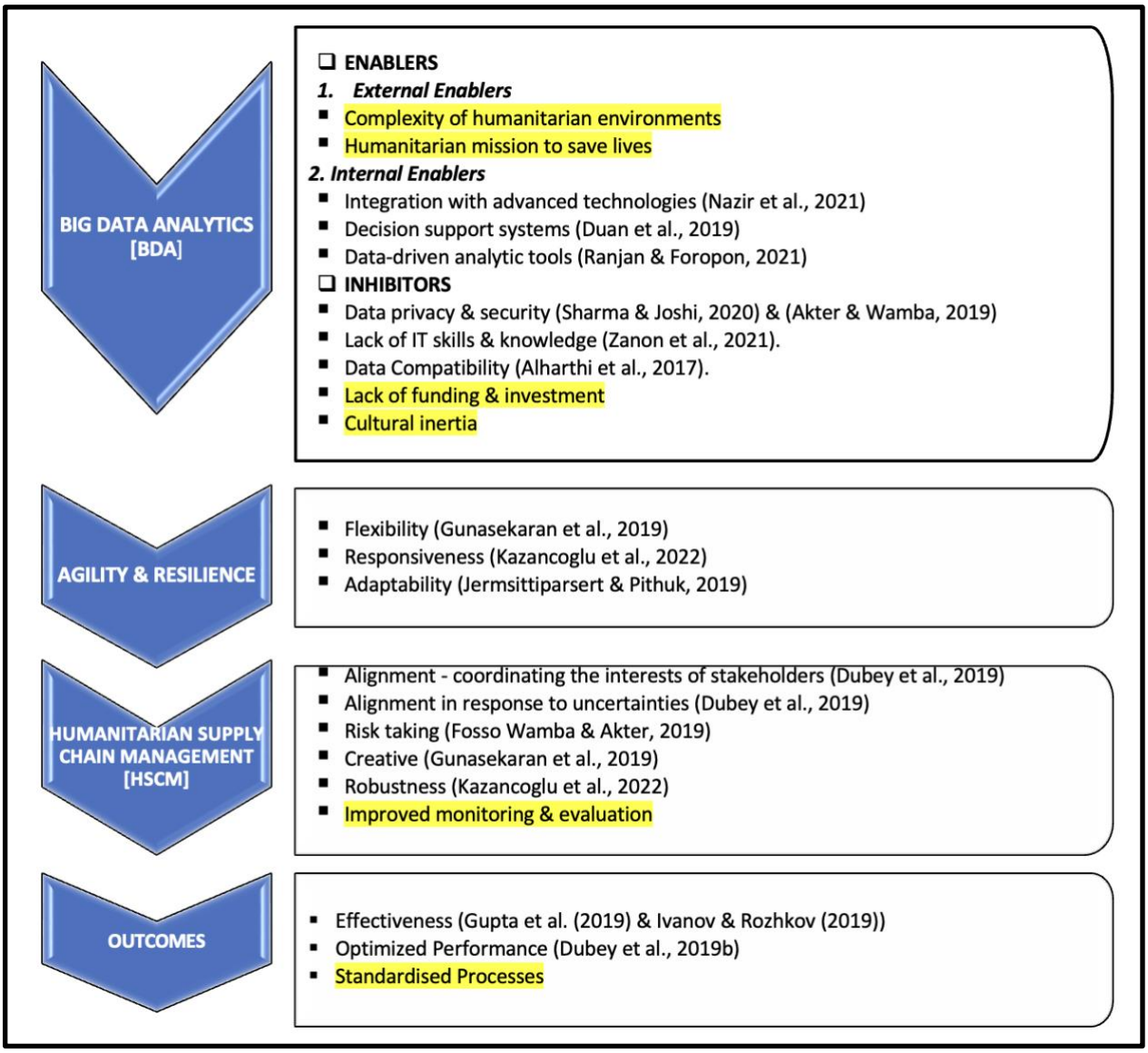

Figure 6: Revised Conceptual Framework from Data Analysis

The data analysis identified that the sub-construct of "external enablers" introduced two themes (all new) and the construct of outcomes, which consisted of 3 themes (1 new and two old). The structures inside the conceptual framework are interconnected with each research issue.

The revised conceptual framework was strengthened by adding antecedents such as organisational capabilities realised through visionary leadership and availability of funding, as well as the environment influenced by the complex operating environments and the mission that drives the operation of HNGOs. Through the interviews, the researcher found that these foundational elements influence the successful implementation of BDA, agility, and resilience within HSCM processes. The results also showed that the interaction between BDA, agility and resilience led

to improved HSCM, culminating in optimised operational outcomes such as alignment, increased stakeholder satisfaction and a conducive environment for innovation and continuous improvement. The graphic above illustrates the interconnectedness and flow of these fundamental components within the revised framework.

This chapter is organised by the research questions to highlight and discuss the 22 themes arising from the analysis and chapter 2 literature review. The researcher chose 13 themes for further analysis, of which six were potentially new themes that provided key insights and understanding of the research question. To offer this analysis, the mentions of the theme by type of agency were considered alongside the researcher's comprehension of the essential themes in the data. This approach was utilised to identify probable similarities and contrasts across the groupings of agencies. However, the mentions by sector do not accurately reflect the importance or significance of a particular theme. The choice to examine this issue for discussion was motivated by the wide range of experiences observed within the cases and the opportunity for comparative cross-case analysis. This facilitated the acquisition of valuable insights into the participants' experiences and contributed to a more profound comprehension of the phenomenon.

The presentation of findings is organised by each research question, as discussed in Chapter 3. For reference, each participant group in the tables and quotations has been assigned a colour key as follows.

Table 1: Participant groups (agencies) and colour coding

Type of Organisation	**# of Orgs**	**Group Description**	**Colour Code**
Global HNGO – across many countries	2	The 2 Global HNGOs operate globally, delivering essential aid and support to people and communities affected by crisis and conflict.	
Consultants in the HNGO field	1	The consultants interviewed belong to an agency that uses their extensive experience in the humanitarian field to identify and address gaps, such as the need for improved tools and data insight.	

Local HNGO – South African based	1	The locally based HNGO operate primarily within South Africa, offering crucial aid and support to individuals and communities affected by regional crises and challenges.	
Donor organisation	1	A leading US-based body, collaborates with various sectors to combat global health threats like AIDS, tuberculosis, and malaria, providing vital support and resources to enhance healthcare infrastructure, widen access to essential treatments, and promote disease prevention.	

The researcher observed that the frequency with which participants mentioned a topic or theme did not necessarily indicate its significance level within the context of this qualitative study. The frequency of mentions of a specific theme revealed similarities and differences between participants and groups of participants. The way that this research showed how each participant group mentioned each theme is by using the following notations:

- Few or no mentions
- Some mentions
- Many mentions.

A select few of the identified themes were explored in depth throughout the following discussion. These themes were chosen for their significant contributions to fresh and enhanced perspectives. Our discussion centred around newly discovered and pre-existing themes within the original conceptual framework.

While the pre-existing themes were not highlighted in yellow, the possible new themes were clearly distinguished by the application of a bright yellow highlighter.

5.3 RQ1: Effect of agility and resilience in HSCs' efficiency and effectiveness

Within this section, the research delved into the themes that pertain to the research question regarding the impact of agility and resilience on efficiency and effectiveness within HSCs. After analyzing the data, the researcher discovered five themes that fall under this construct. Notably, two of these themes have offered significant insights, which are outlined in the table 2 below.

Table 2: Themes from findings for RQ1.

THEME	SIMILAR	DIFFERENT	DISCUSSED
	Existing theme	New theme	
Flexibility	✖		Yes
Adaptability	✖		Yes
Effectiveness	✖		Yes
Standardised processes		✖	Yes
Improved monitoring & evaluation		✖	Yes

5.3.1 Theme 1 - Flexibility

One of the key themes that will be discussed in the context of RQ1 is flexibility. In this context, flexibility refers to the ability of humanitarian supply chains to adapt to unforeseen challenges quickly and efficiently, shifts in demand, or sudden interruptions. By using vast amounts of real-time data to anticipate potential disruptions and understand dynamic needs, BDA provides a comprehensive view of supply chain operations. This is particularly important in humanitarian contexts, where situations are often volatile and can change quickly. Essentially, the theme of flexibility highlights the transformative potential of BDA in making humanitarian supply chains more adaptable, responsive, and resilient.

Evidence of Flexibility from Findings

The study collected evidence by comparing mentions of "flexibility" in different groups. This comparison was necessary due to the significant differences in their operational tactics, regional focus, and operational dilemmas, despite being united under a standard humanitarian banner. The aim was to identify patterns and differences in how flexibility was conceptualised and implemented, which required a deeper interpretative insight into the multi-layered meanings attached to flexibility in different entities. The research provided deep insights into the multi-faceted role of flexibility, highlighting its central role in improving the agility and resilience of

humanitarian supply chains and its indispensability in ensuring adaptive and timely interventions in various crisis situations. The table below presents the evidence on flexibility.

Table 3: Evidence of Flexibility

Evidence of Theme 1 - Flexibility	
Quotation	**Sector**
…ability to respond to an event rapidly while also maintaining flexibility. (Participant B.R) *Who can I respond to more quickly, or, as I will do concretely, to that emergency in that area? Faster becomes a compelling medium, right? (Participant B.E)*	Consultant
…. resources and processes in real-time to meet the evolving needs of the affected population.	Global HNGO
….. policies behind …. are not flexible to kind of react to those results. (Participant A.P)	Local HNGO
…. that is why we need to build systems supply chain that helps us to number one, respond to changes as quickly as possible… (Participant E.A)	Donor agency

Cross-case and in-case analysis of flexibility

The participants' viewpoints on flexibility are presented in Table 4 below.

Table 4: Mentions of Flexibility by grouping.

THEME	**HNGO**	**HSC Consultant**	**Local HNGO**	**Donor**
	Mentions by grouping			
Flexibility	Many	Many	Many	Many

The interviews with various participants highlighted the crucial importance of flexibility in emergency humanitarian situations. The participants agreed that in unpredictable settings, agility and resilience are key factors that lead to flexibility, enabling the HSCs to respond to events

effectively and swiftly like natural disasters. The HSC systems are designed to be structured and aligned, with the aim of ensuring a speedy and flexible response to such emergencies. However, one participant from a global HNGO pointed out that some policies can limit the level of flexibility, which can result in a slower emergency response. This feedback highlights the need to continuously review policies and procedures to ensure that the HSCs can operate with maximum flexibility and efficiency.

Conclusion on the theme of flexibility

The analysis underlined that flexibility is a common thread throughout organisational groupings. Participants overwhelmingly recognised their crucial role in promoting flexible humanitarian supply chains. However, the extent of flexibility was significantly influenced by the readiness of HNGOs and the prevailing strategies and conditions in the HNGO's operating environment.

5.3.2 Theme 2 – Adaptability

The analysis of the data revealed an additional theme of "adaptability". Several participants recounted their experiences of how the operational environment of HSCs necessitates agencies to possess the capacity to modify their designs in response to structural shifts, disruptions, and evolving circumstances. In essence, the interviewees highlighted that adaptive capacity in their contexts was not just about reactive change but also about harnessing the power of data to anticipate, prepare for and manage challenges to ensure that humanitarian aid is delivered efficiently and effectively, regardless of the obstacles.

Evidence of Adaptability

The participants' viewpoints on adaptability are presented in Table 5 below.

Table 5: Evidence of Adaptability

Evidence of Theme 1 – Adaptability	
Quotation	**Sector**
…. being portable enough and being you know having this proper system in place to make sure that you can adapt to any like factors that might affect your organisation. (Participant B.T) *… So, we had to come up with ways to continue working, even though there was a pandemic…. (Participant B.T)* *…. ability to return to normal or above normal after you've experienced the shock…. (Participant B.R)*	Consultant

… ability to adapt to whatever external environments…. being able to adapt to that influence or external or a shock and continue. But we were not able to do that one because it's just too expensive… (Participant A.P) There was a lot of customization that had to happen that came with its challenges. And now, four years later, we're still editing. And hopefully, we're going to get better with time in a nutshell… (Participant A.P)	Local HNGO
…. digital data collection, in this case, I think is huge. Because it enables adaptive management. And so, I think that is a good example of bringing efficiencies… (Participant D.N)	Global HNGO
…It's something that was not expected, but it then shocked the Supply Chain system. ….. The ability for it to come back to its normal way of operating after it just received a shock or hurt… (Participant E.S) …. making sure that the supply chain can still work irrespective of changes…. (Participant E.V)	Donor agency

In-case and cross-case analysis of adaptability

On the theme of adaptability, all the participants agreed that HSCs needed to get back to their original shape, especially after going through major disruptions. Many of them used the recent pandemic as an example. Some consultants felt that agencies can adapt faster if they use their services.

Table 6: Mentions by group.

THEME	**HNGO**	**HSC Consultant**	**Local HNGO**	**Donor**
	Mentions by grouping			
Adaptability	Many	Many	Many	Few

Local HNGOs and the global HNGOs, despite agreeing that adaptability is an essential aspect of resilience, noted in some cases that cost and length of time to execute slow down the adaptation to the ever-changing contexts. The similarities in the responses show that agility and resilience in HSC bring adaptability that allows SCs to function during emergencies and return to normal after handling an unforeseen humanitarian event. The participants had similar meanings about HSC having suitable systems that enable emergency adaptability. A participant thus explained how the appropriate management style in HSC is the adaptive management style that permits occasional

changes to the external environmental needs of the organisation. One participant used the occurrence of COVID-19 as an example, which put pressure on HSCs to function well regardless of the humanitarian responses required under COVID-19.

Conclusion on the theme of adaptability

Participants in the discussion recognized the vital role of adaptability in humanitarian supply chains and agreed unanimously on its importance. They also acknowledged the significance of technology in enabling adaptability. However, there were differing views on the challenges hindering the fulfilment of full adaptability, with financial limitations, managerial approaches, and the need for consistent improvement being notable obstacles. The evidence presented on adaptability mostly showcased similarities with context-specific comments across distinct agency groups, demonstrating that agility and resilience in HSCs foster adaptability to bring about effective changes to address unforeseen humanitarian situations.

5.3.3 Theme 3 – Effectiveness

The analysis of the data revealed an additional theme of "effectiveness". Various participants emphasized how agility and resilience within the HSC enable them to effectively handle emergencies, conflicts, and disaster situations through efficient collaboration, communication, and response. The participants demonstrated a distinct understanding of effectiveness compared to for-profit organisations by aligning their understanding of effectiveness to their humanitarian primary goal of saving lives rather than just operational or performance effectiveness. Effectiveness in HSCs, from the participants' viewpoint, therefore, implies saving lives or meeting the needs of survivors at the right time, place, cost, and quality.

Evidence of Effectiveness

The participants' viewpoints on effectiveness are presented in Table 7 below.

Table 7: Evidence of Effectiveness

Evidence of Theme 1 – Effectiveness	
Quotation	**Sector**
So, you need those information flows between those different nodes. So that your supplies can follow the same route and so that you can deliver	Consultant

the supplies kind of at the right time at the right place at the right cost with the right quality….. (Participant B.R) *So, it's a little bit easier for us to obtain metrics and to do have standardized processes and I think that whether it be AI or blockchain, see these as enablers of effective operations…. (Participant B, R)*	
I don't think we've gone into a state when you're looking at effectiveness as the entire supply chain. Right now. It's all about are you doing using cash, if … (Participant A.P) *Have people who have this understanding and have the technical know-how in terms of core supply chain capabilities so there's one thing to have the passion it's also another thing to have the core supply chain capabilities to help drive the effectiveness and effectiveness as it relates to supply chain management. (Participant A.D)*	Local HNGO
I understand that for data governance is a very, it's a very important issue, especially to ensure that we effectively manage the supply chains… (Participant D.N) *The effectiveness of supply chain is a good communication and collaboration. This makes supply chain to be effective and efficient… (Participant D.T)*	Global HNGO
So that's another way where, you know technology has been used to optimize supply chain and I also think there's now a lot of work going into the use of…. (Participant E.V) *So having effective collaboration between the different actors ensures that the supply chain runs effectively, and I think I found out very effective which ensures that the team that works in the supply chain, how working collaboratively and of course they share information seamlessly (Participant E.V)*	Donor agency

In-case and cross-case analysis of effectiveness

The participants in the discussion on effectiveness shared similar views that agility and resilience are crucial for HSCs to handle humanitarian situations effectively and promptly, and to recover from major disruptions. They cited the recent pandemic as an example. Agility and resilience help HSCs to communicate and collaborate efficiently with other agencies and their employees. Participants from both global and local HNGOs mentioned the use of technology to enhance

agility and resilience, leading to effective HSC responses to any humanitarian situations. This further implies that the way data is analysed and managed can have a significant impact on the effectiveness of HSCs.

Table 8: Mentions by group.

THEME	HNGO	HSC Consultant	Local HNGO	Donor
	Mentions by grouping			
Effectiveness	Many	Many	Many	Few

The participants in the discussion on effectiveness shared similar views that agility and resilience are crucial for HSCs to handle humanitarian situations effectively and promptly, and to recover from major disruptions. They cited the recent pandemic as an example. Agility and resilience help HSCs to communicate and collaborate efficiently with other agencies and their employees. Participants from both global and local HNGOs mentioned the use of technology to enhance agility and resilience, leading to effective HSC responses to any humanitarian situations. This further implies that the way data is analysed and managed can have a significant impact on the effectiveness of HSCs.

The agility and resilience of HSCs were the focus of discussion among participants, who agreed that these qualities enable HSCs to respond effectively and promptly to humanitarian situations and quickly return to their original shape following major disruptions. The recent pandemic was cited as an example, and participants noted that agility and resilience allow HSCs to communicate and collaborate effectively with other agencies and employees. Technology was also mentioned as a tool that can bring agility and resilience to HSCs, thereby yielding effective responses to humanitarian situations. The management and analysis of data were noted as key factors that impact effectiveness.

In addition, the participants from the global and local HNGOs acknowledged that agility is the ability of an HSC to respond quickly and efficiently to rapidly changing situations, particularly natural disasters. They also recognised the importance of resilience, which enables HSCs to withstand and recover from disruptions while maintaining essential functions even in the face of severe infrastructure damage. The consultants and participants from the donor organisation emphasized that agility and resilience result in rapid responses to crisis situations, delivering essential services and goods in a timely manner to the most vulnerable people. By reducing

response time, minimizing disruptions and bottlenecks, and maintaining effective communication and collaboration, agility and resilience improve the overall efficiency of supply chains, resulting in more coordinated and streamlined operations to deliver to those in need.

Conclusion on the theme of effectiveness

In conclusion, participants' main effectiveness sentiments were centred on speed of response and ability of an HSC to rebound to its original status after carrying out a humanitarian operation successful. The participants showed their appreciation how agility and resilience are built on technologies in HSC to yield effectiveness in the operations. Such effectiveness is seen through good communication, collaboration and coordination that lead to the delivery of humanitarian supplies at the right time, right place, right quantity, and right quality.

5.3.4 Theme 4 – Standardised Processes

The theme of standardisation in HNGOs due to technology usage emerged as a key finding during the semi-structured interviews. This finding is consistent with research on agile and resilient HSCs, which shows that the integration of BDA, has a significant impact on these protocols. The participants were confident in their assertions that the development of standardized processes and protocols is not just a by-product of technological integration, but a strategic outcome that results in more efficient and effective supply chains.

The use of BDA has led to several practices that support the standardisation of processes in HNGOs and make them more reliable in responding to humanitarian crises. The participants expressed confidence that this approach to standardisation is a necessary response to the chaotic and unpredictable nature of such crises. By leveraging BDA, HNGOs can analysed and manage data in a more efficient and effective manner, which ultimately leads to more standardised and reliable processes. This, in turn, enhances the overall effectiveness of HSCs and ensures that essential services and goods are delivered promptly to those in need.

Evidence of Standardised Processes

The evidence on standardised processes was selected by comparing the mentions of this theme across different agency groupings. The following table summarises the evidence:

Table 9: Evidence on standardized processes

Evidence of Theme 1 – Standardised Processes	
Quotation	**Sector**

I think that there's a big opportunity for technology in what I've seen…. And I've just seen how using procurement platforms and E procurement can really enhance the process…. I have *seen examples of using a general procurement platform where the tender is uploaded into a system and it kind of follows a standard format and then each different part of the tender package is a different document…. then all the responses are located centrally in one area.... That's what I've noticed where the time savings really are, is that it's much easier to evaluate a lot of these tender packages digitally when you can consolidate all the answers and you're able to see how they responded to the different questions (Participant B.R)* *…So it's a little bit easier for us to obtain metrics and to do have standardized processes and I think that whether it be AI or blockchain, see these as enablers of effective operations….how do we ensure that whatever comes out of your agency, and also comes out of my agency, when we send it to the last day, it's comparable and can make sense to an independent entity outside of our agencies. (Participant B.R)*	Consultant
I think in terms of partnerships with other agencies towards ensuring that these systems are somehow standardized and can somehow be used across agencies to begin to build a somewhat an industry standard, so to speak…. (Participant C.D)	Global HNGO
…. then what kind of technologies could we use to ensure quality, which is difficult in our environment where some national governments don't even have a quality standard in place…. (Participant A.P) *…So that cloud-based solution helps there be more coordination, faster, ability to pinpoint and mitigate risk and all speak the same language in a standard way…. (Participant A.S)*	Local HNGO
…. I also think there's now a lot of work going into the use of what I would call the GS one standard, which you must see that products are tracked from manufacturer up to the end user the story of that product with the GT the global standard, identifier number you can track product and of course, they store as well. You can also track them with GS1 code. And then the product is tracked from hand to hand. So, these are like, you know, technology solutions that have been put in place to make	Donor agency

sure that supply chain works effectively in a way that is less cumbersome and most effective and efficiency. (Participant E.V)	

The evidence presented in the table suggests that standardisation is a key concern for both global and local HNGOs, as well as for donor organisations and consultants. The participants in the semi-structured interviews were confident that the development of standardised processes is a strategic outcome that leads to more efficient and effective humanitarian supply chains. The integration of big data analytics was seen as a major factor in this development, enabling HNGOs to analyse and manage data more efficiently and effectively, and to develop more reliable and standardized processes.

The evidence supports the idea that the use of big data analytics leads to standardised processes that are more efficient and effective in responding to humanitarian crises. These standardized processes are seen as a necessary response to the chaotic and unpredictable nature of such crises. By developing more reliable and standardised processes, HNGOs can more effectively and efficiently deliver essential services and goods to those in need, ultimately improving the overall effectiveness of humanitarian supply chains.

In-case and cross-case analysis of Standardised Processes

As presented in the table in the previous section, the insights gained from the different perspectives of the participants highlight the critical role of BDA as a catalyst for the formation of standardised protocols within HSCM.

Table 10: Mention by grouping

THEME	HNGO	HSC Consultant	Local HNGO	Donor
	Mentions by grouping			
Standardised Processes	Many	Many	Many	Many

Insights from participants suggest that the sector is at the brink of a revolution that is being driven by data-driven technologies. The BDA serves as a bridge between various operational methodologies, enabling a seamless and interoperable framework that goes beyond the practices of individual organisations.

As participant C.D stresses the significance of cross-agency collaboration for establishing industry standards, it becomes apparent that BDA is the key to achieving this desired coherence. The underlying concept is that when data analytics informs supply chain practices, the outcome is an ecosystem in which metrics, processes, and outcomes become comparable, efficient, and universally understood.

Moreover, the application of BDA in quality assurance, as highlighted by participant A.P., emphasizes its role in compensating for the lack of established government standards, ensuring that quality remains unaffected even in a challenging environment. Cloud-based solutions and standards for product tracking, as mentioned by participants A.S. and E.V., are practical examples of the potential of BDA to promote a standardized representation of HSCM, facilitating a coordinated approach, mitigating risk, and increasing transparency throughout the aid delivery chain.

