Master's Thesis

Ms.C. in Innovation and Industrial Management

Artificial Intelligence in Sustainable Sourcing

An explorative study on Artificial Intelligence inside Sustainable Sourcing

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Abstract

This exploratory qualitative study aims to investigate how the technology "Artificial Intelligence" can aid a large multinational conglomerate company, IKEA, in solving some of their sustainable sourcing challenges. By mapping the challenges and investigating the opportunities for applying AI as a solution, and by highlighting the factors needed for successful adoption, this study concludes that AI can assist, to a certain degree, in solving some sustainable sourcing challenges. Moreover, there are some preconditions companies should meet and limitations of AI that they have to address before AI can be applied in the sustainable sourcing field. Finally, the findings of this study provide some managerial implications and recommendations for companies who aspire to source sustainably through technological innovations like Artificial Intelligence.

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1. Introduction

1.1. Background

In the last decades, there has been an increased interest amongst businesses and general society to develop more sustainable practices. Inside the business sector, the existing body of research on drivers for sustainable practices suggests that both internal factors, like reputation, organisational culture, and competitive advantage, but also external drivers, such as regulation, societal values and norms, and stakeholder pressure, are reasons behind firms' integration of sustainability into their business practice (Jerónimo Silvestre et al., 2018). Consequently, many firms are developing sustainable practices to show responsibility, making this the new standard practice of doing business (Brown et al., 2017; Quintos, 2020).

One activity profoundly impacted by integrating sustainability into businesses is supply chain management, more specifically sustainable sourcing (Brown et al., 2017). A universally accepted definition of sustainable sourcing has proved elusive; nonetheless, it can be understood as the coordination of supply chains towards economic, environmental, and social sustainability (Pagell et al., 2010; Ahi & Searcy, 2013; Van Den Brink et al., 2019). The concept of sustainable sourcing has received more attention due to firms' realisation of the environmental, societal, and economic impacts they generate, not through their direct operations but rather spread throughout their entire supply chains; consequently, businesses have realised that sustainable sourcing is an integral part of becoming sustainable (Sanders et al., 2019; Giunipero et al., 2019). Despite the increased attention that sustainable sourcing received, evidence suggests that companies are still struggling to source sustainably, with many still unresolved challenges. As illustrated by a recent case, global media uncovered how well-known companies with advanced sustainable sourcing schemes were sourcing material from suppliers, active in a region with widespread human rights abuse (UN News, 2021), confirming the presence of firms' unresolved sustainable sourcing challenges.

As firms are searching for solutions to sustainability-related challenges, artificial intelligence, hereafter referred to as AI, has received increased attention as a means for solving them (Vinuesa et al., 2020). Numerous definitions are used to frame AI. Most of them include capabilities that were previously exclusive to humans, like perception, decision-making, prediction, automatic knowledge extraction and pattern recognition, interactive communication, and logical reasoning (Vinuesa et al., 2020). In addition, studies have shown that AI can assist with achieving sustainable development goals (Vinuesa et al., 2020), promote environmental governance, and assist firms' sustainability transition (Nishant et al., 2020). However, while there are numerous documented cases of how AI could promote, improve and enable sustainability in private companies, governments and other organisations, the usage of AI has generated considerable amounts of debate in academia, as some researchers question whether the benefits that AI can create, can be attained in a sustainable manner (Larsson et al., 2019). Moreover, there are also other factors that companies must consider for the successful adoption of AI into an organisation (Cubric, 2020). Thus, when adopting AI for sustainable sourcing, companies must also evaluate these different factors to ensure successful and sustainable technology adoption.

1.2. Problem discussion

As the background indicates, AI has a potential role in the transition toward sustainable business practices; however, what is less clear is AI's feasibility in sustainable sourcing. This indicates an uncertainty linked to how, when and if AI should be adopted within this field, a belief confirmed by previous research (Vinuesa et al., 2020). According to research (Giunipero et al., 2019; Larsson et al., 2019), multidisciplinary studies on how technologies, like AI, can potentially impact sustainable sourcing, and the consequences, are needed. Furthermore, as discussed in the background, before adopting AI, there are several factors that must be understood. These different adoption factors have somewhat been explored in previous literature, but not in the context of sustainable sourcing.

Based on the information above, a clear knowledge gap exists of AI's capacity to aid companies in solving challenges inside the field of sustainable sourcing. Furthermore, as the hype around AI and its capacities increases (Panetta, 2021), more knowledge is needed to objectively assess AI's potential benefits, preconditions, and limitations, when deployed inside sustainable sourcing.

1.3. Purpose and Research Questions

The overarching purpose of this thesis is to explore AI's usefulness inside a specific field, namely inside sustainable sourcing. In other words, to what extent AI could aid a sizeable multinational conglomerate in solving challenges inside this field. By mapping the challenges and investigating the opportunities of applying AI inside the field, the ambition is to depict the benefits and limitations of AI as a solution to firms' challenges inside sustainable sourcing and identify potential preconditions that need to be considered for successful adoption.

To achieve the purpose of this study, two main research questions, and one sub-question, have been developed. Firstly, to explore AI's usefulness inside sustainable sourcing, the following research question was formulated:

> **RQ1:** How can AI aid a firm in solving challenges inside sustainable sourcing?

Secondly, to understand firms' sustainable sourcing challenges, the following question was devised:

> **RQ1.1:** What are the main challenges for a large multinational conglomerate for sourcing sustainably?

Finally, to grasp the potential limitations and preconditions of AI for sustainable sourcing, the following research question was developed:

> **RQ2:** What preconditions and limitations should a large multinational conglomerate consider before adopting AI for sustainable sourcing?

1.4. Case description

With respect to this, a single case study on a multinational conglomerate is carried out. The chosen company is IKEA, a global furniture retailer that aims to, and is to some extent already implementing, digital solutions for sustainable sourcing. Moreover, the company has set up a sustainability strategy - the People and Planet Positive strategy- that steer the company forward towards sustainable development of their business (IKEA, 2020). One of its significant areas within its sustainability strategy is its vision to source raw material sustainably. The company has categorised their raw materials into four different subgroups: forestry, agriculture, recycled, inorganics, and virgin fossil (IKEA, 2021). To achieve the sustainable sourcing targets by 2030, the company is interested in understanding how different technologies, like Artificial Intelligence (AI), can be adopted to drive this agenda forward. Moreover, the company wants to understand the potential preconditions and limitations of applying AI, to fully align a potential adoption of AI with IKEA's sustainability ambitions.

1.5. Delimitations

In this study, certain limitations were made to provide an in-depth understanding of the case being studied. One of these limitations is connected to definitions since there are many different definitions of sustainable sourcing and artificial intelligence. Moreover, these concepts are often used synonymously with other terms. Therefore, to avoid misinterpretations, we decided to provide the reader with more straightforward definitions that can be used throughout this study. Furthermore, this study is unable to encompass the entire range of IKEA's raw materials; therefore, we limited ourselves to cover one raw material category, which is forestry. However, early on, we became aware of the interrelatedness of forestry and other raw materials, especially agriculture. Therefore, we decided not to limit ourselves to solely forestry, but to also encompass agriculture, together collected under the umbrella term “organic raw materials''. Moreover, due to practical constraints, the reader should also understand that although this study's scope is sustainability, we have decided not to include any sustainable sourcing challenges or solutions that cover circularity.

1.6. Disposition

The disposition of this thesis is as following. We start off with a literature review of the thesis, where we are introducing the reader to the subject. After that, there is a chapter on the methodology, and then the empirical findings. Thereafter, the analysis and discussion are illustrated, and finally the conclusions.

Figure 1 Thesis disposition

2. Literature review

This chapter presents the theoretical concepts used throughout this study. Firstly, the concept of sustainable sourcing will be introduced, and after that, some sustainable sourcing challenges will be elaborated. We will then introduce the reader to the concept of Artificial Intelligence (AI), discuss some application areas and the preconditions and limitations of AI. Finally, the major theoretical findings will be summarised.

2.1. Sustainable sourcing

This chapter will give a brief overview and background on sourcing and sustainable sourcing. This will enable the reader to understand the challenges that will be presented afterwards in the results section.

2.1.1. Sourcing

In the past, a firm's competitive advantage primarily stemmed from internal capacities like intellectual property, knowledge, and expertise that were connected to core functions of the firm; sourcing was mainly seen as a supportive, non-core function inside a firm, primarily there to ensure materials used in the manufacturing process, were available (Chase & Jacobs, 2018). Today, as a consequence of increased globalisation and better communication, the gravity of a firms' competitive advantage has shifted away from its internal capabilities towards successful management of supplier networks with the goal of improved resource utilisation, sometimes going as far as outsourcing the firm's core functions, making supply chain management, including sourcing, increasingly complex, and a fundamental part of a firm's competitive advantage and the ability to endure (Chase & Jacobs, 2018)

Previously, there was no clear distinction between sourcing, procurement, and purchasing concepts, as they described a relatively simple process between a buyer and seller. Today, due to the increased importance and the consequent increase in research and knowledge expansion, they each try to occupy a specific place inside the supply chain management field (Chase & Jacobs, 2018). Due to the previous alternating usage, these concepts are still nonetheless diffuse. According to Chase and Jacobs (2018), purchasing was long seen as a synonym for sourcing, and today it mainly covers the function of acquiring the needed equipment, materials and services that a firm requires. When it also includes additional activities such as contract administration, specifications development and supplier quality control, it is instead called procurement (Wisner et al., 2019). In contrast to simple purchasing, strategic sourcing is the development and management of relationships with suppliers that enable firms to meet their needs and achieve their strategic objectives (Chase & Jacobs, 2018). While this distinction is rather precise, we need to acknowledge that in practice, these words are still often used synonymously (Wisner et al., 2019).

2.1.2. Sustainable Sourcing

In 2011, the United Nations (2011) put forward the "Guiding Principles on Business and Human Rights", which provided some guidelines on how companies could integrate social aspects into their organisation and their overall supply chains. Moreover, the global compact, introduced by the United Nations in 2005, also advocated companies to adopt sustainability goals and practices, where environmental, social, and governance are incorporated into companies' supply chains; the introduction of these guiding principles and goals pushed the sustainable sourcing area forward (van den Brink et al., 2019).

Agrawal & Lee (2019) claim that sustainable sourcing has become an essential topic on a company's agenda since if companies want to offer sustainable products, they must source the material(s) needed for sustainably producing such products.

With the problems surrounding the concept of sourcing in mind, merging it with sustainability does not produce more clarity, as the objectives and scope of sustainable sourcing at different firms vary. Similar expressions that describe identical concepts as sustainable sourcing, are often used inside the literature, whereby sustainable is sometimes exchanged for other words, including responsible, ethical, and green sourcing. Moreover, the term sourcing is also, in this case, used interchangeably with purchasing and procurement, leading to an ambiguity recognised by many (ICMM, 2015; van den Brink et al., 2019). Because of this ambiguity, there is no general definition recognised universally. However, as this definition and scope challenge has lately been noticed by academia, certain framings that delimit and frame the concept of sustainable sourcing (or responsible sourcing, or sustainable supply chain management, or ethical sourcing) started getting recognised. Among others, Pagell et al. (2010) describe sustainable sourcing as managing all activities occurring upstream of the supply chain to achieve economic, environmental, and social sustainability (also known as “triple bottom line”). Similarly, Reuter et al. (2010) frame the concept as integrating the triple bottom line into supply chain management objectives. An even more comprehensive definition, in line with the previously mentioned, is offered by Ahi & Searcy (2013), explaining it as a voluntary coordinated effort throughout the supply chain to improve triple bottom line performance, through the coordination of critical business systems and the management of resources associated with procurement, production, and distribution of products and services. In essence, and with the purpose of improved clarity of this thesis, we frame sustainable sourcing as the sum of all actions and efforts to improve the performance of environmental, social, and economic factors by coordinating the supply chains.

2.1.3. Sustainable sourcing challenges

Much of the available literature on sustainable sourcing deals with questions related to traceability, supply chain complexity and compliance. This section discusses these areas to get an insight into some of the sustainable sourcing challenges that many companies are facing today.

2.1.3.1 Supply Chain Complexity

A growing body of research studies the complex relationships between suppliers and buyers, the so-called multi-tier relationships, due to the ever-increasing complex relationships that companies today have with their suppliers (Gong et al., 2018). According to Carter & Easton (2011), supply chains have become increasingly complex. As Gurtu et al. (2017) argue, this supply chain complexity can be explained by the manufacturing and trading practices that have become more globalised. Moreover, companies' increased outsourcing and global sourcing strategies have resulted in supply chains becoming increasingly fragmented and complex (Mena et al., 2013). For example, Mejías et al. (2019) investigate multi-tier supply chains in the fashion industries and conclude that due to the low level of transparency, inherent to multi-tier relationships, firms struggle to evaluate, investigate and manage their suppliers. Moreover, as Wilhelm et al. (2016) highlight, because of these multi-tier relationships, firms often lack the opportunity to enforce policies on certain suppliers and lack direct contractual agreements with them.

To understand, evaluate, and improve the level of sustainability their products attain, firms must first know where their products are being produced, by tracing their products along the supply chains (Van den Brink et al. 2019). According to the authors, the importance of understanding how supply chains are organised, and how these different structures consequently impact companies' sustainability efforts, have been studied throughout the literature. Due to the globalisation and specialisation of firms, supply chains have become increasingly branched and complex, and consequently, a good overview of the suppliers is increasingly tricky and demands advanced traceability approaches (ibid.). Similarly, in a report by Leong et al. (2018), it is recognised that traceability is hampered by several factors stemming from the complexity of contemporary supply chains; amongst others, the unstandardised ways of labelling, manual input work, and a lack of digitised records. In cases where products were composed of blended materials, these challenges were even further exaggerated (Leong et al., 2018).

Due-diligence relationships often aid this traceability and compliance systems (Van den Brink et al., 2019). Due diligence is a responsible business practice wherein the buyer examines a product's relevant background information before purchasing it, while the selling party discloses all known information about it (Sprague & Valentine, 2016). If companies cannot trace suppliers, which sometimes is the case in some supply chains, firms cannot guarantee that their products were produced sustainably (Van den Brink et al., 2019), which can lead to misconduct and public outrage. As highlighted by Veit et al. (2018), this can consequently impact consumers' purchasing patterns and steer them away from that firm.

Another issue inside these complex supply chains is the amount of available data aggregated inside firms at the end of the supply chains; the massive amounts demand from employees to filter and send only data they deem essential, leading to human errors (Ebinger and Omondi, 2020). According to the authors, this sometimes leads to erroneous data-driven decisions that might not produce the intended results.

2.1.3.2 Assessing the impact

Another challenge recognised in academia, is the inability among firms to assess their sustainability impact. Governments and other stakeholders are pressuring businesses around the globe to improve their practices and mitigate the adverse effects they cause, increasingly highlighting the indirect sustainability impacts linked to supply chains (Houdet et al., 2012). These actors use different policy approaches that can target more local impacts, like mandatory Environmental Impact Assessments (EIA's), to legislation focused on non-local sustainability impacts caused by the focal firm's supply chain, like the EU timber regulation, that demands traceability of timber products (Pajares et al., 2020). However, Gurtu et al. (2017) identify a lack of an encompassing performance measurement system to evaluate and track firms' supply chains performance. The authors highlight, among other needs, that for a systematic change to occur, companies must decide upon standard definitions to ensure a sustainable supply chain. Moreover, the authors stress that due to the unwillingness among certain actors in the supply chain to share data, the unavailability of data, and the time needed to collect it, firms struggle to collect and analyse the data needed for making supply chains more sustainable (Gurtu et al., 2017), consequently affecting the ability to assess impact.

The transition toward improved sustainability, demands more holistic approaches that consider broader impact assessments, and includes upstream supply chain impacts; an aspect met by lifecycle assessments (Notarnicola et al., 2017). Life cycle assessments evaluate the impact that products and services have on the environment throughout their life, from raw material extraction, manufacture, distribution, usage to disposal or recycling, covering local and upstream impacts (Krishna & Manickam, 2017). However, even though these assessments consider a wide variety of impacts, they still often fail at capturing the full scope, amongst others, because of regional variations that different practices have (Notarnicola et al., 2017). Furthermore, according to the authors, when devising the scope of life cycle assessments, non-quantifiable aspects with vague definitions and scope, and aspects lacking data, tend to be omitted, inevitably losing certain aspects, like local biodiversity. In contrast, when local authorities evaluate the appropriateness of projects that firms want to engage in, like constructing a new facility, so-called Environmental Impact Assessments (EIA) are utilized to understand the potential environmental impacts that the projects have on the immediate surroundings (ibid.). However, EIA's try to include as many environmental aspects as possible, excluding off-site impacts (Ritter et al., 2017). Furthermore, a tendency exists only to evaluate easily measurable aspects, often omitting more complex ones, and when employed, the effect they have on the approval decisions is often marginal (ibid.), except in case of biodiversity protection (Roos et al., 2020). These challenges require holistic approaches to solve based on a wide range of metrics (Ritter et al., 2017). Therefore, to truly understand and improve the environmental impact, improved and more comprehensive methods are needed that consider a broader range of variables combined with regionalised datasets, demanding large amounts of localised data (Notarnicola et al., 2017). Furthermore, it is vital that cost-effective solutions that are quick and comprehensive at evaluating overlooked aspects, like biodiversity, are adopted to lessen the impact on the environment (Ritter et al., 2017).

2.2. Artificial Intelligence

The purpose of this chapter is to give a brief background on Artificial Intelligence, how it is applied today, the different benefits and limitations it presents, and preconditions that must be met before adopting it.

2.2.1. The development of AI

A large and growing body of literature has investigated Artificial Intelligence (AI). One of the pioneers in the academic field is Alan Turing, who in the 1950s developed a test, still used today, for distinguishing humans from an artificial intelligence system (Haenlein & Kaplan, 2019a). However, despite the extensive literature on AI, the definition of the concept is a contested topic inside academia and the broader public, as there is no clear-cut definition, and as a report shows, AI often means many things to different people (Accenture, 2020). Still, authors do try to define the concept. Russel and Norvig (2020) categorise AI into four broad categories, that is systems that act humanely, think humanly, act rationally and think rationally, and according to the authors, the research so far has been chiefly concentrated on AI's ability to act rationally, that is, to do the right thing. According to the authors, what the right thing is, depends on what the AI application was programmed to do. Others define it differently, and to illustrate the many definitions, Table 1 highlights some of the definitions of AI that have been discovered throughout the literature review.

Author(s)	Definition
Copeland (2020)	*"Artificial intelligence (AI) is the ability of a computer or a robot controlled by a computer to do tasks that are usually done by humans because they require human intelligence and discernment."*
Haenlein & Kaplan (2019b)	*"A system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation."*
Gungör (2020)	*"Artificial intelligence (AI) is an umbrella term for various methodologies that are designed to provide computers with human-like abilities of hearing, seeing, reasoning and learning."*
Oxford English Dictionary, (2021)	*"The capacity of computers or other machines to exhibit or simulate intelligent behaviour; the field of study concerned with this. Abbreviated AI."*
Vinuesa et al. (2020)	*"Although there is no internationally agreed definition of AI, for this study we considered AI as any software technology with at least one of the following capabilities: perception—including audio, visual, textual, and tactile (e.g., face recognition), decision-making (e.g., medical diagnosis systems), prediction (e.g., weather forecast), automatic knowledge extraction and pattern recognition from data (e.g., discovery of fake news circles in social media), interactive communication (e.g., social robots or chat bots), and logical reasoning (e.g., theory development from premises)."*
Canhoto & Clear (2020)	*"We define AI as an assemblage of technological components that collect, process, and act on data in ways that simulate human intelligence."*

Table 1 AI Definitions

Together, these studies and the definitions highlight an incoherent use of AI when describing it in previous studies, which potentially highlights the difficulty of defining AI as a concept. Overall, as these definitions indicate, AI can be described as an umbrella term for several software techniques and approaches that possess the ability of learning, processing, interpreting and reasoning in a similar fashion to humans. Thus, this rather broad definition will be used in this thesis.

2.2.2. AI Fundamentals

As the previous section illustrated, AI is often described as an umbrella term for several different software techniques and does not entail a single technology. These software techniques are sometimes clustered in the literature into different groupings, such as voice recognition, natural language processing, computer vision, robotics and motion, planning and optimisation, and knowledge capture. Through these different techniques, an AI application combines and utilises this different software. As it is out of scope for this study to cover all these, the ones discussed with interview respondents are presented; thus, only Machine Learning (ML) and Computer Vision are included.