Conclusion on the theme of Standardised Processes

In conclusion, the findings from the interviews with key players in the humanitarian sector point towards a feeling that BDA is becoming a cornerstone for the development of standardised protocols in HSCM. These findings show that BDA is not only an operational tool, but also a strategic architect of standardised protocols. These protocols have helped redefine the HSCM landscape by enhancing resilience and agility that organisations have applied universally, thereby increasing their efficiency in operating in an environment that demands rapid and adaptable action in the face of crises.

5.3.5 Theme 5 – Improved monitoring & evaluation

This theme of improved monitoring and evaluation was identified through the mapping process applied to the data. Interestingly, it was not found in the conceptual framework presented in chapter 2, but it emerged as a new theme from the analysis.

Evidence of improved monitoring and evaluation

Table 11: Improved monitoring & evaluation

Evidence of Theme 5 – Improved monitoring & evaluation	
Quotation	**Sector**
…So, it's a little bit easier for us to obtain metrics… (Participant B.R)	Consultant
…So, the primary motivation for investing in technology is to facilitate end to end visibility. So, they just want to be able to say for a program manager to be able to say I have data from other stock, goods in transit, and these ones I have, I can distribute…. (Participant C.D) *I think that in my view, that the use of data would be the next that they have collected it but now they need to begin to use it to make them more efficient and make them more effective in what they do… (Participant C.D)* *… we had implemented this system in about 60 plus countries offices…working on the configuration, working on the updates of existing policies of the existing process maps, etc. But then working a lot on capacity building of the existing supply chain teams that can enhance them to use productively… (Participant D.V)* *…. If we weren't collecting data digitally as we are there's no way that we could do an annual basis report on our achievements of our global results. Because we wouldn't have access to that data. So, I think that is a huge achievement… (Participant D.N)* *. And the other part is when it comes after the implementation of the ERP which is enhancing that data visibility or data analytics that is required to provide you that understanding of what are the processes that require some order support or additional focus in improvement… (Participant D.V)*	Global HNGO
…. That was the product then was used to track or what was happening in terms of supply chain. And you'd expect all partners to access the system and enter the data, which will give us the visibility to what was happening globally…. (Participant A.P)	Local HNGO

that's where there was an improvement when we started having many tools in the toolbox. So, we started being allowed to respond using cash to respond by buying locally or regionally which was really great times to kind of start doing thinking through some new processes. (Participant A.P) *And we're able to re-use some of that data to predict them and then we kind of want them to now move to higher ground. Those are the things that that is really worked… (Participant A.P)* *…You have to have standard systems that allow people to do the plug and play and you need to use data to analyse both how at the country program level or at the operational leverage like the ongoing operations…Like how efficient you are being and what are the areas of focus for improvement. (Participant A.S)* *I think historically, the systems were implemented just to be able to facilitate transaction and to be able to report to donors, but there's an increasing expectation and understanding that we should do more with that data, not just report but really analyse…..analytics and dashboards are so important, but also it allows regional and global support staff to go into the system and evaluate how things are working how healthy the transactional maturity and analytical maturity is…. (Participant A.S)* *…. we are going to see those appreciation in helping drive our demand forecast and spend analysis… (Participant A.D)*	
…. You want to have visibility into what is going on. Take for instance, you want to do something like track and trace you want to know from the point where you have done planning to procure certain products. You want to understand where and how they are being manufactured, how they're being transported. Across the stream down to the warehouses, you want to be able to optimize the best locations to put them you want to be able to understand the road networks and how to optimize how to distribute them to their customers. (Participant E.A) *…And so, when we have a better integrated information systems we can integrate and provide better visibility, data sharing between health organisations. And that helps inform decision making…. (Participant E.A)*	Donor agency

In-case and cross-case analysis of improved monitoring & evaluation

Drawing upon the evidence from the interviews, the research findings illustrate that BDA has become an indispensable catalyst for enhancing monitoring and evaluation processes in HSCs.

Table 12: Mention by grouping

THEME	HNGO	HSC Consultant	Local HNGO	Donor
	Mentions by grouping			
Improved monitoring & evaluation	Many	Many	Many	Many

The findings highlight a significant transition from rudimentary data collection to a sophisticated, strategic use of BDA, which in turn has significantly improved performance metrics and predictive logistics capabilities in HNGOs. Most of the participants emphasised the importance of the amplified role of BDA in integrating systems that has enabled a seamless flow of real-time decisions, optimised resource allocation and fine-tuning financial strategies. This according to some of the findings has been instrumental in fostering a culture of transparency and accountability throughout HNGO operations, therefore improving relationships and trust with the donors. The consensus emerging across the different groupings was the emphasis on recognition of BDA not only as a tool to increase operational efficiency, but also as a fundamental component to promote agility and resilience through better data utilisation.

Conclusion of analysis of improved monitoring & evaluation

To conclude, the interviews provide evidence that supports the revolutionary relevance of BDA in the context of HSCs. By strategically using BDA, organisations have improved their monitoring and evaluation measures, fostering a proactive and data-centric environment that prioritises adaptability and robustness. Furthermore, the integration of BDA has resulted in significant enhancements in logistics, transparency, and resource allocation, facilitating timely and well-informed decision-making processes. The findings of this study indicate that all the groupings interviewed perceive BDA as a crucial facilitator for transforming HSCs. Moreover, the results suggest that BDA possesses a broader scope beyond its role as a tool for enhancing operational efficiency, as it serves to safeguard humanitarian endeavours against potential global crises.

5.4 RQ2: What are the enabling factors of BDAs leading to the agility and resilience of HSC?

The study aimed to provide new insights and ideas related to research question 2. From the data analysis, five themes were identified, with three already present in the conceptual framework from Chapter 2. The remaining two themes were categorised as external enablers and were added through the mapping process applied to the data. Only five themes were discussed in this section as they were particularly helpful in expanding the researcher's understanding of the study subject. The six themes that enable BDA in HSCs are listed in the table below, with three internal and two external enablers (highlighted in yellow).

Table 13: Themes emerging for RQ2.

THEME	INTERNAL/EXTERNAL ENABLER	SIMILAR	DIFFERENT	DISCUSSED
		Existing theme	New theme	
Integration with advanced technologies (IT)	Internal enabler	✖		Yes
Decision support systems	Internal enabler	✖		Yes
Data-driven analytic tools	Internal enabler	✖		No
Complexity of humanitarian environments	External enabler		✖	Yes
Humanitarian mission of saving lives	External enabler		✖	Yes

5.4.2 Theme 1 – Integration with advanced IT

The first theme to be discussed in the context of RQ2 is that of integration with advanced IT. This area serves as the backbone for implementing and optimising BDA to improve the agility and resilience of HSCs. The role of IT infrastructure, its integration with data analytics tools and its

ability to process and disseminate information rapidly are fundamental to realising the potential benefits of BDA for HSC.

Evidence of integration with Advanced IT

To compare the mentions of information technology across different agency groupings, evidence was selected and presented in the form of a table below.

Table 14: Evidence of integration with Advanced IT

Evidence of Theme 1 – Integration with Advanced IT	
Quotation	**Sector**
…. But I mean, to get through it, I think that it's kind of that piece going back to let's say you use some form of technology or some platform that helps you give information. I think one of the key elements is still to be able to get information rapidly, and then to be able to act upon that information (Participant B.R) *… think about what things like that you can actually send for position provisions and you can send humanitarian aid without the need for maternal dimension, human, human, individual dimension, which allows you to go in areas where you couldn't reach before… so I think the future is very is bright but I also think that there will be need to temper that future with ethical considerations as we embrace AI….(Participant B.E)* *….by analysing historical data in identifying your vulnerabilities in supply chain …and you can optimize your inventory, avoid usage as well because your trends big data can help you to start to manage, to look at how you have been using your inventory and potentially where the areas of leakages or wastage have been happening…. (Participant B.T)*	Consultant
…So like food programs, monitoring how decisions are being done, monitoring how the malaria program those things like distribution of nets and things like that. There also has been advancements in technology to that which are not ERP, but it helps in tracking and managing inventory. (Participant C.B)	Global HNGO

…. The other thing I think, is just truly investing in systems. Our cycle of investment of systems is so slow, because first we have to convince ourselves that it's worth that very scary investment……. We just have to accept that we're in a phase of the world where systems and data are how we do things now. And kind of get over that. second guessing all the time. And then lastly, I would just say as part of that, as a subtopic of that is embracing data analytics, embracing big data to make decisions is something that the private sector that became fact for the private sector long ago. (Participant A.S)	Local HNGO
So, I think the way forward is we should embrace new technologies. Because there is no going back actually. So, we should embrace and adopt new technologies as quickly as possible. (Participant E.A) *I'll talk about track and trace for instance, this digitalization global Big Data has helped to implement you know, track and trace systems and in our healthy supply chain so we know by the use of technologies like Internet of Things RFID that's like the radiofrequency identifications, we can actually track how a product moves by every stage in our supply chain from manufacturer to delivery and that actually helps us with transparency helps us to fight what we call counterfeiting and also enhance the product safety and quality….(Participant E.A)* *There are a lot of advanced systems that are used for sourcing for managing your suppliers for even automatically generating FIDs, RFQs that request for quotations for instance that even you can use to prequalify suppliers to ensure that you're getting the best supplier at the right cost to deliver the right product. (Participant E.A)*	Donor agency

Cross-case and in-case analysis of Integration with advanced IT

The evidence presented on integration with advanced information technology highlighted the importance of this theme across all agency groupings, indicating similarities in their perspectives.

Table 15: Mentions by grouping.

THEME	HNGO	HSC Consultant	Local HNGO	Donor
	Mentions by grouping			
Integration with advanced IT	Many	Many	Many	Many

The participants' sentiments revealed a crucial insight: advanced information technology integration is the key enabler of BDAs that result in HSC agility and resilience. Rather than relying on a single technology, the responses from the different participant groups demonstrated how different analytic technologies are being used in HNGOs to enable agility and resilience in emergency humanitarian operations. The consensus among all the groups was that digital technologies, including RFID, GPS, mobile technologies, blockchain, and artificial intelligence, are essential to HSC to get rid of paper-based processes and boost productivity in operational tasks like cash distribution, inventory management, mobile money systems, price data tracking, and supply management predictive analysis.

The views of consultant participants are particularly noteworthy, given that they provide HSCs with advisory services and influence the need for HNGOs to adopt efficient and effective technologies like artificial intelligence and BDAs. RFID and GPS, for instance, were seen as critical in enabling efficient data gathering necessary to build big data required for financial inclusion of beneficiaries, real-time and offline capabilities that allow data to be obtained in remote areas. The data collected through technology helps HSCs make quick decisions, solve problems, and share information. Although one consultant participant expressed concern about over-reliance on technology, two other participants highlighted the importance of infrastructure development in easing the implementation of technologies in HSC that bring agility and resilience. The second group of participants to explain the importance of IT such as mobile technologies were the global HNGO participants. The global NGO participants' viewpoint was that BDA systems enable performance measurement and decision-making through technologies such as mobile technologies. These technologies make inventory management more efficient and effective as tracking, bottlenecks and stock-out situations are easily monitored, controlled, and eliminated. One global HNGO participant also contended how through usages of technologies, agencies have reduced lead time and HSC business are optimised through lean processes as in the following statement:

"…. make the lead time shorter if it takes like three months to deliver the vehicle, what are the processes that I that I can put in place, so that that remains can be reduced to two months or so…" (Participant C.ad)

The third group of participants to show IT as a critical enabler of BDAs was participants from donor organisations. The donor participants, as expected gave an external view of the research problem and explained how technology facilitates global collaboration between agencies, governments, communities, and donors. With such cooperation, technology enables timely delivery and short response time in HSCs during crises. With technology usage in HSCs, bottlenecks and disruptions are minimised as operations are more streamlined in HSCs to respond more swiftly and timely to concerns. As such, within HSCs, the donor participants explained that technologies enable supply chain operational process optimisation that improves the speed of delivery. One donor participant gave an example of how HSC operations' time management is enhanced with new technologies such as GPS that permit geo-spatial analysis, satellite imagery technology, and real-time data management and environmental monitoring. In this way, decision-making is also improved using technologies to yield data-driven decisions. However, at least one of the donor participants highlighted that technologies come with problems to HSC, such as cyberattacks, and faster adoption of technology only occurs when communities accept and participate in it.

The fourth group of participants with similar views on IT as a critical enabler of BDA was the participants from local HNGOs. The participants from local HNGOs believed that new technologies improve efficiency and agility with more accessible data collection methods than in the past. Data analytics were explicitly mentioned as efficiency enablers in HSC's operational processes, such as stock management, market monitoring, and product flow/tracking management. More efficiency was seen as possible through routing technologies allowing agencies to respond quickly in emergencies. One participant from the local HNGO thus explained how faster data-driven decision-making can improve the response to disasters and communication of identified risks to humanitarian partners. HNGOs can then put appropriate risk management strategies to counter identified threats.

The two main differences in the participants' views of IT as a critical enabler of BDAs were given concerning the need for leadership support in the importance of ITs critical for agility and resilience in HSCs. The other view was the need for transparency when adopting new ITs since they come

at a cost to the organisation and ultimately to the donors. This transparency makes implementing countries to be accountable.

Conclusion on the theme of integration with advanced IT

The evidence for information technology presented similarities and differences between all organisation groupings. Most participants believed that various information technologies are critical enablers of BDA in HSC, leading to their agility and resilience. However, leadership support and transparency make the adoption of ITs more effective and aligned with donor and organisational needs.

5.4.3 Theme 2 – Decision support systems

From compiling the feedback of the respondents, the theme of decision support systems (DSS) emerged as one of the enhancers of agility and resilience of HSCs through BDA. The role of decision support systems (DSS) emerged as a pivotal theme. DSS is a central aspect of the modern data-driven landscape, bridging the gap between raw data and actionable insights. Given the scale and complexity of BDA and its impact on humanitarian supply chains, it is imperative to use a mechanism that can sift through vast amounts of data and deliver accurate results. This section delves into the intricacies of DSS and presents the findings realised by the respondents on this theme.

Evidence of decision support systems

The evidence was selected by comparing the mentions of decision support systems across the different agency groupings. The table below is a table of evidence on decision support systems.

Table 16:Evidence of decision support systems

Evidence of Theme 2 – Decision support systems	
Quotation	**Sector**
…. So, I always like to think of these in terms of kind of trade-offs that you can be agile or lean and you can try to find a middle ground to but your standard operating procedures or your supply chain manual or you know any kind of documentation or guidance that you have at the organisation level. This should document the different options and the trade-offs between these, and I think that helps implementers explore the different options. And you know, how those can, what the trade-offs	Consultant

are, and they can it can help them inform their decision process (Participant B.R)	
The use of mobile technology is an important facet of improving operations and investing in business systems to drive decisions. (Participant C.ad)	HNGO
…. you need to be a data driven organisation and based on the values data provides, I have seen organisations now move in that direction of investing in Enterprise Resource Planning software's applications, I have seen organisations and invest in analytical tools, visualization tools, and building capacities and competencies among these areas… (participant A.D)	Local HNGO
…And at every point in time you need to have access to data to be able to make decisions and that is where digitalization comes in that is where big data comes in. That is where analytics comes in. Because you want to improve the efficiency, the accuracy and the decision-making process. You want to have visibility into what is going on… (Participant E.A) *Artificial Intelligence enhances decision-making…. (Participant E.V)* *This is a strength to the upstream decision making, upstream level where they can use this to forecast and quantification and all of that. And then there's also the use of technology, using you know, simple, Open Data kits to collect data to compare service data and consumption data. The analysis of these two can show how quality data is so for example, you know that when the consumption report is being analysed with the service report, you are in a better position to know where the disparities are, and then there can be root causes. This is one of the areas we, my organisation has used open data kit tools to be able to collect data at those levels analyse the different disparities between the data gap and ensure improved quality of records of reports and decision making. (Participant E.V)*	Donor agency

As shown in the table above, respondents repeatedly emphasised the profound impact of technological advances on decision-making processes. One participant under the consultants grouping pointed out, "*The use of technology enhances data-driven decision-making*,"

underscoring the central role of technology in harnessing the power of data to make informed decisions. Another participant echoed this sentiment: "*Using mobile technology is an important aspect of improving operations and investing in business systems to make decisions*." The overarching theme here is the indispensability of technology in shaping data-driven strategies. The essence of this relationship was further illustrated by comments such as *"technology enables data-driven decision-making" and "data visualisation is important for accurate decision-making.*" In addition, there was also a hint of the emerging areas of technology, as illustrated by the statement, *"Artificial intelligence improves decision-making.*" This collection of quotes highlights the collective consensus: the integration of technology, particularly in the form of data analytics and AI, has become a cornerstone for effective decision-making in the modern landscape.

Cross-case and in-case analysis of decision support systems

The evidence of decision support systems presented similarities between the agency groupings, as all expressed similar viewpoints on the importance of this theme. Though the participant groups used different technologies, the arguments all showed how their technologies are part of decision support systems that enable BDAs used by HSC to be agile and resilient in their business operations.

Table 17: Mentions by grouping.

THEME	**HNGO**	**HSC Consultant**	**Local HNGO**	**Donor**
	Mentions by grouping			
Decision support systems	Many	Many	Many	Few

Local and global HNGOs along with donor participants all expressed their agreement on the usefulness of new technologies such as big data BDA in enabling data-driven decision-making. The participants have recognized the significance of BDA, AI, mobile technologies, and GPS in providing good decision support systems for ensuring agility and resilience in HSCs. Some local HNGOs have already started using mobile technologies to improve their operations. Moreover, the use of artificial intelligence and BI analytics has become increasingly popular in HSCs to collect and analyse voluminous or big data efficiently. With the help of modern technology, NGOs

can now make swift and accurate decisions using real-time data provided by decision support systems.

One local NGO participant shared their experience of using BDA-based decision support systems to monitor trades and the flow of commodities. This is crucial in countries like Zambia where the movement of maize supplies can be affected by export commodity movement embargos. The consultant participants also highlighted the growing investment in enterprise resource planning (ERP) systems within HNGOs. These ERP systems are providing analytical and visualization tools that build capacities, competencies, resilience, and agility in HSCs.

Finally, a donor agency participant emphasized the importance of BDA in assisting NGOs in forecasting demand and optimizing inventory levels. They also mentioned how BDA can be used to analyse trends using historical and current data to make swift and data-driven decisions that drive humanitarian emergency missions with the proper inventory or supply levels.

Conclusion on the theme of decision support systems

The evidence for decision support systems presented similarities between all organisation groupings. All participants agreed that decision support systems are a key enabler of BDA in HSC. Data-driven decision-making is enhanced when HSC use DSS in BDA. HNGOs are investing in ERPs that come with adequate data analytic tools that assist HSCs in monitoring stocks, trades, and resources. This way, HSCs can build capacity and competencies to remain agile and resilient in humanitarian operations.

5.4.4 Theme 3 – Complexity of Humanitarian Environments

The fourth theme to be discussed in the context of RQ2 is “the complexity of humanitarian environments” as an enabler for BDA. The complicated and often chaotic nature of humanitarian environments presents a paradoxical requirement for BDA in humanitarian supply chains (HSCs). The inherent complexity of these environments, characterised by unpredictable and dynamic challenges, leads to the need and, thus integration of sophisticated BDA tools to promote agility and resilience.

Evidence of Complexity of Humanitarian Environments

The evidence was selected by comparing mentions of the complexity of humanitarian environments across the different agency groupings. The table below is evidence of the availability of funding and investment.

Table 18: Evidence of the complexity of humanitarian environments

Evidence of Theme 1 – Complexity of Humanitarian Environments	
Quotation	**Sector**
…humanitarian environment is a very non-predictable, unpredictable environment, and it's seeing having the ability to crunch your data in terms of analysing large amounts of data… (Participant B.T)	Consultant
… responding to disasters, emergencies and humanitarian crises… ability of a humanitarian supply chain to quickly and efficiently respond to rapidly changing situations, such as the typhoons experienced in different countries and earthquakes, those are natural disasters, whereas human beings have no control… (Participant D.G)	Global HNGO
…. we're talking about high-risk countries like South Sudan… fragile environment in terms of security, also involvement of the national governments they want at some point a push to evolve, national designate in terms of responding to needs …. (Participant A.P) *First and foremost is the location we don't necessarily work in areas where you would say there's going to be internet connection every time. We work in the most remote areas where even connectivity just even there's no power supply. So, the locations that we work with it really makes it impossible…. one example was in Myanmar, where we had mountain climbers; those people were able to climb mountains they will then carry some of that food to be able to access people that are on the other side of the hill or top of the mountain (Participant A.P)* *The focus became on complex countries like Southern Sudan, Congo, Pakistan, etc. So, more complex contexts. And you're working in environments that can be very difficult, both in terms of collecting and sending data, but even things like being able to charge your equipment so you have to get pretty innovative…. which comes with a cost…. (Participant A.S)*	Local HNGO
…. in some of the contests we work on health supply chains, they are complex environments, they are environments, which are already going through some, issue be it war, so they are humanitarian context… some	Donor agency

of the countries where humanitarian supply chain systems that needed to be managed …. (Participant E.S)	

Based on the findings presented above, the inclusion of BDA is seen by experts working in global and local humanitarian NGOs and donor organisations as a powerful catalyst in addressing the challenges posed by the complex nature of humanitarian contexts. Effective management of natural disasters and operations in high-risk and politically sensitive contexts, such as South Sudan as mentioned by one of the participants, requires fast, flexible, and resourceful solutions. The findings reveal how participants felt BDA can effectively support innovative approaches to data collection and resource allocation in remote regions with limited connectivity and power supply, as in the case of Myanmar.

Furthermore, in places ravaged by armed conflict and where infrastructure to support supply chains is compromised, BDA offers a strategic advantage for the effective management and optimisation of aid distribution, according to the findings. The complex nature of these circumstances inevitably requires the use of advanced BDA capabilities to enable effective, efficient, and timely humanitarian responses.

Cross-case and in-case analysis of complexity of humanitarian environments

The evidence of the availability of Complexity of Humanitarian Environments as an enabler of BDA presented similarities and differences between the agency groupings on the importance of this theme.

Table 19: Mentions by grouping.

THEME	HNGO	HSC Consultant	Local HNGO	Donor
	Mentions by grouping			
Complexity of Humanitarian Environments	Many	Few	Many	none

Three of the groups of participants responded and the analysis reveals a pattern where the complexity of each context drives the adoption and innovation of BDA solutions. Whether facing natural disasters, political instability, or infrastructural voids, the unifying challenge is the need for real-time information, adaptive strategies, and logistical ingenuity.

Conclusion on the theme of complexity of humanitarian environments

In conclusion, both the in-case and cross case evidence presented highlight the crucial role of BDA as a mediator. The findings presented show that the use of BDA is an essential innovation to effectively address the challenges of natural disasters, political instability, limited access to remote areas and conflict-related supply chain disruptions. BDA as noted by the participants helps organisations improve their services by providing real-time, adaptive, and predictive capabilities. Given the complex environments that HNGOs operate in, it is essential for them to adopt a strategy based on BDA. The use of BDA enables humanitarian actors to optimise their actions and effectively help people in difficult situations, even in unforeseen and difficult circumstances.

5.4.5 Theme 4 – The humanitarian mission to save lives.

The fourth theme to be discussed in the context of RQ2 is "the humanitarian mission to save lives" as an enabler for BDA. The core mission that underpins the work of humanitarian organisations is the imperative to save lives. This fundamental objective is the driving force behind the adoption and integration of Big Data Analytics (BDA) in their operations. Through the lens of this mission, BDA is not merely a technological advancement; it is a critical asset that enhances the capacity of these organisations to act swiftly and effectively in crisis situations.

Evidence of humanitarian mission to save lives.

The evidence was selected by comparing the mentions of the humanitarian mission to save lives across the different agency groupings. The table below is a table of evidence on the availability of funding and investment.

Table 20: Evidence of humanitarian mission to save lives.

Evidence of Theme 1 – Evidence of humanitarian mission to save lives	
Quotation	**Sector**
…So, I see the exploration of technology to make our jobs more efficient and faster. I'm more for that. But at the same time, we must balance it with the humanitarian space, and the humanitarian mandate to do no harm…. I think the humanitarian sector is more, we're not driven by profit, but we're driven by principle, or we're driven by a mission which makes it a little bit harder to define, with respect to maybe efficiency	**Consultant**

and effectiveness like what does that mean then for an organisation …. (Participant B.R)	
…profit motive, which is what we started with, it doesn't exist for humanitarian, the lifesaving in practice…. (Participant C.D)	Global HNGO
…. we can be in awe of Amazon or Coca Cola or whatever, but they're not trying to save lives, they're trying to make money…. (Participant A.S) *…they do it because they, I would say because they're passionate about saving lives. And their focus, again is just seeing that impact that happens in it kind of limits…. (Participant AP)*	Local HNGO

Cross-case and in-case analysis of humanitarian mission to save lives.

Based on the findings presented, the humanitarian mission of saving lives is at the centre of the integration of BDA in this sector. Participants across the spectrum recognised the unique challenges and opportunities that technology presents in furthering this mission. Participant B.R. emphasised the need to balance technological exploration with the humanitarian principle of "do no harm'," citing the not-for-profit mandate that makes defining success in this sector difficult. The commitment to the humanitarian mission over profit is reiterated by participant C.D. from a global HNGO, who compares the life-saving focus of their work with the profit motives in commercial sectors.

Table 21: Mentions by grouping.

THEME	**HNGO**	**HSC Consultant**	**Local HNGO**	**Donor**
	Mentions by grouping			
Humanitarian mission to save lives	Many	Few	Many	None

The discussion is extended by participant A.S. to the comparison with corporate giants such as Amazon or Coca-Cola, who notes that these companies strive for profit, while humanitarian organisations strive for impact, specifically saving lives. This is a fundamental difference that defines the approach and criteria for success in the humanitarian sector. Participant AP from a local HNGO further emphasises this difference by pointing to the passion for saving lives that drives humanitarian workers. The exclusive focus on humanitarian impact often determines the scope and limits of their interventions.

Conclusion on the theme of humanitarian mission to save lives.

In conclusion, these findings suggest that while BDA offers significant benefits in terms of efficiency and effectiveness, its application in the humanitarian sector needs to be carefully managed to align with the core mission. This requires a nuanced approach that capitalises on the strengths of BDA while considering the unique ethos of the sector and the ethical considerations that apply to it. The use of BDA is therefore not just about introducing cutting-edge technology, but also about improving the ability to save lives, in line with the humanitarian principles that guide the work of these organisations. In this context, BDA is valued not for its own sake, but for its ability to contribute to the life-saving missions that make up the humanitarian sector.

5.5 RQ3: Inhibiting factors of BDAs leading to a lack of agility and resilience of HSC.

This section addresses the third research question, which aims to understand the obstacles or barriers that BDA presents and that potentially limit the agility and resilience of HSCs. While BDA holds great promise, implementing and integrating such sophisticated tools can also present challenges, especially in the specific environment of humanitarian operations. Using the data collected, this section aims to present evidence on these inhibiting factors and highlight their impact on the ability of HSCs to respond and adapt effectively in complex humanitarian scenarios. There were four themes which emerged from the data analysis and two of these provided key insights as indicated in the table below.

Table 22: Themes emerging for RQ3.

THEME	SIMILAR	DIFFERENT	DISCUSSED
	Existing theme	New theme	
Data privacy and security	✖		Yes
Lack of IT skills and knowledge	✖		Yes
Lack of funding		✖	Yes
Cultural inertia		✖	Yes

5.5.2 Theme 1 – Data privacy and security

Data privacy and security emerged as one of the significant hindrances for humanitarian organisations while dealing with BDA, as highlighted in RQ3. As BDA process vast amounts of sensitive data related to beneficiaries, donors, and operational intricacies, maintaining the confidentiality, integrity, and availability of this data becomes critically important. The report emphasizes that a breach or misuse of such data can lead to significant consequences, including legal ramifications and erosion of stakeholder trust. The increasing cyber threats and sophisticated cyber-attacks make securing data an ever-evolving challenge. Therefore, this theme delves deep into the challenges and nuances related to data privacy and security in the realm of BDAs, emphasizing its significance in potentially limiting the agility and resilience of humanitarian organisations.

Evidence of Data privacy and security

The evidence was selected by comparing the mentions of data privacy and security across the different agency groupings. The table below is a table of evidence on data privacy and security.

Table 23: Evidence of Data privacy and security

Quotation	Sector
"… There are security protection and privacy are a huge, huge problem. From multiple ways, multiple dimensions as well..." The emergence of regulations like GDPR and strict policies in countries like India, Indonesia, and the Philippines	Consultant

prohibits the export of citizen data. This necessitates local processing and storage. (Participant B.E)	
"In certain regions, traditional biometric methods like fingerprints or iris scans are viewed with suspicion, pushing organisations to seek alternative data collection methods… A lot of governments have very strong strict policies on storing data in countries, so we face that quite a bit. In India, Indonesia, in Philippines, I think, you cannot get data out of that country of the citizens of our country. So, you have to process that information in the country. It has to be stored within that that region…." (Participant B.E)	Consultant
"While data privacy regulations aim to safeguard personal information, they come with associated costs, including the need to upgrade security controls..." (Participant B.T) *…so as long as AI is done in a responsible way, and it's developed in a way that that protects the beneficiaries as well as bring the insights we need… (Participant B.T)*	Consultant
"…. They don't want their inventory management system to be linked to the DHS tool. Because of the safety of the data. They don't want this data to go to a platform. Even if the cloud is in Guinea, you know, that they don't want this data to be accessible by lobbyists or pharmacy laboratories… (Participant C.A) *"...The challenge lies in integrating new systems within existing policies, especially with emerging technological changes..." (Participant D.V)* *…. On the other hand, what we're also seeing is that a lot of African countries, they're kind of adopting these data protection legislation. But they don't actually have, the systems and processes and governance to really implement it. So, it creates a bit of a funny situation… (Participant D.N)* *So increasingly, governments are going in for, collecting biometric data on all their citizens, like in India with the IVR system, and then raises some questions as well, because, unfortunately, not all countries in which we operate are democratic (Participant D.N)*	Global HNGO
"Questions around optimal data collection, combining datasets for analysis, and deciding on data storage locations are persistent challenges faced…" (Participant D.N)	Global HNGO

"Even with technological advancements, biases in human decision-making can lead to errors in data. Technology, being dependent on human inputs, might not completely eradicate such issues..." (Participant A.P)	Local HNGO

From the findings presented by participants from the various groupings, it's clear that while BDAs offer immense potential for improving the agility and resilience of HSCs, there are also significant privacy and security challenges. Governments around the world have implemented strict policies for the collection, management, and storage of data to protect the privacy of their citizens. While this regulatory environment is essential to safeguarding individual rights, it presents operational challenges for organisations. For example, some countries mandate that data collected within their borders must be processed and stored locally, which affects the flow of information and potentially leads to data silos and therefore hindering the use of BDA. In addition, cultural and regional perceptions of data collection, such as mistrust of certain biometric methods, force organisations to constantly adapt and find alternative solutions. Furthermore, the biases inherent in human data collection processes can lead to errors, underscoring that technology alone cannot be exist on its own; human elements remain crucial.

This issue underscores the delicate balance that HSCs must strike between using BDAs for operational efficiency and navigating the maze of privacy and security challenges. The future of BDAs in HSCs would inevitably require a holistic approach, combining technological solutions with sound policy frameworks and human judgement.

Cross-case and in-case analysis of data privacy and security

The evidence of data privacy and security presented similarities between the agency groupings as most participants expressed similar sentiments on this theme. The participants from the various groups explained differently how data privacy and security a key inhibitors of BDA adoption that lead to agility and resilience in HSCs.

Table 24: mentions by groupings.

THEME	Global HNGO	Consultant	Local HNGO	Donor
	Mentions by grouping			
Data privacy and security	Many	Many	Many	None

The consultant participants were of the same view that data protection, data privacy and data security regulations are crucial in the successful implementation of BDAs. The participants from global HNGOs explained how observation of data protection regulations such as GDPR in the EU region is essential in the effective gathering and analysis of data. Because of this, NGOs face beneficiary data access restrictions in data usage for BDAs. For instance, NGOs are curious about which markets are relevant for beneficiaries, and what they are buying, especially when cash is given without conditions and restrictions. Additionally, NGOs are faced with governments that have become increasingly more protective of beneficiary information collected and its usage in data analytics, management retrieval and storage policies. These privacy regulations are important in protecting individual and organisational privacy.

However, one local NGO participant explained how NGOs end up putting security controls using data exfiltration techniques when data is being taken out of the organisation illegally. Digital tools which come at a cost to organisations, are then used to detect data that has been infiltrated using cloud security monitoring, threat hunting and threat detection.

Conclusion on the theme of data privacy and security

The findings presentation of data protection and security responses in the different groupings of respondents shows that these organisations face the same challenges regardless of their specific focus or sector. The shared narratives reveal a complex interplay between the need to take advantage of BDA and the ever-evolving landscape of legal, cultural, and technological factors. In their quest to protect citizens' data, governments around the world have erected barriers to seamless data operations that can inadvertently lead to potential inefficiencies or isolated pools of information. Furthermore, cultural perceptions and inherent human biases in data collection and interpretation present additional hurdles. It's noteworthy that these problems aren't confined to a particular type of agency but occur across all groupings, highlighting the universal nature of these challenges.

Cultural and regional differences in the perception and management of data protection also contribute to this challenge. Different communities and regions may have different levels of comfort and trust with data collection methods, especially when it comes to personal or sensitive information. Such differences require a tailored approach to handling data in different contexts, making the implementation of the BDA even more complex.

5.5.3 Theme 2 – Lack of IT skills and knowledge

In answering RQ3, a compelling problem that emerged was the profound lack of IT skills and knowledge (theme 2) within agencies operating HSCs. In today's world, where data is the linchpin of innovation, IT mastery is undeniably critical. The landscape is evolving; humanitarian organisations are pivoting to BDA to increase the agility and robustness of their supply chains. However, a huge gap has emerged—a glaring inadequacy in essential IT capabilities. The participants in the semi-structured interviews conducted for this study explained the significant challenges resulting from this lack of IT expertise in this thematic exploration.

Evidence of Lack of IT skills and knowledge

The evidence was selected by comparing the mentions of lack of IT skills and knowledge across the different agency groupings. The table below is a table of evidence of a lack of IT skills and knowledge.

Table 25: Evidence of Lack of IT skills and knowledge

Evidence of Theme 1 – Lack of IT skills and knowledge	
Quotation	**Sector**
…. Probably one of the issues with adopting new technologies is the lack of skills and you know experience to use those technologies… (Participant B.T)	Consultant
…. Skills, limited skills, and sometimes in using the technology although I think increasingly less in the using the technology…. …The problem is increasingly that we continue to have limited skills and kind of seeing the big picture and the setting up the systems and the processes behind the scenes (Participant D.N) *I mean, skills. That is the absolute foundation for doing what we do right.... So, I do think that digital technology has a big role to play there, but only if we have staff that are skilled (Participant D.N)*	Global HNGO
…. members of the teams that we have they don't necessarily have any background in supply chain …. they don't have that training, professional training to be able to have done on the analytic mind and be able, to function in a way a professional would function. (Participant A.P)	Local HNGO

…there is a huge gap for what we call knowledge, knowledge of advanced technology or recent or latest technologies that are applicable to supply chain so human resources is a major challenge in the supply chain stream…. So, we have limited manpower…. (Participant E.A) *…supply chain that will work effectively like I mentioned they have skills are critical the team that work in those supply chain to make it effective is very important. So, one of the challenges. I've seen so far these days, suboptimal capacity of the persons that work in supply chain in terms of technical know-how to be able to effectively use any deployed technology… (Participant E.V)*	Donor agency

Despite the ongoing technological changes highlighted by respondents, a significant barrier felt in the various groups is the lack of IT skills and knowledge. Consultants pointed to the lack of professional training as inhibiting the potential of analytics and hindering the work. This view is also shared by global HNGOs, who pointed to the direct link between the slow uptake of new technologies and the lack of required skills. Local HNGOs emphasised that skilled people are essential for digital technologies to be used effectively, pointing out that while the tools are available, the human capital to use them may not be. Donor agencies, on the other hand, see a shift, pointing out that while the skills gap remains a problem, it is gradually decreasing in technology use. Taken together, these perspectives highlight the urgent need for capacity building in IT skills and knowledge across the humanitarian ecosystem.

Cross-case and in-case analysis of Lack of IT skills and knowledge

The evidence of lack of IT skills and knowledge presented similarities between the agency groupings as all views from the participants explained differently how lack of IT skills and knowledge is a key inhibitor of BDAs.

Table 26: Mentions by grouping.

THEME	HNGO	HSC Consultant	Local HNGO	Donor
	Mentions by grouping			
Lack of IT skills and knowledge	Many	Few	Many	Many

Some of the consultants and local HNGO participants highlighted how BDA adoption is inhibited by a shortage of IT expertise in NGOs. Yet, a few consultant participants instead provided views on how NGOs must have active processes that enable employee knowledge transfer and capacity building to help bridge the skills gap. A few global HNGO participants believed that the HNGOs need to then build relevant skills and competencies around how technologies can be leveraged to support the HNGO business operations.

In addition, one global HNGO participant particularly explained how attrition rates of IT personnel that can handle new technologies vary across different countries depending on whether it's in a developed country or a developing country. As such, a few participants argued that when skilled IT skills are not available, it is difficult to adopt BDAs in HSCs and HNGOs are sceptical to engage in new DBAs. Many participants concurred that there is a huge gap in DBA skills and competencies coupled with a high brain drain due to salary disparities between HNGO and for-profit organisations. Yet, one donor participant went on to single out that the supply chain employees themselves also lack technical know-how on BDAs to operate effectively with agility and resilience.

Conclusion on the theme of Lack of IT skills and knowledge

The theme of "lack of IT skills and knowledge" emerges as a major barrier to the effective adoption and use of BDA in humanitarian supply chains from the findings collected. Feedback from the different groups shows that the lack of necessary training and expertise is preventing organisations from realising the full potential of advanced technologies. Despite widespread recognition of the transformative power of digital technologies, the effectiveness of these tools still depends on the human element. Simply put, without skilled employees who can handle and operate these technologies, companies cannot take full advantage of them. This challenge

underscores not only the importance of technological investment, but also the need to invest in human capital and prioritise education and training to close the knowledge gap. Several participants view a lack of IT skills and knowledge as a key inhibitor of BDA in HSC personnel and the HNGO IT department. There is a high attrition of skilled IT personnel leading to the huge skills gap in BDA competencies. Effective adoption of BDAs is when HSCs enable IT knowledge transfer and capacity building within HSC and the rest of the organisation.

5.5.4 Theme 3 – Lack of funding and investment

In relation to RQ3, this section presents findings on the 3rd theme relating to the lack of funding and investment needed to pursue BDA initiatives. Exploring this theme is critical for this research to understand the challenges HNGOs face in maximising the benefits of BDA in HSCs. The availability of funding tends to determine the scope, scale, and success of technology-enabled initiatives. Quotes from different groups of participants interviewed showed a clear commitment to the need for technological advancement, coupled with a clear recognition of financial limitations.

Evidence of Lack of funding and investment

The evidence was selected by comparing the mentions of lack of funding and investment across the different agency groupings. The table below is a table of evidence on lack of funding and investment.

Table 27: Evidence of lack of funding and investment

Evidence of Theme 3 – Lack of funding and investment	
Quotation	**Sector**
…. Now we have to do with the little funding that we have, but we try and make it work…. (Participant B.T) *… access to things like internet and technology, affordable technology devices, and things like that…. (Participant B.E)*	Consultant
… And why I say this is because you have funding issues …. When you want to deal with technology …. funds will *be required…. So funding is one of them (challenges)…. (Participant C.B)*	Global HNGO
That's the kind of resilience piece and then agility you can just make your operations much more efficient and be able to identify where you can	Local HNGO

with the same number of staff because we do have funding limitations (Participant A.S) *how do you grow and maintain that strategic focus for the supply chain especially given constraints like donor funding (Participant A.S)* *…. it's hard to get people to really accept that you're a strategic partner, or they should take the leap and use their private funding, or their overhead funding on things like technology and the necessary labour resources that are tied to that technology (Participant A.S)* *The forward investment for some of these technologies it's high in some of the smaller organisations that don't necessarily have their private funding and might not necessarily be able to prioritise that. (Participant A.P)*	
So, in terms of budgeting, governments do not have money. Donors are coming in to support but donor support is not sustainable for long time. It can stop at any given time. So, we are looking for that sustainable financing of these digital technologies in terms of paying for licenses, maintenance, and recurring costs that we need to be able to cover including training of new people who are joining organisations as well… (Participant E.S)	Donor agency

Evidence gathered shows that financial constraints are often a significant barrier to the adoption and efficient use of BDAs. Respondents pointed out that working with limited financial resources is challenging and stressed that access to basic resources such as the internet and affordable technological devices is essential. Narratives from global HNGO participants were consistent with this, highlighting the complicated link between technology and funding, and acknowledging that funding was a significant barrier to effective technology uptake.

Local HNGOs reported the difficulties they faced, especially smaller organisations, in obtaining private or general funding for technological advances. This obstacle was compounded when considering the significant initial investment that some technologies require. They found it particularly difficult to convince stakeholders of their value as strategic partners deserving funding for the technology and associated labour resources.

Donor organisations compounded this challenge by pointing to the unsustainable nature of donor support. They emphasised the critical need for sustainable funding, especially regarding recurrent

expenses such as licences, maintenance, and training. The volatility of donor support, coupled with the constant need for funds, put these organisations in a precarious position.

Cross-case and in-case analysis of lack of funding and investment

The evidence of lack of funding and investment presented similarities between the agency groupings as many participants were of the view that lack of funding and investment was a key inhibitor of BDAs.

Table 28: Mention by grouping

THEME	HNGO	HSC Consultant	Local HNGO	Donor
	Mentions by grouping			
Lack of funding and investment	Many	Many	Many	Few

A few local NGO participants viewed lack of funding as a stumbling block, especially for small NGOs without a huge donor funding base. One donor participant brought up an argument on donor funding competition as the cause of funding shortages that impact BDA adoption in HSCs. The sentiment was that though BDA's benefits are perceived, HNGOs fail to prioritise the adoption of these new technologies due to funding limitations. This is why these HNGOs end up failing to grow and maintain their supply chain strategic focus because of financial challenges. However, one local HNGO participant shared a different view that agility and resilience in HSC come when the organisation can make the operations more effective and efficient regardless of funding limitations.

The HSC should then be able to structure better its cost management techniques. Another local HNGO participant shared that small local HNGOs would expect the government as a willing partner to assist them to better prepare for humanitarian emergencies. Instead, governments do not have funding mechanisms to support local HNGOs with funding though they are willing partners in humanitarian situations. Also, a global HNGO participant believed that donors are not always willing to pay for technology investments for large overhead teams such as HSCs. HNGOs should thus keep overhead rates low in the eyes of donors and the public and not introduce technologies that are costly and that also lead to high overhead rates.

Conclusion on the theme of lack of funding and investment

The references to lack of funding and investment showed similarities and differences between all organisational groups. Many participants felt that lack of funding and investment was a major barrier to BDA in high-security settings, given the challenges in obtaining donor grants and the huge costs of implementing and maintaining BDA technologies.

In summary, while the need for and benefits of BDA are widely recognised, the path to their full integration into humanitarian supply chains is fraught with financial hurdles. This underscores the need for sustainable financing models and innovative financial strategies to unlock the full potential of BDAs.

5.5.5 Theme 4 – Cultural inertia

In relation to RQ3, this section presents findings on the 3rd theme relating to cultural inertia which relates to the tendency of a agencies, governments, and societies to resist changes and continue to abide by existing norms, practices, or mindsets. This was a new theme identified from the findings.

Evidence of Cultural inertia

The evidence was selected by comparing the mentions of cultural inertia across the different agency groupings. The table below is a table of evidence on lack of funding and investment.

Table 29: Evidence of cultural inertia

Evidence of Theme 3 – Cultural inertia	
Quotation	**Sector**
…Technology introduces new ways of working, forces you to change tickets decades of established practices. And that can be challenging for a lot of organisations, especially ones that are established for a long period of time, that have done things in a particularly traditional sense, governments that support this kind of activities, notoriously slow introduction to new ways of working and that also becomes a challenge… (Participant B.E)	Consultant
…a change in mindset, a change in culture that needs to be industry wide. Across the donors across a humanitarian agencies and partners	Global HNGO

to understand that investing in supply chain is investing in entire system right up to finance and when we invest in supply chain… (Participant C.D) *Second is of course, the willingness of a change management because supply chain is quite a new methodology or concept that it's used into the humanitarian environment…. (Participant D.V)* *…of course, is the resistance that we are seeing from order departments non supply chain areas on whereby having a system in place means to them additional complexity. Instead of seeing as we were saying a better agile process to be followed. So, they simply decide to use parallel systems or use the system in a different way just to comply with entering the transactions. (Participant D.V)* *…. setback. Again, change management within the institution, where you find they is these group of people who have lived doing things a certain way. And your deployment now forces them to do things in a different way. So, change management, also, on the paradigm shift from the manual way of doing things to automation, that also posed a lot of challenges… (Participant D.G)*	
It's embedded of very hard culture to overcome within organisations or within the humanitarian aid workers psyche where programming reign supreme and everything must be in service of programming, which often gets misconstrued as we should really only pay for programming. That's the most important thing and to the detriment of operations, finance, HR. And it's very hard to break out of that mentality. (Participant A.S) *….having really honest and frank conversations both within agencies and with our donors on how the context is changed around us and how technology has to be embraced, to better serve, so that we can kind of get away from some of those old habits or old ways of thinking around overhead and around what is overhead and maybe kind of demystifying or taking heard of overhead out of our mouths….(Participant A.S)* *I look at the culture of resistance because most often when people will not buy a or feel they are not involved, then there is likelihood to have a resistance. Right then when it comes up to theory of change people*	Local HNGO

not willing to change people lose to old ways of doing things this, I have seen across different organisations roll out a new solution. (Participant A.D)	
…. A lot of health supply chain practitioners are really not adopting all the latest technology. A lot of them are still sceptical, still sticking to old processes that are actually not optimized. (Participant E.A)	Donor agency

According to the findings presented in this section, cultural inertia can significantly impede the adoption and effective use of BDA. HNGOs often operate within a complex ecosystem that has developed its own unique set of norms, practices, and resistance to change. This can create a formidable barrier to the integration of innovative data-driven approaches.

Cross-case and in-case analysis of cultural inertia

When examining the impact of cultural inertia within individual organisations grappling with the integration of big data analytics (BDA) into HSCs, a complex picture emerges.

Table 30: Mention by grouping

THEME	HNGO	HSC Consultant	Local HNGO	Donor
	Mentions by grouping			
Cultural inertia	Many	Many	Many	Few

Participant B.E. emphasises the difficulties of established organisations in adapting to technological innovations related to their historical processes and practises. This assessment is shared by participant D.V., who not only emphasises the resistance of departments outside the supply chain who see new systems as an additional burden, but also notes the general hesitation towards change management within the humanitarian sector. Participant D.G also emphasises the challenge of moving from manual to automated processes, a task made more difficult by entrenched ways of working. Participant A.S. says that programming is more important than operational aspects in their culture, which suggests a way of thinking that does not recognize how important it is for the supply chain to work well. Participant A.D. points out that resistance to change is a recurring theme in all organisations, often due to a lack of involvement in the

introduction of new systems. Finally, participant E.A. points to the scepticism that still exists among healthcare supply chain professionals who cling to outdated and sub-optimal processes. Collectively, the results from the different participants show that cultural resistance is a big reason why BDA is not used more in HSCs.