2.2.2.1. Machine Learning

AI-based applications are often created with the help of Machine Learning (ML), a subfield within AI that covers a wide range of learning techniques (van Duin & Bakhshi, 2017). Using ML, AI systems can learn from existing data and experiences by testing different ways of reaching outcomes and improve their performance with time and additional data (Brynjolfsson & McAfee, 2017). As a result, ML has become a common fundamental component of contemporary AI solutions and is one of the reasons for AI's surge in popularity in the last decades (Canhoto & Clear, 2020).

There are three ways for machines or algorithms to learn: supervised learning, unsupervised learning, and reinforced learning (Russell & Norvig, 2020; Canhoto & Clear, 2020). In supervised learning, an algorithm learns from labelled data (Brynjolfsson & McAfee, 2017; Delua, 2021; Russel & Norvig, 2020). According to the authors, when the AI algorithms are being trained, they are fed with sets of inputs and outputs that they then analyse; in practice, this would be a picture of a dog (input) together with the label "dog" (output), which are then analysed for the shapes in the picture. When such a program is fed with many sets of these input-output pairs from different animals, the system will learn to discern them; after the algorithm has been trained enough, it is possible to feed it with only an input, like a picture of a cat, and it will recognise it and return the output, like the label "cat", a very similar process to how small children learn to couple objects with object names by parents firstly telling them what they are called (ibid.).

The second way of training AI algorithms is unsupervised learning, where systems learn by themselves. This is done by feeding them lots of input data that the algorithms then cluster together based on their characteristics; if these clusters would be then presented to humans, they could recognise a cluster as cats, another one as dogs, etcetera (Brynjolfsson & McAfee, 2017; Delua, 2021; Russel & Norvig, 2020).

Lastly, in reinforcement learning, the programmer determines a goal, allowable actions and describes certain constraints (Brynjolfsson & McAfee, 2017; Russel & Norvig, 2020). According to the authors, after that, the system tries different approaches to reach the goal and is either rewarded or punished, depending on if it reached the goal and to what extent. A chess game is often an excellent example for describing reinforcement learning; here, the system tries different sets of moves, is rewarded if it wins, and is punished if it loses (ibid.). These different ML approaches algorithms can be trained to recognise patterns in real-time datasets and even predict them (Dhall et al., 2020). However, suppose the amount of available data for training AI algorithms is modest. In that case, the resulting AI applications will achieve lower reliability, especially true for more advanced types of AI developed by unsupervised learning, like deep neural networks that demand more data for proper function (Cubric, 2020). Figure 2 illustrates the ML learning process. As the figure illustrate, input data could either be structured or unstructured, then the system can learn from this data, or by learning from input-output pairs. Finally, a result, the outcome, is delivered (Elliot & Andrews (2017).

Figure 2 Machine Learning Process; adopted from Elliot. & Andrews (2017)

2.2.2.2. Computer Vision

Another key technology is Computer vision, which enables companies to capture, process and analyse digital images and make sense of these (Elliot & Andrews, 2017). This technology is accelerating in terms of its application areas and is widely used for monitoring deforestation (Elliot & Andrews, 2017; Ritter et al., 2017) and often helping other technologies to function. For example, by training AI systems to recognise objects through ML, these systems can develop comprehensive capabilities of recognising a multitude of objects inside images often collected under the term “Computer vision” (Elliot & Andrews, 2017).

2.2.3. AI Maturity

Until today, AI's applicability is somewhat limited due to it being in the early stages of development. Depending on developmental stage, AI can be classified into three different categories, including narrow AI, general AI, and super AI (Güngör, 2020; Haenlein & Kaplan, 2019a). Today’s AI applications are within narrow AI, primarily focusing on solving individual challenges, carrying out specific tasks, and specific purposes (Russell & Norvig, 2020; Kerzel, 2021; Fjelland, 2020). An example of this could be an AI system monitoring water pressure inside piping, recognising patterns of over-pressure, and rerouting water and pressure to other sections to mitigate the risk of leakage (Mounce et al., 2010). In contrast, General AI is described as a system that can mimic various human capabilities and adapt to different environments and situations, similarly to humans (Güngör, 2020). These hypothetical general AI systems, in contrast to narrow AI, perform a variety of different tasks, not specialising in one (Russell & Norvig, 2020), and they can reach human intelligence levela, including learning from experience and solving complex problems (Goertzel, 2014; Khakurel et al., 2018). A step further, super AI is outperforming humans at everything we do, making machines superior to human beings, both in the range of the tasks it can solve, significantly exceeding the original scope it was programmed for, and the solutions' quality (Haenlein & Kaplan, 2019b; Gill, 2016; Khakurel et al, 2018). To date, AI applications with general or super capabilities have yet not been developed (Naudé & Nicola, 2020; Riahi et al., 2021), and according to some researchers, we have not come closer to them, despite the impressive advancements within narrow AI (Fjelland, 2020). Furthermore, the concept of narrow AI itself can be questioned (Russel & DeLallo, 2020). Despite the narrowness that AI applications are developed for, the development often leads to process developments, that are adopted in similar cases (ibid.). An example of this is convolutional neural networks developed for recognising human signature, that are now being utilised for image recognition inside medicine and autonomous driving (Russel & DeLallo, 2020).

2.2.4. Opportunities & benefits of using AI

To understand the opportunities of using AI, grasping the fundamentals behind AI applications is essential. To begin with, algorithms are an essential feature of AI’s practical applications, as they set the rules and act as instructions for how AI applications should solve different tasks, in essence being the building blocks of AI inside any software system (Burgess, 2018). Moreover, all AI applications rely upon some data, such as historical or real-time data (Canhoto & Clear, 2020), and AI uses this data to capture relevant insights for solving the task at hand (Burgess, 2018). In recent years, several technological breakthroughs and the reduction in their costs, like increased processing power, increased amounts of data collection through sensors and Internet of Things (IoT), cloud storage and computing, etcetera, have increased the number of opportunities for applying AI (Brynjolfsson & Norvig, 2017;

Russel & Norvig, 2020; Burgess, 2018). This increased data availability, often described in the literature as big data, has also increased AI's overall usability (ibid.). The increased amount of data is significant, as most AI applications need some form of data to function and create value (Burgess, 2018).

As previously mentioned, AI progress in the last two decades can mainly be attributed to the increase of available data and the improvements inside machine learning. These new advancements created new opportunities and hype surrounding AI. According to Akerkar (2018), the main benefits of AI lie within its ability to recognise patterns inside large volumes of data, structured data, like databases, and unstructured data, like images, texts, and video footage. According to the authors, by adopting AI, firms can increase the value of the data they possess, as AI can generate new unique insights from it, increase its transparency and objectivity, and visualise it more effectively, enabling firms to make improved decisions and innovate faster. Furthermore, when changes appear inside the data, AI can automatically and swiftly adjust to the new patterns and underlying circumstances with the help of various ML techniques and ensure that it consistently achieves objectives to the highest possible levels (ibid.). While many of these effects can be achieved in more conventional ways, they would have been costly and thus often not feasible, as AI is primarily a cost reduction technology, thanks to its excellent scalability and automatization opportunities (Agrawal & Kirkland, 2018).

Another feature of AI that is recognised as highly valuable is AI's ability to make future predictions based on past occurrences, like forecasting consumer demand or forecasting weather (Agrawal et al., 2017; Cubric, 2020; Pham, 2020). This ability could further automate many tasks; however, human judgement should not be undervalued, as this is often needed for many advanced tasks, even when AI systems support them (Agrawal et al., 2017). A severe weakness of this is stressed by Burgess (2018), who argues that as an AI application relies upon data for its predictions, the challenge of bias should not be underestimated, further elaborated in section 2.2.6.2.

AI's capabilities of aiding humans can also be divided into several areas, based on their characteristics and the extent they help or take over specific tasks, as explaiend by Herweijer and Waughray (2018). Acoording to them, the so-called automated intelligence can help humans perform tasks perceived as laborious and repetitive, like sorting household garbage. Similarly, assisted intelligence helps reduce the time and increase the quality of the performed tasks by uncovering patterns in data (Herweijer & Waughray, 2018). Augmented intelligence involves systems that assist humans in understanding and predicting future events, such as assisting policymakers in creating simulation models for greenhouse gas emissions (Herweijer & Waughray, 2018). Furthermore, autonomous intelligence completely takes over decision-making tasks, not needing any human intervention, like adaptive home heating automatically regulates temperature and helps save money for the owner (ibid.).

2.2.5. AI Hype

Despite this ongoing discussion of AI's opportunities, several lines of evidence suggest that many business managers do not understand the areas where AI's capabilities can be leveraged. As the literature highlights, there are some AI application areas where AI can have a significant impact, but besides understanding these opportunities, it is also essential to understand what AI cannot do, as the potential of deploying AI can sometimes be overinflated (Ng, 2016; Burgess, 2018). By reviewing the Gartner Hype Cycle, a common way for understanding a technologies' maturity level, through the cycles' five stages - innovation trigger, the peak of inflated expectations, the trough of disillusionment, the slope of enlightenment and plateau of productivity, the hype level of technology can somewhat be exposed (Panetta, 2020) According to the "Hype Cycle for AI 2020", most AI-related technologies are within the stage of innovation trigger and peak of inflated expectations, indicating a low commercial value for contemporary AI (Panetta, 2020).

As Grace et al. (2018) suggests, predicting AI's opportunities in the future is somewhat tricky, as AI development relies on scientific breakthroughs. Moreover, as Burgess (2018) argues, the many definitions of AI make plotting AI on a curve complicated. This highlights the difficulty of understanding AI's development and future opportunities. Nonetheless, there are many investments into AI, and some AI applications are, albeit the maturity level, bringing real value for many businesses (Panetta, 2020). Thus, there is both evidence for AI being hype, but also research that suggests that AI can generate significant value for firms.

2.2.6. Preconditions and Limitations of AI

A great deal of research has investigated the different preconditions and limitations of using AI within several fields. Since previous research on AI in sustainable sourcing is currently scarce, the following sections include general studies on AI adoption, obstacles and challenges.

2.2.6.1. Preconditions

Before companies can adopt AI in their organisations, there are certain preconditions that companies must first meet. For example, a starting point for any AI adoption should be to construct an AI strategy that includes its goal of using AI and illustrates how it aligns with its overall business strategy (Burgess, 2018; Chui & Malhotra, 2018). Akerkar (2018) also highlights that the problem itself should be a focal point, and after that, AI's feasibility should be outlined, as AI is not usable for each business activity. Moreover, one of the most fundamental factors for AI utilisations is data availability and quality and technology infrastructure (Cubric, 2020; Ng, 2016; Riahi et al., 2021; McKinsey & Company, 2018). Here, the authors stress the importance of data to train AI algorithms to produce high-quality outcomes (Cubric, 2020; Ng, 2016; Riahi et al., 2021). Still, however, research highlights that many companies lack the proper techniques for collecting data needed for AI to function (Chui & Malhotra, 2018).

Manyika et al. (2017) stress the importance of well-functioning data ecosystems for adopting AI successfully. In the same vein, Bergstein (2019) explains that data storage records are often stored in separate systems, thus not connected to the overall data banks. If applying machine learning, these applications will only learn from the available data, potentially skew the outcome it produces, as it was programmed on partial data; thus, better connections between different data systems are a fundamental aspect that needs consideration when trying AI systems to achieve better, less skewed results (Bergstein, 2019). As Canhoto and Clear (2020) stress, the costs of the technological requirements, like processing power and access to different databases, must also be considered by managers before adopting AI. Ebinger and Omondi (2020) suggest that companies must also consider data security issues, protect intellectual property, and balance privacy against transparency, when integrating different technologies, like AI, in a company.

2.2.6.2. Limitations

Previous research has also dealt with the limitations of AI (Burgess, 2018; Khakurel et al., 2018). According to these studies, one of the most prominent limitations is bias. On the one hand, machines lack humans' emotional intelligence, and thus the preconceived understanding that sometimes influences human's decision-making, but on the other hand, humans can decide how to train AI applications, and they may have a bias in their input data that AI applications rely upon, which consequently can impact the output received from these AI applications (Haenlein & Kaplan, 2020; Burgess, 2018; Khakurel et al., 2018). Often, bias is reduced by increasing the sample being used, yet, this is sometimes difficult, primarily when companies solely rely upon internal data, and sometimes external data can have some bias too (Burgess, 2018). In addition, several researchers suggest that (Haenlein & Kaplan, 2019a; Burgess, 2018) companies that use AI and ML applications may find it hard to interpret how these applications arrived at a specific decision. For instance, an ML trained application can decide whether a person should get loan approval, but it may not provide any information on why such a decision was made (ibid.). Consequently, the transparency of certain decisions becomes negatively impacted, a challenge more commonly known as "the black box challenge" (Haenlein & Kaplan, 2019a; Burgess, 2018).

Many studies have also examined AI's impact on workers and the ongoing debate on the level of destruction AI potentially creates when introduced in a company. Traditionally, it has been argued that there is a risk that AI may take over some jobs when introduced in a company (Hanelein & Kaplan, 2020). However, others (Hung, Rust & Maksimovic, 2019) argue that AI will replace only certain tasks and that these tasks are often those that require analysing, interpreting, and processing information. Still, tasks that are heavily relying upon human judgement and feelings will be managed by humans (Hung, Rust & Maksimovic, 2019). This view is somewhat consistent with Wilson and Daughtery (2018), who argue that AI will complement humans and not replace them.

Much of the current literature on AI also pays particular attention to knowledge management. As research highlights (Chui & Malhotra, 2018), companies generally do not possess the right skills to use AI in the most optimal way, a clear barrier to adopting AI successfully in companies. Moreover, organisational misalignment can occasionally occur. According to Bergstein (2019), it is crucial that employees within different departments, like business and IT, understand AI fundamentals to use it optimally. Knowledge of AI's processes and functionality is essential as it further helps employees trust the AI applications' outcome (ibid.). Similarly, Manyika et al. (2017) argue that knowledge is vital within companies, as it impacts employees' understanding of the systems in use, as well as the trustworthiness of the outcome it produces. For example, in a study by McGovern et al. (2017) investigate the opportunity to use AI for weather predictions, the authors concluded that forecasters must trust the results of an AI application to utilise it. Similarly, a report published by PWC highlight trustworthiness concerns among employees as one of the significant factors for slowing down AI adoption in companies (Rao et al., 2017).

2.2.7. AI in Sustainable Sourcing

As highlighted in previous sections, the concept of sustainable sourcing is often synonymously used with other concepts, including responsible sourcing and ethical sourcing. Thus, by taking this into account, literature concerning responsible sourcing, ethical sourcing, and supply chain are reviewed. Albeit the scarcity of multidisciplinary research on AI application areas for sustainable sourcing (Giunipero et al., 2019; Larsson et al., 2019), this section will highlight some examples where AI has been applied for sustainable sourcing. Most of these examples are provided either by consultancy companies or businesses who have, together with others, developed some AI solutions. The section aims to give insight into the application areas for AI in sustainable sourcing and highlight that most solutions are primarily developed for specific challenges, companies, and goals.

The literature highlights several areas where AI is and potentially will impact supply chain management. By conducting a literature review on over a hundred reports, Riahi et al. (2021) highlight several AI application areas in the supply chain. For example, the authors elaborate on AI's role in managing risks and how deploying AI in the supply chain can lower costs, increase performance, and make the supply chain more agile and resilient. Additionally, AI can assist companies in selecting suppliers and evaluate them according to a pre-set criterion (Riahi et al., 2021). Other authors argue that he potential benefits that AI provides must also be balanced against the potential risks of acquiring them. As researchers (Russel, 2017; Larsson et al., 2019) explains, understanding the challenges and risks of using AI is essential, as otherwise, AI may, instead of creating business value, hamper the company's overall sustainability objectives and goals. Dauvergne (2021) claims that while AI accelerates supply chains' efficiency and productivity, AI's resource extraction and waste generation from the technology production outbalance the benefits. Similarly, Khakurel et al. (2018) study how AI impacts five domains of sustainability, including social, economic, technical, environmental, and individual. The authors conclude by saying that AI impacts all these dimensions, both positively and negatively. Therefore, the eagerness to apply AI in organisations should not be substituted with any negative impacts that AI could potentially have (Khakurel et al., 2018). Moreover, the net benefit of acquiring these must be considered, as developing AI solutions is expensive (Cubric, 2020). All in all, this suggests that there is potential for applying AI for improving supply chain performance.

Regarding sustainable sourcing, there are some business applications where AI has been deployed to provide value. For instance, Google and Unilever teamed up in building a platform to detect deforestation by using AI and cloud computing with satellite imagery, thus helping Unilever get a more holistic view of the ecosystems related to the company's supply chain and deforestation risks; here, AI helps to make sense of large and complex data, and together with satellite imagery, provide insights for helping Unilever in their sustainable sourcing scheme (Google Cloud, 2020). Concerning the forestry industry, AI also helps with tracking and identifying individual tree logs (TietoEvry, 2021). On this note, the United Nations has recently developed a standardised and customisable tool for ecosystem accounting by using AI, which helps users, primarily countries, understand the conditions of the world's ecosystems (UN, 2021).

The consultancy company PWC demonstrates several areas where AI can be applied. For instance, AI could be used, together with satellite imagery, to detect land-use changes, monitor and detect habitat loss, and improve weather and disaster resilience through AI's prediction and automatization capabilities (Herweijer & Waughray, 2018). In combination with big data, AI can efficiently collect, facilitate and process information in real-time, which could potentially increase a supply chains' visibility, and therefore help firms accelerate their traceability and tracking (Ebinger & Omondi, 2020) and analyse the impact of climate change (Sanders et al., 2019). This is also supported by Alicke et al. (2020), who states that AI can enable end-to-end transparency in supply chains and help with analysing a large amount of data.

Finally, in a report, the authours Herweijer & Waughray (2018) highlight that AI can assist in detecting illegal deforestation or other events through a real-time geospatial dashboard over the planet. However, developing a user-friendly and straightforward tool with high qualitative information is complex and requires collaboration between several different stakeholders (Herweijer & Waughray, 2018). As evident from the examples above, AI often does not constitute the entire solution but is complemented with other technologies. As Ebinger and Omondi (2020) conclude, when discussing different technologies, like AI application areas, the authors mention that "catch-all" technologies do not exist. However, all in all, these examples provided in this section present some evidence for applying AI for sustainable sourcing.

2.3. Summary of theoretical findings

This literature review aimed to provide the reader with a deeper understanding of the existing research related to the main concepts of this thesis, sustainable sourcing and artificial intelligence. Together, these studies provide insights into these two fields and the application areas of AI. However, the literature review also reveals the scarce research on how, when, and if AI can solve sustainable sourcing challenges. Although the section 2.2.7. illustrates some earlier adoption of AI for sustainable sourcing, previous research is scarce. Therefore, this paper aims to make a theoretical contribution by filling this gap, and provide guidelines on the preconditions and limitations of AI Figure 3 illustrates a short summary of the main key takeaways from the literature chapter.