Resistance to change is evident in all cases, particularly in organisations rooted in traditions and long-standing practises. Participants B.E., D.V., D.G., A.D. and E.A. discuss how this resistance manifests itself, ranging from scepticism towards new technologies to reluctance to move away from manual processes. C.D., a participant, highlighted the need for greater understanding of the value of BDA's investment in supply chain improvement. The analyses also highlight the operational challenges that arise when cultural inertia is at play. Departments that resist changing their methods lead to a lack of system adoption or the creation of parallel systems that undermine the potential benefits of BDA, as participant D.V. notes.

Furthermore, the prioritisation of programming over operational efficiency described by participant A.S. reveals a mindset that underestimates the transformative power of BDA in optimising humanitarian operations. The need for engagement and involvement in the change process described by Participant A.D. proves to be a critical factor in mitigating resistance and fostering a more receptive culture. Finally, despite their demonstrated potential for optimization, scepticism towards new technologies underlines the widespread reluctance to abandon familiar but less efficient methods, as Participant E.A. noted.

Conclusion on the theme of cultural inertia

The analysis of cultural inertia as a barrier to integrating BDA in HSCs reveals a multi-layered obstacle due to entrenched practices, resistance to change and a deep-rooted prioritisation of programming over operational improvements. Testimonials from various sector professionals highlight a universal challenge: the difficulty of moving from traditional, manual processes to more innovative, data-driven approaches. This resistance is not just a question of replacing old systems with new ones but requires a significant shift in mindset and organisational culture across the humanitarian sector. There is a clear need for robust change management strategies, greater involvement, and participation from all levels of the organisation, and a redefinition of value that includes operational effectiveness as critical to the humanitarian mission. Overcoming this cultural inertia is essential to unlocking the full potential of BDA and enabling more responsive, efficient, and effective humanitarian operations.

5.6 Conclusion of overall findings

This chapter presented the main findings from the gathered data through structured interviews to assist in answering the research questions of how BDA affect agility and resilience in HSC. The three research questions were answered using sub-questions to understand the participants' views on the effect of agility and resilience on HSC's efficiency and effectiveness. Thematic analysis was then conducted using inductive and deductive coding in the three research questions.

An Excel analysis tool was then used to categorise the responses into groups of consultants, local HNGO, global HNGO and donor participants. Since the study aimed not to conduct a comprehensive review but to develop new insights and understanding, not all themes in the conceptual framework were discussed in this section. Therefore, the themes presented and discussed were the most standing ones that provided new understanding and critical insights into the research questions. Potential new themes that were identified through the mapping process applied to the data were added to the conceptual framework.

CHAPTER SIX: DISCUSSION OF FINDINGS

6.1 Introduction

This chapter discusses the findings presented in Chapter 5 whilst linking them to the literature. The discussion follows the same format as Chapter 5, where the researcher organises the discussion systematically by research question.

For each of the 13 themes, the systematic approach was used to compare the main research findings with the literature in three steps. The three steps taken to identify the literature are described below. It is important to note that each subsequent step was only undertaken if the search results from the previous step were either insufficient or non-existent.

Step 1: Word search on three selected articles presented in the literature.

Step 2: If literature was not identified in Step 1, the researcher identified three outstanding scholars from the previously evaluated literature. The researcher then searched for other relevant publications by these scholars that had appeared within the last five years. A word search was conducted on the topic in these more recent articles, indicating the words used. If the word search revealed relevant literature, a comprehensive analysis was conducted to identify similarities or discrepancies with the research findings. If the word search did not reveal any relevant literature on the topic, step 3 was carried out.

Step 3: A Boolean search term was used to look for the appropriate construct on Google Scholar. If this search turned up literature on the subject, it was read and compared to the research results to see what was the same or different. If this search didn't turn up any results, it was seen as a sign of possible differences and a possible addition to the body of literature. Any new literature presented and discussed in this chapter has been included in the reference list. This is additional literature beyond that covered in Chapter 2.

This systematic process was conducted to determine whether the results presented in Chapter 5 were consistent with the existing literature or represented a new contribution to current knowledge. A conclusion was reached at the end of each section. This chapter ends with the presentation of a revised conceptual framework. Table 31 below summarises the three research

questions, corresponding theoretical construct, selected key themes discussed in Chapter 5, and key literature.

Table 31: Summary of research questions, theoretical construct, key themes discussed, potential new themes, and key scholars from Chapter 2.

1. What is the effect of agility and resilience in HSCs' efficiency and effectiveness?	Agility & Resilience	*Theme 1*	Flexibility	(Altay et al., 2018a; Dubey, Bryde, Foropon, et al., 2022; Dubey et al., 2019)
	Agility & Resilience	*Theme 2*	Adaptability	
	Agility & Resilience	*Theme 3*	Effectiveness	
	Agility & Resilience	*Theme 4*	Standardised Processes	
	Agility & Resilience	*Theme 5*	Improved monitoring & evaluation	
2. What are the enabling factors of BDA leading to the agility and resilience of HSCs?	Enabler - internal	*Theme 1*	Integration with advanced technologies	(Dubey, Bryde, Dwivedi, et al., 2022; Dubey, Bryde, Foropon, et al., 2022; Raguseo, 2018; Sheng et al., 2019)
	Enabler - internal	*Theme 2*	Decision support systems	
	Enabler - External	*Theme 3*	Complexity of humanitarian environments	
	Enabler - External	*Theme 4*	Humanitarian mission to save lives	
3. What are the inhibiting factors of BDAs leading to a lack of agility and resilience of HSCs?	Inhibitor	*Theme 1*	Data security and privacy	(Alharthi et al., 2017; D. Bell et al., 2021; Karuppiah et al., 2021; Kazancoglu et al., 2022; Sheng et al., 2019).
	Inhibitor	*Theme 2*	Lack of IT skills and knowledge	
	Inhibitor	*Theme 3*	Cultural Inertia	
	Inhibitor	*Theme 4*	Lack of funding and investment	

Source: Author's own

In Chapter 2, primary scholars were discussed for each research question. For RQ1, which focuses on the construct of the effect of agility and resilience in HSCs, the primary authors were Altay et al. (2018) Dubey et al. (2022) and Dubey et al. (2019). For RQ2, investigating the construct of enablers of BDA leading to agility and resilience in HSCs, Dubey et al. (2022), Dubey, et al. (2022), Raguseo (2018), and Sheng et al. (2019) were selected. Finally, for RQ3, investigating the construct of barriers to BDA leading to a lack of agility and resilience in HSC, the main researchers included in the study were Alharthi et al. (2017); Bell et al. (2021); Karuppiah et al. (2021); and Kazancoglu et al. (2022).

For each of the nine selected themes, a comparison of the findings with the literature is discussed. The themes are discussed in the context of the research question, and for each theme, the three-step process has been followed where relevant. In cases where additional scholars and literature

were identified in steps 2 and 3, these have been included in this chapter as they were identified through the analysis process undertaken. This literature needs to be updated in Chapter 2.

6.2 RQ1: Effect of agility and resilience in HSCs' efficiency and effectiveness

Research question 1 was formulated to gain further insights into how agility and resilience influence the effectiveness and efficiency of HSCs. Table 32 below is an extract from the main table in the previous section, which shows the themes from Chapter 5. There is no potential new theme for this research question that was discussed.

Table 32: Key themes discussed - RQ1.

RESEARCH QUESTION	THEORETICAL CONSTRUCT	START OF CHAPTER 6	START OF CHAPTER 6	KEY LITERATURE
1. What is the effect of agility and resilience in HSCs' efficiency and effectiveness?	Agility & Resilience	*Theme 1*	Flexibility	(Altay et al., 2018a; Dubey, Bryde, Foropon, et al., 2022; Dubey et al., 2019)
	Agility & Resilience	*Theme 2*	Adaptability	
	Agility & Resilience	*Theme 3*	Effectiveness	
	Agility & Resilience	*Theme 4*	Standardised Processes	
	Agility & Resilience	*Theme 5*	Improved monitoring & evaluation	

Source: Author's own

6.2.1 Theme 1- Flexibility

Flexibility "as an outcome of agile and resilient HSCs" was an existing theme presented in Chapter 2. A literature review search was sufficient when comparing the findings from this theme to the literature, and therefore, no further steps were taken. The targeted word search included iterations of flexibility and adaptability.

Flexibility – Recap of key findings

The key research finding on the theme of flexibility within HSCs was the stressed unpredictability of the environments in which HNGOs perform their operations, requiring them to have SCs that react rapidly to change. The importance of flexibility realised through technological integration with technologies such as BDA, IoT and AI was repeatedly emphasised by participants, highlighting that it is not just a theoretical concept but has a direct impact on the effectiveness of aid delivery in the field. Further evidence of this came from the experiences of some interviewees who reported that technologically induced flexibility of HSCs ensured that aid reached beneficiaries promptly and appropriately, meeting their changing needs in real-time.

Flexibility – Recap of key literature

In Chapter 2, Dubey et al. (2020) highlight the importance of flexible humanitarian supply chains to respond quickly to unpredictable disasters and dynamic humanitarian needs. Unlike commercial organisations, humanitarian organisations often must rush to establish supply chains due to the unpredictability of disasters. This requires a degree of agility that allows for the rapid building of trust (Altay et al., 2018b; Devitt et al., 2023; Dubey et al., 2020; Gligor et al., 2019), commitment and collaboration between the different actors involved in disaster response. This agility, fostered by improved information sharing (Al-Khatib, 2023; Dubey et al., 2018; Jermsittiparsert & Pithuk, 2019; O'Regan, 2019), facilitates the rapid establishment of operational frameworks and networks of relationships necessary for effective and efficient disaster response.

Literature mentioned that flexibility and resilience are intrinsically linked under the umbrella of agility (Gligor et al., 2019; Kazancoglu et al., 2022; Mccann et al., 2009; Tukamuhabwa et al., 2015). While flexibility ensures that the supply chain can adapt to immediate disruptions, resilience ensures that these adaptations are sustainable in the long term and allow for the continuous provision of relief goods even during protracted crises. BDA enhanced flexibility and resilience together strengthen HSCs, making them both responsive (Kazancoglu et al., 2022; Munir et al., 2022; Richey et al., 2022) in the short-term and sustainable (Bag et al., 2020; Srhir et al., 2023) in the long term, leading to more effective(P. Kumar & Singh, 2022) humanitarian responses.

Flexibility – Comparison of key findings to the literature

Dubey, et al. (2020) mention that because HSCs operate mainly in complex environments, they are compelled to have flexibility, enhancing their ability to adapt quickly and efficiently to unforeseen challenges. The findings also showed that HSC agility and resilience drive the HNGOs' ability to understand the dynamic needs of emergencies and rapidly reshape their operations to meet the required conditions. Participants overwhelmingly recognised their crucial role in promoting flexible humanitarian supply chains. This is similarly acknowledged in the literature that crises or disasters have forced HNGOs to develop HSC systems that are robust and flexible (Chari et al., 2021; Dubey et al., 2019; Jermsittiparsert & Pithuk, 2019; Kazancoglu et al., 2022). Dubey et al. (2019) also recognised that the major dimension of agility in the context of HSCs is the ability to adjust tactics. In this way, HSCs use their flexibility to respond to emergency situations swiftly and in a timely manner.

The participants concurred that BDAs provide a comprehensive view of supply chain operations, using vast amounts of real-time data to anticipate potential disruptions, understand dynamic needs and rapidly reshape the supply chain. This is like Giannakis and Louis (2016) contention that IT integration is a key enabler for HSC flexibility. Information technology also plays a crucial role in encouraging the use of BDA in logistics and supply chain operations through improving inventory visibility, coordination, flexibility, and competitiveness of the agencies participating in the HNGO sector (Dubey et al., 2020a; Dubey, et al., 2020b). An organisation with an agile supply chain can respond to dynamic environmental changes within the shortest possible time and show flexibility in adjusting capabilities to handle the situation using emerging technologies such as BDA (Gunasekaran et al., 2019).

Furthermore, Gunasekaran et al. (2019) found that an agile supply chain can respond to dynamic environmental changes within the shortest possible time and show flexibility in “adjusting capabilities” to handle the situation using emerging technologies such as big data analytics. Moreover, past research on agility has found that supply chain flexibility is a key enabler of agility (Feizabadi et al., 2021; Gligor et al., 2019). Similarly, Chari et al. (2021) and Dubey et al. (2019) argue that agility's most important characteristic is flexibility and finding alternatives when faced with disruptions is an added advantage. This means HSCs ought to operate within high levels of flexibility to maintain resilience and agility. However, from the findings, the extent of flexibility, as pointed out by the participants, is also influenced by the readiness of HNGOs, their prevailing strategies and their operating environments. Findings also revealed that HSCs need to respond quickly enough to the sudden needs and demands of people affected by disasters. In practice, flexibility comes with the ability to deliver relief material fast to the affected individuals in disaster areas.

Dubey, et al. (2020) further posit that agility is cultivated through improved information sharing and supply chain visibility, facilitating the quick establishment of operational frameworks and relational bonds necessary for effective and efficient disaster response. This concurred with some views of the participants, who pointed out that information sharing, and collaborative were imperative for effective operations of HNGOs. Therefore, as confirmed by both literature and findings, flexibility is an important organisational component especially when working in unpredictable and complex environments.

Flexibility – Conclusion on theme

This research confirms existing literature highlighting the paramount importance of flexibility in HSCs. Operating predominantly in complicated and unpredictable environments, HSCs need the flexibility to adapt quickly to unforeseen challenges and disruptions. Agility is enhanced by BDA and information technology and promotes fast, efficient response to dynamic emergencies by supporting real-time adaptation of tactics and strategies. This agility, fostered by improved information sharing and supply chain visibility, enables organisations to meet disaster-affected people's immediate needs and demands and validates flexibility as an essential organisational component in managing complex humanitarian operations.

6.2.2 Theme 2 - Adaptability

Adaptability was an existing theme presented in Chapter 2. A literature review search was sufficient when comparing the findings from this theme to the literature, and therefore, no further steps were taken. The targeted word search included iterations of flexibility and adaptability.

Adaptability – Recap of key findings

Adaptability was a significant theme in the data, highlighting its crucial role in HSCs. Participants consistently reported that organisations needed to adapt their operations in response to disruptions and changing situations. The participants viewed this adaptability as not only reactive but also involving the use of data to anticipate and address challenges before they occur proactively. Some examples from findings, such as the recent COVID pandemic, revealed the need for adaptability in HSCs. While there was agreement on the importance of adaptability, obstacles to its realisation cited by participants included financial constraints, management approaches and the constant need for improvement. The general feeling was that agility and resilience in HSCs inherently promote adaptability, essential for responding to unforeseen humanitarian events.

Adaptability – Recap of key literature

The literature presented in Chapter 2 on adaptability in HSCs mentions that agility and resilience are associated with the adaptive capacity of organisations. Some authors, such as Jain et al. (2017) and Yaqub (2023) associate agility with adapting quickly to environmental changes. A rapid response is a sign of adaptability and helps HSCs respond to disasters. Dubey et al. (2014

& 2019) and Calvo et al. (2020) examine the ability of supply chains to change course quickly and accelerate their operations, which is critical for HSCs in volatile environments.

In addition to flexibility, the book also emphasises resilience. According to Dennehy et al. (2021) and Ivanov & Das (2020) HSCs can adapt and find a new equilibrium or restore the existing one during disruptions. HSCs adapt to obstacles, as Kazancoglu et al. (2022) and Queiroz et al. (2022) explain resilience flexibility. Adaptability means changing working methods in the face of difficulties.

The research by Dubey et al. (2019) and Ivanov and Dolgui (2021) demonstrates the multi-layered adaptability of HSC through agile and resilient interactions. These two properties make the HSC responsive and robust enough to recover and continue operation under pressure. This adaptability is highly dependent on technology. According to Gupta et al. (2019) and Ivanov and Rozhkov (2019) technology enhances the organisational and flexible capabilities of HSCs. Innovation is the key to adaptation.

The literature also emphasises the diversity of adaptability in different situations. Jermsittiparsert and Pithuk (2019) argue that agility, resilience, flexibility, and adaptability are separate characteristics that contribute to the adaptability of supply chains. It is crucial to understand that adaptability is a spectrum of capabilities HSCs utilise to deal with mission unpredictability.

This section concludes that HSCs need to be adaptable. Agility and resilience show that flexibility is a diverse and dynamic characteristic essential for HSC effectiveness in uncertain and hostile contexts. Although adaptability can take many forms and involve many tactics, according to the literature, it is necessary for humanitarian operations in disaster and crises.

Adaptability – Comparison of key findings to the literature

In the dynamic and often volatile context of humanitarian supply chains, adaptability is repeatedly emphasised in this research's findings and academic literature. The scientific consensus, reflected in the studies by Dubey et al. (2019) and Ivanov et al. (2021) is that agility and resilience are critical for humanitarian supply chains to respond effectively to the uncertainties and abrupt changes that characterise crises. This is further elaborated by Paciarotti et al. (2021) and Jahre and Fabbe-Costes (2015) who discuss the need for quick action and the ability to respond to sudden shifts in demand and supply.

However, the findings revealed that practical complexities and financial constraints associated with improving adaptive capacity often need to be more represented in the literature. While studies such as those by Heaslip and Stuns (2019) and Kovacs and Spens (2012) recognise the unpredictability of emergencies, the findings suggest that the cost and effort of continuous adaptation can be prohibitive, highlighting a gap that academic research may need to address further.

The role of technology in supporting adaptability is reiterated in the literature, where Gupta et al. (2019) and Ivanov and Rozhkov (2019) discuss how digital tools can drive efficiencies that favour agile and resilient supply chain operations. This theoretical perspective is consistent with practical adaptations involving digital data collection and analysis, emphasising the value of technology for managing and mitigating supply chain disruptions.

Overall, the literature emphasises the twin pillars of agility and resilience as critical to the continuity and effectiveness of humanitarian response. The research conducted by Gligor et al. (2019) and Tarigan et al. (2021) supports the idea that adaptive capacity is not merely a reactive measure but rather a strategic approach that learns from past disruptions to strengthen future responses. This aligns with the general experience of the participants and suggests that while the principles of adaptive capacity are theoretically sound, their application is often limited by the availability of resources and the complexity of real-world logistics.

6.2.3 Theme 3 - Effectiveness

Effectiveness “as an outcome of agile and resilient HSCs” was an existing theme presented in Chapter 2. A literature review search was sufficient when comparing the findings from this theme to the literature, and therefore, no further steps were taken.

Effectiveness – Recap of key findings

Examining the theme of the "effectiveness" of agile and resilient HSCs from the findings revealed a consensus on its critical role in crisis response. The use of technology has been highlighted as a key factor in driving effectiveness in agile and resilient HSCs. This is because it improves data management and analysis, increasing effectiveness. This effectiveness is measured not only by the speed of response but also by the ability of the supply chain to return to pre-crisis levels of efficiency following a humanitarian response. Effective HSCs are characterized by minimal

disruption, streamlined operations, and continuous communication, coordination, and collaboration between authorities and stakeholders.

Effectiveness – Recap of key literature

The literature on presented in Chapter 2 on "effectiveness" in agile and resilient HSCs emphasises the need for flexibility and resilience to respond quickly and robustly to disasters and crises. Paciarotti et al. (2021) emphasise the immediacy of post-disaster relief, while several studies highlight the unpredictability of emergencies that require agile and resilient supply chains (Altay et al., 2018b; Dubey, 2020; Gligor et al., 2019). The interaction between agility and resilience is complex as they may require different strategies and resources. Emerging technologies such as BDA are seen as key to improving both characteristics as they provide the ability to organise, anticipate and flexibly mitigate risks (Gupta et al., 2019; Ivanov & Rozhkov, 2019). In essence, the literature asserts that agility and resilience are essential for HSCs to effectively fulfil their roles in crisis situations and ultimately save lives and reduce suffering through adaptable and efficient supply chain operations.

Effectiveness –Comparison of key findings to literature

In the literature presented in chapter 2, the theme of effectiveness in HSCs is dealt with using the constructs of agility and resilience. According to authors like Dubey et al. (2019) and Raj et al. (2023) agility, with its emphasis on speed and flexibility, correlates directly with the efficient and effective delivery of aid in emergency situations and supports the findings that timeliness is a crucial measure of HSC performance. Resilience, as described by Gligor et al. (2019) and Ivanov et al. (2021) defines effectiveness as the ability of the HSC to maintain operations and recover quickly from disruptions, reflecting findings that emphasise the importance of robust and uninterrupted aid distribution.

Gupta et al. (2019) discussed how new technologies like BDA can make HSCs more flexible and stronger. This supports earlier research that shows how important technology is for keeping operations running smoothly and having good response systems in HSCs. This technological edge is critical to ensuring the effectiveness of HSCs, as evidenced by the ability to minimise disruption and maintain vital communication links, as noted in both the literature and research findings. Authors such as Stewart & Ivanov (2022) confirm these points and claim that such capabilities are essential for managing humanitarian crises. To summarise, both findings and key literature concur in suggesting that the effectiveness of HSCs is inherently linked to their agility

and resilience, which are complemented by technological integration to ensure that humanitarian assistance is delivered quickly, reliably, and efficiently.

Effectiveness – Conclusion on theme

This study reflected a similar outcome to the literature with regards to effectiveness "as an outcome of agile and resilient HSCs".

6.2.4 Theme 4 - Standardised Processes

The topic of "standardised processes" was a potential new theme arising from the findings in Chapter 5. As there was no reference to standardised processes as an outcome of efficient and effective HSCs in the literature review in Chapter 2, the subsequent documented steps were followed to identify additional literature that could be compared to the findings of this study.

For step 2, a targeted word search was conducted in the top articles from the scholars identified in chapter 2, using the keywords namely, standards, standardised, standard operating procedures, and standardised protocols. Step 2 identified a brief reference to standardisation in (Paciarotti et al., 2021) and (Jahre & Fabbe-Costes, 2015).

Standardised Processes – summary of key findings

According to the research findings, BDA is increasingly recognised as a fundamental component in creating standardised HSCM processes. The findings highlight the broader importance of BDA, which goes beyond its practical applications and serves as a strategic driver for developing standardised processes. The processes developed based on the insights gained through BDA are significantly transforming HSCM by improving resilience and flexibility.

Standardised Processes – Summary of key literature

The discourse on the role of standardisation within HSCs reveals a landscape marked by complexity and the need for enhanced coordination. Paciarotti et al. (2021) identify the absence of standardisation as a significant challenge for humanitarian logisticians. According to this article, the need for standardisation in HSCs manifests in varied protocols, metrics, and practises of the various aid organisations. Such differences not only hinder interoperability but also make cooperation, which is crucial in times of crisis, easier.

According to Jahre and Fabbe-Costes (2015) standards play a fundamental role in establishing and operating logistics networks, especially in humanitarian contexts. Standards play a crucial role in facilitating cooperation between different organisations by creating a degree of uniformity and thus promoting harmonious operations. Standards have the potential to provide a common framework and set of expected outcomes that promote coherence between many organisations, facilitating the necessary adaptability to the ever-changing demands of humanitarian emergencies. In their article, Raut et al. (2021) also posits that BDA plays a significant role in developing lean management models for internal organisation operations, therefore facilitating the establishment of standardised procedures and waste reduction.

Standardised Processes Comparison of critical findings to literature

Comparing the results of this study with the existing literature, a consistent picture emerges of the influence of technology and BDA on the standardisation of procedures in HSCM. The current literature consistently shows the role of technology as a catalyst for introducing standardised standards. The results of this study are consistent with this view and emphasise a significant improvement in the consistency of processes achieved through technological advancement and the targeted use of big data analytics. The results show that the need for advanced technology support significantly contributes to the existing lack of standardised processes. The lack of advanced technology hinders the ability to implement data-driven standardisation, highlighting the great importance of BDA in developing a more coherent and effective strategy for humanitarian logistics and operations.

Standardised processes – conclusion on theme

The thematic analysis of process standardisation in HSCM shows a strong correlation between the integration of BDA and HSC consistency. The study results and the literature suggest that BDA refines, and catalyses standardised processes. This research shows that standardisation is a technique to improve HSCM efficiency, agility, and resilience. BDA is essential for creating robust, flexible processes that respond to the diverse and dynamic nature of humanitarian emergencies. Therefore, the theme of standardised processes was updated as a new theme on the conceptual framework and will no longer be highlighted in yellow.

6.2.5 Theme 5 – Improved monitoring & evaluation

The topic of “Improved monitoring & evaluation” was a potential new theme arising from the findings in Chapter 5. As there was no reference to Improved monitoring and evaluation as an

outcome of efficient and effective HSCs in the literature review in Chapter 2, the subsequent documented steps were followed to identify additional literature that could be compared to the findings of this study.

For step 2, a targeted word search was conducted in the top articles from the scholars identified in Chapter 2, using the keywords measurement, analysis, monitoring, and continuous improvement. Step 2 identified several references to these keywords in (Altay et al., 2023; Dubey et al., 2019; (Heaslip et al., 2019; Jahre & Jensen, 2010; and Oloruntoba & Banomyong, 2018).

Improved monitoring & evaluation – recap of key findings

The findings emphasise the central role of flexible and HSCs in improving monitoring and evaluation capabilities. As the participants emphasised, technological investments aim to achieve end-to-end transparency within HSCs. This transparency is not just about collecting data but also about utilising this data to make processes more efficient and effective. The introduction of Enterprise Resource Planning (ERP) systems in many country offices is evidence of this, with a focus on building the capacity to utilise data productively. Digital data capture is a crucial enabler, enabling comprehensive annual reporting and insight into global performance.

In addition, introducing multiple tools enables different responses, such as local purchasing, which facilitates process innovation. With the data collected, companies can react in real-time and perform predictive analyses for proactive measures. The emphasis on standard systems and data analyses ensures that operational efficiency is consistently reviewed and areas needing improvement are identified. This change from using methods only for transactions to a more in-depth analytical approach lets staff in different regions and worldwide evaluate the transactional and analytical maturity level to help with demand forecasting and spending analysis.

Participants emphasised the need for visibility within the organisation and across the entire supply chain, from planning to procurement to distribution. Optimising routes and warehouse locations becomes possible with this data-driven approach. Integrated information systems provide improved data sharing between healthcare organisations, support informed decision-making, and ultimately contribute to improved monitoring and evaluation of HSCs.

Improved monitoring & evaluation – Recap of key literature

Improved monitoring and evaluation (M&E) are an essential outcome of agile and resilient HSCs, enabling real-time data collection and adaptive response strategies, as outlined by Dubey et al. (2019) and Charles et al. (2016). Resilience fortifies M&E systems against infrastructure disruptions, ensuring uninterrupted data flow for immediate and recovery responses (Heaslip et al., 2019). Technological advancements enhance M&E through improved data accuracy and availability, facilitating operational decision-making (Altay et al., 2023; Heaslip et al., 2019; Kunz & Reiner, 2012). Additionally, Oloruntoba and Banomyong (2018) emphasize the importance of capacity building in the use of monitoring tools for successful M&E implementation. Enhanced monitoring and evaluation further influence resource allocation and strategic planning, proving crucial in humanitarian (Jahre & Jensen, 2010). This body of literature underscores the pivotal role of effective M&E systems within agile and resilient HSC frameworks, which ultimately contribute to improved humanitarian outcomes.

Improved monitoring & evaluation – comparison of key literature to findings

The research findings align well with the literature on the importance of effective M&E in agile and resilient HSCs. The studies by Dubey et al. (2019) and Charles et al. (2016) emphasise real-time data capture and the ability to respond adaptively. This aligns with findings that ERP system implementation and digital data capture facilitate end-to-end transparency and operational adaptability. The resilience that protects M&E systems from disruption discussed by Heaslip et al. (2019) reflects the research participants' emphasis on using data to respond to current needs and predict and prepare for future crises. This resilience ensures that M&E systems continue functioning and provide data to inform responses even if the infrastructure fails.

As the main findings also suggest, Altay et al. (2023) and Heaslip et al. (2019) both cite technological advancements as being essential to improving data availability and accuracy, which are necessary to effective M&E. Kunz and Reiner (2012) also highlight the enhanced decision-making capabilities enabled by such advances, which aligns with the participants' recognised need for data transparency and analysis for better decision-making in HSCs.

Capacity building, a critical element cited by Oloruntoba and Banomyong (2018) is reflected in the findings, where a focus on training and improving the capacity of supply chain teams is seen as critical to the productive use of M&E tools. Finally, Jahre and Jensen (2010) talk about how better monitoring and evaluation can affect strategic planning and the use of resources. This

aligns with research that shows how predictive analytics and data-driven approaches help with process innovation and strategic response.

The key research findings confirm the call in the literature for robust M&E systems as a basis for improved humanitarian action. The integration of technologies, emphasis on resilience, focus on capacity building, and strategic use of data for decision-making are common themes that highlight the transformative impact of M&E in agile and resilient HSCs.

Improved monitoring & evaluation – conclusion on the theme

In conclusion, the analysis of key study findings and current literature emphasises the importance of M&E for improving flexible and resilient humanitarian supply chains. Integrating advanced technical systems such as ERP and digital data collection and analysis is key to end-to-end transparency and informed decision-making. This digital advancement supports scientific views that emphasise real-time data collection and adaptive response tactics to manage and reduce disasters. This section highlights that both practitioners and academics agree that robust M&E systems are strategic assets that strengthen the resilience and agility of HSCs. They are necessary to deliver humanitarian assistance efficiently, effectively, and somewhat in the face of current and future problems.

The improved monitoring & evaluation theme is therefore, no longer identified as a potential new theme (and no longer highlighted in yellow) and has been updated to be a theme existing in the literature.

6.2.6 Conclusion on RQ1 – Comparison of key findings vs. literature

To summarise, the investigation of research question 1 has shown that agile and resilient HSCs are essential for an efficient crisis response. The consistency of the research findings with the established literature on five key themes: flexibility, adaptability, effectiveness, improved monitoring and evaluation, and standardisation of processes underlines the multi-faceted strengths of well-organized HSCs. Flexibility and adaptability ensure that HSCs can adapt promptly to new needs and volatile conditions, while effectiveness is demonstrated through the timely and appropriate delivery of assistance.

Enhanced M&E is recognised as essential for informed decision-making and continuous improvement. Finally, the standardisation of processes is confirmed as critical to ensuring reliable and efficient operations. This synthesis of empirical data and scientific research paints a

comprehensive picture of the current state of HSCs and sets the stage for actionable insights into their optimisation. At the end of this section, it becomes clear that fostering agility and resilience in HSCs is beneficial and essential to advancing humanitarian efforts worldwide.

6.3 RQ2: What are the enabling factors in BDAs leading to the agility and resilience of an HSC?

Research question 2 was formulated to gain further insights into the enablers of BDA that influence the effectiveness and efficiency of HSCs. Table 33 below is an extract from the main table in the previous section, which shows the themes from Chapter 5. There is no potential new theme for this research question that was discussed**.**

Table 33: Key themes discussed for RQ2.

RESEARCH QUESTION	THEORETICAL CONSTRUCT	INTERNAL/ EXTERNAL	THEMES (at start of Chapter 6)	OUTCOME
2. What are the enabling factors of BDA leading to the agility and resilience of HSCs?	Enabler	Internal	Integration with advanced technologies	Existing theme retained
	Enabler	Internal	Decision support systems	Existing theme retained
	Enabler	External	Complexity of humanitarian environments	Potentially new theme retained as existing theme
	Enabler	External	Humanitarian mission to save lives	Potentially new theme retained as existing theme

Source: Authors' own.

6.3.1 Theme 1 - Integration with advanced technologies

Integration with advanced technologies as an enabler of BDA in HSCs was an existing theme presented in Chapter 2. A literature review search was sufficient when comparing the findings from this theme to the literature, and therefore, no further steps were taken.

Integration with advanced technologies – recap of key findings

Participants highlighted that integrating advanced technologies into HSCs was a crucial aspect of improving their organisations' flexibility and resilience, as the key findings indicated. This integration primarily revolved around introducing BDA and its synergy with state-advanced IT infrastructure. Key technologies such as RFID, GPS, mobile technologies, blockchain, and artificial intelligence have been identified as critical in streamlining processes, improving inventory management, and facilitating real-time decision-making.

Participants from the various groups, including consultants, global and local HNGOs, and donor organisations, consistently pointed out how these technologies had transformed operational management and predictive analytics in the sector. However, alongside these benefits, challenges such as the need for robust governance support, transparency in IT adoption, and mitigation of cybersecurity risks also emerged. This integration promoted efficiency and strategic decision-making in HSCs and underlined the necessity for a balanced approach that combined technological advances with organisational and ethical considerations to exploit their potential in humanitarian contexts fully.

Integration with advanced technologies – recap of key literature

The literature presented in Chapter 2 gives us helpful information about using new technologies to make BDA possible in humanitarian supply chains. The studies by Dubey et al. (2022a) and Dubey et al. (2022b) show that combining new technologies with BDA makes it much easier for HSCs to make decisions and run their businesses more efficiently. These studies show how crucial real-time data analytics and predictive models are for predicting and handling supply chain problems, making it more flexible and able to bounce back from setbacks. Raguseo (2018) focuses on the predictive power enabled by such technological integrations and shows how they help more effective anticipation of humanitarian crises and responsive planning. Sheng et al. (2019) expands on this theme, highlighting the importance of integrating different data sources and utilising sophisticated analytical techniques. This combination of technologies in BDAs is essential for making smart and quick decisions, making HSC operations more responsive and effective overall. In summary, key literature presented how important it is to include advanced technology as a basic need for BDA, which supported the idea that this makes humanitarian supply chains more flexible and resilient.

Integration with advanced technologies – comparison of Key literature vs. Findings

A comparison of key literature on integrating advanced technologies as an enabler for BDA in HSCs with current research results shows that the scholars 'perspectives and findings are broadly in line and that there are some clear insights.

Real-time data analytics and predictive models play a very important role in making decisions and running operations more efficiently, as shown in the research by Dubey et al. (2022a) and Dubey, et al. (2022). These elements are emphasised as crucial for improving decision-making processes. This point of view is very similar to the research results that said combining advanced

IT and BDA in HSCs is essential for quick and well-informed decision-making, which is especially important during emergencies.

Regarding predictive capabilities and crisis anticipation, Raguseo (2018) emphasises the predictive power of BDAs in effectively anticipating humanitarian crises. The research findings that demonstrate how integrated technologies like GPS and RFID significantly improve the agility and resilience of HSCs by contributing to the prediction and management of supply chain disruptions confirm this aspect.

Regarding technology integration and data consolidation, Sheng et al. (2019) focus on integrating different data sources and applying advanced analytics techniques for informed decision-making. This is reflected in current research and shows how other technologies, from blockchain to AI, synergistically interact with BDA to streamline the operation of HSCs.

In addition, the literature highlights the benefits of operational optimisation and improved stakeholder coordination. The research findings also show how technological integration improves coordination and operational efficiency. In addition, the role of technology in improving transparency and the need for sound governance are highlighted, which is consistent with the literature but also provides additional insight into the balance between technological advances and organisational and ethical considerations.

The comparison shows a strong correlation between the literature and the research findings. Both emphasise the critical role of advanced technologies and BDA in improving decision-making, predictive capabilities, and operational efficiency in HSCs. Still, they also acknowledge the challenges and advocate for a balanced approach to integrating these technologies.

Integration with advanced technologies – conclusion on theme

In summary, this section backs up what has already been argued by scholars by showing how critical new technologies and BDA are for making HSCs more agile and resilient. The research findings and the literature emphasise the importance of RFID, GPS, AI, and blockchain technologies in improving decision-making, predictive capabilities, and operational efficiency. However, the findings also provide additional insights into the need for sound governance, transparency, and ethical considerations in adopting these technologies and reveal a nuanced understanding of the challenges and opportunities presented by technological advances in HSCs.

6.3.2 Theme 2 - Decision Support Systems

Decision support systems as an enabler of BDA in HSCs was an existing theme presented in Chapter 2. A literature review search was sufficient when comparing the findings from this theme to the literature, and therefore no further steps were taken.

Decision support systems – recap of key findings

Decision Support Systems (DSS) in HSCs were found to be linked to BDA's growing importance for flexibility and resilience based on the findings. Different participants from different groups pointed out that how the need to connects massive amounts of data to actionable insights enabled them to pursue BDA. From local and Global HNGOs to donor agencies and experts, all interviewees agreed that technological improvements greatly impact their decision-making. They mentioned that technology integration, especially BDA and AI, are key to good decision-making. Several of them pointed out that mobile technologies, ERP systems, and advanced analytical tools are becoming more and more essential for their data-driven decision-making. Overall, all organisational groupings agreed that decision support systems advanced BDA capabilities in humanitarian response, with most of them using it to monitor stocks, trade, and resources and make data-driven decisions.

Decision support systems – recap of key literature

On the topic of 'decision support systems" in HSC, the literature offers insightful perspectives on the factors that enable BDA. Dubey et al. (2022) emphasize the role of BDAs in improving real-time decision-making, which is essential for HSC agility. This is achieved through the rapid processing of big data that provides timely insights for decision support. Similarly, Dubey et al. (2022) highlight how BDA contribute to operational efficiency and resource allocation, which are critical to the resilience of HSCs. Raguseo (2018) talks about how BDA can predict things, which is very important for predicting humanitarian crises and making plans for how to respond. This is done by adding predictive insights into systems that help people make decisions. Sheng et al. (2019) discusses the technological advances in BDAs, particularly the importance of integrating different data sources for informed decision-making. Taken together, articles studies emphasize that fast data processing, predictive analytics, efficient resource management, and integration of data sources are fundamental BDA features that increase the agility and resilience of HSCs through improved decision support systems.

Decision support systems – comparison of key literature vs. findings

Comparing the research findings with the key literature, it becomes clear that decision support systems (DSS) play a crucial role as an enabler of BDA in HSCs. This aligns with and extends the foundational work of scholars such as Dubey et al. (2022a) and Raguseo (2018) who emphasize the importance of BDA in improving decision-making within HSCs. This research contributes to this narrative by detailing how DSS not only support but actively enable the effective use of BDA in these contexts. By integrating advanced technologies such as AI, mobile technology, and GPS into DSS, this section has demonstrated DSS' enabled BDA is practically applied to improve operational agility and resilience in HSCs. The findings go beyond the theoretical implications presented in the reviewed literature and provides real-world examples of DSS in action, creating a more comprehensive understanding of how DSS facilitates the use of BDA to improve efficiency and effectiveness in humanitarian operations.

Decision support systems – conclusion on theme

This section identifies DSS as a crucial enabler for BDA to improve decision-making in HSCs. The research findings align with existing literature, highlighting the significant role of technologies like AI and mobile tech in enhancing decision-making. The practical application of DSS in facilitating BDA emerges as a key factor in improving the efficiency and effectiveness of humanitarian operations.

6.3.3 Theme 3 – Complexity of Humanitarian Environments (External enabler)

The theme of "complexity of humanitarian environments", is an existing theme that presented in the literature in Chapter 2. However, based on new findings from Chapter 5, the researcher redefines this theme as an external enabler on the redefined framework. A search of the literature review was sufficient when comparing findings from this theme to scholarly articles, and therefore no further steps were taken.

Complexity of humanitarian environments – recap of key findings

The findings revealed how important it is for BDAs to act as mediators in humanitarian efforts. Participants highlighted that using BDA was a big step forward in solving problems created by complex operating environments such as natural disasters, unstable governments, and wars. Participants talked about how BDA's real-time, flexible, and predictive features help improve the services that their organisations offer. Adopting an approach that uses BDA was not only helpful,

but it was also necessary for these humanitarian actors to enable them to effectively optimize their responses in tough and unpredictable situations because of the complex environments that they work in.

The complexity of humanitarian environments – a recap of key literature

Richey et al. (2022) emphasise the dependence on multiple data sources for supply chain management, reflecting the complexity of humanitarian operations. Fosso Wamba et al. (2019) emphasise the transformative role of BDA, which increases the complexity of decision-making processes. As Talwar et al. (2021) talk about, IT has gone from being a tool to a central part of how humanitarian organisations work, which makes things even more complicated.

The real-world uses of these technologies in humanitarian logistics emphasised by Dubey, et al. (2020) and Mandal & Dubey (2021) show how they can help with better inventory management and coordination. In addition, Akter et al. (2016) and Kankanamge et al. (2021) point out the indispensability of AI in the effective use of big data, adding another layer of technological complexity.

The overarching shift towards data-driven decision-making in such volatile environments observed by Bhadani and Jothimani (2016), Li and Liu (2019), and Liu et al. (2023) underscores the complex dynamics that humanitarian organisations must manage. Together, these scholars illustrate the nuanced challenges in humanitarian environments where technology and data management are central to operational success and resilience.

Complexity of humanitarian environments – Comparison of key literature vs. findings

Comparing the interview findings with the key literature reveals a cohesive understanding of the complexities inherent in humanitarian environments and the role of BDA in navigating these challenges. The interview evidence resonates with the perspectives shared in the literature, particularly regarding the unpredictable and dynamic nature of humanitarian settings. For instance, Talwar et al. (2021) noted the evolving role of IT in humanitarian agencies, reflecting the findings where the participants emphasised the necessity of adaptive and innovative IT solutions in complex humanitarian scenarios. Similarly, the challenges of natural disasters, political instability, and remote area access discussed in the interviews align with the assertions of Dubey et al. (2020) and Mandal and Dubey (2021) who highlighted how BDA and IT improve inventory management and coordination in such demanding contexts.

Furthermore, the necessity of AI in utilising big data, as pointed out by Akter et al. (2016) and Kankanamge et al. (2021) echoes the interview findings where BDA's real-time, adaptive, and predictive capabilities were deemed essential for effective humanitarian response. This correlation underscores the criticality of advanced analytical tools in complex environments, a notion supported by the literature. The convergence of these findings with the literature not only validates the interview results but also reinforces the understanding that in the intricate and unpredictable realm of humanitarian efforts, BDA stands as a crucial enabler for agility and resilience, as also suggested by Fosso Wamba et al. (2019) and Richey et al. (2022).

Complexity of humanitarian environments – conclusion on theme

The study's findings echoed the literature, illustrating how the complexity of humanitarian settings acts as a catalyst for applying BDA in HSCs, enhancing their agility and resilience.

6.3.4 Theme 4 – Humanitarian mission to save lives (External enabler)

Humanitarian mission to save lives as an external enabler of BDA application in HSCs, making them more agile and resilient, is a potential new theme arising from the findings in Chapter 5. As there was no direct reference to this theme in Chapter 2, the subsequent documented steps were followed to identify additional literature that could be compared to the findings of this research.

For step 2, a targeted word search was conducted in the top articles from the scholars identified in chapter 2, using the key words: mission, goals, providing relief, and saving lives. Step 2 identified reference to task in the following top articles: Bag et al. (2022); Bell et al. (2021); Gazi & Gazis (2020); Gupta et al. (2019); Kondraganti (2021); Kondraganti et al. (2022); Monaghan & Lycett (2013); and Raut et al. (2021).

Humanitarian mission to save lives – a recap of key findings.

The findings on the theme of the "humanitarian mission to save lives" as an external enabler for implementing BDA in HSCs highlight the central role of BDA in improving operational efficiency and effectiveness while aligning with the core humanitarian principle of saving lives. Participants from various fields agreed that while BDA makes things more efficient and effective, it needs to be used in a way that goes within the sector's core values and duty to not harm. This balance reflects HNGOs commitment to saving lives and not profiting, which starkly contrasts the objectives of the commercial sectors. The results show that using BDA in the humanitarian sector is seen as more than just a technological advance. It is seen as an essential tool that helps save

lives, which means that the adoption and use of this technology must be handled in a nuanced and ethical way.

Humanitarian mission to save lives – summary of critical literature.

A scientific analysis of the "humanitarian mission to save lives" underlines its crucial role in introducing technology and BDA in humanitarian operations. Bag et al. (2022) and Bell et al. (2021) both talk about how this core mission affects the use of technology and push for the use of BDA to help make decisions and run missions more efficiently while saving lives. Gazi and Gazis (2020) and Gupta et al. (2019) go further, pointing out that the role of technology in humanitarian work goes beyond efficiency and is fundamentally linked to achieving the primary goal of saving lives.

Kondraganti (2021) and Kondraganti et al. (2022) focus on the practical implications of BDA and emphasize the need to balance its application with the life-saving mission. Monaghan and Lycett (2013) discuss the ethical and strategic dimensions of BDA and emphasize that the technology must serve the overarching humanitarian goal. Raut et al. (2021) also talk about the ethical issues and better operational capabilities that BDA brings. They also make the case for a way of putting it into action that puts the humanitarian mission first. Overall, these studies suggest that the pursuit of saving lives is a fundamental motivator for the use of BDA in humanitarian work and that such technology should not only be focused on efficiency but must also be closely aligned with humanitarian principles.

Humanitarian mission to save lives – comparison of key literature vs. findings.

The comparison between the key literature and the findings of the participants interviewed on the topic of "humanitarian mission to save lives" as a basic requirement for BDA in humanitarian operations shows both similarities and nuanced differences.

Literature, like Bag et al. (2022) and Bell et al. (2021) stresses how important the humanitarian mission is in shaping how technology is used and makes the case for BDA to help make decisions and run operations more efficiently. This aligns with the findings of participants who recognize the need for BDA to improve efficiency in life-saving operations. Both the literature and the findings agree that the core mission of humanitarian aid has a direct influence on the integration and application of technological solutions.

Gazi and Gazis (2020) and Gupta et al. (2019) extend this perspective, noting that the role of technology in humanitarian work goes beyond efficiency and is fundamentally linked to the primary objective of saving lives. This echoes the views of the participants who emphasize the balance between technological advancement and the humanitarian principle of "do no harm" The participants' views are consistent with the literature emphasizing the ethical dimensions of technology use in humanitarian contexts.

Kondraganti (2021) and Kondraganti et al. (2022) focus on the practical implications of BDA and emphasize the need to balance its application with the life-saving mission. This is reflected in the participants' observations about the need for a nuanced approach to BDA that supports the mission of saving lives while recognizing the unique challenges of the humanitarian sector.

Monaghan and Lycett (2013) and Raut et al. (2021) discuss the ethical considerations and enhanced operational capabilities that BDA brings. These considerations are also reflected in the interviews, where participants discussed the ethical challenges and the need for responsible implementation of BDA in line with humanitarian principles.

Humanitarian mission to save lives – conclusion on theme.

To summarise, the main literature and interview results show a consensus on the importance of the BDA's focus on the humanitarian mission of saving lives. Both sources recognize the critical role of BDA in improving the efficiency and effectiveness of humanitarian operations. However, they also emphasize the need for a balanced and ethically responsible approach that ensures that the use of technology serves the overarching humanitarian goal without compromising ethical standards.

6.3.5 Conclusion on RQ2 – Comparison of Key Literature vs. Findings

The discussion of RQ2 establishes that the enabling factors of BDA, such as the integration of advanced technologies, decision support systems, the complexity of humanitarian environments, and the humanitarian mission to save lives, are pivotal in enabling the need to implement BDA in HSCs that are seeking to be agile and resilient.

Based on the findings and this discussion, the researcher categorised “Complexity of Humanitarian Environments” and “Humanitarian Mission to Save Lives” as external enablers. This grouping comes from the understanding that these factors are not part of the organisation's structure but greatly affect how BDA usage is enabled in HSCs. The complexity of the

environments in which HSCs operate and the fundamental humanitarian mission to save lives guide and shape the drive by HNGOs to use technology and BDA. These themes, initially highlighted as potential new additions, are now identified as existing themes in literature. As a result, they are no longer highlighted in yellow in the revised framework.

6.4 RQ3: What are the inhibiting factors of BDAs leading to a lack of agility and resilience of an HSC?

Research question 3 was formulated to provide further understanding and insights into the inhibiting factors of BDA usage in HSCs that lead to a lack of agility and resilience. Table 34 below is an extract presented earlier which shows the selected themes from chapter 5 that were discussed, including the potential new themes from the findings, highlighted in yellow.