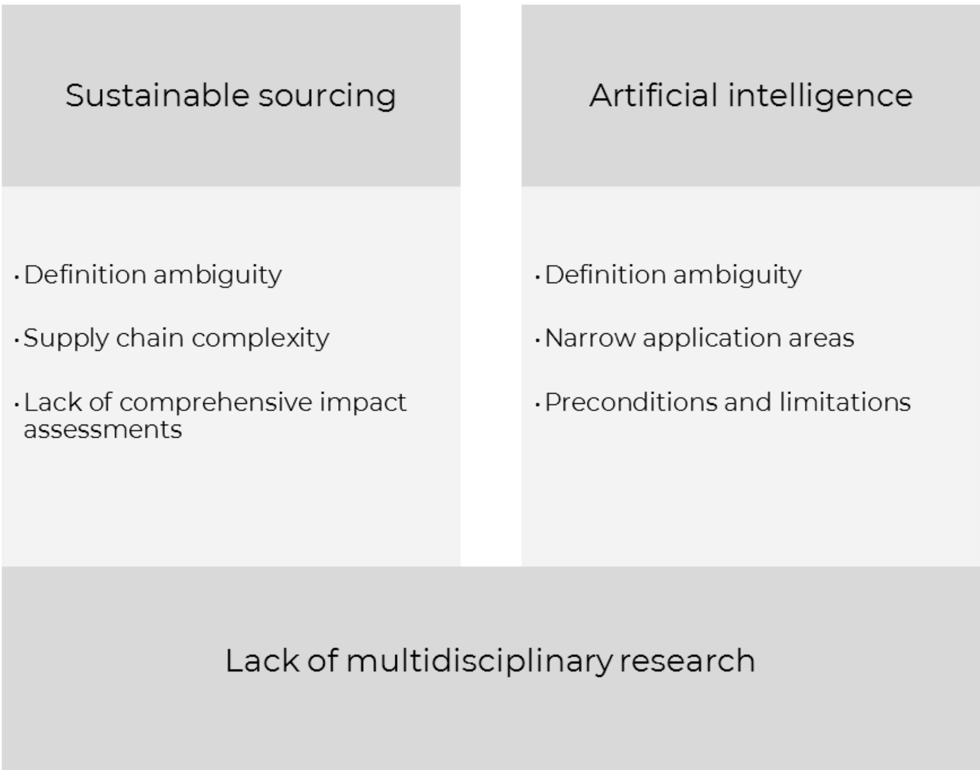

Figure 3 Summary of the theoretical findings

2.4. Framework

2.4.1. Task-Technology Fit Framework (TTFF)

As multidisciplinary studies that combine artificial intelligence and sustainable sourcing are scarce, a framework that evaluates the fit between the characteristics of the identified challenges and characteristics of AI's capacity was needed. A widely utilised framework was identified, popular both academically and practically, primarily inside the Information System field, but also inside other fields (Spies et al., 2020), was the task-technology fit framework (TTFF), depicted in Figure 4. In the simplest iteration of its original form, the framework compares the tasks that need to be done with the functionalities that a technology offers, predicting its effectiveness (Goodhue & Thompson, 1995; Goodhue, 1998). Although the framework has primarily been used within the information system field, it will be applied in this study to evaluate how AI can potentially aid firms in solving their sustainable sourcing challenges. To use this framework, it is adopted to look instead at the characteristics of the sustainable challenge and compare them with AI's characteristics and evaluate their fit. A potential critique of using this framework is that the framework has not been used previously within the AI context, based upon the research we have reviewed. Thus, it may be questioned whether the framework could potentially be used within such context. However, we believe that this could then be somewhat of a contribution. Moreover, the framework does not encompass other potential issues that may evolve within an organisation when applying different techniques for solving certain challenges. As the literature review highlights, these are also important when adopting new technology, like AI, in a company, which this thesis also aims to highlight.

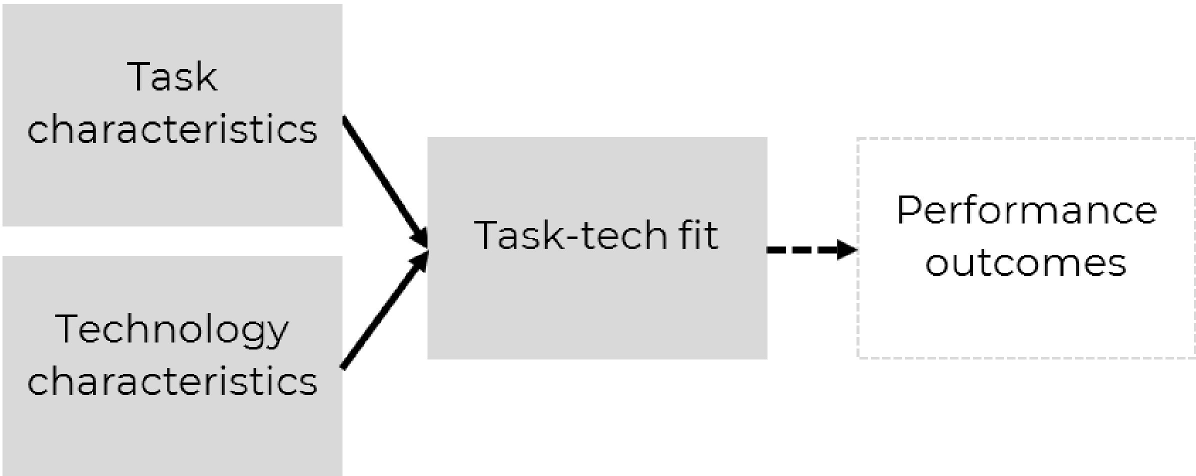

Figure 4 Task-Technology Framework; based on Goodhue & Thompson (1995)

3. Methodology

In this chapter, the overall approaches and methods conducted in this thesis will be discussed. The section covers a description of the chosen research strategy, research design, and the fit between those two. Moreover, the data collection, consisting of both primary data and secondary data, will be discussed and elaborated from their appropriateness connected to the purpose of this study and research question(s). A section that discusses the analysis, including tools, how the analysis was conducted, and a section on the overall quality of this study are also covered. In Figure 5 we present the summary of our methodology.

3.1. Research strategy	- Abductive - Exploratory - Qualitative
3.2. Research design	- Single-case study
3.3. Research method	- Semi-structured interview - Narrative literature review
3.4. Data analysis	- Thematic analysis - Task-Technology Fit Framework
3.5. Quality	- Low validity - Low reliability - Low replicability

Figure 5 Methodology summary

3.1. Research Strategy

3.1.1. Qualitative Approach

To answer the research questions and fulfil the purpose of this thesis, a qualitative exploratory research strategy was used. While we are aware of other research strategies that can be used, such as quantitative or mixed approaches (Bell et al., 2019), we considered the explorative qualitative approach to best fit our purpose and preconditions.

One of the primary reasons for conducting a qualitative explorative study was due to the limited multidisciplinary research on Artificial Intelligence and Sustainable Sourcing. Thus, testing theories would have been difficult, often the point of departure for quantitative studies and confirmatory studies (Bell et al., 2019), and therefore the qualitative explorative study was chosen. Furthermore, to answer the research questions and fulfil this thesis' purpose, in-depth views, knowledge, and insights from the respondents were required. Bell et al. (2019) describes qualitative research strategy as opposed to a quantitative research strategy, as more descriptive, providing in-depth knowledge and a better understanding of the studied phenomena. An explorative qualitative research strategy thus enabled us to research an area characterised by lack of research and allowed us to acquire the in-depth understanding needed for answering the research question(s) and fulfilling the purpose of this study (Bell et al., 2019). Moreover, as the ambition of this study is to provide an in-depth understanding of the challenges and potential solutions to these, and due to the explorative nature of this study, we found that the usage of non-numerical reasoning would better explain and reason about these areas that up until today are missing, and thus fulfil the purpose of the study. As Bell et al. (2019) argue the use of non-numerical reasoning is often used within qualitative studies.

The research is guided by an abductive approach, which according to Bell et al. (2019) is an approach that allows researchers to process empirical material and consult existing theories, often iteratively throughout the research, making this study a case of interpretive research. This iterative process enabled us to deepen the understanding of the subject by acquiring different perspectives from existing literature and respondents in a dialogical way. This consequently allowed us to explore and put together a strong understanding of the sustainable sourcing challenges that the case company is facing while investigating AI's potential for solving these issues. An alternative within qualitative research would be to use an inductive approach, where the data is the primary basis for theory development (Bell et al., 2019). However, we believe that the abductive approach helped us merge different perspectives into a complete illustration, whereby both theoretical and empirical data were collected in an alternating fashion throughout interviewing respondents from the case company and companies and experts in the field. This helped us fulfil our purpose and seek the best explanation(s) to answer our research question(s).

3.2. Research Design

3.2.1. Case Study Choice

Several different research design frameworks are to choose from when conducting a study that guides the data collection and analysis process (Bell et al., 2019). In this thesis, we have chosen the single-case study as our research design, described by Bell et al. (2019) as an in-depth and detailed study of a single case, whereby the case could be, for instance, an organisation, a location, an event or a person, whereas IKEA's sustainable sourcing is the case in this study.

When conducting a case study, the researcher concentrates on the case itself, studying it in its everyday context (Bell et al., 2019). As we wanted a research design that is explorative and provides an in-depth understanding of the study object to provide viable solutions. According to Bell et al. (2019), case studies are often used to gain a deep insight into a subject. Thus, this research design fits well with this study's overall purpose. Moreover, case studies are commonly used as a research design when the researcher aims to answer research *"how"* or *"why"* questions. (Yin, 2018) As this study aims to investigate how AI can assist in solving sustainable sourcing challenges and to some extent why certain sustainable sourcing challenges exist, a case study research design seemed appropriate to use. Therefore, the research questions themselves provided strong arguments for using such a research design.

Researchers can also decide upon whether to conduct a single case study or a multiple case study. The primary purpose of this study is not to identify the most common challenges nor to provide solutions for them; instead, the aim is to solve the more complex challenges inside sustainable sourcing that cannot be resolved by traditional approaches or technologies, requiring an in-depth understanding of their essence. Thus, by studying a single case, IKEA's sustainable sourcing, we provided an in-depth understanding of the complex challenges they are facing. As earlier described, and as argued by several authors (Yin, 2018; Bell et al., 2019), a study that aims to explain something in-depth is very much aligned with a single case study. An alternative would have been a multiple case study, whereby multiple cases are examined, which would have probably resulted in a higher number of sustainable sourcing challenges that would better represent the overall landscape of existing challenges. However, based on the reasoning around the complex challenges and the need of understanding them in-depth, the single case study seems to be the preferred choice.

Yin (2018) makes a distinction between different types of cases, ranging from unique, critical revelatory, typical, and longitudinal. These distinctions are crucial, as depending on this choice, the external validity is impacted (Bell et al., 2019), a quality measure that will be discussed in section 3.5. Without explaining these in-depth, IKEA as a case could arguably be both unique and representative. For instance, its uniqueness originates from its extensive sustainability work, often being portrayed as one of the most sustainable companies in the world. Therefore, the insights in this study may be somewhat limited for other companies. However, the case could also be classified as a representative. Like many other companies, IKEA aims to improve its sustainable sourcing efforts, an aim it shares with many other firms. Moreover, as the company has worked with sustainability for a long time, the challenges they are currently facing will be the future challenges for many companies, thus acting as a representative case for others to follow and learn from. Thus, the recommendations and solutions provided in this thesis, can to a certain extent, provide insights that others can use.

3.2.2. Case Selection

This study will use IKEA's sustainable sourcing venture to illustrate advanced sustainable sourcing challenges that exist. The identified problem did not primarily steer the selection of the case company. Instead, the case company was first contacted. After some initial meetings that helped us understand the areas needing further investigation, a practical problem was chosen. This was done by comparing the identified areas with IKEA's potential of being a solid base for a case study. After we identified the problem, we discussed whether other companies could be more appropriate to study. However, we believed that IKEA as a case could provide, due to its size, knowledge and overall strong sustainability ambition, a deep understanding of complex challenges in sustainable sourcing, thus providing scientific value and insights like few other companies.

As the delimitation section also highlights, the study primarily studies organic raw materials, including agriculture and forestry. This choice was taken as forestry is the primary raw materials used in IKEA's products (IKEA, 2021). Throughout the study, we also discovered that challenges concerning forestry are often impacted by agriculture, thus including them into our scope under the umbrella term “organic raw materials”.

3.3. Research Method

To answer the research question and fulfil the purpose of this study, both primary and secondary data were collected. While the researcher collects primary data often through interviews, secondary data is making use of already existing knowledge (Bell et al., 2019). The primary data was collected through interviews with case company representatives to identify the sustainable sourcing challenges IKEA faces. After that, we interviewed AI practitioners to understand the possibilities of applying AI for solving these challenges. The secondary data was gathered through a narrative literature review and document analysis. This process was conducted iteratively throughout the study, in the spirit of the abductive approach, where the interviews somewhat guided us in the right direction in terms of relevant literature, while relevant literature helped us in understanding different concepts, design interviews, and the subject. Consequently, previous knowledge was supplemented by new knowledge or further dissected in an upcoming interview, resulting in an in-depth understanding of both the challenges of sustainable sourcing and potential of AI within the field.

3.3.1 Collection of Primary Data

In this thesis, the qualitative interview was used as the main method of primary data collection. This, as stressed by Bell et al. (2019), allowed us to get a thorough understanding of this study’s topic through the views and insights of the respondents. The interview format was suitable, as some of the sustainable sourcing challenges linked to IKEA could not have been outlined in-depth by exclusively analysing documents, interviews with the case company were needed. Furthermore, due to the continuous technological development, we needed to get an updated view of the subject, thus interviews with AI developers were needed. This would not have been possible by solely reviewing the literature, as research may be outdated or not yet published. Therefore, interviewing AI practitioners with relevant and updated knowledge was imperative for answering this study’s research questions and fulfilling the purpose. By collecting data through interviews, we were also able to control the material, ensure that the research question would be answered, and that the data was of a high standard.

Since this study aims to provide an in-depth explorative understanding of AI’s potential inside sustainable sourcing and the challenges that IKEA is currently facing, the point of departure was to collect data through semi-structured interviews, allowing us to both ask predetermined questions but also be flexible in terms of asking additional questions if any interesting themes, relevant for the study, emerge throughout the interviews, which will allowed us to get a deep insight into the subject. In addition, using semi-structured interviews gave us the ability to compare respondents' answers (Bell et al., 2019), which was important when searching for interlinkages between different viable recommendations, solutions, and challenges that IKEA is currently facing. Moreover, to guarantee that the research question was answered and the purpose fulfilled, some structure and guidance throughout the interviews were needed. Since an abductive approach guides the research, additional material needed for interviews to promote or best explain the findings in this study, could always be added, giving us a continuous in-depth understanding.

There are, however, some limitations of using the semi-structured interview format. One of the significant drawbacks is related to the topics addressed throughout the interview. These could potentially create bias, steering the interviewees to incorporate the interviewers' depiction of challenges. We addressed this by allowing themes to emerge throughout the interviews, not strictly being preoccupied with the interview guide questions, and letting the interviewee frame the relevant challenges, consequently reducing the potential confirmation bias throughout the interview. Still, a more unstructured interview process could have potentially reduced such bias and provided a deeper insight into the individual respondents' view on the world (Bell et al., 2019). However, an unstructured approach could have produced results that were not comparable to each other and were not compatible with our research questions, thus not relevant for our thesis. Furthermore, conducting and analysing unstructured interviews was considered to take additional time compared to semi-structured interviews. Thus, semi-structured interviews were more suitable.

3.3.1.1 Sampling and selection of respondents

In this study, we used purposive sampling, which according to Bell et al. (2019) aims to sample respondents relevant to the research question, The purpose of this study is not to draw generalisable conclusions that can apply to all business cases, nor does this study indicate that people chosen to interview can be random. Therefore, as Bell et al. (2019) argued, purposive sampling was seen as a fitting sampling technique.

Purposive sampling was complemented by snowball sampling, which is, as explained by Bell et al. (2019), a type of purposive sampling where researchers use respondents' contacts, otherwise missed, to provide the material needed for the empirical material and analysis. For example, when interviewing IKEA respondents, we also asked them to provide us contact details to other relevant respondents that could help us in our study. On the one hand, it allowed us to get hold of many relevant respondents, but using such a method must also be questioned. The usage of respondents' contacts could provide us with viewpoints based on the same values, creating a biased view. However, as our empirical results were continuously compared to insights from the literature, we felt that the abductive approach somewhat mitigated this bias. There are, however, other ways of sampling, such as convenience sampling, whereby respondents are chosen based on their availability and accessibility (Bell et al., 2019). However, although such sampling techniques are time-saving, convenience sampling was not considered to fit with the aim of our interviews, namely, gaining insights from respondents with specific knowledge, which would help us answer our research questions and fulfil the purpose of this thesis.

To fulfil the purpose of this study, we gathered information from two distinct knowledge clusters, namely sourcing challenges and AI respondents. We approached the potential respondents in two distinct ways, depending on which of the groupings above they belonged to. To select the appropriate respondents, we provided some information related to our subject, so that the respondent could understand the area of interest, and thus either direct us to people we could talk to or talk with us themselves. This ensured the respondents' knowledge would match our needs, with relevant insights that could help us fulfil this research's purpose and answer the research question. One issue in terms of sampling, problematised by Bell et al. (2019), is that the number of interviews needed for saturating our theoretical knowledge, which can vary greatly. This means that we could hardly have discerned the number of persons we had to interview at the outset of our research. In practice, however, we noticed when concepts started to repeat themself, and no real new insights were gained by interviewing additional people, thus reaching theoretical saturation.

3.3.1.1.1. Inside sourcing challenges

As the first step in our primary data collection, we needed to outline IKEA's sustainable sourcing challenges. Therefore, we first identified respondents inside the firm with an in-depth understanding of the field being studied, both the forestry and agriculture fields. The need for respondents with in-depth understanding was decided because we presumed that in-depth knowledge was needed to identify sourcing challenges and understand them, both from a general and practical perspective, all in line with the case study design. Therefore, we started our interview data collection by firstly talking to people within the forestry sourcing field. As the connection between forestry and agriculture became evident, throughout the interviews, we decided to include respondents that are also working with this type of raw material.

Consequently, the empirical results are somewhat impacted by the larger number of respondents with a forestry background, which the reader of this thesis should be aware of. However, the people that we interviewed at the case company were mostly working within the same area, that is, the forestry department, but in different roles, providing us with an in-depth understanding of the challenges that they face in their specific work role, allowing for an encompassing understanding of the raw materials' sustainable sourcing challenges at the company. Table 2 demonstrate the respondents chosen for this study.

ID	Date	Occupation	Location	Length (min)
Respondent 1	25/3	Forestry Specialist	Teams	45 minutes
Respondent 2	25/3	Forestry Specialist	Teams	55 minutes
Respondent 3	31/3	Responsible Land-Use Leader	Teams	80 minutes
Respondent 4	13/4	Forestry Manager	Teams	40 minutes
Respondent 5	15/4	Sustainability Development Leader	Teams	60 minutes
Respondent 6	26/4	Sustainability Development Project Leader	Teams	55 minutes
Respondent 7	30/4	Project Leader	Teams	50 minutes

Table 2 IKEA respondents

3.3.1.1.2. AI Respondents

To map the opportunity for AI in sustainable sourcing, we identified firms and respondents with extensive AI knowledge. Due to the ongoing technological development of AI, the interview respondents needed to have contemporary knowledge about this field, and preferably even some sourcing knowledge, to critically discuss AI's impact on this field, both benefits and drawbacks. Several companies were contacted, and we managed to get hold of four companies and some respondents from these (Table 3). While the views of these respondents may not reflect reality fully, they still provide some insights into how AI could potentially aid in solving sustainable sourcing challenges. Importantly, these companies are not "specialising" in organic raw materials. However, we believe that due to the newness of the field being studied, and since we use organic raw materials merely as a delimitation criterion, we thought, by interviewing general AI respondents, we could also get some general answers that can help us understand how AI can be used for solving sustainable sourcing challenges, not only challenges within forestry or agriculture.

ID	Date	Firm type	Occupation	Location	Length (min)
Respondent 8	5/5	Consultancy	Data scientist/ mathematician	Teams	50
Respondent 9	6/5	Consultancy	Programmer	Teams	45
Respondent 10	7/5	Consultancy	Senior Data Scientist / AI Architect	Teams	40
Respondent 11	10/5	GIS Provider	Environmental Scientist/Imagery & Remote Sensing Expert	Teams	60
Respondent 12	10/5	GIS Provider	Human Geographer, Statistician/Customer Success Manager	Teams	60
Respondent 13	10/5	GIS Provider	Human Geographer/Key Account Manager	Teams	60

Table 3 AI respondents

3.3.1.2. Interview guide

An interview guide, commonly used in semi-structured interviews (Bell et al., 2019), was used in this study to ensure that relevant questions related to the overall purpose and research questions were asked. However, if needed to allow for an in-depth understanding of the subject and to fulfill the purpose of this study, some follow-up questions were used. When using and formulating the interview guide, it was vital for us to maintain a balance between steering the interview and collecting relevant material and letting the respondents steer and show their knowledge of the area. In addition, the use of an interview guide allowed comparability and structure, which further assisted the data analysis. Thus, less time and resources were needed to devote to that process.

Two different interview guides were created. Firstly, one that aimed to understand the different sustainable sourcing challenges that IKEA faces (see Appendix A). This guide was created by reviewing previous literature but also by reviewing some internal documents. The interview guide for the AI companies was somewhat steered by the findings in the interviews with the IKEA respondents. This is because our ambition was to find relevant solutions for these challenges; thus, we needed to ask questions related to the sustainable sourcing challenges IKEA has. It is important to remember that the challenges we wanted to find solutions for, are primarily challenges identified through interviews with IKEA. If we had interviewed other companies, other challenges could have emerged. This impacts, both the data gathering from the AI respondents, and the overall results of this study. The interview guide was also adapted accordingly to some respondents, as some areas were more suitable to discuss with some respondents, than others. To ensure that the interview guide was of high quality, we asked our supervisor at IKEA for feedback before conducting the interviews.