Table 34: Key themes discussed - RQ3.

RESEARCH QUESTION	THEORETICAL CONSTRUCT	INTERNAL/ EXTERNAL	THEMES (at start of Chapter 6)	OUTCOME
3. What are the inhibiting factors of BDAs leading to a lack of agility and resilience of HSCs?	Inhibitor	Internal	Data security and privacy	Existing theme retained
	Inhibitor	Internal	Lack of IT skills and knowledge	Existing theme retained
	Inhibitor	Internal	Cultural Inertia	Potentially new theme retained as existing theme
	Inhibitor	External	Lack of funding and investment	Existing theme retained

Source: Author's own

6.4.1 Theme 1 – Data Privacy and Security

Data privacy and security "as an inhibitor of BDA implementation and adoption in HSC leading to the lack of agile and resilient HSCs" was an existing theme presented in Chapter 2. A literature review search was sufficient when comparing the findings from this theme to the literature, and therefore, no further steps were taken.

Data privacy and security - recap of key findings

About research question 3, which focuses on the inhibiting factors of BDA in humanitarian supply chains, the issue of data privacy and security was clearly highlighted based on the interviews conducted by the researcher. These interviews revealed that ensuring data privacy and security is a key concern as BDAs process large amounts of sensitive data. This is particularly critical as HSCs manage sensitive information about beneficiaries, donors and operational details. The outcomes from the participants' research show the big problems that can happen when data is

lost or misused, such as legal problems and a loss of trust among stakeholders. As more complex cyber threats have appeared, the issue of data privacy has become more difficult making it even more difficult for HNGOs to pursue BDA initiatives. The interviews underscored the delicate balance required in utilizing BDAs for operational efficiency and addressing the multiple challenges of data privacy and security.

Data privacy and security - recap of key literature

The literature on data privacy and security in the context of humanitarian aid and crisis management emphasizes the critical need to balance the benefits of BDA with the protection of personal privacy. Key research papers by Bell et al. (2021), Salah (2021) and Gupta et al. (2019) emphasized the importance of strong safeguards to protect sensitive information while ensuring efficient data sharing between agencies. Ethical considerations were also of importance, as noted by Roberts and Faith (2021) who focused on transparency, informed consent, and accountability in HNGOs.

Data privacy and security - comparison of key literature vs. findings

Looking at the literature review presented in Chapter 2 and comparing it to the findings presented in Chapter 5 in data privacy and security in humanitarian settings, the researcher observed that there are similarities. The literature emphasises the need to balance the benefits of BDA with privacy protection in humanitarian assistance and crisis management, as Bell et al. (2021), Salah (2021) and Gupta et al. (2019) highlight the importance of robust safeguards. This general focus aligns with the findings which address the intricacies of sensitive data management restricting the quick adoption of BDA and echoes the emphasis on ethical considerations in the literature highlighted by Roberts and Faith (2021) about transparency, informed consent, and accountability.

The findings add context to the theme by focusing more on the problems that data governance laws like the GDPR and other local laws in some countries cause in HSC operations. Participants highlighted how hard it is to process and store data in certain parts of the world and gave a detailed look at how to deal with different cultural and regional views and the biases that come with collecting data from people. This comparison shows a common theme in both literature and findings: the need for a fine balance between using new technology in BDA and ensuring that privacy and security rules are strictly followed in humanitarian operations.

Data privacy and security - conclusion on theme

The researcher noted no differences between the literature and the research findings on the role that the need to implement “Data privacy and security” plays as an inhibitor of BDA implementation and adoption. The research findings confirmed the discussions in the extant literature. This, therefore, adds to the body of knowledge on the inhibiting role of data privacy and security in adopting BDA in HSCs to make them agile and resilient.

6.4.2 Theme 2 – Lack of IT skills and knowledge

Lack of IT skills and knowledge “as an inhibitor of BDA implementation and adoption in HSC leading to the lack of agile and resilient HSCs” was an existing theme presented in Chapter 2. A search of the literature review was sufficient when comparing the findings from this theme to the literature, and therefore no further steps were taken.

Lack of IT skills and knowledge - Recap of Key findings

According to various groupings in the findings, the theme of "lack of IT skills and knowledge" emerged as a significant obstacle to adopting BDA within HSCs. This gap, as mentioned by the participants, manifests itself in a need for more professional training and expertise to implement and utilise BDA tools effectively. Consultants, global and local HNGOs and donor participants alike pointed out that, besides the challenge of limited skills in setting up and managing BDA systems, there was also a general lack of analytical skills within HSC teams, and high turnover rates of qualified IT staff, particularly in the non-profit sector.

Lack of IT skills and knowledge - recap of key Literature

A severe lack of IT skills and knowledge of digital technologies is often cited as one of the main reasons why BDA is not widely used and adopted in HSC. Scholars such as Bag et al. (2020), Karuppiah et al. (2021) and Zanon et al. (2021) emphasize that the slow adoption of AI-powered BDA is due to insufficient knowledge of digital technology, compounded by a lack of advanced skills to address humanitarian challenges. Pizzi et al. (2020) who point out that it prevents the use of new technologies in humanitarian aid, also highlight this gap. Furthermore, Alharthi et al. (2017) and Kunz & Gold (2017) point to the lack of data analysts capable of processing large amounts of data to gain meaningful insights. To fix this problem, Akter et al. (2016) and Choi et al. (2018) say that people should be trained in data-related fields. However, Pizzi et al. (2020) say that it might be harder to match these skills with strategic goals in HSC environments that are not stable.

Literature, such as Bag et al. (2020) and Heaslip et al. (2019) also talks about how important education and training are. They say that current training programs are not keeping up with the fast changes in high-security technology, which means that there is a big gap between the skills of the workforce and the technology available.

Lack of IT skills and knowledge - comparison of key literature vs. findings

The literature, including the work of Bag et al. (2020), Karuppiah et al. (2021) and Zanon et al. (2021) emphasizes the slow adoption of AI-powered BDA due to a notable lack of IT expertise and knowledge of digital technologies. This view closely aligns with this research's findings, which also point to a significant gap in basic IT skills in humanitarian organisations.

The literature suggests that this skills gap is not just a technical deficit but also a lack of understanding of how technology can be used to address complex humanitarian problems. Pizzi et al. (2020) emphasize the difficulty of effectively using emerging technologies to improve humanitarian aid, which is also reflected in this research's findings. The shortage of data analysis professionals pointed out by Alharthi et al. (2017) and Kunz and Gold (2017) is also consistent with the findings from local and global HNGO participants presented in Chapter 5, who pointed out that there is a lack of qualified personnel capable of analysing large data sets to gain actionable insights withing the humanitarian sector.

The plea by Akter et al. (2016) and Choi et al. (2018) for the development of human resources with BDA skills is also echoed by findings from local and Global HNGO participants. This research's findings also highlight the urgent need for IT capacity building and knowledge transfer in the humanitarian sector. According to Pizzi et al. (2020) the difficulties in aligning these capabilities with strategic objectives in unstable HSC environments exacerbate this need and slow down the adoption of technology, as highlighted by the findings.

Lack of IT skills and knowledge - conclusion on theme

There were no differences noted by the researcher between the literature and the research findings on the role that the need to implement “Lack of IT skills and knowledge” plays as an inhibitor of BDA implementation and adoption. The research findings confirmed the discussions in extant literature. This therefore adds to the body of knowledge on the inhibiting role played by “lack of IT skills and knowledge” in the adoption of BDA in HSCs.

6.4.3 Theme 3 – Lack of funding & investment

Lack of funding and investment “as an inhibitor of BDA implementation and adoption in HSC leading to the lack of agile and resilient HSCs” was an existing theme presented in Chapter 2. A search of the literature review was sufficient when comparing the findings from this theme to the literature, and therefore no further steps we taken.

Lack of funding & investment - recap of key findings

In the findings presented in Chapter 5, participants from the four groups highlighted the problem of "lack of funding and investment" in the pursuit of BDA initiatives. The research looked at the success of technology-enabled initiatives.

Participants mentioned that challenges faced by HNGOs in maximizing the benefits of BDA in HSCs are exacerbated by the lack of funding and investment in technology. Some participants mentioned that donors specify that only a certain percentage of their donation should be used for operational expenses which plays a critical role in determining scale of IT projects that these agencies pursue in BDA. Participants highlighted the challenges of working with limited funds and emphasized the importance of basic resources such as internet access and affordable technology devices. Representatives from global HNGOs highlighted the complicated relationship between technology and funding, citing funding as a key barrier to effective technology adoption.

Local HNGO participants expressed difficulty in raising private or general funds for technological advances, citing difficulty in convincing stakeholders of the value of these investments. The significant initial investment required for certain technologies was an additional hurdle.
Participants from donor organisations stressed that donor support was not sustainable and that sustainable funding, particularly for recurrent expenditures such as licenses, maintenance, and training, was urgently needed, urging governments to also chip in with funding support. Participants underlined the vulnerability of organisations that rely on donor support, as it is volatile and new funding is constantly needed.

In summary, the findings highlight the significant impact of financial constraints on the implementation and effective use of BDAs in HSCs. The reports from the various participants repeatedly highlighted the complicated challenges associated with securing funding for technological advances in humanitarian operations.

Lack of funding & investment - recap of key Literature

In Chapter 2, a review of literature highlighted the pivotal role of financial resources in HSCs. Burkart et al. (2016) emphasised the importance of financing methods, while Besiou et al. (2011) and Kabra et al. (2023) highlighted the obstacle of limited financial resources. The literature also establishes a link between insufficient investment in technology and the slow adoption of BDA in disaster response centres, with studies by Balcik et al. (2010), Gupta and George (2016), Kovacs and Spens (2012), and Oloruntoba and Grey (2006) highlighting the complexity of prioritising technology funding amidst the urgency of disaster response. Empirical evidence from Kunz and Reiner (2012) underpins the link between financial constraints and slow technology adoption. The strategies proposed by Nurmala et al. (2017) are in line with Van Wassenhove (2006) who emphasises external funding and donations as solutions. In summary, the literature reviewed in Chapter 2 emphasises the need to address financial and investment challenges to realise the full BDA potential in HSCs.

Lack of funding & investment - comparison of key literature vs. findings

The literature reviewed in Chapter 2 emphasises the central role of funding and investment in the success of big data analytics initiatives in HSCs. Chapter 5 shows the results of interviews with four different groups of people: consultants in the HNGO sector; donor agencies; local HNGOs; and global HNGOs. These interviews gave this research useful information about the empirical challenges that come up when agencies try to implement BDA projects without enough finances and investment.

The literature indicates that limited financial resources are a significant barrier to technological advancement in the humanitarian sector (Kabra et al., 2023). This aligns with the findings, where participants from the different groups of organisations consistently highlighted financial constraints as a clear barrier to technological advancement in HSCs. Participants' statements underpinned the impact of financial constraints on the scope, scale, and success of technology-enabled initiatives highlighted in the literature.

Quotes from participants from the HNGO sector emphasized the difficulties of working with limited financial resources and the importance of access to basic resources such as the internet and affordable technical equipment. The literature, particularly the studies by Kovacs and Spens (2012) and Oloruntoba and Grey (2006) highlighted the complexity of prioritising funding for technological advances given the urgency of disaster response. This complexity was reflected in the findings where participants highlighted the challenges of securing funding, particularly for

smaller organisations that struggle to convince stakeholders of the value of technological investment.

The literature emphasises the link between underinvestment in technology and slow adoption of BDA in HSCs (Gupta & George, 2016; Van Wassenhove, 2006). The findings support this link, with participants emphasising the need for resources to address technological challenges. The importance of external funding and donations to facilitate technology adoption emphasised in the literature coincided with participants' concerns about the sustainability of donor support.
In summary, the comparison between the literature and the findings provides a consistent account of the inhibiting role of the lack of funding and investment in the adoption and effective use of BDA in high security centres. Both the literature and the findings highlight the complex challenges associated with securing funding for technological advances in humanitarian operations and emphasise the critical need for sustainable financing to fully realise the benefits of technological advances in the humanitarian sector.

Lack of funding & investment Conclusion on theme

There were no differences noted by the researcher between the literature and the research findings on the role that lack of funding & investment plays as an inhibitor of BDA implementation and adoption. The research findings confirmed the discussions in extant literature. This therefore adds to the body of knowledge on the inhibiting role played by “lack of funding & investment” in the adoption of BDA in HSCs.

6.4.4 Theme 4 - Cultural inertia

“Cultural Inertia” was a potential new theme arising from the findings in Chapter 5. Cultural inertia refers to the resistance within organisations to adopt new technologies or processes due to entrenched habits, mindsets, or organisational norms. This resistance can be a major barrier to embracing innovative practices such as BDA, which require not only technological adaptation but also a shift in organisational culture and mindset.

At this stage there was no evidence of the theme of cultural inertia being discussed in the literature that was reviewed in chapter 2. Therefore, the three-step process described in section 6.1 above was followed:

Step 1

The following selected articles for the word searches were already reviewed in Chapter 2

- Gupta & George (2016)
- Dubey et al. (2019)
- Alharthi et al. (2017)

The words used to sear the articles where:

- Resistance to change.
- Lack of data culture
- Cultural shift
- Resistance to technology

There were some matches with the word searches on the three selected articles. Therefore, the comparative analysis of the research findings to the extant literature is discussed in the next section.

Cultural inertia - recap of key findings

The main findings of this research indicate that cultural inertia manifests itself in various forms in HSCs. These include an unwillingness to deviate from traditional ways of working, scepticism towards new technologies, and a general reluctance to change established ways of working as pointed out by participants from all the groupings. The findings highlighted that this resistance was often due to a lack of understanding of the benefits of BDA, fear of the unknown, and comfort with familiar processes. The findings also pointed out that cultural inertia can significantly slow down the process of integrating BDA into existing systems and prevent the potential benefits that these technologies offer in terms of efficiency, agility, and data-driven decision-making.

Cultural inertia - recap of key literature

The literature on cultural inertia related to the adoption of BDA in HSCs highlights the critical role of organisational culture in the adoption of new technologies. Dubey et al. (2019) and Gupta and George (2016) emphasise that the speed of technology adoption is significantly influenced by a "big data" culture in organisations. They argue that a data-driven culture is essential for the effective application of BDA in HSC operations. This involves not only the implementation of technology, but also a fundamental shift in the mindset of employees.

Dubey et al. (2019) go on to state that an environment must be created where employees are motivated and willing to engage in the complex processes of BDA, which include data visualisation, advanced data analytics and data integration techniques. Creating such a culture is critical for HSC to realise the potential of BDA to improve agility and resilience. Alharthi et al. (2017) further adds to this perspective by noting that employee motivation is key to the transition to a data-driven culture. This means that employees must not only be tech-savvy, but also willing and enthusiastic to integrate BDA into their regular workflows. As a result, without a supportive and encouraging culture, even the most sophisticated data analytics tools cannot be utilised effectively.

Overall, then, the literature suggests that the presence or absence of a data-driven culture is a key factor in the success of BDA implementation in health authorities. This points to the need for further research into how cultural factors, particularly the willingness and readiness of staff to adopt data-driven approaches, impact on the ability of health authorities to become more agile and resilient using BDA. This research is important to understand the barriers to BDA adoption and ways to overcome them so that humanitarian organisations can take full advantage of big data technologies.

Cultural inertia - Comparison of key literature vs. findings

Dubey et al. (2019) and Gupta and George (2016) focus on the importance of a "big data" culture and its influence on the adoption of new technologies. They point out that a data-driven culture within HSCs is crucial for a conducive environment for the application of BDA. This is consistent with the findings of the interviews, in which participants from different sectors, including consultants and HNGOs, expressed challenges related to changing established practises and mindsets. These challenges are an expression of cultural inertia, where established organisations, especially those with long histories and traditional approaches, show resistance to new ways of working and the introduction of technology.

Alharthi et al. (2017) emphasises the need for employee motivation and a change in mindset to enable the effective application of BDA in HSCs. This perspective is reflected in the interview responses, where participants emphasised resistance to change, particularly in areas outside the supply chain, which see new systems as adding complexity rather than as an opportunity for improved agility. This resistance was found to be due to ingrained culture and traditional ways of working, indicating a significant gap between the recognition of the need for a data-driven culture and the practical implementation of such a culture in humanitarian organisations.

Overall, the findings from the literature and interviews concur that cultural inertia is a major barrier to the adoption of BDA in HSCs. Both sources recognise the need for cultural change towards new technologies and data-driven approaches. However, the interviews provide a more nuanced understanding of how this inertia manifests itself in practise, highlighting the challenges organisations face in moving from traditional, manual processes to innovative, data-centric operations. This comparison highlights the complexity of cultural change in the humanitarian sector and the need for targeted strategies to overcome resistance and promote a more adaptive and technology-friendly organisational culture.

Cultural inertia - conclusion on theme

There were no differences noted by the researcher between the literature and the research findings on the role that cultural inertia plays as an inhibitor of BDA implementation and adoption. The research findings confirmed the discussions in extant literature. This therefore adds to the body of knowledge on the inhibiting role played by “cultural inertia” in the adoption of BDA in HSCs.

6.4.5 Conclusion on RQ 3 – Comparison of key literature vs. findings

RQ3 investigated what inhibits the use of BDA and associated technology in HSC, which contributes to their lack of agility and resilience. Issues identified and discussed in this context include data privacy and security, a lack of IT skills and knowledge, a lack of funding and investment, and cultural inertia.

In terms of privacy and security, the literature and findings agreed that a balance needs to be struck between the benefits of BDA and the protection of personal privacy. The literature emphasized the importance of security measures and moral concerns, and the results confirm this. They showed that data governance laws can be difficult to understand and that a careful balance needs to be struck between the use of technology and the protection of privacy.

In terms of the lack of IT skills and knowledge, both the literature and the findings emphasised the significant gap in IT skills and knowledge of digital technologies in health authorities. The issues identified in the literature, such as the lack of sufficient knowledge and skills, were also echoed in the findings, where individuals from different groups emphasised the need for professional training and knowledge for BDA implementation to work well.

In terms of lack of funding and investment, the literature and findings consistently emphasised the inhibiting role of financial constraints in the successful implementation of BDA initiatives in HSCs. Both sources emphasised the difficulties in securing funding for technological advances, particularly the difficulties faced by smaller organisations in convincing stakeholders of the value of technological investment.

Finally, the potentially new theme of cultural inertia emerged from the findings, highlighting the resistance within organisations to adopting new technologies due to entrenched habits, mindsets, or organisational norms. The literature and findings concur on the importance of a data-driven culture for successful BDA implementation, emphasizing the need for organisational change and employee motivation.

In conclusion, this research found no differences between what was written in the literature and what was found in the research about what hinders BDA implementation in HSCs. Both sources highlighted the complex challenges associated with data protection, IT skills, funding, and cultural inertia. This consistency between the literature and the findings helped this research to get a better idea of what is holding HSCs back from adopting BDA, which can then be used to help them become more agile and resilient.

6.5 Conclusion

This chapter concludes by summarising the changes in the conceptual framework that emerged from the comparative analysis of the research findings with the literature and research in this chapter.

6.5.1 Revisions resulting from Chapter 6 comparative analysis.

The re-labelled themes will be presented as such in the amended conceptual framework presented in table 35 below:

Table 35: Summary of all selected themes, as amended post-comparison with findings.

RESEARCH QUESTION	THEORETICAL CONSTRUCT	INTERNAL/ EXTERNAL	THEMES (at start of Chapter 6)	OUTCOME
1. What is the effect of agility and resilience in HSCs' efficiency and effectiveness?	Outcomes	Internal	Flexibility	Existing theme retained
	Outcomes	Internal	Adaptability	Existing theme retained
	Outcomes	Internal	Effectiveness	Existing theme retained
	Outcomes	Internal	Standardised Processes	Potentially new theme retained as existing theme
	Outcomes	Internal	Improved monitoring & evaluation	Potentially new theme retained as existing theme
2. What are the enabling factors of BDA leading to the agility and resilience of HSCs?	Enabler	Internal	Integration with advanced technologies	Existing theme retained
	Enabler	Internal	Decision support systems	Existing theme retained
	Enabler	External	Complexity of humanitarian environments	New theme
	Enabler	External	Humanitarian mission to save lives	New theme
3. What are the inhibiting factors of BDAs leading to a lack of agility and resilience of HSCs?	Inhibitor	Internal	Data security and privacy	Existing theme retained
	Inhibitor	Internal	Lack of IT skills and knowledge	Existing theme retained
	Inhibitor	Internal	Cultural Inertia	Potentially new theme retained as existing theme
	Inhibitor	External	Lack of funding and investment	Potentially new theme retained as wxisting theme /classified as external inhibitor

6.5.2 Revised conceptual framework.

The conclusions drawn from the comparative analysis between the research findings and the literature reviewed are presented in the "Conceptual Framework" section below. The research led to the following results (Figure 7):

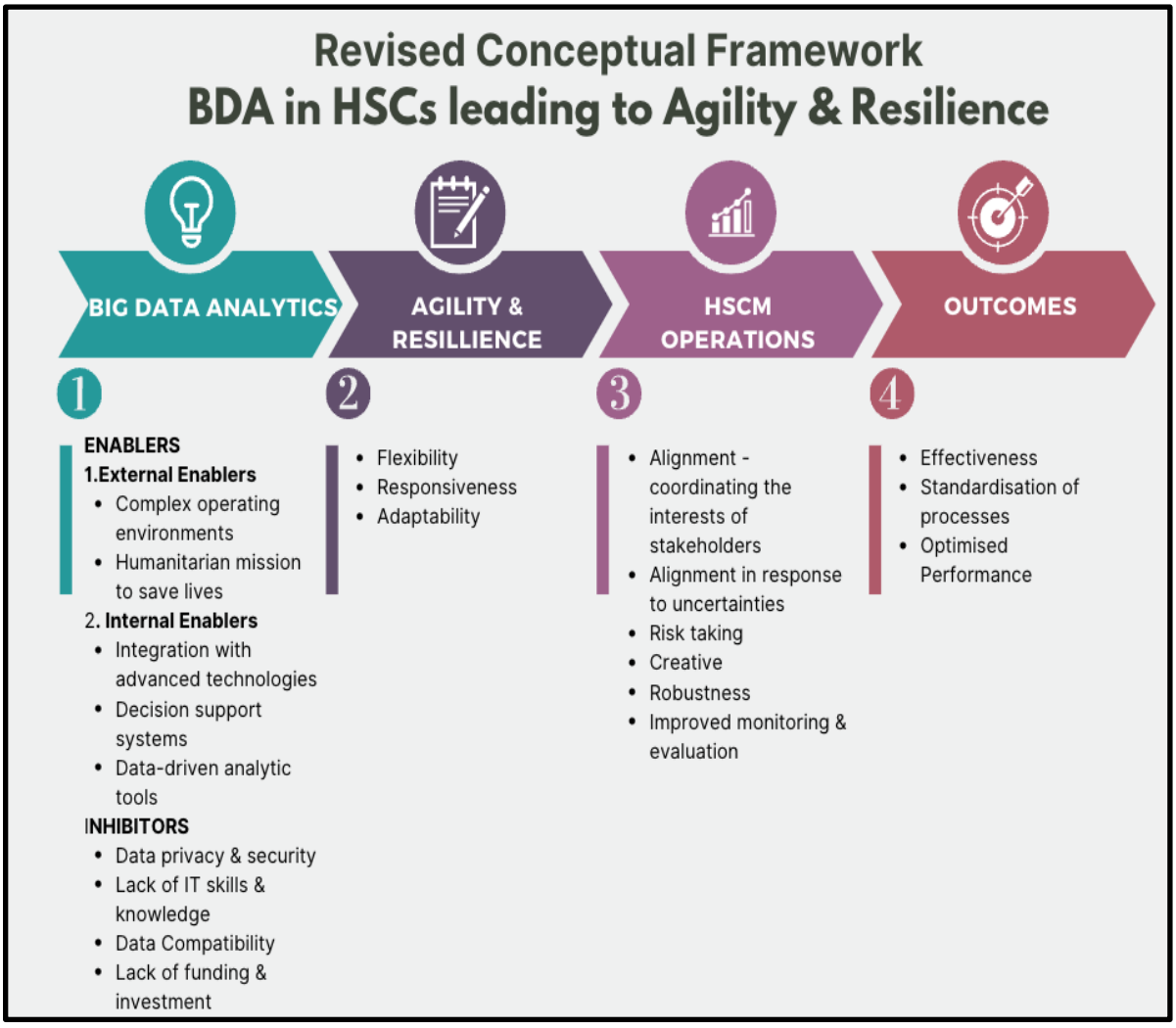

Figure 7: Revised conceptual framework (Source, Author)

CHAPTER SEVEN: CONCLUSION

7.1 Introduction

This chapter aims at presenting this study's outcomes as derived from findings analysed and discussed in the previous chapter. The study sought to explore the effect of agility and resilience of HSC in adopting BDAs, inhibiting factors of BDA adoption in HSC, and enabling aspects of BDA adoption in HSC. The participants were employees from local HNGOs, international HNGOs, consultants, and donors to capture the internal and external views about BDA adoption in HSCs. The study conclusion and recommendations show that the research questions were answered. The main aim of the research was to generate new understanding and insights about how agility and resilience are built in HSC using BDAs. Hence, the chapter is organised around each research question to reach theoretical conclusions. Vital findings are discussed within the extant literature. In addition, the research contributions, limitations of the study and suggestions for future research are presented.