3.3.1.3. Interview process

The interviews were conducted in two phases. Firstly, we interviewed representatives from IKEA, which enabled us to develop a comprehensive understanding of IKEA's challenges for sourcing sustainably. Secondly, we interviewed AI practitioners, who helped us understand how AI can potentially solve these challenges and the preconditions and limitations of AI. Before the interviews, the respondents were informed about the subject, time taken, and an invitation was sent out. Moreover, we ensured the respondents' anonymity, as we wanted to provide a safe environment for them to share their thoughts without being scrutinised afterwards. Due to the pandemic situation, all the interviews were conducted remotely through Teams, an online communication tool, with the cameras on, to provide a sense of being present.

Throughout the interviews, both of the authors of this study participated, whereby one of us was taking a more leading role in directing the interviews, while the other was taking notes, occasionally asking some control questions. By dividing the interview tasks between us, we felt like we could focus on the interviewee and attain as much information as possible. We also used probing to ensure that we collected the material needed to answer our research questions and fulfil our purpose during the interviews. While this could potentially impact the answers given, it also allowed us to focus on the relevant areas of the thesis. The interviews were voice recorded and later transcribed, utilizing voice-to-text software. As these types of software are not entirely accurate, we compared the text to the audio files to find any irregularities. While this consumed additional time, there was a net benefit compared to doing everything without software support.

3.3.2. Collection of Secondary Data

3.3.2.1. Document analysis

To be able to understand the challenges that the case company is facing fully, we decided to study several documents to get a deeper insight into the company's strategies, challenges, and the progress that the company has already made, and to get a background to the focal company and the contextual setting that it operates within. These insights could then be used for the interview guide to help us dig deeper into the case company's challenges. Bell et al. (2019) explain that using documents to provide a background is expected in case studies and valuable for understanding the case studied. Thus, this fits well with our research design. Nevertheless, we recognised the limits of solely trusting documents as a source for data collection; thus, both interviews were conducted, and literature covering the subject was used.

3.3.2.2. Narrative Literature Review
To gather a deeper understanding of the areas of interest, understand what is already known about the thesis' subject, and investigate whether there are any contradictions or disagreements in the existing literature that this thesis must consider, a literature review was conducted throughout the process of the thesis. As already touched upon, the intertwined way of conducting interviews and collecting theoretical knowledge is linked to the abductive approach of this study, allowing us to adapt the interviews' content and, in parallel, back these arguments up with relevant literature that could be used for following interviews. Bell et al. (2019) discusses two literature review approaches: a systematic review and a narrative review. While a systematic literature review is a detailed review that aims to understand how research can extend to the already existing research, a narrative literature review is commonly used to gain a deeper insight into a subject, providing researchers with an introduction to the subject that they aim to gain more insight into (Bell et al., 2019). Due to the lack of research in the field being studied and a non-confirmatory approach, we concluded that a narrative review fits the purpose of this study the best. Moreover, as Bearman et al. (2012) argued, that a systematic literature review requires that the researcher has a clear objective with conducting the literature review. However, in this thesis, knowing all the dimensions that should have been considered beforehand was difficult, as emerging objectives, concepts, and other areas of interest developed throughout the thesis' process. Additionally, a systematic literature review would have been impractical as this thesis follows an abductive approach, thus demanding that we conduct numerous systematic literature reviews, which would have taken too much time when considering this thesis's time frame.

Even if the narrative literature review lacks a structured and transparent approach, which is more common in the systematic literature review, many researchers have adopted systematic approaches when conducting narrative literature reviews. Here, researchers have explicitly explained how the narrative literature review takes place and uses inclusion and exclusion criteria to congregate relevant literature. Thus, it can be argued that the gap between narrative and systematic literature review has throughout the years diminished. (Bell et al., 2019) As the steps in the systematic literature review can improve the study's overall quality and transparency (Bell et al., 2019), we decided to adopt some of the approaches that are characterised by a systematic literature review as these procedures could increase the overall replicability and thus the quality of the study. One example of where we used an approach that is merely characterised by a systematic literature review was the usage of inclusion and exclusion criteria. Since secondary sources are sometimes collected for other purposes, and therefore, the quality cannot be guaranteed (Bell et al., 2019), we wanted to ensure we used relevant secondary data and material. Therefore, before any literature review was conducted, to ensure relevant literature and material were collected, inclusion and exclusion criteria were discussed and determined, guiding us to find and select the most suitable material for this study (see Figure 6). By integrating some systematic methods, while also using a narrative literature review to get an insight into the subject, we were able to find relevant literature while critically evaluating the literature according to pre-set criteria, without adopting the comprehensive approach that systematic literature reviews require.

Most of the literature reviewed was found on the database "Supersök", a database provided by the University of Gothenburg's library, "Web of Science", and Google Scholar. As discussed in the literature chapter (see Chapter 2), some of the concepts and definitions, such as sustainable sourcing, use different synonyms; thus, we had to, before conducting the literature, identify several synonyms in use, to ensure that the right keywords were used. Furthermore, since this study's subject is constantly updated, we have researched literature throughout the thesis, getting an updated view throughout the process. This is also aligned with the abductive and iterative processes that this study is characterised by. Moreover, even if the aim throughout the literature review was always to use literature with high citations to increase the potential quality of the results, the newness of the subject made it challenging to use highly cited literature as an assurance of quality solely. However, we believe that the opportunity to retrieve literature relevant to the subject, as recent as possible, outweighed the aim of retrieving articles cited a lot.

Inclusion criteria	- Academic articles - Consultancy reports from well-recognised firms - Internal documents from case-company - AI articles published after 2010. - Sourcing articles published after 2010.
Exclusion criteria	- AI articles published before 2010. - Sourcing articles published before 2010. - Sensitive material from the case-company.

Figure 6 Inclusion and exclusion criteria

3.4. Data analysis

In the following section, the thematic analysis used in this study will be described. We will also illustrate the analytical framework used for structuring the analysis.

3.4.1. Thematic Analysis

Qualitative research usually does not have as rigorous analysis methodology as quantitative approaches; it is instead often concerned with discovering patterns (Bell et al., 2019). To produce a scientific value in terms of generating insights into sustainable sourcing challenges and how these can potentially be solved through AI, we decided to use a thematic analysis as our analytical framework. Thematic analysis is described as a procedure aiming to cover, analyse, and distinguish patterns within data (Braun & Clarke, 2006). There are, however according to Bell et al. (2019), different approaches to qualitative analysis, such as grounded theory, narrative analysis, and discourse analysis. Besides the level of codification of procedures, these are somewhat similar to thematic analysis, as they are all concerned with searching for patterns (Bell et al., 2019). One advantage of thematic analysis is that it is not as time-consuming and more flexible than grounded theory (Bell et al., 2019), which was two solid motives for choosing the thematic analysis framework when analysing the data. Moreover, it allows us to get an overall structure of the empirical data, helping us to outline sustainable sourcing challenges, the potential for AI in aiding these, and the preconditions and limitations that must be considered for using AI. However, due to thematic analysis' lack of a structured process for analysing data (Bell et al., 2019), the risk of subjective bias and lack of replicability increased. To decrease this, we always ensured to conduct the different parts connected to the thematic analysis in pairs, especially in the coding process, where we both interpreted the results individually and compared the results afterwards, making sure that similar interpretations had been made.

The initial step of the analysis was a deep dive into the material collected through the interviews, which started when first transcribing the interviews, that is, the process of dealing with the raw material data (Bell et al., 2019). After every interview, the transcription was done, containing all the material from the interviews, allowing us to get a thorough understanding of the material being analysed, which consequently helped us familiarise ourselves with the data. This also reduced bias as we did not remove any data from the recorded material and guaranteed that no important finding was overlooked. We used the qualitative software analysis tool "Atlas.ti", assisting us in our thematic analysis. The transcribed material was inserted into this program, and we also used it when colour coding our data. The colour coding was conducted directly after each interview, to assure that the memories were recent and to avoid misinterpretations. The coding was based upon both codes emerging from the empirical material and predetermined codes based upon the literature review (see Appendix C and D). This allowed us to be both explorative in the sense that new emerging areas of interest could emerge from the data while focusing on the study's objectives. After we were finished coding all the texts, we grouped the codes into several sub-themes based on their characteristics, and finally, we aggregated these into different themes. Based on these, we identified several challenges presented in the analysis and the discussion section. This may be somewhat of a biased process, as it is subjective, and the risk of leaving important information out of the study is evident. To account for this, we always discussed the different codes and themes, conducted the analysis separately and then together, used the literature when needed to back up certain themes, and used the transcribed material when in doubt.

3.4.2. Analytical Framework

Due to having two parallel thematic sections, sustainable sourcing challenges and AI solutions, we needed an analytical framework to help us structure our analysis. As explained in the literature review, the Task-Technology Fit Framework (TTFF) satisfied the needs, simultaneously being a relatively simple framework that we believed would help us gain insights into the potentials that AI might offer inside sustainable sourcing (see section 2.4.1. for additional information about the framework and Figure 7.). By combining the task (challenge) characteristics with technology characteristics (AI's capabilities), we discovered certain fits, that we present in the analysis section. However, we did not look at the performance impacts that this framework is concerned with, as the applications were hypothetical, and thus we did not have the ability to evaluate them.

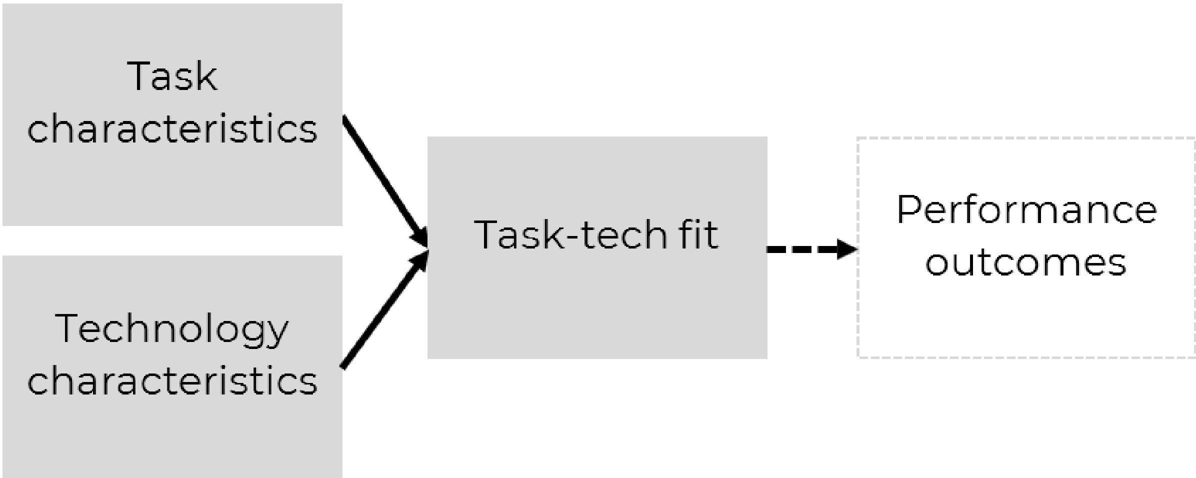

Figure 7 Task-technology fit framework

3.5. Quality of the study

There are different ways or criteria to use, like validity, replicability, and reliability, when assessing a study's overall quality, and many discussions in academia in terms of which criteria is the most suitable one to use in qualitative studies. Although the usage of validity, replicability, and reliability has caused a great deal of discussion, as these are measures of a study's quality are often linked to quantitative studies, not qualitative (Bell et al., 2019), these measures will be used in this thesis, as they are well-known measures that many are aware of. Therefore, the following sections will discuss linking these concepts to the study to evaluate the overall quality.

3.5.1. Validity

Validity covers a range of concepts that are more or less applicable inside qualitative research. Of all the concepts, one is especially relevant for a qualitative study, namely external validity, also known as the generalisability of results. External validity refers to the overall generalisability of a study's results, and in single-case studies, the external validity is commonly low, as it examines only one case. Thus, it is questioned whether a single case can provide general insights that can apply to more than solely that case (Bell et al., 2019). As this study only investigates one company's sustainable sourcing approach and the surrounding challenges, the generalisability can be questioned. However, as Flyvbjerg (2006) stated, making such generalisations is not the central goal of case studies. Nonetheless, although the research design indicates a low level of generalisability for the findings, other companies facing similar challenges may learn from this study's result and gain valuable insights and potentially apply it in their companies. This means that despite the low generalisability value of this study, it might represent a high degree of general usability. However, it should also be noted that this is neither the primary purpose of this study, and organisational differences may provide difficulties in terms of applying similar solutions; thus, this should be carefully considered. Therefore, due to the practical essence of the case company's challenges, the primary purpose of this thesis is not to provide any findings that can be representing all companies, but rather to provide some insights into the challenges experienced by one company with a long history of actively working towards sourcing organic raw material sustainably, and how these challenges could potentially be solved through Artificial Intelligence, including recommendations that follow.

3.5.2. Reliability & Replicability

Reliability and replicability are terms denoting two concepts of quality. Reliability can be seen as the level of fluctuations of measurements and concepts and is especially important inside quantitative research (Bell et al., 2019). As this study is qualitative, and the concepts and definitions and their interpretation by different researchers are clearly inconsistent and ambiguous, researchers trying to repeat this study might get rather different results, based on the people they talk to and how they interpret the concepts. To increase the reliability of this study, we defined the studied concepts and explained why we chose those, explained our collections methods and ways of analysing the results, ensuring the highest possible level of reliability. Due to the qualitative nature of this study, however, the reliability should nonetheless be relatively low. Replicability is the ability for other researchers to carry out the same research and come to the same results (Bell et al., 2019). To do so, researchers must explicitly explain the steps taken for carrying out the research (Yin, 2018). Therefore, all the steps taken in this study have been explained, motivated and described comprehensively in the methodology section, and achieve a high degree of replicability. However, since we are only conducting a single-case study on a company, and therefore, investigating the sustainable challenges of this company, achieving the results that replicable, may be hard to achieve, if researchers investigate other companies. Thus, the replicability of this study is partially hampered.

4. Empirical results

In this chapter, the data collected from the interviews is presented and categorised into different subthemes and themes. These themes highlight the main discussions and their background that is currently prevalent at the case company. See Appendix C and D for a summary of all themes, subthemes and codes that emerged during the interviews with sustainable sourcing and AI respondents.

4.1. Sustainable sourcing

A summarised version of the insights retrieved from the interviews with seven case company representatives is presented in the following section, divided into several themes and subthemes. These themes aim to illustrate sustainable sourcing at IKEA from the respondents' perspective and better mirror the discussed topics than the challenges that emerged, which are introduced in chapter 5. As evident from previous sections, sustainable and responsible sourcing are used synonymously in this study, but as most of the respondents used the term "responsible sourcing", this is primarily term used in this section.

4.1.1. Knowledge

4.1.1.1. Technology knowledge

All the Respondents discussed the adoption and usage of technologies within several contexts at the case company. Respondent 1 discussed the new IT (Information Technology) development journey that the company is embarking on, as the systems currently used to support responsible sourcing are inefficient and outdated. Moreover, emerging technologies were also discussed. Both Respondent 2 and Respondent 3 mentioned that the case company is assessing several technological solutions, including blockchain and artificial intelligence (AI). However, as Respondent 2 mentioned, the practicality of these technologies is not certain, as it is not fully understood whether these technologies can support the company in dealing with the most prominent obstacles and to what extent. Elaborating on this, Respondent 2 discussed the potential and the issues of using blockchain technology for sourcing forestry raw materials, as the products often are a mixture of components from various sources. For example, paper and paper pulp incorporate a considerable number of sources in a sole product without separating and tracing them individually. General technologic knowledge that covers the main present and emerging technologies was recognized by Respondent 2 as a necessity when adopting emerging technologies.

4.1.1.2. Knowledge asymmetry

Different knowledge levels connected to technology were observed inside the company. Respondent 3 demonstrated how AI is being used in the interviewees' daily work, whereas Respondent 1 mentioned that the respondent lacked any AI knowledge. Moreover, Respondent 3 emphasised the limited number of people working with advanced technological solutions in their daily tasks. This, according to the respondent, puts additional pressure on ensuring that any potential new systems are simple to adopt and easy to use.

Respondent 6 was positive towards new technological solutions for responsible sourcing, but the respondent said that sometimes company managers overestimate what technology can do. However, the respondent also stressed the importance of increased technological knowledge within the sustainability team, clarifying that many members in the responsible sourcing team lack proficiency in data analytics, which will be more requested in the future, not only at IKEA but globally.

4.1.1.3. Knowledge and action gap

Throughout the interviews, tools for information collection were discussed. When talking to Respondent 3, the respondent mentioned a tool that the interviewee is using for spotting deforestation. However, the Respondent mentioned that one of the critical issues experienced was how to act upon the expanded insights gained by the tools' new processing of information. Similarly, Respondent 2 mentioned that, when discussing different tools for information collection, it is not only about collecting information but also about visualising and processing this information, as well as structuring the databases and information flows needed for information extraction. Respondent 2 said that whilst existing technology solutions could be used to solve some obstacles related to responsible sourcing, the current tools cannot deal with data that is often complex to understand and interpret and thus does not lead to further action. Furthermore, automating the analytic functions and real-time warning systems was seen as imperative by Respondent 3. According to the Respondent, the company does spot checks on deforestation, but the ambition is to become more automated so that the company will have access to more sustainability-related real-world knowledge that will better mirror reality, and that will enable effective action, where it is most needed.

4.1.2. Organisation

4.1.2.1. Holistic development approach

In IKEA's sustainability report for the fiscal year 2020, a holistic approach to responsible sourcing is discussed. The approach highlights the importance of evaluating various sustainability aspects, including business ethics, children's rights, food security, land rights, biodiversity, land use, traceability and transparency, among others, in a broader context and in relation to each other, when assessing the extraction and production of raw materials (IKEA, 2021). All of the Respondents discussed the importance of working with, and transitioning towards, a holistic approach. According to Respondent 6, this holistic approach is not unique for IKEA; instead, an increasing number of companies are moving in this direction. As part of the holistic approach, Respondent 6 stressed the importance of not prioritising one sustainability aspect over another, elaborating that companies often focus on aspects that are currently fashionable, instead of addressing the entire range.

Several Respondents also discussed different obstacles connected to this holistic approach. According to Respondent 5, one of the critical issues is that sustainability aspects, like biodiversity, are very context-specific, and depending on what and where companies source, there are different issues connected to that context, making universal definitions and metrics impractical. All these different local aspect variations must be, according to Respondent 1 and 5, understood to fully appreciate the sustainability aspects that are important specifically in the region and for the material in question, and then one is truly able to start impacting them positively. Another issue that the holistic approach creates, discussed by Respondent 3 and 5, was the new and more complex insights that need to be managed accordingly. Furthermore, as explained by Respondent 7, the increased resources, such as time demand, for planning and organising a holistic approach can decrease resources, like time, spent on action.

Respondent 1 stated that it often takes many mobilisations to ensure this broad and holistic approach is adopted, a thought also reflected well by Respondent 4, who said that holistic sustainability is more complicated than rocket science. As the Respondent explained, it is essential to integrate different dimensions and aspects when sourcing sustainably, find a balance and solutions that will satisfy all the stakeholders with different values in the whole supply chain. Moreover, as Respondent 5 explained, currently, IKEA does not possess an exhaustive and all-encompassing risk assessment approach that can be applied to holistically assess all the sustainability aspects. This is, according to the Respondent, a result of a lack of universally accepted definitions, which consequently impacts available measurement techniques and measuring tools.