7.2 Principal theoretical Conclusions

This section presents the conclusions of this study for each of the research questions. Similarities and differences were discussed in the last chapter. Differences are identified as five potential sub-themes, which are refinements to the existing literature and are highlighted in light orange in Table 38 below, namely:

- Visionary leadership
- Lack of trust in technology
- High employee turnover rates
- Complex donor funding structures
- Inadequate financial resource allocation

Table 36 - Conclusion of research, similarities and differences to literature

RESEARCH QUESTION	THEORETICAL CONSTRUCT	INTERNAL/EXTERNAL	THEMES	KEY RESEARCH CONCLUSIONS	
			Yollow = identified as a potentially new theme in Chapter 6	**Theme similar to literature**	**Nuanced difference to literature = Potential sub themes**
1. What is the effect of agility and resilience in HSCs' efficiency and effectiveness?	Outcomes	Internal	Flexibility	Existing theme retained	
	Outcomes	Internal	Adaptability	Existing theme retained	
	Outcomes	Internal	Effectiveness	Existing theme retained	
	Outcomes	Internal	Standardised Processes	Potentially new theme retained as existing theme	
	Outcomes	Internal	Improved monitoring & evaluation	Potentially new theme retained as existing theme	
2. What are the enabling factors of BDA leading to the agility and resilience of HSCs?	Enabler	Internal	Integration with advanced technologies	Existing theme retained	
	Enabler	Internal	Decision support systems	Existing theme retained	
	Enabler	External	Complexity of humanitarian environments	Potentially new theme retained as existing theme	
	Enabler	External	Humanitarian mission to save lives	Potentially new theme retained as exixting theme with nuanced difference - sub-theme	Visionary leadership
3. What are the inhibiting factors of BDAs leading to a lack of agility and resilience of HSCs?	Inhibitor	Internal	Data security & privacy	Similar - with nuanced difference - sub-theme	Lack of trust in technology
	Inhibitor	Internal	Lack of IT skills & knowledge	Similar - with nuanced difference - sub-theme	High employee turnover rates
	Inhibitor	Internal	Lack of funding & investment	Similar - with nuanced difference - sub-theme	Complex donor funding structures
					Inadequate financial resources allocation
	Inhibitor	Internal	Cultural Inertia	Potentially new theme retained as existing theme	

7.2.1 Conclusions on RQ1: Effect of agility and resilience in HSCs' efficiency and effectiveness

The purpose of RQ1 was to gain new insight and understanding about how flexibility and adaptability affect the overall efficiency and effectiveness of HSCs. Disasters and crises are unpredictable, unstable, and uncertain, forcing HNGOs to develop HSC systems that are adaptable, robust, and flexible (Dubey et al., 2019). Adaptive capacity in humanitarian context is not just about reactive change but also about harnessing the power of data to anticipate, prepare for and manage challenges to ensure that humanitarian aid is delivered efficiently and effectively, regardless of the obstacles.

Five main themes discussed in Chapter 6, relating to research question, are concluded in Chapter 7: flexibility, adaptability, effectiveness, standardised processes, and improved M&E.

Five of these themes from this study were all identified in the existing literature and found to be similar and consistent with the literature. Two of them had initially been identified as potential new themes, but however after Chapter 6, the researcher determined that there was existing research around these two areas of standardised processes and improved M&E as outcomes of BDA influenced agility and resilience in HSC.

Regarding flexibility, the research outcomes from Chapter 6 are like the literature. Flexibility was identified as a cornerstone of HSCs' ability to adapt to dynamic and unpredictable humanitarian environments. The findings reiterated the importance of flexibility (Dubey et al., 2020). They confirmed the existing literature that emphasises the need for agile supply chains, especially in the face of unforeseen challenges (Gligor et al., 2019). Findings were further supported by literature which argued that using different technologies together, especially BDA, is a key part of making HSCs more flexible and adaptable to new requirements and needs (Giannakis & Louis, 2016).

When exploring adaptability, Chapter 5 and the literature are similar in that they conclude that this quality plays a crucial role in managing disruption and proactively responding to new challenges. Participants recognised the need for organisations not only to reactively respond to change but also to harness the power of data for proactive anticipation (Dubey et al., 2019). In line with the literature (Ivanov & Dolgui, 2021; Jain et al., 2017) this study emphasises the multi-layered adaptability of HSCs fostered by agility and resilience. Even though adaptability makes sense in theory, the results show that it is hard to keep adapting because of practical issues and limited funds (Heaslip & Stuns, 2019; Kovacs & Spens, 2012).

In terms of effectiveness, the study confirms its central importance for crisis response and the provision of humanitarian aid. Both the results and the literature emphasise that effectiveness is measured not only by speed but also by the ability to recover pre-crisis efficiency levels (Dubey et al., 2019; Paciarotti et al., 2021). Agility and resilience are crucial constructs to ensure the effective functioning of the HSC (Gligor et al., 2019; Raj et al., 2023). Technology, especially BDA, is also a key factor in making HSC more efficient and effective at getting aid to people quickly and reliably (Gupta et al., 2019; Stewart & Ivanov, 2022).

Standardisation of processes was presented as a potential new theme in Chapter 6, demonstrating the transformative role of BDA in creating uniform strategies in HSCM. The findings were consistent with the literature highlighting the importance of standards in facilitating collaboration and harmonising processes in HSCs (Jahre & Fabbe-Costes, 2015; Paciarotti et al., 2021). BDA is also seen as a catalyst for developing standardised procedures, providing a common framework, and improving the overall resilience and flexibility of HSCs (Jahre & Fabbe-Costes, 2015; Raut et al., 2021) as confirmed by the findings.

In the broader context of humanitarian supply chains, the fifth theme identified, improved monitoring and evaluation, emerged as a critical aspect of ensuring humanitarian action's flexibility, resilience, and overall effectiveness. The findings emphasise the central role of flexible HSCs in improving monitoring and evaluation capabilities (Dubey et al., 2019). This aligns with existing literature emphasising the importance of effective M&E systems that enable real-time data collection and adaptive response strategies (Charles et al., 2016). Resilience is a key factor in strengthening M&E systems against disruption (Heaslip et al., 2019).

In conclusion, the complexities of HSCs, the five themes for RQ 1 provided a comprehensive exploration of the interplay between flexibility, adaptability, effectiveness, standardised processes, and improved M&E. As a pillar supporting efficient and effective humanitarian aid delivery, flexibility emerged as a cornerstone, acknowledging the need for agile responses to dynamic environments. Adaptability, essential for proactive change, resonated with the challenge of harnessing data's power to anticipate and manage unforeseen crises.

Effectiveness, measured beyond speed, incorporates resilience and technology, emphasising the crucial role of BDA. Standardised processes, initially a potential new theme, find validation in BDA's transformative impact on creating uniformity within HSCs. Finally, the criticality of improved M&E emerged as a pivotal element, supporting flexibility, resilience, and overall

efficacy of humanitarian actions. This holistic comprehension builds a consistent structure for handling HSC complexities, paving the way for future developments in humanitarian logistics and operations.

7.2.2 Conclusions on RQ2: Enabling factors of BDAs leading to the agility and resilience of HSCs.

Research question 2 aimed to gain insight and new understanding into the enablers of BDA adoption and implementation in HSCs. Gaining insights into the enablers of BDA implementation may assist agencies and stakeholders in developing and strengthening enablers, resulting in higher adoption.

The four main themes discussed in Chapter 6, relating to research question 2, are concluded in chapter 7: integration with advanced technology, decision support systems, complexity of the humanitarian environments, and humanitarian mission to save lives.

These four themes were all identified in the existing literature and found to be similar and consistent with the literature. However, for the humanitarian mission to save lives, one nuanced difference of ‘visionary leadership” was concluded as a potential sub-theme and was added as a refinement to the existing literature. The similarities are discussed first, and differences are concluded at the theme's end.

The theme of integration with advanced technologies demonstrated the unanimous recognition of the transformative power of technologies such as RFID, GPS, mobile technologies, blockchain and artificial intelligence. As described in the literature (Dubey et al., 2022; Raguseo, 2018; Sheng et al., 2019) these technologies play a central role in streamlining processes, improving decision-making, and increasing overall operational efficiency in health centres. The findings underline the consensus that advanced technologies are fundamental components for realising the full potential of BDA in humanitarian contexts.

The second theme analysed in Chapter 6 was decision support systems (DSS) as an enabler for BDA in HSCs. The findings were in line with what has already been written in literature by Dubey et al. (2022) and Raguseo (2018) on how DSS can be used in real life they help enable the use of BDA. The need for better decision-making and more flexible operations in humanitarian operations enables BDA, according to literature and findings, to emphasize the important role of DSS in improving the efficiency and effectiveness of humanitarian operations.

The theme of the complexity of the humanitarian environment was posited as an external enabler emphasised by the need by HSCs to cope with the complex challenges associated with

operations. This theme aligns with existing literature, Fosso Wamba et al. (2019) and Richey et al. (2022) emphasising the crucial role of BDA as a tool to manage the unpredictable and dynamic scenarios that often occur in humanitarian operations. The analysis of this theme emphasised the need for adaptable and innovative IT solutions that include BDA to manage the complex dynamics of humanitarian environments successfully.

The humanitarian life-saving mission theme as an external enabler of BDA adoption and implementation and adoption was analysed in Chapter 6. The discussion brought up critical ethical issues that need to be considered before BDA can be used in HSCs. The consistency between the findings and the literature Bag et al. (2022) and Bell et al. (2021) emphasises that while BDA improves efficiency, it must be deployed in a way compatible with the fundamental humanitarian principle of saving lives. Both the study and the literature argue for a balanced and ethically responsible approach to introducing technologies and emphasise the actual link to the overarching goal of humanitarian operations.

Regarding the nuances in humanitarian mission to save lives, although the central theme was consistent with literature, one new sub-theme was identified in this study as a potential difference, as no reference in the context of enablers of BDA in HSCs was found in the literature. This sub-theme from visionary leadership plays a critical role in driving technology adoption and facilitating digital development to improve these systems' flexibility and resilience. As Ateş et al. (2020) and Frennesson et al. (2021) emphasise, visionary leaders are critical to the leadership of preparedness initiatives and contribute to the speed, efficiency, and sustainability of humanitarian action. In addition, Park (2021) provides a real-life example of visionary leadership steering a company through the digital revolution and times of crisis, showing how a forward-thinking approach can contribute to global supply chain mobility and humanitarian efforts during the COVID-19 pandemic. These insights emphasise the critical role of visionary leadership in embracing technological advances and driving digital transformation for the resilience and effectiveness of humanitarian supply chains. Despite generalising the need for visionary leadership, this literature does not mainly focus on this theme being an enabler of BDA adoption in HSCs.

In conclusion, the analysis of these themes emphasises the interconnectedness of technological integration, decision support systems, environmental complexity and humanitarian mission. These things work together to make HSCs more flexible and more robust, and they help us see the many challenges and chances that new technologies bring to the humanitarian field.

7.2.3 Conclusions on RQ3: Inhibiting factors of BDAs leading to a lack of agility and resilience of HSC.

Research question 3 aimed to gain insight and a new understanding of the inhibitors of BDA adoption and implementation in HSCs, making them less effective and efficient due to lack of agility and resilience. Gaining these insights could help HNGOs understand the specific inhibitors that make BDA less useful. With this knowledge, HNGOs can strategically allocate resources, build capacity, and collaborate to overcome identified inhibitors, improving their ability to utilise BDA for more efficient and resilient humanitarian operations. In addition, the findings guide ethical considerations, risk management and advocacy for the responsible introduction of BDA in the humanitarian sector.

The four main themes discussed in Chapter 6, relating to Research Question 3, are concluded in Chapter 7: data security and privacy, lack of IT skills and knowledge, cultural inertia and lack of funding and investment.

These four themes were all identified in existing literature and found to be similar and consistent with the literature. However, nuanced differences were identified for all the themes, leading to the conclusion that potential sub-themes were added as refinements to existing literature. Table 38 below shows these sub-themes:

Table 37 - Sub-themes for RQ3.

RESEARCH QUESTION	THEORETICAL CONSTRUCT	INTERNAL/EXTERNAL	THEMES	KEY RESEARCH CONCLUSIONS	
			Yollow = identified as a potentially new theme in Chapter 6	Theme similar to literature	Nuanced difference to literature = Potential sub themes
3. What are the inhibiting factors of BDAs leading to a lack of agility and resilience of HSCs?	Inhibitor	Internal	Data security & privacy	Similar - with nuanced difference - sub-theme	Lack of trust in technology
	Inhibitor	Internal	Lack of IT skills & knowledge	Similar - with nuanced difference - sub-theme	High employee turnover rates
	Inhibitor	Internal	Lack of funding & investment	Similar - with nuanced difference - sub-theme	Complex donor funding structures
					Inadequate financial resources allocation
	Inhibitor	Internal	Cultural Inertia	Potentially new theme retained as existing theme	

The similarities are discussed first, and the differences are concluded at the end of the section.

HSCs face challenges in implementing BDA due to data privacy and security issues. A significant challenge is navigating a complex ecosystem and balancing BDA's many benefits with data protection. This multifaceted task involves collecting, storing, processing, and disseminating humanitarian data. Implementing strong protections while incorporating BDA into HSC operations is stressed throughout the literature and findings. The successful

implementation of BDA in humanitarian circumstances requires a resilient and secure data infrastructure, according to Bell et al. (2021), Gupta et al. (2019) and Salah (2021). In humanitarian supply chains, sensitive data on beneficiaries, donors, and operations is processed. Thus, protecting sensitive data is legal and ethical and essential to stakeholder trust. In this setting, ethics highlight transparency, accountability, and responsibility.

A sub-theme identified under this main theme was “Lack of trust in technology” and methods used for data collection as an inhibitor of BDA adoption and usage in HSCs. Findings from this research repeatedly emphasised the issue of trust mainly when organisations use biometric processes to collect beneficiary information or other methods such as AI. In an article by Beaumais (2023) the scholar investigated how trust worked with numbers in the humanitarian field and showed how concerns and doubts humanitarian workers have about the accuracy of numbers. Fast (2023) research on the use of data and ethics in HNGOs emphasises the centrality of trust in using data and technology for humanitarian purposes. This highlights the intricate relationship between data management, ethical considerations and establishing trust in the humanitarian landscape.

Both the literature and research findings recognise the IT skills gap as a widespread problem affecting the humanitarian sector's ability to realise the full potential of BDA. Bag et al. (2020), Karuppiah et al. (2021), and Zanon et al. (2021) contribute to this consensus by highlighting the impact of the skills gap on the adoption of BDA in HSCs. The research findings support these assertions and highlight organisations' practical challenges in training staff and promoting a comprehensive understanding of BDA tools.

The challenges associated with needing more IT skills and knowledge go beyond a mere lack of technical expertise. The literature and findings emphasised that the slow adoption of AI-powered BDA is not only due to insufficient knowledge of digital technology but is also influenced by a lack of understanding of how technology can address humanitarian challenges. This gap extends beyond the technical domain to the broader organisational context, where people need more analytical skills to derive meaningful insights from BDA.

To address this gap, the literature recommends training programmes that keep pace with the rapid changes in high-security technology (Bag et al., 2020; Heaslip et al., 2019). However, it remains to be challenging to align these capabilities with the strategic objectives of humanitarian organisations, especially in unstable environments (Pizzi et al., 2020).

The identified sub-theme of “high labour turnover” within HNGOs further complicates the landscape. The high staff turnover within humanitarian non-governmental organisations

(HNGOs) exacerbates this problem and forms a sub-theme that adds to the difficulties of maintaining a skilled and stable workforce. The turnover of IT staff, a recurring theme in the literature, is particularly pronounced in the non-profit sector and makes the sustainable introduction of BDA tools even more challenging (Pizzi et al., 2020).

As highlighted in the literature by Besiou et al. (2021) and Kabra et al. (2023) financial constraints are a significant obstacle to implementing BDA in HSCs. The findings from this research provided practical insights into the challenges organisations face and highlighted the need for sustainable funding for various aspects of technological initiatives.

This research identified and classified as a sub-theme the complex “donor funding structures” as a further challenge to implementing BDA in HSCs. Chandler (2001) exploration highlighted how human rights NGOs have played a pivotal role in shaping a new humanitarian agenda, potentially introducing intricacies and tensions in funding mechanisms. Gordon (2020) points to the challenges of navigating a “risk society,” where regulatory frameworks may further complicate funding processes. Kamstra and Schulpen (2015) emphasise how donor funding can homogenise NGOs, limiting their flexibility and adaptability in different contexts. Literature also points to the power dynamics involved in donor-NGO relationships, underscoring the influence of financial contributions on decision-making processes within HNGOs (Reith, 2010). Additionally, Rose et al. (2013) and Seybolt (2009) collectively reinforce the notion that the intricate web of donor funding can hinder the agility and responsiveness of humanitarian efforts in the face of complex and evolving challenges. However, this research noted that these articles did not focus on the influence of the “complex funding structures” on the implementation and adoption of BDA in HSCs.

The sub-theme of "non-allocation of financial resources" for technology initiatives is proving to be a significant barrier to adopting and implementing BDA in HSCs. Researchers have found that limited finances are often allocated for the development and integration of technology solutions, which hinders the full realisation of the potential benefits of BDA in supply chain management (Gordon, 2020; Kamstra & Schulpen, 2015). The need for more funding for technological advances, including data analytics tools and infrastructure, is a barrier to adopting innovative solutions that could improve the efficiency, transparency, and responsiveness of humanitarian supply chains (Reith, 2010; Rose et al., 2013). This sub-theme highlights the need for a strategic shift in resource allocation to ensure that financial support is directed towards the technological initiatives critical to unleashing BDA's transformative power in optimizing HSC operations. Addressing this challenge is essential to promoting a more resilient and adaptive approach to humanitarian logistics by effectively integrating cutting-edge technologies.

To summarise, financial constraints, including the complexity of donor funding and the allocation of financial resources, pose significant challenges to implementing BDA in humanitarian supply chains. The literature and findings consistently point to the urgent need for sustainable funding and strategic resource allocation to increase the effectiveness of BDA initiatives.

Cultural inertia, initially identified by this research as a potentially new theme emerging from the findings of Chapter 6, reflects resistance within organisations to adopting new technologies. The literature highlights the central role of organisational culture in adopting BDA (Dubey et al., 2019; Gupta & George, 2016) which is consistent with the practical challenges identified in the findings. The need for a data-driven culture and resistance to change underline the importance of organisational readiness.

In summary, the findings and literature in this section on RQ3 contribute to understanding barriers to BDA adoption in HSCs by combining theoretical discussions with practical insights. The challenges highlight the complexity of improving agility and resilience in HSCs by adopting BDA. These findings form the basis for future research and action in the dynamic landscape of humanitarian supply chains.

7.2.4 Amended Conceptual Framework.

The conceptual framework is the same one presented at the end of Chapter 6 but has been reworked for better communication of the research conclusions. All the sub-themes identified are shown in blue (in *Figure 8 on next page*):

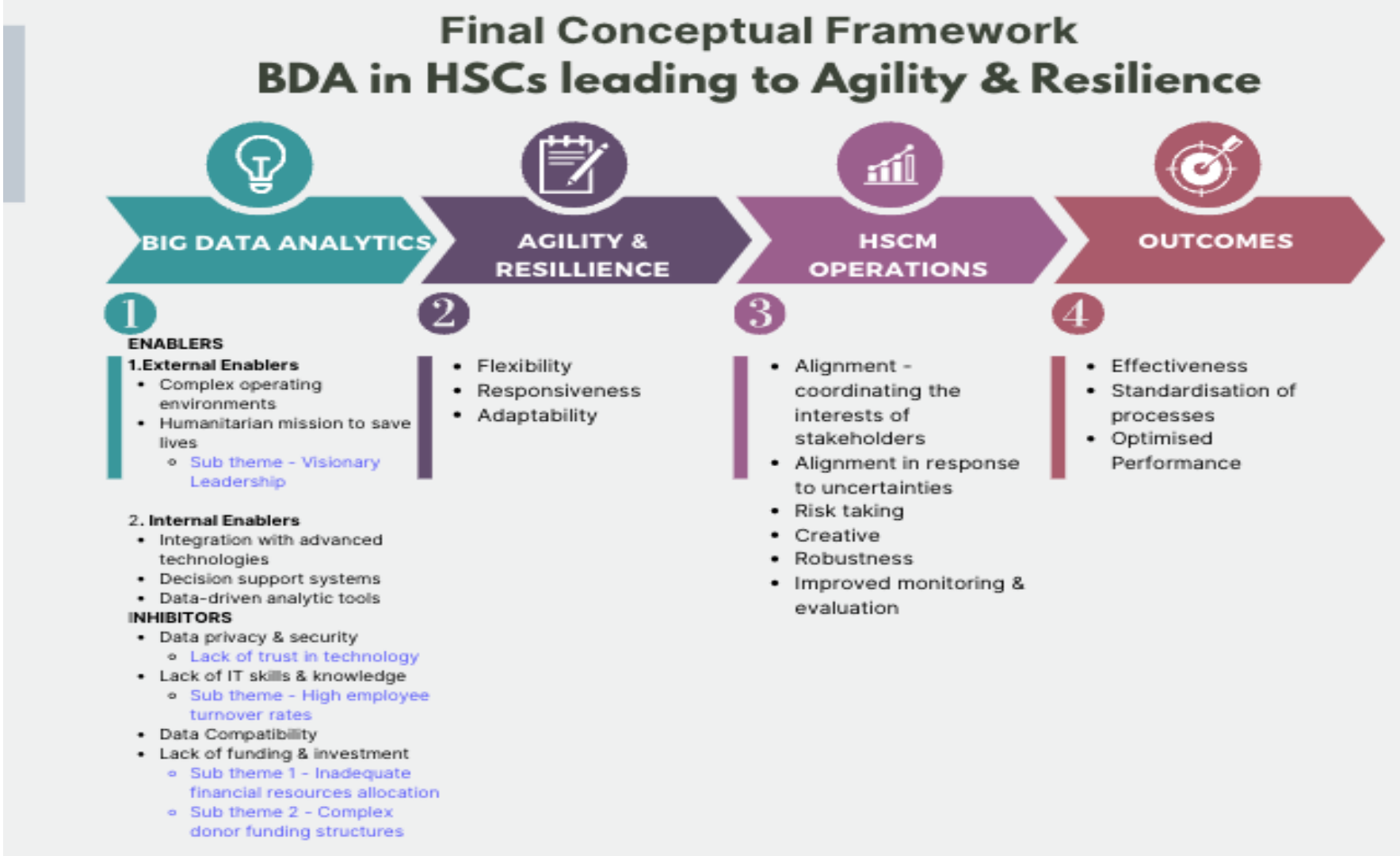

Figure 8 - Final conceptual framework

7.3 Research contribution

This research aimed to explore and gain new insights into the study of the influence of BDA on Agility and Resilience in Humanitarian Supply Chains. The intended contributions were to make a theoretical contribution related to HSCM literature. The research contributions are divided into three categories: additions to the body of knowledge, refinements to the body of knowledge and potential extensions to the body of knowledge.