4.1.2.2. Definitions, metrics, objectives and impact assessment

All the Respondents discussed the importance of definitions and metrics for pushing the sustainable sourcing agenda forward. However, Respondent 1 said that sometimes in an organisation, people may have different views on what certain aspects contain, and without a clear universal interpretation, it is difficult to understand what is included and how to measure it. In addition, Respondent 7 said that those definitions should be developed with all relevant stakeholders. Respondent 5 said that definitions are highly connected to scoping, and a universal definition for certain aspects is vital for creating a global understanding of a topic, such as biodiversity. The Respondent also noted that using offsetting schemes to compensate for a sustainability aspect is not always possible. For example, as the respondent stated, biodiversity is a local phenomenon, and thus initiatives such as tree planting in another location – a common offsetting method – does not compensate for the loss of the local biodiversity. Therefore, the Respondent stressed the importance of deciding what a company stands for and supporting global interpretations applied on local levels. In addition to this, Respondent 3 stressed the importance of precise specifications and that the current specifications are formulated too narrowly and do not cover all the aspects needed for holistic sustainability assessments. Moreover, as Respondent 4 said, assessing the impact of certain initiatives or actions can be difficult, as it sometimes takes decades for nature to regenerate visibly.

Respondent 1 mentioned that no large-scale multinationals have overarching impact assessments covering all sustainability aspects in their supply chains. As discussed during all the interviews, this is often connected to the lack of clear scientific guidelines, evidence-based definitions, and consequently, impact assessment methodologies that firms can adopt, a point especially stressed by Respondent 6. Connecting back to what previous respondents have mentioned regarding the lack of universally accepted definitions and thus impact assessments, Respondent 4 expressed that the firm must firstly frame the sustainability aspects, what they do and do not encompass. Moreover, Respondent 6 and 7 stressed that there is a risk connected to firms creating their own definitions and impact assessment methodologies since every company can design their own approach, which may not be in line with the scientific, institutional view of sustainability. Respondent 6 elaborated on this and said that IKEA is primarily a home furnishing company and defining the outline and metrics of biodiversity and other sustainability aspects is not their primary area of expertise. Respondent 7 elaborated on this, saying that firms defining themselves what is and is not sustainable is a significant threat for truly sustainable practices. Respondent 6 also said that some existing impact assessments are to be used but often are expensive, especially in terms of conducting such assessments on every single material used. In addition, the respondent said that these assessments are not always capturing all the essential parts that should be included in such assessments.

4.1.2.3. Action focus

Throughout the interviews, the idea of becoming less process-oriented and more performance-focused was discussed. This was something that Respondent 4 acknowledged, saying that they are putting pressure on their certification partners, but also on IKEA itself, to become less process-oriented and instead become more performance-focused. According to the Respondent, this will enable organisations to move from assessing impact through measuring actions towards assessing impact through measuring performance outcomes and understanding the real-world net outcomes that supply chains produce, a view shared by Respondent 5.

Measuring performance outcomes compared to the actions was also discussed with other respondents, whereby Respondent 1 questioned whether legislative compliance truly is an objective of sustainability, saying: "What is the endgame and how can we do this in the best way?". A similar view was expressed by Respondent 4, who asked rhetorically what the purpose with traceability is? As the Respondent explained, traceability is a tool, so the question is for who or what such tool should be used. The respondent elaborated whether it should be to increase transparency towards customers, to satisfy their curiosity, so they know from which region their products come from, or to mitigate risks connected to environmental degradation and ensure sustainable production of products, the latter being respondents' choice. Similarly, Respondent 5 and 6 reflected upon this and the need for additional information by stressing transparency to help consumers make more informed choices. Respondent 6 also said that companies should become better at providing this information, as they can benefit by differentiating themselves from competitors and thereby create a competitive advantage over other companies. However, the respondent problematised the possible abundance of dissimilar information that creates a difficulty for consumers to choose the "better" product, illustrating this by asking:" ...this bar of chocolate says it is child labour free, but the chocolate bar next to it says it has a net-zero carbon emissions footprint, so which do you choose?".

4.1.2.4. Interconnection between ecological systems

Most Respondents discussed the relationship between agriculture, forestry, and the linkage between these different raw materials sourcing systems. Respondent 3 explained that many of the sourcing obstacles that IKEA faces are not solely connected to producing individual raw materials, instead of being linked with practices on a more systemic level. The Respondent further explained that the production of forestry raw materials is not the main culprit for deforestation; instead, it is agriculture, a thought shared with Respondent 4. This was further discussed by Respondent 2, who mentioned that deforestation is impacted by a drastically growing food demand and infrastructural expansion. To ensure the retention of forests, Respondent 3 mentioned the importance of working with the local landowners for communicating the benefits of forests, such as ecosystem services, and thus the protection of these. Consequently, due to the interconnections between different raw materials and systems, Respondent 6 said that it is vital that companies adopt a landscape approach or ecosystem approach when sourcing raw materials to ensure a better overview of whole systems, rather than sub-optimising based on individual supply chains.

4.1.3. Suppliers

4.1.3.1. Supply chain set-up and partnerships

IKEA has close to 1600 direct suppliers that have to abide by IWAY, IKEA's code of conduct, ensuring suppliers adhere and follow IKEA's values. (IKEA, A). These requirements were discussed throughout the interviews. According to Respondent 1, IKEA and its suppliers are required to have procedures in place that ensure conformity, run risk assessments, and collect documents essential for IKEA. As the respondent explained, a system needs to be in place that ensures a certain level of origin traceability for materials used in production. According to Respondent 1, this system is needed for IKEA's legal compliance, including risk mitigation. However, as stated by Respondent 6, IKEA's code of conduct system had historically covered mostly first-tier suppliers, and in some cases, a few tiers down the supply chain. Therefore, according to Respondent 6, IKEA updated the company's code of conduct standard "IWAY 6.0", which aims to target actors throughout the supply chain that were previously not covered. However, as Respondent 6 said, IKEA can only put demands on partners that they have a contractual relationship with, consequently making it more difficult for IKEA to put demands upon actors that the company does not have any direct legal agreement with.

Respondent 3 mentioned that relationships with IKEA's suppliers are key for information collection and discussed the importance of working together with suppliers and other stakeholders further down in the supply chain, not only for analysing risks but also for continuous improvement. According to Respondent 6, this is also aligned with IKEA's new code of conduct system, which historically focused on compliance but is now complementing compliance efforts with developmental approaches by helping suppliers to develop and improve their operations continuously. Furthermore, as Respondent 1 said, IKEA wants to help its suppliers comply with policy expectations and surpass them. According to Respondent 5, this can be achieved by educating suppliers and helping them see beyond most common practices and instead try innovative approaches, like cultivating local varieties of staple foods that might positively impact the local biosphere. Simultaneously, the Respondent also stressed the importance of market acceptance for such changes to be feasible.

4.1.3.2. Verification and compliance

Respondent 3 highlighted that one of the significant weaknesses of multinationals' responsible sourcing system is their poor connection with local sources that are furthest down the supply chain, such as the farmers producing and harvesting raw materials. According to the respondent, this is also the site of most existing sustainability issues, such as deforestation, a view shared with Respondent 5. Respondent 1 mentioned that the current structure is focused on individual suppliers but that the ambition inside forestry is to run full supply chain audits, all the way back to the forest. Respondent 3 said that this is partially already in place, but not to the extent they want to. As the respondent said, there is always a need to do a lot more, but everything comes down to balancing what to do in the right way, not by collecting paperwork but by verifying reality. Similarly, Respondent 3 mentioned that historically there was no direct line for obtaining the detailed information necessary for enabling responsible sourcing, that would extend throughout the supply chain to the local sources. Instead, most information was retrieved by travelling between each level of the supply chain, creating communication difficulties and risks. Respondent 1 explained that most of this type of work is currently built upon paperwork. As Respondent 2 mentioned, relying on documents from suppliers is a customary practice inside supply chain management and in IKEA, but sometimes, the suppliers cannot thoroughly verify these documents, which is not only an issue for IKEA and its suppliers but a global issue for many companies. Respondent 2 mentioned that although IKEA trusts their suppliers, verifications are occasionally needed, and sometimes there are even cases of fraud. For example, in a recent case from 2020, IKEA representatives were conducting a routine audit on a supplier as part of the IKEA due diligence system and discovered falsified documents which required IKEA to take decisive actions (Ingka, 2020). Moreover, as Respondent 6 said, suppliers can have different, often unstructured, systems, which increase the time taken for collecting information.

4.1.3.3. Managing non-compliance

The new complex insights enabled by technological advancements and collected because of a more holistic sustainable sourcing agenda must, according to the respondents, be managed by preferably committing to and mitigating the impacts within a certain supply chain or by exiting and withdrawing its sourcing from that supply chain, and thus avoiding the negative impact. According to Respondent 5, IKEA's approach is to stay and make a difference when they believe it is possible; as the interviewee stated:" ... change happens when you stay, and you work through something." Working together with the suppliers was also discussed during the interview with Respondent 3, who said that it is important to engage rather than exclude suppliers, as IKEA can raise the standards, such as by working with certification schemes and due-diligence systems. However, as the respondent expressed, this puts the company in a delicate situation, as it opens the possibility of being easily scrutinised by NGOs and competitors.

4.1.4. Traceability, Transparency, and Information

4.1.4.1. Traceability and external pressure

All the Respondents discussed both the importance and the obstacles connected to traceability and transparency among companies. In addition, Respondent 5 discussed the importance of traceability and transparency and the significance of tracing and understanding where IKEA is sourcing from as a prerequisite for sustainability efforts. Respondent 4 expressed the importance of traceability, especially within the global forestry industry, because of increased societal and legislative demands. As the Respondent mentioned, this is important as there are still many countries and regions where forests are not sustainably managed. In addition, according to the respondent, illegal logging is still standard and requires additional attention and risk mitigation. The supply chain setup was also discussed throughout the interviews. Respondent 3 said that many firms and NGOs want fully segregated and certified supply chains for better traceability. The respondent, however, problematised this and said that this could harm certain suppliers and lead to many companies withdrawing from countries that lack the prerequisites for these types of tracing. As the Respondent put it, "this is when you start the debate about the importance of certain issues in responsible sourcing."

4.1.4.2. Complexity of the supply chain and its effects on information

All the respondents discussed the differences between a simple and more complex supply chain within the forestry industry and the additional demands that certain supply chain set-ups put on both IKEA and its suppliers for properly tracing raw materials. Respondent 2 expressed that as manufacturers try to decrease the risks of shortages and price-hikes by avoiding becoming too dependent on individual suppliers, this leads to an increase in suppliers and sources, extensively increasing the diversity and complexity of the supply chain. This is something that, according to Respondent 2, creates obstacles in terms of tracing and transparency, as it becomes difficult to understand where all the supplies are coming from, and which sub-suppliers have been used. Respondent 4 said it is sometimes difficult to run highly detailed traceability inquiries on some products, mainly due to these highly globalised and diverse supply chains. Respondents 2 and 4 illustrated the increased complexity behind full traceability and transparency in the case of certain blended materials to make matters worse. The Respondents explained that products composed of blending materials with different origins, like fibre in a paper, are difficult to trace properly, as the fibre is mixed and comes from various suppliers and sources. As explained by these respondents, when the components are blended, it becomes difficult to know from which supplier, and what amount of a certain material, from a certain supplier is coming from, and on which day.

4.1.4.3. Information and suppliers

Throughout the interviews, information collections between IKEA and its suppliers were addressed. Respondent 2 mentioned that the tendency among global companies is increasingly to ensure full traceability, yet the process is not simple, and there are, as the Respondent puts it, many bottlenecks and hiccups on the way. Respondent 1 mentioned that IKEA is working to simplify the information collection process and implement new cooperative reporting processes to ensure that the information received is correct and that the process is less time-consuming for the supplier. However, according to Respondent 1, the willingness among suppliers to adopt certain systems varies, whereby some suppliers see the value in using such systems, while many are challenged by the time and resources required to use such systems. Respondent 2 mentioned that to collect information needed for tracing, IKEA requests information from their suppliers. For certain products, both Respondent 1 and Respondent 2 expressed that it is difficult to fully get information needed, as some suppliers may not want to share information, mainly when it is business-sensitive information or do not possess the means of collecting it, thereof lack incentives for collecting it. As Respondent 2 explained, retrieving information from these sources and information security becomes an issue for commercial reasons. Even within IKEA, Respondent 2 mentioned that some information is not shared freely between different IKEA departments, as this information could potentially corrupt the existing supply chain and dismantle it because of suppliers bypassing and taking over other suppliers.

4.1.4.4. Objectives with data collection

The objectives of using information collected from suppliers were discussed. According to Respondent 4, IKEA’s objective is to ensure that the supply chain is compliant with IKEA’s standards and due-diligence system, and by that complies with current legislation, not to “chase” individual products through the supply chain and create vast paper trails. As Respondent 1 expressed, legal requirements demand a certain level of traceability that enables firms to assess and mitigate sustainability risks effectively. Simultaneously the respondent was contemplating about what is a reasonable amount of information, considering that information collected should have an explicit purpose and should be collected to enable positive impact.

4.1.5. Internal and external pressure

4.1.5.1. Resources

The Respondents' view on resource allocation, both in terms of time, costs, and labour, connected to sustainable sourcing was discussed throughout the interviews. Respondent 1 expressed that companies must always consider and balance costs and benefits. The respondent explained that the time to work and understand certain issues, such as biodiversity, needs to be balanced with the costs incurred by these types of explorations. This thought was shared by Respondent 3, who mentioned that it could be challenging to balance the costs and benefits incurred by sustainability work. The time required for tracing was also discussed by Respondent 2, who mentioned that the company could provide the documents needed for ensuring, in this case, the legality of wood harvested in a high-risk country. This is, however, according to the respondent, a time-consuming process, with much time dedicated to collecting the needed information at suppliers and sub-suppliers.

Respondent 1 mentioned that many resources are being put into the collection of documents, as some authorities demand the extensive pursuit of documentation instead of working on projects that might have had a more significant impact on sustainability at the source. However, the respondent stressed the importance of doing this, but that some resources could be distributed better instead of using all resources inside one area. Respondent 3 also discussed this, relating to a discussion on enough information, that it is sometimes difficult to know what is enough and what is too much, what is sensible, and what is not, exemplifying it by asking:" ... should we track 1kg of soy feed?". In addition, the systems themselves are often very time-consuming when tracing certain materials; according to Respondents 1 and 2, it often takes much time to get information, especially in more complex supply chains. Respondent 1 said that the daily concern is to always think about the resources that the company always wants to do more, but the question is whether it is reasonable and whether the firm is achieving what it wants to achieve. The respondent pointed out that it often comes down to a balance of what to do in the right way. Additionally, the respondent said that the process for tracking the materials' exact origin is primarily manual, which is a time-consuming process.

Another thought expressed by Respondent 6 was that some departments inside organisations have more resources than others, which inevitably leads to certain parts of the sustainability agenda advancing faster than others. Consequently, as expressed by Respondent 7, IKEA's sustainable sourcing schemes have reached different stages, depending on the commodities and materials, and that the forestry sourcing scheme has advanced more compared to other commodities and raw materials.

4.1.5.2. Legislative demands and compliance

All the respondents discussed the external demands that are influencing IKEA's responsible sourcing scheme. One of the significant demands that were discussed with all respondents was legislation and compliance. According to Respondent 1, IKEA and other businesses must meet different legislations that many countries have, such as the European Union's and the United States' timber traceability legislations, requiring companies to have a due-diligence system and access to information. The respondent said that legislation has a positive impact as it creates a mandate and prioritises inside firms in terms of resource allocation; however, it also puts additional resource pressure upon the firm.

As expressed by some respondents, legislation can also hinder companies from working with other sustainability aspects. Respondent 5 elaborated on this and stated that too strong governance in the form of too detailed regulation or direct governmental ownership is also not beneficial. Sometimes, Respondent 1 said, there is a lack of understanding from authorities, as audits might demand excessive levels of traceability, like tracing the origin of a single piece of paper, which is currently exceptionally time-consuming and complicated and often leads to hypothetical outcomes. According to Respondent 1, creating this level of traceability incurs high costs on each level of the supply chain, resources that could have been used towards other projects instead. Respondent 4 also mentioned that due to legislative pressure, many suppliers that IKEA is working with are distracted by working with compliance, and resources that could have been used for investments into better practices are instead used for collecting traceability papers. According to Respondent 4, this also exposes the firm to another risk, as some in the supply chain may feel inclined to falsify documentation.

Respondent 2 thought that the amount of labour needed to satisfy the legislative demands was irrational, especially in products with complex traceability characteristics, like paper. However, Respondent 2 also expressed that traceability is needed because of the inadequate governance in countries of origin (weak legislation in countries of origin and lack of legislative enforcement), which leads to a compensation effort in developed countries and an increased pressure on firms active there. The respondent expressed that the company must develop an approach that could efficiently collect documents needed for compliance; however, everything comes down to balancing the extent of IKEA's information collection effort with its availability and the feasibility of retrieving it.

Respondent 3 expressed that future legislation can put additional pressure on companies to trace commodities. As further developed by Respondent 6, sustainability initiatives prioritised today are often identified based on expectations of future legislation, and similar thoughts were expressed by Respondent 7, saying that if they do not do it, that is sustainable sourcing, it will be regulated. Some respondents discussed future legislation connected to traceability, whereby Respondent 3 expressed that this legislative demand could be easier to fulfil in developed countries than developing countries, as they have better tools for implementing relevant systems. Consequently, the respondent explained that it could result in a decrease in sourcing from developing countries.

4.1.5.3. Anthropogenic activity

Respondent 4, 5, and 6 also discussed future obstacles connected to the consequences of anthropogenic activity. The respondents expressed that climate change in combination with standard unsustainable practices like overconsumption and monoculture cultivation has already created several sustainable sourcing issues, like the bark beetle spreading into the northern hemisphere or the Panama disease infesting banana plantations. Respondent 4 said that the future impacts of anthropogenic activity on sustainable sourcing must be understood, and companies must know how to deal with them.

4.1.5.4. Scrutiny and commitment

During the interview, Respondents 3 and 6 said that large multinationals are slow to adapt and change policies across their organisation, sometimes experiencing resistance to change. Moreover, as discussed by Respondent 3, firms do not always want to commit to sustainability completely. As Respondent 3 puts it, this is often because companies are afraid of being scrutinised by different stakeholders, like non-governmental organisations (NGOs) or journalists. Respondent 3 exemplified this by discussing a situation that occurred several years ago when an NGO accused IKEA of deforestation practices when they found eleven hectares of deforested land amongst 500,000 hectares of the intact landscape. Respondent 1 said that historically, forestry had been one of the most scrutinised industries, both from the public and legislation. Respondent 6, nonetheless, feels that the commitment in IKEA is present.

Respondent 6 mentioned that many customers request information to make sustainable choices. However, the respondent said that companies sometimes struggle to offer customers the information they want because firstly, companies need to have the information, and secondly, they also need to verify it. This can, according to the respondent, be difficult. Furthermore, Respondent 6 said that the more transparent the product's supply chains become, the easier it will be to find deviations. While Respondent 6 thought of this as a benefit, as it helps IKEA improve, it also exposes the firm to negative campaigns. Furthermore, Respondent 6 expressed that it is important for IKEA to trace where their raw material is coming from and be transparent about it towards customers and other external stakeholders.

4.2. Results from the interviews with the AI companies

Below, the empirical results from the interviews with company representatives from several firms offering artificial intelligence and other digital solutions are provided.

4.2.1. Artificial Intelligence Characteristics

During the interviews with respondents and from insights in the literature review, the characteristics of artificial intelligence emerged as a theme from the analysis.

4.2.1.1. AI as a definition

All respondents mentioned the difficulty of defining artificial intelligence, and even though all the respondents tried to define AI, it was evident that the term often leads to confusion and is used inconsistently. According to Respondent 10, the issue of defining AI is in many ways originating from the many different ways and fields it can be applied to, which consequently creates much confusion. Despite this, the respondents' definitions of what AI entails was somewhat coherent. According to Respondents 8 and 9, it needs to possess the capacity to perform tasks that would otherwise require humans for something to be AI. Respondents 11, 12, and 13 somewhat agreed with this definition, saying that they understood the idea of AI in a broader sense, defining the starting point as algorithms that can do advanced operations that humans traditionally perform. This definition somewhat differs from Respondent 10's view of AI, who instead talked about developing computer programs that can adjust to the environment and simultaneously learn from it. The respondent said that AI-based systems could learn from either experience or pre-programmed rules. Additionally, Respondent 10 was reluctant to compare contemporary applied AI with humans due to AI's current limitations, comparing its current capacity to insects rather than humans.

The lack of a universal definition can, according to some respondents, cause problems, as potential AI adopters cannot assess if the system, they are adopting is AI or conventional software. As Respondent 9 said, this can potentially fool many people and companies into applying AI solutions just because of the term popularity. Many, according to the respondent, make false claims related to what AI can solve, and therefore, some basic understanding of AI at companies could potentially help in finding the relevant AI application areas.

4.2.1.2. AI as a support

Most of the respondents stressed the importance of viewing AI as a tool that aids people in their everyday work by taking over repetitive and time-consuming tasks, freeing them to work on more exciting tasks. However, the respondents said that AI might not be able to solve all the tasks. Respondent 10 said that AI applications can solve some complex challenges in some cases, but AI is usually not more intelligent than humans, as the respondent stressed. According to the respondent, AI only does what it was built to do and what humans tell it. Both Respondent 8 and 9 clearly stated that AI is only a tool amongst all the others. According to Respondent 9, AI acts as a tool that supports people and will not, at least not for now, completely replace people. Simultaneously, all the respondents stressed that AI often is complemented with other programs, systems, and tools rather than AI operating free-standing.

4.2.1.3. AI hype

A standard view amongst the respondents was that applications with AI capacity are often sought after by clients, even though AI may not deliver the expected results. Respondent 9 said that people are sometimes overinflating what AI solutions can solve. This view was also shared by Respondent 10, saying that AI can solve complex and precise problems, but identifying such problems is sometimes quite tricky and highlighted the importance of defining a business problem before applying any techniques for its sake. According to Respondent 8, AI is often portrayed as a solution to solve problems that humans cannot. However, according to the respondent, contemporary AI can only solve previously understood and solved challenges by humans, AI's main benefit being the processing speed. Moreover, the respondent said that these solutions often demand substantial time and energy to develop correctly and achieve satisfactory results.

Some of the respondents talked about AI as a "buzzword". Respondent 10 explained that companies are often requesting AI solutions because it is the latest buzzword. The respondent acknowledged that despite the respondent specialising in AI consultancy services, there are often more straightforward, more accessible and cheaper solutions than AI, a view echoed by Respondent 9. Respondent 9 said that there is much buzz around AI and that people in charge of implementing these solutions must be smart to look through what AI can or cannot do. Moreover, the respondent said that many firms get stuck when developing AI solutions internally due to lacking adequate AI experience and knowledge. Elaborating on the lack of AI knowledge amongst higher management, Respondent 8 mentioned that programmers and computer scientists noticed that using the word AI, when applying for internal budgets, increases the chance of getting them approved, even though they sometimes do not contain any real AI components at all.

4.2.1.4. AI maturity

During the interviews, the current and historical development of AI was discussed. Respondent 10 discussed AI's newness and its consequential infancy inside the educational field, stressing the lack of AI-related courses and university programmes. The rapid development of AI as a field was also discussed with the respondents, where Respondent 10 said that the field of AI is constantly developing, changing from year to year, resulting in regular new developments like AI-based tools, applications, and programmes. According to the respondent, this rapid development leads to an absence of standardised and generic AI solutions and demands from the developers to combine different components for achieving desired results, a process requiring developers with extensive AI knowledge.

The current and future potential of AI was also somewhat discussed. Respondent 10 said that AI has become impressively good at dealing with large amounts of data in some cases, like image detection, and that in some cases, AI has even replaced humans. Despite this, there are still some doubts about AI's potential, and Respondent 10 exemplified this when talking about weather predictions, and that often in these cases, AI is not producing better results compared to humans, as the underlying mechanisms of these are not fully captured in an AI application. Moreover, the respondent highlighted the challenges ahead, stating that the future application areas of AI may be limited, primarily within localised problems. Respondent 10 said that more research to understand the underlying impacts and cause-effect relationships are needed for more complex issues before any AI can be applied for solving such issues.

4.2.2. Preconditions and Limitations of AI

The literature review and when discussing AI applications and possibilities, a common theme emerged: the various preconditions needed for a successful adoption of AI and the barriers obstructing it.

4.2.2.1. Data

A common subtheme seen as of the utmost importance by all respondents was the availability of data that AI programs can use and quality. As explained by Respondents 8 and 9, companies first need to have data before they can even start with a project. Although, as contemplated by Respondent 10, today's society has the means to be data-driven, what is needed are the structures and recognition of an opportunity. According to Respondent 11, data availability and quality are the point of departure and boundary for employing AI. A practical example given by Respondent 11 was the image quality from satellites, which limits the extent of possibilities for AI, as it can analyse and categorise things that can be discerned on the images, while objects that are too blurry cannot be identified and later processed.

When working on AI projects, as explained by Respondent 8, stumbling upon data availability and quality issues is common and a real barrier to AI adoptions, as without it, many great ideas for AI do not proceed past the idea stage. As explained by Respondent 8, without a good quality of data, AI users will not get reliable results, diminishing the solution's usability and the extent of its usage. An example of this issue, illustrated by Respondent 9, was the collection and aggregation of decentralised data from suppliers with different collection practices and with different collection extent, resulting in a decreased quality of the aggregated data. Another issue connected to data availability is the location of the relevant data, as explained by Respondent 10. The respondent said that some organisations might have data that is of no internal value to them, while others might have great use for it, creating incentives for the trade with data and extensive collaboration. The outcomes of this increased collaboration scope would, according to Respondent 9 and 10, lead to exponential benefits for all parties involved. However, according to Respondent 10, this can create conflicts with the privacy interests of individuals that the data is based on, demanding clear legislation on how and when data can be shared and handled.

Additionally, as explained by Respondent 8, even with good quality of data, output reliability might be inadequate initially; however, it usually improves with time and delivers to customers when it reaches a certain reliability threshold. Furthermore, Respondent 8 explained that data exists that measures an adjacent phenomenon in certain scenarios and is correlated or related to the data that you want to measure, and that could be used for the project. This, however, could mean that the reliability of the output might be reduced, according to Respondent 8. Regardless of the data quality and availability, Respondent 8 said that some solutions might not be feasible to implement in practice, even if data is available and of good quality, due to, amongst others, impracticality, costs or low added value.

4.2.2.2. Organisational AI knowledge

Another identified subtheme was AI knowledge inside organisations. According to Respondent 8 and 10, the field of applied AI is relatively new, with new advancements occurring regularly. Consequently, according to Respondent 10, experienced professionals inside the field are scarce. Furthermore, Respondent 9 expressed that employees need first to learn some fundamentals of AI to acquire the basic capacity of recognising AI opportunities, a thought mirrored by Respondent 8 when talking about the ability to spot opportunities. Furthermore, as explained by Respondent 10, due to the significant interest in AI among businesses, many pilot projects are organically appearing inside firms, but without real broader planning and organisational integration, leading to failures that are costly to redesign later time. According to Respondent 8, decision-makers inside firms are often less apt inside technology and have thus limited understanding of AI's capacity and its applicability, leading to additional barriers and misconceptions of AI adoption.

Respondent 9 expressed that companies sometimes develop certain AI solutions themselves without considering how to maintain and evolve such solutions. Therefore, according to the Respondent, these solutions end up being not in use as they are not fully integrated into the organisation. In addition, Respondent 8 mentioned that when firms adopt various AI solutions, miscommunication issues can appear when employees with a business background and technical background communicate with each other, creating alignment issues.

4.2.2.3. Defining the problem

When discussing the application areas of AI, all the respondents were unanimous that defining the problem before applying any solutions is highly important. According to all respondents, this problem definition should be the major starting point before applying any digital solution. However, Respondent 11 argued that solutions can be defined by both the opportunity to apply them and the problems that are defining them, but that in general, the problem should be the guideline for what solution companies should adopt. Moreover, Respondent 8 stressed the importance of precaution, as the same solution may not possess the same value for companies with similar challenges, which must be considered too before adopting any digital solution, whether AI or something else. Thus, an aspect echoed by all respondents was the emphasis on the centrality of the challenge when discussing AI adoption, saying that the problem always has to be the point of departure when implementing or adopting AI solutions. According to the respondents, adopting AI for its sake is not a sound strategy, as according to Respondent 8, AI will most often not be a part of the best solution. As elaborated by the Respondent, it does not matter if AI is or is not part of the solution; the focus should be to solve the problem. Similarly, as expressed by Respondents 12 and 13, the real question is what the best technology for solving the challenge is. Furthermore, as explained by Respondent 9, for AI to become a feasible option, companies need first to understand the challenge, define it, and then decide what and how to measure it.

4.2.2.4. Buy-in and trustworthiness

Another barrier to adoption is, according to Respondent 8, trust. As the respondent explains, users of AI solutions often do not entirely trust the produced results, demonstrating the importance of good quality of data, and the process of validating results, ensuring they match with expected outputs, and through that ensuring trust for the solution and usage in firms. In relation to this, throughout the interviews, some of the respondents problematised humans' capacity to understand which basis an AI application made certain decisions on. According to Respondent 10, this is due to the so-called "black-box effect" of AI, making it difficult for humans sometimes to understand potential misjudgements made by AI applications. Therefore, the respondent stressed the importance of this awareness among AI adopters before applying or developing any AI-based solutions since the ability to trace back why certain decisions were made might be difficult.

4.2.2.5. Regulations

Another discussed potential challenge was regulations. Here, Respondent 10 mentioned that clear regulations connected to data usage and data ownership are needed. Currently, regulation is lagging behind AI development, which according to the respondent, is quite common when society is going through technological paradigms, but essential to have in place to fully utilise technologies, like AI, in an ethical way. Moreover, both Respondent 10 and 12 mentioned that there are some existing regulations on data collection from a privacy protection perspective and that this is important always to consider when applying these digital solutions. Respondents 11, 12 and 13 also said that as data has become more available, privacy concerns have increased, and different regulative forces have been implemented. As data is being widely collected, and some of this data is extremely sensitive, the respondents stressed that AI could help with blurring different objects, including faces and other privacy-sensitive information. This, according to the respondents, is an essential feature of AI when analysing different geographical data. According to Respondent 11, firms should also ensure that their solution providers feed their data to their AI applications and are not being accessed by any third parties.

4.2.3. AI's potential benefits inside sustainable sourcing

The potential benefits of adopting AI inside sustainable sourcing at companies was a recurrent theme observed throughout the interviews and in the reviewed literature. This theme came up, for example, in discussions of AI's value and usefulness and when examining previous research on AI.

4.2.3.1. Resource savings & automation

Some respondents expressed that using AI can sometimes be quite costly to develop and adopt. However, generally speaking, the participants expressed that using AI-based systems usually results in cost savings, as processes that earlier demanded human intervention can be automated. All of the respondents mentioned that both time, labour and money could be saved when adopting AI applications. For instance, Respondent 9 mentioned that some AI applications can increase a company's overall productivity since AI can do tasks quicker and more efficiently than humans, especially for repetitive tasks, and where a large amount of data is involved. Respondent 8 agreed with this, adding that the adoption of AI can result in decreased total costs and time needed for certain tasks, addressing the scalability at which AI can solve a problem compared to humans. To exemplify this, the respondent mentioned a project that uses satellite imagery and AI to verify production sites that it sources from. The respondent said that if it would instead rely on humans for gathering the same information, the process would have been much more time consuming and expensive. The respondent emphasised that firms using similar solutions can thus have complete aerial overviews, guaranteeing information trustworthiness due to the data's objectivity.

One of the respondents said that the potential benefits and business value created by AI varies and is context-dependent, exemplifying it by the usage of a hypothetical digital tool for verification and monitoring of suppliers' adherence to sustainability standards that effectively reduces the risk of overlooking supplier misconduct, and by that, avoiding subsequent scrutiny and fines. Furthermore, another benefit for firms that own their AI applications, according to Respondent 8, is the knowledge built into them, making them accessible for the firm, compared to information or solutions that are inside people's minds, going away. This, according to the respondent, also creates opportunities for continuous improvements.

4.2.3.2. Insights

Another benefit presented by some of the respondents is AI's ability to create certain new insights, otherwise too laborious or expensive when generated by humans. As an illustration, Respondent 9 mentioned that in one of their animal-welfare projects, an AI solution based on computer vision could monitor, structure continuously, and analyse livestock surveillance footage, identifying instances of animal welfare distress. Humans could have also created these insights, however according to the respondent, this would have required at least three working shifts, and depending on the total number of surveillance places, several people inside each shift. Ultimately, with these AI solutions, Respondent 9 said that companies can get continuous insights and alerts that help companies act upon these new insights and improve their work if something stands out from the ordinary. Other application areas for such service, could according to Respondent 9, also be used for detecting product defects.

4.2.3.3. Trustworthiness

Another sub-theme that emerged during the interviews, in connection to the benefits of AI, was AI's trustworthiness. According to Respondent 8, AI enables increased reliability because of decreased monitoring costs. The respondent said that when human auditors are employed for monitoring production sites, they usually choose a sample from all possible sites and inspect them, as auditing all sites would have been time-consuming, and therefore costly. However, if AI is used, employing AI in combination with satellite imagery can lead to continuous monitoring and auditing of all sites, not just a sample of them. According to Respondent 8, this means that even with a lower-case precision than human on-site audits, increased overall precision is achievable, as more sites can be monitored and audited continuously. Moreover, Respondent 8 discussed AI's ability to be objective. For instance, the respondent said that when companies want to audit or monitor certain areas, AI solutions use data to objectively identify any misconducts, while humans may be influenced by other factors when auditing or monitoring sites. Therefore, the respondent argued that AI solutions are more objective than humans, consequently increasing the final results' reliability.

4.2.3.4. Monitoring

Several cases of applied AI have been presented to us by all Respondents, where AI is primarily being used inside continuous monitoring. As indicated by many respondents, AI is not the only component in a solution but is instead integrated with other systems, programs, and tools, providing wholesome benefits. Geographic information systems were the most frequently mentioned systems that integrate well with this AI functionality, mentioned by Respondents 8, 9, 11, 12, and 13. An example presented by Respondents 11, 12 and 13, was the use of satellite imagery of forests combined with artificial intelligence, which was employed to monitor bark-beetles spread into Sweden. By supplying the AI-based application with data, the respondents said that its algorithm was trained to recognise forests attacked by the spruce beetle, making it easier to spot areas of beetle attack.

Several solutions combining imagery and AI for wildlife and animal welfare monitoring were mentioned. These included monitoring catfish populations, albatross nesting grounds, habitat extent of different larger animals through GPS tracking, and livestock welfare monitoring. Respondent 8 also mentioned a solution with satellite imagery, where AI analyses satellite images to identify and verify solar module locations. Although it is primarily used within the energy sector, the respondent said that there are opportunities to transfer these solution principles to other industries or product categories, indicating a potential use for similar solutions within sustainable sourcing.

One of the practical problems discussed with the respondents was identifying product origins through tracing. Respondent 9 said that many systems help companies track their product components and map their origins. However, the interviewee was not involved in these and was therefore unaware if AI was a part of those solutions. Moreover, the respondent also added that sometimes blockchains are a solution to these challenges, but simple databases are enough. Another area discussed throughout the interviews was scoring systems. Respondent 9 mentioned a scoring system used to evaluate a firm's sustainability performance based on choices made by firms that went through a simple algorithm and later presented the score. However, the respondent also said that it is vital to have predefined performance metrics; otherwise, companies may focus on certain ones, leaving other, equally essential metrics unmeasured. Another case mentioned by Respondent 10 was inside the construction industry, where AI was used to recognise critical deviations based on CO_2 variation.

4.2.3.5. Prediction

Throughout the interviews, several AI respondents said that one of the most significant values and gains that AI brings is the opportunity of making continuous predictions, an attribute closely related to monitoring. For instance, Respondent 10 spoke about the many application areas for AI in different industries or different usages. However, Respondent 10 also said that to make those predictions, up to this day, AI still may need some human involvement. For instance, the respondent said that to predict future events complex in nature, such as sustainability-related occurrences, humans must first, before being able to train AI applications for it, understand these complex occurrences, and build up a model that incorporates all these aspects. Only then, as the respondent put it, AI can be used to make predictions.

Some of the respondents discussed the opportunity of using AI applications for predicting supply chain performance. For example, Respondent 8 mentioned that they have a system that tracks supply chain reliability, disruptions and resilience, and evaluates supplier's ability to deliver. Assessing this and the potential of using AI for it was something that Respondent 10 recognised, too, saying that AI could predict potential disruptions in the supply chain. Additionally, an example mentioned by Respondent 12 that combined satellite imagery with AI was the monitoring of tree-growth cycles inside electric distribution-networks maintenance. Based on the historical data, the respondent said that tree-growth speed was predicted, enabling efficient scheduling of maintenance occasions when trees near power lines had to be trimmed. Furthermore, the same technique is being used for land-use change monitoring and deforestation prediction, an example mentioned by Respondent 8 and 12. Another example mentioned by Respondent 13 is the usage of satellite images and AI inside predicting environmental impacts, like sea-level rise due to global warming, and its consequences, both for organisms, and human infrastructure, like ports, including the ability to model scenarios.

In another case, introduced by Respondent 11, AI was fed with water pressure data from continuous monitoring and predicted leakage based on that data. The respondent also presented another case for monitoring mining operations, its environmental impacts, and predicting occurrences of critical events. Some of the AI respondents also discussed the opportunity of using AI for predicting supply chain performance. However, Respondent 9 mentioned that there could be more straightforward solutions than AI for predicting supply chain performance. The respondent also problematised the usage of AI-based applications, primarily built upon historical data, for predicting the future and exemplified this by saying, “who would have predicted Covid-19?”.

4.2.3.6. Scenario modelling

Another opportunity for applying AI was according some respondents inside scenario modelling. This was exemplified by Respondent 11, who said that the newly available data created by, amongst others, smart devices, create new data sets that can be used for predictive modelling of different outcome scenarios. Respondent 13 said that from a risk assessment perspective, some advanced AI systems can model the consequences of different events, such as climate change, or if some disruptions occur along the supply chains. The respondent exemplified this by mentioning the recent case in the Suez channel, where many boats got stuck, causing many disruptions in companies’ supply chains. With these AI advanced systems, the respondent said that it would have been possible to test different scenarios and see how various choices impact the event outcomes in the supply chain. For example, by predicting shipping container delays and redirecting them, the respondent said improved outcomes could be achieved, like more resilient supply chains. However, as Respondent 12 expressed, these systems can calculate the individual risk, but the analyst, or the human, can make decisions based on the presented information. There were also some suggestions by Respondent 12 that scenario modelling could be used to predict future occurrences, such as flooding or hurricanes, to understand sensitive regions that companies supply when historical data is available.

4.2.4. Summary of AI in sustainable sourcing

Most of the respondents pointed out the lack of multidisciplinary research and worked on AI and sustainable sourcing. Therefore, the answers given on AI’s potentials in sustainable sourcing were somewhat hypothetical. However, Respondent 11 mentioned that the increasing amount of data available creates new opportunities for using AI inside different fields. This view was also shared by Respondent 10, who said that since many processes within the area of sustainable sourcing are data-driven, there is a huge potential for applying AI in the field, aiding companies in simplifying processes. However, the respondent also stressed that many non-AI digital solutions could be used for sustainable sourcing, which sometimes serves the purpose better than AI.

5. Analysis & Discussion

In order to understand how AI could potentially aid in solving sustainable sourcing challenges, the Technology-Task Fit Framework (TTFF) is used (see Figure 8). As earlier mentioned, AI's characteristics (technology characteristics) are matched with the task characteristics (IKEA's sustainable sourcing challenges) to see how well they fit together. Firstly, AI's characteristics will be introduced by combining empirical data and the literature review. Secondly, the identified sustainable sourcing challenges identified in interviews with IKEA will be grouped, introduced, and discussed. After that, the potential for AI in aiding these challenges will be analysed. Lastly, as identified both in the literature and from the empirical data, preconditions and limitations are laid out.