7.3.1 Additions to the body of knowledge

This research significantly expands the existing body of knowledge in the field of HSCM by shedding light on the multi-layered impact of big BDA on key dimensions such as efficiency, effectiveness, agility, and resilience. This study brings forth a comprehensive understanding of how BDA, when integrated with information technologies, decision support systems and adequate funding, acts as a central force in improving agility and resilience within humanitarian supply chains. This paper offers scholars and practitioners a nuanced perspective on the transformative potential of BDA in addressing the complexity of humanitarian operations. By exploring the interplay between BDA geographical and organisational contexts, this study provides a solid foundation for future research on the evolving dynamics of HSCs.

7.3.2 Refinements to the body of knowledge

Based on the work done in this research, there is potential contribution to the body of knowledge in the following areas which are nuances of difference and are, therefore a possible refinement to the body of knowledge. The areas of potential improvement are illustrated in the table below as new sub-themes highlighted in orange.

Table 38 - Potential refinements to the body of knowledge

		KEY RESEARCH CONCLUSIONS	
THEORETICAL CONSTRUCT	**THEMES**	**Comment**	**Sub-theme**
Outcomes	Standardised Processes	Potentially new theme retained as existing theme with nuanced differences	
Outcomes	Improved monitoring & evaluation	Potentially new theme retained as existing theme with nuanced differences	
Enabler	Complexity of humanitarian environments	Potentially new theme retained as existing theme with nuanced differences	
Enabler	Humanitarian mission to save lives	Potentially new theme retained as existing theme with nuanced differences	Visionary leadership
Inhibitor	Cultural Inertia	Potentially new theme retained as existing theme with nuanced differences	

7.3.3 Potential extensions to the body of knowledge

The research lays the foundation for possible additions to the existing body of knowledge and identifies specific sub-themes that require further investigation.

Building on the study's recognition of data security and privacy challenges, potential extensions could address nuanced differences, such as the sub-theme of "lack of trust in technology". By looking into how trust in technological systems changes in humanitarian supply chains, we can better understand the doubts and worries that can get in the way of BDA integration going smoothly. In line with the emphasis on the lack of IT skills and competencies barrier, further research could focus on a nuanced difference, particularly the sub-theme of "high staff turnover". Understanding the impact of high turnover rates on the sustainable development and application of IT skills in humanitarian organisations would provide insights into the human resource challenges associated with BDA adoption.

The research highlights the critical role of funding and investment in realizing the benefits of BDA. To build on this theme, looking into subtle differences, like the "complex donor funding structures sub-theme," would help us better understand how the complicated financial systems that support humanitarian supply chains work. In addition, a deepening of the sub-topic "non-allocation of financial resources" could provide insights into the specific challenges related to resource allocation and shed light on the factors that hinder the full potential of BDA in humanitarian contexts.

These potential extensions provide a roadmap for future research endeavours and allow for a more detailed exploration of the challenges related to data security, IT capabilities, and financial aspects, enriching the theoretical landscape of BDA implementation in humanitarian supply chain management.

Table 39 - Potential extensions to the body of knowledge

		KEY RESEARCH CONCLUSIONS	
THEORETICAL CONSTRUCT	**THEMES**	**Comment**	**Sub-Themes**
Inhibitor	Data security & privacy	Similar - with nuanced difference - sub-theme	Lack of trust in technology
Inhibitor	Lack of IT skills & knowledge	Similar - with nuanced difference - sub-theme	High labour turnover
Inhibitor	Lack of funding & investment	Similar - with nuanced difference - sub-theme	Complex donor funding structures
			Non-allocation of financial resources

7.4 Recommendations for management and other stakeholders

The recommendations for management and other stakeholders are organised by each research construct. They are drawn from the theoretical conclusions, particularly where differences were identified between research outcomes and the current literature. The recommendations are directed at HNGO leaders, donors, consultants working with HNGOs and other stakeholders/interested parties.

7.4.1 Focus on the allocation of financial resources to technological integration.

Recognising the critical role of funding in realising the potential benefits of BDA and related technologies, this recommendation highlights the need for a targeted and well-structured allocation of financial resources. By prioritising investment in information technologies, decision support systems and IT skills development, humanitarian organisations can overcome challenges such as data security, privacy, and skills shortages. This targeted approach aims to optimise BDA integration and ensure a robust decision support system that improves humanitarian supply chains' flexibility, resilience, and overall efficiency. Through a targeted allocation of finances, organisations can overcome inhibiting factors and unlock the transformative potential of technology to advance humanitarian efforts.

7.4.2 Prioritising education and training

A key recommendation is to prioritise training and education initiatives to improve the successful integration and use of BDA in HSCs. Given the inhibiting factors identified in the study related to a lack of IT skills and competencies, prioritising training programmes is imperative. Humanitarian organisations should invest in comprehensive training for their staff to build and strengthen their knowledge of BDA technologies, artificial intelligence, and other relevant tools. This proactive approach will not only close current skill gaps but also create a foundation for continuous learning and adaptation to new technologies. By developing a workforce with the necessary skills and knowledge, organisations can overcome barriers, ensure the effective implementation of BDA and maximise their potential to improve agility, resilience and overall efficiency in humanitarian supply chains.

7.4.3 Refine labour retention policies.

To support the integration of BDA into HSCs, a crucial step is to refine employee retention measures. With high turnover rates impacting IT skills and competencies within the sector, organisations should strategically rethink and improve their retention strategies. This may include introducing incentives, professional development opportunities and career development programmes tailored to individuals working in technology-related roles. By refining retention measures, humanitarian organisations can attract a stable and skilled workforce, mitigating the negative impact of high turnover on BDA implementation. This recommendation aims to create an environment that encourages staff to remain engaged, continuously contribute their expertise and promote the sustainable development of IT skills essential for the successful deployment of BDA in humanitarian supply chains.

7.4.4 Collaborative funding structures

To optimise the integration of BDA into HSCs, an important recommendation is to promote cooperation between donors and HNGOs in funding structures. Given the complexity of donor funding identified in the study, this recommendation emphasises the need for concerted efforts between donors and HNGOs to streamline funding mechanisms. By co-designing funding structures, donors and HNGOs can more effectively address challenges related to financial constraints. This strategic collaboration ensures synchronised allocation of financial resources for BDA implementation and increases the potential for transformative impact on the agility, resilience, and overall efficiency of humanitarian supply chains.

7.4.5 Enhance trust in technology - Transparency and engagement.

To combat the "lack of trust in technology" that stems from concerns about data security, a key recommendation is to implement strategies that strengthen trust through transparency and engagement. Humanitarian organisations should prioritise open communication about data security measures so that stakeholders know exactly how their data is being protected. Establishing transparent practises and protocols promotes trust in the use of technology. In addition, actively engaging stakeholders, including aid recipients, donors and field staff, through education and awareness-raising programmes can demystify technological processes and build trust. By proactively addressing concerns, clarifying safeguards, and involving stakeholders in the decision-making process, organisations can alleviate concerns around technology, paving the way for a more trusting and widespread adoption of BDA in HSCs.

7.4.6 Promoting visionary leadership for BDA integration

To drive the successful integration of BDA) into HSCs, a key recommendation is to cultivate visionary leadership in HNGOs. Visionary leaders should guide the strategic integration of BDA by recognising its transformative potential and championing its implementation. These leaders can create a compelling vision for the organisation's technological future and align BDA initiatives with humanitarian objectives. By fostering a culture of innovation and adaptability, visionary leaders can inspire teams to embrace change, overcome resistance and actively contribute to the effective deployment of BDA. Finally, leaders should invest in their understanding of BDA technologies to make informed decisions. This recommendation emphasises the critical role of leaders in managing the complexity of BDA integration and promoting a forward-looking approach in HSCs.

7.5 Limitations of the research

This section discusses the limitations of this research. The limitations of the research design and methods were discussed in Chapter 4 (refer to section 4.21).

- This research explored the influence of BDA on agility and resilience in HSC that results in their effectiveness and efficiency. This study focused on four unique groupings: local HNGO, global HNGO, consultants in HSCs and donor organisations. The limitation was that the study's outcomes related to those specific agency groupings only.

- This study identified five potential new sub-themes of visionary leadership, lack of trust in technology, high labour turnover, complex donor funding structures, and non-

allocation of financial resources. The limitation is that this study needed to explore these themes in further detail.

7.6 Suggestions for future studies

Three areas of future research were identified.

- This study focussed on only four groupings: local HNGO, global HNGO, consultants in HNGO space and donor agencies. Further research could be extended to other groups, such as government agencies, technology solution providers, academic institutions, and end-user beneficiary groups, to better understand BDA integration in different humanitarian contexts.

- Explore the impact of BDA on agility and resilience in HSCs from the perspective of end-user beneficiary groups. Investigate how BDA implementation affects aid delivery, responsiveness, and the overall satisfaction of the individuals and communities receiving humanitarian assistance.

- Explore the impact of BDA on agility and resilience in HSCs from the perspective of end-user beneficiary groups. Investigate how BDA implementation affects aid delivery, responsiveness, and the overall satisfaction of the individuals and communities receiving humanitarian assistance.

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APPENDICES

APPENDIX 1 - CONSISTENCY MATRIX

Table 40: Consistency Matrix

RESEARCH QUESTIONS	LITERATURE	DATA COLLECTION	ANALYSIS TECHNIQUE
What is the effect of agility and resilience in HSCs' effectiveness and efficiency?	Altay et al., 2018; Bier et al., 2019; Gunasekaran et al., 2019; Pavlov et al., 2019; Yakub, 2023	Online semi-structured interviews with HNGO supply chain senior personnel.	Thematic analysis on transcribed scripts
What are the enabling factors in BDAs leading to agility and resilience of HSCs?	Akter et al., 2021; Duan et al., 2019; Dubey et al., 2020; Fosso Wamba et al., 2017; Kankanamge et al., 2021; Richey et al., 2021; Talwar et al., 2021	Online semi-structured interviews with HNGO supply chain senior personnel	Thematic analysis on transcribed scripts
What are the inhibiting factors of BDAs leading to a lack of agility and resilience of HSCs?	Altay et al., 2018; Dubey et al., 2019a, b; Gupta and George, 2016; Gupta and Gupta, 2019; Hristidis et al., 2010; ISACA, 2014; Pizzi et al., 2020; Sharma et al., 2018; Zanon et al., 2021	Online semi-structured interviews with HNGO supply chain senior personnel industry documents	Thematic analysis on transcribed scripts

APPENDIX 2 – ETHICAL CLEARANCE

GIBS ETHICAL CLEARANCE APPLICATION FORM 2023/24

G. APPROVALS FOR/OF THIS APPLICATION

When the applicant is a student of GIBS, the applicant must please ensure that the supervisor and co-supervisor (where relevant) has signed the form before submission

STUDENT RESEARCHER/APPLICANT:

29. I affirm that all relevant information has been provided in this form and its attachments and that all statements made are correct.

Student Researcher's Name in capital letters:	[redacted]
Date:	23 Jun 2023
Supervisor Name in capital letters:	JILL BOGIE
Date:	23 Jun 2023
Co-supervisor Name in capital letters:	
Date:	23 Jun 2023

Note: GIBS shall do everything in its power to protect the personal information supplied herein, in accordance to its company privacy policies as well the Protection of Personal Information Act, 2013. Access to all of the above provided personal information is restricted, only employees who need the information to perform a specific job are granted access to this information.

Decision:

Approved

REC comments:

Thank you for your ethics application. Good luck with your research.

APPENDIX 3: RESEARCH TIMELINES

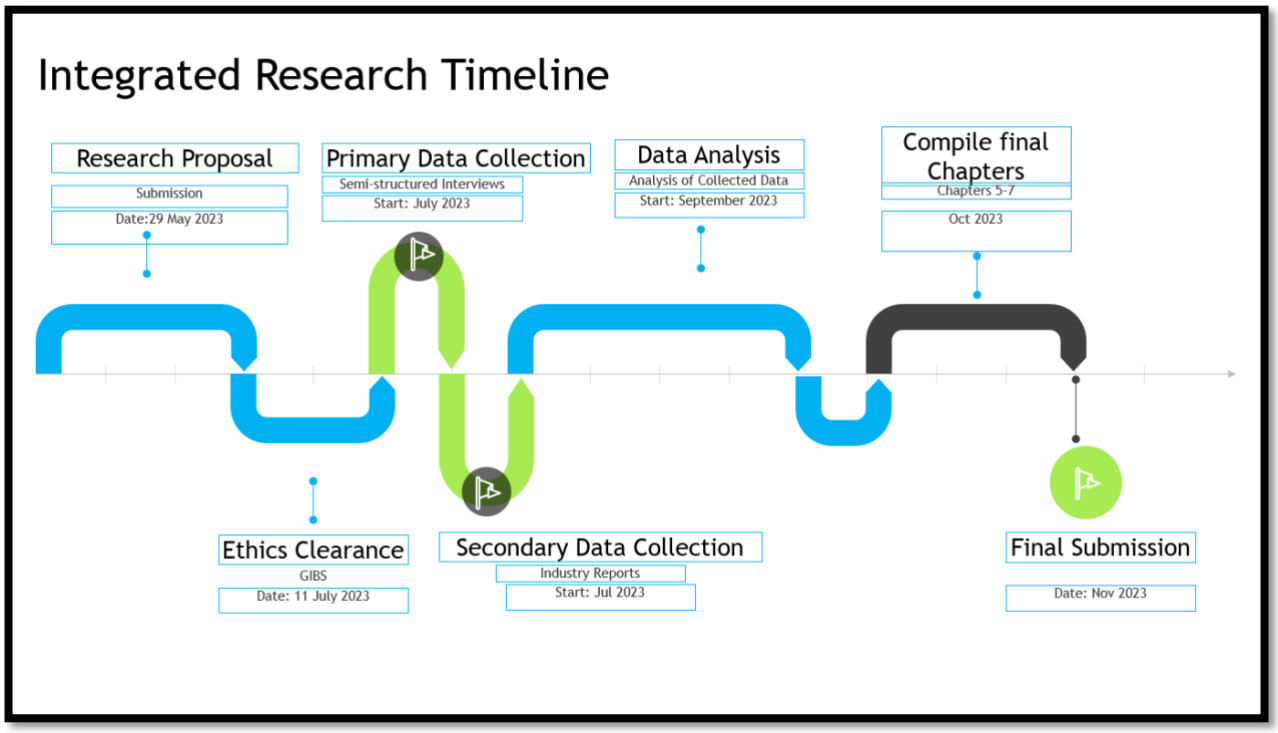

Figure 9: Integrated research project timeline

APPENDIX 4 - INTERVIEW PROTOCOL

1. **Please could you tell me about your work experience in Humanitarian Supply Chains?**
    - *This question will help establish the interviewee's background and expertise in the field of humanitarian supply chains, providing context for their responses.*
2. **In your experience, what are the key factors in in HSCs being effective and efficient?**
    - *This question explores the interviewee's insights into the critical factors that contribute to effectiveness and efficiency within humanitarian supply chains, setting the foundation for discussing the influence of BDA on these aspects.*
3. **In your experience, in what way does emerging technology used to enhance efficiency and effectiveness is in HSCs?**
    - *This question seeks to understand the interviewee's perspective on the role of emerging technologies in improving efficiency and effectiveness within humanitarian supply chains, including their potential impact on agility and resilience.*
4. **I wonder if you could tell me what the terms agility and resilience mean to you in the context of a humanitarian supply chain?**
    - *This question aims to elicit the interviewee's understanding and definition of agility and resilience within the specific context of humanitarian supply chains, providing a basis for further discussion on their relation to BDA.*
5. **In your experience, what are the challenges in utilising technology?**
    - *This question explores the interviewee's insights into the challenges and barriers associated with the adoption and utilization of technology within humanitarian supply chains, setting the stage for discussing potential obstacles related to BDA.*
6. **In your opinion please how do you overcome those challenges?**
    - *This question seeks the interviewee's perspective on strategies or approaches to address the challenges identified in the previous question, providing insights into potential solutions or best practices.*
7. **Please let me know what you and your organisation have achieved to date in using technology for BDA in your HSC?**
    - *This question aims to gather information about the interviewee's specific context and organisations' achievements or experiences related to utilizing technology, including BDA, within their HSC operations*.
8. **What do you see as the way forward to utilise emerging technology in HSCs?**
    - *This question invites the interviewee's thoughts and recommendations on the*

future direction of utilizing emerging technologies, including BDA, within humanitarian supply chains, providing insights into potential opportunities and strategies.

2 ADDITIONAL QUESTIONS TO BE USED AS AND WHEN IT IS NECESSARY:

a. **Probing questions** - be used as and when it is necessary.
   i. *Could you provide more specific information about [specific aspect]?*
   ii. *Could you please tell me more about that? – this will be kept neutral.*
   iii. *Could you elaborate on how [specific process] works?*
   iv. *Can you provide an example to illustrate your point?*
   v. *What evidence or data supports your assertion?*
b. **Clarifying questions** – to be used rarely unless if necessary.
   i. *Explain unfamiliar acronyms.*
   ii. *Resolving ambiguities.*
   iii. *Checking assumption*

Gordon Institute of Business Science
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APPENDIX 5 – INFORMED CONSENT FORM

Informed consent for interviews

Note: *This standard informed consent letter to be used in qualitative interviews, must be separate from interview guide, must be signed before the interview commences. The signed form must be stored separately from the data collected*

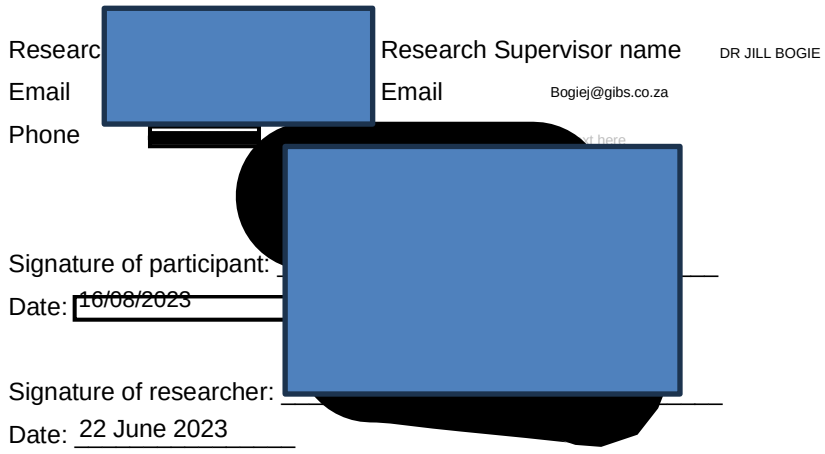
I am conducting research on the topic "Towards an understanding of the influence of Big Data Analytics (BDA) on the Agility and Resilience in Humanitarian Supply Chains'. Our interview is expected to last 55 minutes, and will help us understand

- What is the effect of agility and resilience in HSC's effectiveness and efficiency?
- What are the enabling factors in BDAs leading to agility and resilience of an HSC?
- What are the inhibiting factors of BDAs leading to a lack of agility and resilience of an HSC?

Your participation is voluntary and you can withdraw at any time without penalty. By signing this letter, you are indicating that you have given permission for:

- The interview to be recorded;
- The recording to be transcribed by a third-party transcriber, who will be subject to a standard non-disclosure agreement;
- Verbatim quotations from the interview may be used in the report, provided they are not identified with your name or that of your organisation;
- The data to be used as part of a report that will be publicly available once the examination process has been completed; and
- All data to be reported and stored without identifiers.

If you have any concerns, please contact my supervisor or me. Our details are provided below.



Researc
Email
Phone

Research Supervisor name DR JILL BOGIE
Email Bogiej@gibs.co.za

Signature of participant:
Date: 16/08/2023

Signature of researcher:
Date: 22 June 2023

APPENDIX 6: CODES

1st Order Categories	Concepts
Funding Challenges	Funding & Investment
Government & Community support	Collaborative Platforms
Coordination between stakeholders	Stakeholder Engagement
Training, knowledge transfer & Learning - Knowledge management	Training & Capacity Building
Complex Operating environments	Complexity of Humanitarian Environments
Transparency & Visibility - data & product	Real-time Information Sharing
Data Storage & Processing	Data Quality & Accessibility
Data-driven decision making	Decentralized Decision-making
Systems Performance & Evaluation	Optimised perfomance
Technology Sustainability	Sustainable technologies
Collaboration between stakeholders	Alignment in coordinating the interests of stakeholders
Limited Donor Funding	Funding & Investment
Cultural inertia hindering acceptance of change	Cultural and Social Acceptance
Trust between stakeholders	Alignment in coordinating the interests of stakeholders
Funding & Resource scarcity	Funding & Investment
Operational context variability	Complexity of Humanitarian Environments
Risk Management	Risk Taking
Data Quality management	Lack of Data Quality and Integrity
Political influences	Regulatory and Legal Constraints
Trust between agencies and government	Collaborative Platforms
Beneficiary-centric solutions	Adaptive Capacity
Infrastructure for Technology	Technological Infrastructure
Prioritization of projects	Flexibility in Operations
Longevity of project timelines	Adaptive Capacity
Technology use as an enabler	Analytics Tools & Software
Partnerships with governments & local authorities	Collaborative Platforms
Better data collection	Real-time Data Collection Challenges
Data Security & Governance	Data Security and Privacy Concerns
Systems & Data Integration	Standardized Protocols
Ability to speed operations	Quick Response Time
Donor advocacy	Funding & Investment
Process Improvement & Focus	Continuous Monitoring & Feedback
Standard Operating Procesess	Standardized Protocols
Building trust -between stakeholders	Collaborative Platforms
Need for Investment in Technology	Funding & Investment
Change Management need	Cultural and Social Acceptance

Lack of trust in technology	**Relevance**
Unattractive work environment	**Inadequate Skilled Personnel**
Skills gap	**Inadequate Skilled Personnel**
Humanitarian mission - save lives	**Stakeholder Engagement**
HSC Continuum	**Training & Capacity Building**
Performance measurement & improvement	**Optimised perfomance**
Analytics & Reporting	**Real-time Information Sharing**
Inclusivity of stakeholers (communities, governments, implementing agencies)	**Inclusivity**
Leadership support & Vision	**Visionary Leadership**
Long term perspective	**Visionary Leadership**
Visionary leadership	**Visionary Leadership**
Efficient & Optimized performance	**Efficient operations**
Information Sharing	**Real-time Information Sharing**
Cost of Technology challenge	**Cost Implications**
Access to Technology	**Analytics Tools & Software**
Robust strategies and processes	**Robustness**
Cost Management	**Cost Implications**
Ethical and Transparent Operations	**Data Security Measures**
Adaptability	**Flexibility in Operations**
Innovative approach	**Training & Capacity Building**
Communication and collaboration between stakeholders	**Stakeholder Engagement**
Compliance to Donor requirenments	**Stakeholder Engagement**
Implementation Cost Challenge	**Cost Implications**
Responsiveness	**Quick Response Time**
Standardization of systems & processs	**Standardized Protocols**
Community acceptance and support	**Alignment in coordinating the interests of stakeholders**
Resource Allocation focus	**Lack of Standardization**
Preparedness	**Quick Response Time**
Acceptance of Change	**Cultural and Organizational Barriers**
Private-Public Sector Collaboration	**Collaborative Platforms**
Regulation of technologies	**Regulatory and Legal Constraints**
Real-time data collection	**Real-time Data Collection Challenges**
Intra-organisation coordination	**Inter-agency Coordination**
Process, people & technology focus	**Standardized Protocols**
Relationship Management between stakeholders	**Collaborative Platforms**