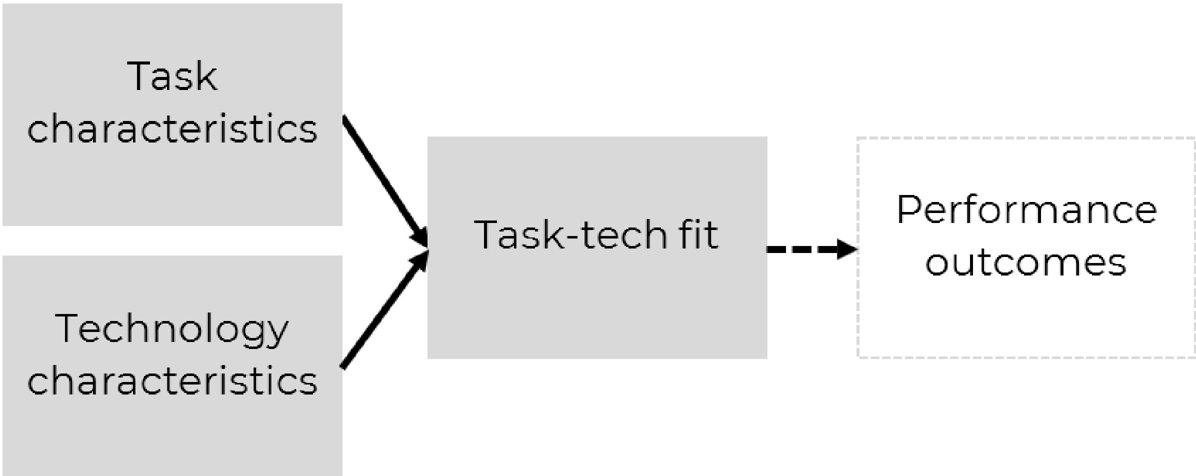

Figure 8 Task-technology fit framework

5.1. AI - Technology Characteristics

5.1.1. Monitoring and prediction

Certain insights about AI's capacity that emerged from the analysis of the interviews is its usability for the identification and monitoring of various occurrences inside a broad range of areas. As shown in the results section and explained by the literature section (Dhall et al., 2020), when an occurrence is well-understood, measurable, and data available, AI can be trained to recognise these occurrences' patterns and afterwards search and identify them in daily real-world data. In the empirical results and literature, several application areas were mentioned, like identifying and monitoring deforestation, or the spread of spruce beetles, and identifying individual tree species families (Ritter et al., 2017). As identified in the empirical data AI creates new insights, otherwise too laborious or expensive when generated by humans. Furthermore, as demonstrated by the results and literature (Akerkar, 2018; Dhall et al., 2020), with additional time and data, monitoring can be supplanted by predictive functionality, where AI starts to recognise the initial patterns of an occurrence. As exemplified in the empirical results, these include the monitoring and predicting three growth speeds and deforestation prediction. Similarly, the literature review shows AI being applied for simpler predictive functionality, like forecasting demand (Cubric, 2020; Agrawal et al., 2017), to more advanced examples, like rainfall prediction (Pham et al., 2020).

5.1.2. Scenario planning

Another capacity usable inside sustainable sourcing is the ability of AI to support scenario planning through monitoring and predicting real-time occurrences. As explained in the literature (Dhall et al., 2020; Agrawal et al., 2017; Cubric, 2020; Pham, 2020; Burgess, 2018) and shown in the empirical results, AI can be trained, based on available data, predict different occurrences and their probability. An interesting finding from the empirical evidence stated by some respondents is that due to these features, AI could potentially assist in modelling different scenarios, an insight confirmed by the literature (Baryannis et al., 2019). Thus, while humans must decide which scenarios to follow and which risks to take, AI can aid them in providing the possible outcomes of their decisions (Agrawal et al., 2017; Wilson and Daughtery, 2018). Furthermore, as expressed by a respondent, an increase of available smart devices increases total available data and enables integrating these features into new areas.

5.1.3. Automatization

As shown in the literature (Herweijer & Waughray, 2018) and empirical results, AI can automate several manual tasks that would otherwise demand human intervention. Moreover, by training algorithms through AI approaches like ML to perform these tasks, AI can significantly reduce the costs connected to this type of labour (Agrawal & Kirkland, 2018). Furthermore, as shown by the literature (Herweijer & Waughray, 2018; Agrawal & Kirkland, 2018**)** and empirical results, AI can deliver these results faster, more accurate, and cheaper than humans could, thanks to its scaling capacity and the ability to continuously process large amounts of data which increase the overall productivity of a company.

5.2. Applied Framework

Based upon the empirical data, with support from the literature review, three sustainable sourcing challenges were identified, including supply chain issues, information overload, and finally, impact assessment and predictions. These will be discussed in the following sections, while simultaneously, the fit between AI characteristics and the challenge is evaluated.

5.2.1. Challenge 1: Supply Chain Issues

5.2.1.1. Challenge characteristics

One of the significant challenges identified from the interviews with IKEA respondents is supply chain issues. As several IKEA respondents stated, due to the inherent complexity of current supply chains caused by their increasingly globalised and diverse supply chains, with countless sub-suppliers, and often without direct contact to suppliers at the raw materials' origin, IKEA and its suppliers have to put many resources into collecting information, both money-wise and time-wise, to understand where their raw materials are coming from. As many IKEA respondents state, all this complexity consequently hampers IKEA's ability to ensure adequate traceability, in turn limiting the extent of transparency. A strong relationship between multi-tier supply chains and low transparency is also recognised in the literature (Mejías, Bellas, Pardo & Paz, 2019). Several respondents recognise this challenge at IKEA who state that many firms experience problems mapping their supply chains, partially because of the tendency to use complex supply chains, but also due to the advanced traceability legislation they must oblige in these markets, like EU's timber regulation (Pajares et al., 2020). Interestingly, this challenge does, according to some IKEA respondents, not occur with all products. For example, certain raw material products have simpler supply chains, such as wood planks, and are easier to trace, enabling a more significant degree of traceability and transparency. Therefore, an interesting finding is that the level of accurate traceability and transparency is dependent on the level of the supply chain complexity and opacity, which in turn is dependent on the raw materials used in the products.

The need for traceability puts additional resource pressure on businesses, resulting in difficulties in balancing resources, as companies must always account for costs and the benefits connected to their operations, not only for traceability reasons but resource allocations in general. Moreover, understanding what is sensible or not in terms of collecting information is often a struggle for workers within sustainability, as acknowledged by some respondents. Empirical evidence points towards certain resource balancing issues, where legislative demands that might have minor positive impacts on sustainability incur high costs that could have been used on ventures that significantly impact sustainability. As one of the IKEA respondents said, suppliers often are fully occupied by working with compliance and therefore miss the opportunity to work with other initiatives that could promote sustainability. Moreover, the respondent expressed that these time-consuming traceability demands can expose firms to additional risks, as some suppliers may feel inclined to falsify documents. In sum, traceability is vital for enabling sustainable practices in the supply chain (Van den Brink et al., 2019); however, as evident from the empirical data, the demands that traceability puts on companies, especially for certain raw materials that are harder to trace, can result in disproportionate resource allocation, when compared to their sustainability impact. Nonetheless, as shown in the empirical results, ensuring sustainability, from the local source down to the focal firm, is essential, as most environmental damage occurs there, a statement supported by literature (Sanders et al., 2019). Thus, guaranteeing sustainable supply chains down to the final supplier is highly important for evaluating and mitigating sustainability impacts.

Another issue is according to some respondents that companies that IKEA does not have direct legal bindings with are harder to target in terms of both traceability and sustainability initiatives, as IKEA cannot put pressure on these companies to the same extent as their direct suppliers, which consequently creates traceability challenges, and is time-consuming. This issue is also recognised in the literature where Wilhelm, Blome, Wieck and Xiao (2016) express that as many companies lack direct legal contracts with suppliers inside multi-tier supply chains, they struggle to enforce sustainability initiatives on these suppliers. Moreover, as highlighted in the empirical chapter, IKEA often has to rely upon documents provided by suppliers that travelled between the various levels or have to be obtained by contacting the suppliers on the different levels, which increases the risk of errors or intentional misconduct. Furthermore, some of the IKEA respondents mentioned that the information needs to be put into the origin tracking systems manually, making it a time-consuming effort prone to human errors. This challenge is also recognised in previous research (Leong et al., 2018).

Another challenge emerging from the empirical data is related to the difficulty of verifying tracing documentation. According to one of the IKEA respondents, suppliers have different internal information reporting systems and procedures, sometimes even based on paper documentation, increasing the time taken for collecting verification documentation and the quality of the outcomes. Additionally, as shown by the empirical results, some suppliers are, due to competitive reasons, not willing to share all the necessary information, as this exposes them to being bypassed or undercut. Consequently, this impacts IKEA's possibility to ensure adequate traceability, limiting the extent of transparency. The literature also highlights this challenge, saying that firms struggle to collect information from their suppliers, and as a consequence, companies sometimes struggle to get the data needed to make their supply chains fully sustainable (Gurtu et al., 2017). Altogether, the issue of verification and information sharing poses substantial challenges for IKEA's sustainable sourcing agenda.

5.2.1.2. Fit with AI characteristics

Several potential fits between AI's characteristics and the first sustainable sourcing challenge, supply chain issues, were identified. As highlighted above, one of the challenges that IKEA experiences, is related to the collection of information, consequently impacting traceability and transparency, resulting in a lack of relevant information and data. As some of the AI respondents highlighted, using AI's ability to monitor certain aspects and developments at and around suppliers' operations could create the possibility to monitor development on the ground, like in the cases of deforestation monitoring, monitoring of mining operations, etcetera., enabling firms like IKEA to access information that was previously difficult to obtain, and even verify information obtained from the suppliers. This could help firms identify misconduct and act upon it, reducing the overall risk of missing non-compliance and improving the real-world sustainability record. Moreover, other AI tools that collect end-to-end data could assist and possibly simplify the traceability work by collecting information throughout the supply chain (Ebinger & Omondi, 2020). While this solution does not directly address the challenge of gaining access to some information that certain suppliers are not willing to share, and the problem with falsified documents remains, it does, however, circumvent them by delivering some of the needed information without possibilities of someone tampering with it, thus giving real-world insights to IKEA. Nonetheless, as many of the AI respondents discussed, other technologies can aid companies with these issues.

As found in the literature (Agrawal & Kirkland, 2018) and empirical results, AI benefits from its scalability. This means that AI's capacity can be doubled, quadrupled, etcetera., while the costs increase by only a fraction (Agrawal & Kirkland, 2018). This can make it feasible to continuously monitor whole supply chains instead of individually auditing a small sample of suppliers, increasing the chance of catching misconduct when the data is available. Furthermore, AI's objectivity can further aid firms here, as AI generally has a lower number of biases built into its reasoning system than humans, reducing the chance of human error (Akerer, 2018). In other words, AI can verify a larger sample of sites than humans and be more objective when doing so. These additional benefits of AI can create a clear opportunity for AI inside the sustainable sourcing field resulting in potential benefits that companies can reap. As some AI respondents express, monitoring could be further developed into prediction, enabling firms to act before certain occurrences happen. The predictive functionality in these cases could be even further integrated into strategic scenario planning tools and aid managers in taking the best available actions (Herweijer & Waughray, 2018; Agrawal et al., 2017; Cubric, 2020; Pham, 2020).

Another challenge that emerged in the empirical data was obtaining tracing information from sub-suppliers due to its labour-intensive nature. As suppliers often use different systems, they then have to manually transfer data from internal systems into IKEA's tracing systems, sometimes even from unstructured data, like hand-written paper sheets, increasing the chance of human error and making it labour intensive, thus reducing the likelihood of getting all the needed data and it being of good quality. Here, as some AI respondent mentioned, AI could potentially help free up some resources that could be used for other sustainability activities or other value-added activities instead. Furthermore, AI could automate some of these repetitive, continuous processes through AI trained algorithms that could mine the needed data instead of manually copying it (Akerer, 2018). This indicates a good fit with AI's capacity, in so being a potential facilitator of improvement, mainly in cases where the suppliers already have certain data in their internal system, that is then manually transferred to IKEA's tracing systems. Through the hypothetical automatisation of this process with the help of AI, resource savings in terms of time and costs could be achieved (Herweijer & Waughray, 2018; Agrawal & Kirkland, 2019). Furthermore, due to the decrease of manual input, human errors could decrease, improving data reliability. All of this, however, is limited by the availability of data that suppliers possess. For example, if the suppliers do not have digitised information systems and instead rely on paper-based book-keeping, this approach would not work; however, other AI approaches focusing on unstructured data might (Akerkar, 2018). Furthermore, as evident in the empirical section, only a fraction of all the missing information could be obtained in this way; thus, AI's potential to aid firms in collecting all the needed information is limited to some instances, all depending on the level of digitization of their suppliers and sub-suppliers. Furthermore, other approaches like centralised systems might be more convenient and feasible for solving this challenge.

5.2.2. Challenge 2: Information Overload

5.2.2.1. Challenge characteristics

As stated by several respondents, many companies, including IKEA, are shifting their supply chains away from an exclusive compliance focus towards a more holistic development approach that positively impacts the real world. This, as revealed in the empirical section, entails evaluating various "sustainability aspects", such as business ethics, children's rights, food security, land rights, biodiversity, land-use, traceability and transparency, simultaneously and in relation to each other, when assessing the extraction and production of raw materials. This, according to some IKEA respondents, also demands an increased amount of data that needs to be collected, processed, and analysed to ensure that the decisions made have real and beneficial impacts on the various sustainability aspects. As Notarnicola et al. (2017) and Ritter et al. (2017) explained, a wider more holistic approach demands more information and data and the ability to collect and process it. Moreover, as indicated in the empirical section, defining every sustainability aspect is often complex, which further complicates the usage of the holistic approach in some sense, an insight supported in the literature (Gurtu et al., 2017).

Another interesting finding emerging from the data was that, according to some of the IKEA respondents, there is a need for automated, fast and real-time analysis that can simultaneously handle various variables and parameters, evaluate and analyse this information, and enable action in time. However, as one of the IKEA respondents argued, the information often becomes too complex, consequently impacting the ability to take actual actions where it is most needed. An explanation to this is given by one of the respondents, who said that the supply chain's structure, relating to the previous chapter on supply chain issues, become highly complex and entangled, and therefore difficult to analyse and comprehend. As Ebinger and Omondi (2020) argue, this leads to large amounts of information that companies must deal with, which could potentially result in increased human errors.

5.2.2.2. Fit with AI characteristics

Also, in this case, a potential fit was identified. Here, AI's usefulness lies in its ability to quickly process large amounts of data and recognise patterns it is trained to recognise. (Akerer, 2018) Even in cases where patterns are multi-dimensional, and would otherwise demand trained professionals to recognise, AI trained algorithms can continuously recognise high accuracy. (Akerer, 2018) As IKEA's holistic approach demands more data to be evaluated and analysed, AI's ability to recognise patterns inside large amounts of data and generate unique insights (Akerkar, 2018) could help firms with the new increased dataflows, a benefit recognised the empirical results. As the empirical section illustrates, AI can aid firms in processing the data and creating new insights that are easily understandable and can lead to immediate action. Moreover, AI can collect and process information in real time (Ebinger & Omondi, 2020). However, as some of the respondents say, AI cannot decide upon how these insights should be managed, ranked, nor what action should be taken. Thus, as one of the respondents says, AI systems can provide insights, but acting upon these insights is a task that often requires human intervention. This is somewhat supported in the literature (Naudé & Nicola, 2020; Riahi et al., 2021; Fjelland, 2020; Kaplan & Heinenen, 2019b; Gill, 2016; Khakurel et al., 2018) that states that AI has no actual capacity in terms of acting upon insights outside of its programmed scope, as current AI applications are within narrow AI, which requires human intervention.

5.2.3. Challenge 3: Impact Assessment and Prediction

5.2.3.1. Challenge characteristics

One challenge that some of the respondents from IKEA discuss is the lack of impact assessment and the prediction of potential impacts. As indicated in the empirical section, due to the complexity of certain sustainability aspects, there is a lack of universal definitions and simple metrics, making real-world impact assessments, on a broader scale, difficult. Furthermore, as shown in the empirical findings, these impact assessments are commonly focused on scoring actions undertaken by firms instead of evaluating the real-world impacts they produce. Previous literature also highlights this issue, where several authors (Lenzena et al., 2006; Ritter et al., 2017) state that wholesome assessments of the impact firms have on the environment are scarce and deficient, often missing or omitting essential factors. Simultaneously, the lack of universal definitions and measurements poses a profound challenge for companies' impact predictions and assessment capabilities (Gurtu, Searcy and Jaber, 2017). As stressed by some respondents, some firms are creating their own definitions of certain concepts and impact methodologies, however, this presents a barrier for achieving sustainability, as companies can design their own customised approaches that may not be in line with a scientific, institutional view of sustainability, and consequently not lead to real sustainability.

Another issue that emerged from the empirical data is that some respondents say that it is difficult to understand how certain complex challenges caused by anthropogenic activities, like climate change, will impact firms' sourcing. One of the respondents stressed that to deal with these different complex challenges, it is crucial to understand the future implications from several sustainability-related challenges, such as climate change, to ensure a long-term and viable, sustainable sourcing and management of raw materials.

5.2.3.2. Fit with AI characteristics

In this section, a potential fit with the challenge characteristics was identified. Some of the respondents discussed the potential usefulness of AI for assessing impact and prediction. As explained by (Dhall et al., 2020), AI can be trained to recognise patterns and then search for them in daily data, and further recognise initial signs of pattern occurrence, and through that, predict them. As exemplified in the empirical section, AI can be leveraged to continuously monitor certain aspects with the help of satellite imagery, surveillance footage, tracking devices, etcetera, for monitoring deforestation and the spread of spruce beetles as exemplified by one of the respondents. Through this, a potential exists for continuously assessing individual impacts on the environment that IKEA's supply chains have and assessing how their sustainability projects impact them. As in the previous case, monitoring impact could be further developed with predictive functionality and integrated into scenario modelling.

AI could potentially, together with big data, aid in assessing the impacts from, for example, climate change (Sanders et al., 2019). Still, as stressed by both IKEA and AI respondents, the lack of universal definitions and metrics remains, consequently restricting the opportunity of assessing impacts, both through AI or conventionally. As illustrated by some of the respondents from IKEA, universal definitions and metrics for many aspects, like biodiversity, are yet not established. Without them, evaluating the impact of certain outcomes is difficult and incomplete (Gurtu et al., 2017), and AI's current usability, limited. Moreover, the available data for conducting these types of assessments is also a potential constraint, as stressed by several respondents, and the literature is highlighting data as a fundamental aspect needed when applying AI (Cubric, 2020; Ng, 2016; Riahi et al., 2021; McKinsey & Company, 2018). Thus, this limits the aid that AI can offer within impact assessment and prediction to a fraction of cases, which can be valuable for certain firms if those cases are recognised as highly valuable.

Some of the respondents said that when the challenges are adequately defined, and when the underlying causes of different challenges are well understood, and where data is both available and of good quality, AI can predict future recurring events. However, similarly, with other forecasting tools, AI cannot predict non-regular occurrences, where one of the respondents mention the Covid-19 outbreak to illustrate this case. Moreover, as shown by empirical results, occurrences, like weather predictions, are still difficult to completely understand for humans, thus using AI to predict the outcome of such an event will encounter the same difficulties and arguably somewhat similar results. As illustrated in the results section, contemporary AI cannot solve problems that even humans cannot comprehend, instead of being an asset in cases where a clear understanding of causality, the presence of measurable metrics, and historical data are available, a conclusion somewhat supported by the literature (Khakurel et al., 2018).

5.3. Overall comments on AI in sustainable sourcing

Overall, both the empirical data and the literature (Ebinger & Omondi, 2020) highlight the lack of ready-to-use generic technological solutions employed by a broad range of actors. Instead, most of the available and presented solutions were case-specific, and many of the AI respondents discussed other technologies or solutions that could better serve the needs, aiding companies in solving the sustainable sourcing challenges. Thus, the substance behind contemporary AI's hype may be questioned. Still, AI possesses large potentials when a fit between the challenge at hand, and the characteristics of AI, match, as apparent in previous sections. Moreover, as recognised in the literature (Brynjolfsson & Norvig, 2017; Russel & Norvig, 2020; Burgess, 2018) and the empirical section, with an increased amount of data and technological breakthroughs, there are also new opportunities for AI within different fields, in which sustainable sourcing is one of these.

5.4. Preconditions and Limitations

This section aims to discuss the insights from the literature review and the empirical evidence that highlights the preconditions that must be met and the limitations of AI that must be addressed before the technology could be applied inside the sustainable sourcing field.

5.4.1. AI Maturity

A limitation worth considering is the development of AI as a field. On this note, one of the AI respondents expressed that due to the novelty and the ensuing rapid and constant development, there is an absence of standardised and generic solutions that can be applied for each business problem. As the literature highlights, most of the applied AI solutions are still within narrow AI, far from achieving general or super AI superiority. (Naudé & Dimitri, 2020; Riahi et al., 2021)**,** and therefore, one of the respondents is somewhat questioned the potential of AI, especially as it in some cases does not produce results better than humans. Furthermore, regardless of AI's evolution, and in connection to the sustainable sourcing challenges discussed during the interviews, one of the respondents expressed that there are certain events, like climate change, that humans first need to understand before AI can start aiding with sustainable sourcing challenges. Here, one of the respondents said that even though there may be some potential for applying AI-based applications for solving certain challenges, the challenges themselves can be pretty hard to define and understand as these are in nature complex to grasp, and the cause-effect relationships are often not always clear. Thus, although the AI field may develop, other conditions must be met before applying these solutions to the challenges at hand.

5.4.2. Hype

As evident in the previous section, even when all the requirements are met for adopting AI, it might still not be the best solution to the problem. As many respondents mention, there might be other solutions, simpler and cheaper, that can similarly solve the problem. These findings further support the idea of AI's applicability, saying that AI is not always the solution to all problems and that the AI's capacity is sometimes overinflated (Ng, 2016; Burgess, 2018). There is, however, evidence in the literature (Panetta, 2020) and the empirical section highlighting the potential of AI. Still, as Gartner's Hype Cycle for AI 2020 reveals, the technology is far from achieving its full potential. It is also interesting to note that the overinflated expectations are not exclusively to adopting firms, according to some respondents, but also amongst firms developing and offering AI applications. As one of the respondents mentioned, projects that contain any AI features are often rewarded with higher budgets. Furthermore, as shown in the empirical results, AI is often not operating by itself but is relatively integrated and complemented with other systems to fully function. Concerning this, the empirical evidence highlights the importance of AI knowledge (which will be discussed in later sections), as it helps companies to understand what AI can and cannot do. Taken together, these results suggest that firms should be aware of the drawbacks and limitations of current AI and not simply adopt it for the sake of it, a view also reflected in the empirical data.

5.4.3. Defining AI

As shown in the literature review, there are many different definitions of AI, and the concept itself can mean many different things to people (Accenture, 2020). These results corroborate the findings from the empirical data, where many respondents expressed that the definition of Artificial Intelligence is still somewhat elusive. Whereas some AI respondents draw the differentiation line between AI and traditional software by ramifying AI as software with human capacities, others do not. Based on the broadest definitions captured in the interviews, people have been using AI for decades, while according to more restrictive definitions from other respondents, AI has been only recently applied inside practical environments. As one of the respondents outlined, firms applying AI that is only advanced human-written algorithms might lead to firms not understanding the true potential of “new” AI. As a result of the definition ambiguity, one of the respondents expressed that companies may adopt AI-based applications without fully understanding what they can and cannot do. In this sense, defining AI is an essential step for understanding the opportunities, limitations, and preconditions needed for employing it successfully in a company.

5.4.4. Problem definition

One clear finding emerging from the empirical data and evidence in the literature (Akerkar, 2018) is the importance of problem definition before applying AI in an organisation. All the AI respondents stress the importance of defining the problem at hand that they want AI applications to solve and that the technology itself should not be the driver of the solution. As many of the AI respondents stressed, this is the focal point for AI adoption, as the problem often directs the solution at hand. In cases where challenges at hands are not clearly understood, defined, and measured, AI cannot help. These results match those observed in earlier studies, where findings suggest that companies must define problems to adopt AI in an organisation (Akerkar, 2018). Interestingly, one of the respondents also expressed that the solution itself could define the opportunity of applying them, but the general guideline is always to state the problem at hand, and thereafter apply the technology. Moreover, one of the respondents also expressed that companies should be cautious when looking at more general AI solutions, as the same solution may not possess the same value for all companies with similar challenges, thus customised solutions for every company is needed, as are individual evaluations of its value.

5.4.5. Data Quality and Data Availability

Data quality and data availability are preconditions for AI to function (Cubric, 2020; Ng, 2016; Riahi et al., 2021; McKinsey & Company, 2018). This is one of the most apparent findings, where all the respondents highlight the importance of data quality and availability for AI even to become an option. Interestingly, one of the AI respondents said that often, suppliers in firms’ supply chains have different data collection practices, which therefore decrease the quality of the aggregated data. Relating to the empirical section, there is an issue with certain suppliers’ different information collection systems, which impacts collecting data. Moreover, some suppliers do not want to share their data due to competitive reasons, as discussed in section 5.2.1.1. As a result, the suppliers’ different systems and willingness to share data could potentially impact the results' quality if an AI-based solution is employed.

Some of the respondents discuss the different opportunities for collecting data. Here, one of the respondents says that companies can sometimes trade data with each other, and another respondent mentioned that sometimes certain data is hard to measure and that on those occasions, correlated occurrences can be measured instead, circumventing the inability to measure phenomena. As expressed, both in the literature and in the empirical data, for AI to function, AI needs data. As one of the respondents explained, as data availability increases, so does the AI application outcome. These findings are consistent with those of several authors (Cubric, 2020; Ng, 2016; Riahi et al., 2021), who found that historical data is needed for training AI algorithms, and further elaborated on this saying that, where training data is lacking, the resulting AI adoption will have worse performance. However, this data dependency also limits AI in terms of what it can and cannot do. As one of the AI respondents explains, as AI is built upon historical data, making some predictions, decisions, etcetera, the outcome of the application can somewhat be limited. In other words, AI applications can only anticipate recurrent historical events; thus, a somewhat historical bias is found in the AI applications being used, which potentially limits the applicability to certain challenges.

One of the respondents highlighted AI's ability to be objective in its decisions. However, this needs to be put into perspective, as the literature showed that using skewed data leads to biased results and impacts the overall results of the outcome (Burgess, 2018; Khakurel et al., 2018). Here, one of the respondents says that regulations are essential for ensuring that the data used is managed ethically. However, as illustrated in the empirical results, technologies often move faster than regulations, thus relying upon regulations for ethical use of AI may currently not be enough. This is something that companies must think about ethically using AI.

5.4.6. AI Knowledge

The digital transformation is in many ways shaping the way companies organise and operate today, and the need for knowledge related to different technologies, including AI, is something that is highly recognised in previous research (Chui & Malhotra, 2018; Bergsten, 2019; Manyika et al., 2017). However, as evident in the empirical section, due to the lack of AI knowledge in firms, employees have trouble spotting the opportunities of using AI in their organisation. This knowledge gap is also reflected on the managerial level, as both IKEA and AI respondents express that those decision-makers often overestimate what technologies can do. Here, several of the respondents say that despite a general lack of knowledge within many companies, senior managers still push for adopting AI into their organisations, despite themselves not possessing any substantive knowledge that would have been needed for successful adoption of AI. Interestingly, some of the AI respondents argue that thanks to AI enthusiasm present in many firms, individual projects start to emerge within firms, yet lack a broader organisational integration and structure, therefore seldomly resulting in successful adoptions into the organisation. Thus, firms may adopt technologies, for its sake, spending resources without getting the expected results.

Knowledge is also essential as it can help employees trust the AI output (Bergstein, 2019; Manyika et al., 2017; McGovern et al., 2017; Rao et al., 2017). One of the respondents also emphasises the importance of ensuring that employees trust AI in order to use it. The trust is also impacted by employees' ability to understand why an AI-based application made certain decisions, the so-called "black-box challenge", a finding correlating to the literature (Hanenlein & Kaplan, 2019). Therefore, trustworthiness among employees is one key factor to consider before adopting AI, which is often created by an increased knowledge base within companies. Moreover, the literature (Bergstein, 2019) and the empirical section provides evidence of the importance of ensuring that the knowledge does not primarily reside in certain organisational departments but rather be spread throughout the company (Bergstein, 2019). One of the AI respondents also highlights that potential miscommunication can be reduced when the knowledge is not concentrated in one department but instead spread throughout the organisation. While this is seen as an imperative among most of the respondents in this study, the interviews with the IKEA respondents illustrate the varying degrees of knowledge in certain departments. As one of the IKEA respondents expressed, currently, there is a limited number of people working with advanced technological tools inside the sustainability department. Though, as many of the IKEA and AI respondents argue, most firms have varying levels of technological skills and knowledge throughout their organisations, impacting the adoption of different technologies, consequently limiting companies' opportunities to use AI.

5.4.7. Job Supplemented

Another potential factor that must be considered before adopting AI is understanding the organisational changes that may occur when AI is adopted, as workers' job tasks may change when AI is applied. Interestingly, neither AI respondents nor IKEA respondents mention the fear of losing certain jobs when discussing AI adoption, which is often a predominant area of discussion in the literature (Haenlein & Kaplan, 2019a). This could be explained by AI respondents who state that AI will take over some tasks from humans but merely support humans, as AI often does not constitute the whole solution to a challenge. Moreover, up until today, AI can only do what humans tell it to do, strengthening the argument of human intervention when AI applications are adopted and the limits of what AI can do on its own (Burgess, 2018). One part of this explanation may be the development of AI, as AI still only has narrow capabilities (Naudé & Dimitri, 2020; Riahi et al., 2021; Fjelland, 2020), and that only certain tasks will be entirely replaced by AI applications (Hung, Rust & Maksimovic, 2019). All of this points towards the fear of losing jobs being mainly a construct of overinflated expectations of what AI can do, as in practical application, at least currently, its usability is somewhat limited.

5.4.8. Metrics and definitions

The importance of metrics and definitions was something highly stressed by both AI and IKEA respondents. As one of the AI respondents expressed, it is difficult for AI to become a feasible option without any measures. Similarly, many of the IKEA respondents stress the importance of the universally accepted measures and definitions, but these are often absent today. Moreover, some respondents say that companies creating their own definitions of what certain sustainability aspects should entail are dangerous, as these may not be in line with the scientific, institutional view of sustainability. For example, one of the IKEA respondents says that it is often difficult to understand the impacts of decisions being made, as nature often takes a long time to generate visibly. Moreover, as one of the AI respondents says, some future events and their impact are difficult even for humans to understand. This could potentially explain why impact assessments are somewhat challenging to develop fully, As stressed upon in an earlier section 5.2.3.1, AI cannot be applied where humans do not understand the underlying, sometimes complex, cause-effect impacts. Instead, as one of the AI respondents argue, AI must be trained for understanding these complex interrelationships and build up models that incorporate all these different aspects. Thus, a precondition before using any AI application is that metrics and definitions are in place, enabling the starting of measurement and collection of data, something that prior studies (Cubric, 2020) have also noted the importance of.

Another interesting finding emerging from the empirical data is the highly dependent relationships between different ecological systems. As some of the respondents highlight, raw materials are often interlinked. For instance, as one of the respondents explained, deforestation is often a result of agriculture and growing food demand. Thus, the challenges themselves become all integrated, and in order to find solutions for all the sustainable sourcing challenges, understanding these different interrelations must be understood. According to one of the respondents, this is important, as otherwise, it can result in a sub-optimisation of individual supply chains, which is not coherent with sustainable sourcing. Simultaneously, the negative impacts of AI must be understood to ensure that the sustainability efforts are not being substituted (Russel, 2017; Larsson et al., 2019). In connection to this, an interesting insight from the empirical section is that some raw material initiatives receive more resources than others, resulting in further advancements in sustainable sourcing scheme achievements. However, as this section highlights, and as argued by one of the IKEA respondents, it is vital to not neglect one raw material over the other, as they are often connected and impacting each other. These findings are essential to consider before using any technology, whether it is AI or another, as different data and parameters from different raw material supply chains need to be integrated for all-encompassing sustainable sourcing. If companies do not consider this, additional sustainable sourcing challenges may be created.

5.4.9. Net-benefit

The trade-off between the costs and the value received from AI was discussed throughout the interviews. On the one hand, as highlighted throughout the interviews, adopting AI solutions may not be feasible due to the impracticality, costs, or low added value. As mentioned in the literature, high costs can limit companies from adopting new technologies (Cubric, 2020). On the other hand, the empirical sections show clear evidence for potential benefits that companies can reap from applying AI despite the costs. For instance, one of the AI respondents mentioned that if companies develop their own AI solutions, the risk of losing certain knowledge decreases, as the solution itself will always stay within the company, while if an employee possesses the knowledge, it can easily disappear if the employee chooses to leave. Moreover, both scalability, resource savings, and data objectivity are great benefits that AI adoption can provide, discussed by some of the AI respondents. Here, AI can, according to many of the respondents, do certain tasks more efficiently compared to humans, saving many resources to be used for other purposeful activities instead. These efficiency gains are also recognised in the literature (Akerkar, 2018**)**.

As seen in the results section with IKEA respondents, many systems currently in use are becoming obsolete and need to be replaced by more advanced solutions that are more elaborate and offer an increased functional capacity. Consequently, these new technological solutions might be perceived as overwhelming and create new burdens for the organisation, demanding simple adoption approaches and advanced understanding and training. Moreover, as these systems need to be replaced, additional costs for adopting AI solutions may have to be considered.

6. Conclusions

In this section, the conclusions of this study are presented by addressing the research questions. Moreover, some managerial implications and recommendations are suggested, limitations are addressed, and future recommendations are presented.

6.1. The potential of AI in sustainable sourcing

This explorative study has investigated the potential of using AI in sustainable sourcing. The term itself, Artificial Intelligence, has received much attention lately as a means to solve many different challenges. However, multidisciplinary studies on artificial intelligence and sustainable sourcing have yet not been extensively investigated. Thus, this study set out to address this research gap and provide practical guidelines. The following research questions guided the research and will be discussed in this first section:

> **RQ1:** How can AI aid a firm in solving challenges inside sustainable sourcing?
>
> **RQ1.1:** What are the main challenges for a large multinational conglomerate for sourcing sustainably?

In order to answer our first research question, we needed to identify some of the challenges that an extensive multinational conglomerate experiences in sustainable sourcing, using RQ1.1. for identifying them and then looking at the ways AI could aid in solving them. By doing so, we provide a deeper insight into what challenges remain unresolved within the sustainable sourcing field. These challenges were then grouped into three overarching topics: supply chain issues, information overload, and impact assessment and prediction. These identified sustainable sourcing challenges assist us in understanding how AI could potentially be used for solving these and contributes to the current research on sustainable sourcing.

The second aim of this study was to investigate how AI can aid a large multinational conglomerate in solving sustainable sourcing challenges. Among others, AI's capacity to monitor, predict, automate, and aid in scenario planning were uncovered. The Task-Technology Fit Framework (TTFF), used to identify potential fit between sustainable sourcing challenges and AI solutions, reveals some potential for using AI to solve the identified sustainable sourcing challenges. This applies when the needed preconditions are met and where the task, that is, the sustainable sourcing challenge, fits AI's characteristics. As this study has identified, AI can aid companies in collecting information needed for traceability and transparency reasons due to the opportunity of using AI for monitoring conditions at and around suppliers, providing the focal firm with information that would otherwise be difficult to obtain. Furthermore, the information collection process is often time-consuming, and AI's automation capabilities could assist companies with this, freeing up resources that could be used for other sustainability-related tasks and decrease human errors. However, this study has also shown that other technologies are often more suitable for certain tasks and sustainable sourcing challenges and that firms may still struggle in collecting some information that suppliers are not willing or able to share. Moreover, the study found that the level of digitization at suppliers is also a significant obstacle, as this can impact the overall opportunity to apply AI for supply chain issues. These results imply that firstly, AI may not always be the solution to the identified sustainable sourcing challenges, and secondly, companies are somewhat restricted in terms of adopting certain technologies for solving these because of suppliers' digitization levels.

This study has also found that AI could, due to its objectivity and scalability, help verify sites quicker than humans and predict future events before they occur. Furthermore, AI's opportunity of processing a large amount of data and recognising patterns can aid companies in handling much information simultaneously. As many companies move towards a holistic development approach, encompassing many different sustainability aspects, the amount of data needed to be handled increases. Thus, AI could aid in helping companies make sense of this data. However, as AI's capacity is still somewhat limited due to its narrow application areas, not achieving the more significant potential that general and super AI can, humans are still needed to act upon the insights and output that an AI application delivers. Moreover, AI's potential is often limited as it is restricted by the historical data, making some predictions, decisions, etcetera somewhat limited.

The study results also indicate that AI can aid companies in understanding future events, such as climate change, and the impact from these, monitor certain aspects, like deforestation, prevent it from occurring and predict other recurring events. Moreover, the study finds that when humans cannot even understand the underlying casualties, where metrics are lacking, and where data is unattainable and of low quality, AI can, or should not, be used to predict future events.

Taken together, these results suggest that AI could potentially be used in solving some of IKEA's sustainable sourcing challenges. However, despite the potential, it is also recognised that AI has limited capacity to aid firms in solving the identified sustainable sourcing challenges, mainly due to it being a relatively new technology. Furthermore, evidence from this study suggests that there are few ready-to-use generic technological solutions applicable inside this field, and even in those cases where there are some generic solutions, there are uncertainties regarding the balance between costs and value, as well as the feasibility of applying such a solution for a company. A potential explanation for this is that problems are often company-specific, and solutions to these issues must be developed accordingly. Therefore, as problems can differ between companies, and since the problem is directing the solution at hand, AI solutions must often be tailor-made, resulting in a lack of generic applicable solutions.

Concludingly, these results highlight that, in some instances, AI can generate significant value; however, even then, the value it creates needs to be put into relation with its costs, and companies must still consider other aspects before AI can assist in solving sustainable sourcing challenges. This study has also shown that there are cases where AI does not constitute the solution to certain challenges, and in most cases, the technology only comprises a part of the solution. Thus, AI, as a "catch-all" technological solution to sustainable sourcing challenges, can be refuted.

6.2. Factors to consider

This study set out with the aim of assessing the preconditions and limitations that a large multinational conglomerate should consider before adopting AI solutions for sustainable sourcing, with this research question in mind:

RQ2: What preconditions and limitations should a large multinational conglomerate consider before adopting AI for sustainable sourcing?

The current study identified several preconditions needed for utilising AI and limitations that need consideration before adoption. Albeit the potential that AI shows, companies must acknowledge these and be somewhat realistic on what AI can solve. As evident in this study, the newness of applied AI and its narrowness explains the lack of generic solutions. This consequently limits the opportunities of applying the technology and what challenges it potentially can solve. Despite this, many firms are eager to adopt AI in their companies without thinking these investments through. However, as this study highlights, the net benefit of adopting a certain technology, whether it is AI or not, must always be considered as often many resources are needed, both money, time, and labour-wise. Thus, these results indicate that different trade-offs should always be considered when adopting new technology, and to ensure that the choice of adopting a technology fulfils the needs and demands, the net benefit of adopting such technology should always be considered.

AI knowledge, data availability and quality also emerged as essential preconditions that companies must regard before adopting AI. It is possible that these findings could potentially explain the impropriety of applying AI for certain sustainable sourcing challenges, as the data collected from several sources pose a real challenge for not only IKEA but also many other firms with complex supply chains. Moreover, the data needed for AI utilisation also raises some questions, as firms that share data more openly could potentially expose themselves to data privacy issues, which should always be balanced against the importance of sharing data for sustainability-related work. Furthermore, hidden biases should always be treated and limited. Additionally, as many companies lack the relevant AI knowledge, firms have difficulties spotting opportunities for applying AI and understanding the limitations when applying the technology in their organisations; thus, competence building is an essential precondition before adopting AI.

This study also raises some questions regarding job supplements and confirms previous studies that AI will initially instead act as a complement to workers, not completely taking over people's jobs. This finding is essential, as these insights could help companies overcome workers' potential scepticism towards new technologies. Still, however, several challenges, not only among companies but also among AI practitioners, remain evident from the difficulty of defining AI as a concept. In addition, the elusive definition of AI may explain why the technology is hard to fully adopt in companies since many find it hard to describe and do not even know if they are or are not using it. Moreover, the interlinkages between different raw materials must be evaluated to prevent a sub-optimisation of individual supply chains. These must first be in place before any challenges can be solved. Nonetheless, the future potential of AI inside the sustainable sourcing field should not be underestimated. As time will pass, more definitions, metrics, and ways of measuring will probably be developed. Greater collaboration among different partners may be needed to design these definitions and metrics, as companies who develop their own standards and metrics are problematic, as these may not be in line with scientific-based views, thus offsetting sustainability efforts. While deforestation identification and monitoring are some of the most popular and earliest adoptions inside sustainable sourcing, new deployment areas are being developed across several fields, amongst others the spruce beetle monitoring program. As an expanding number of measuring approaches may be added to the already existing ones, an increasingly comprehensive picture of the impacts on the environment, and the impacts of projects trying to improve them, should become possible and available in the future.

Finally, one of the most critical findings that could potentially explain the overall lack of AI solutions for the identified challenges is connected to the shortages of theoretical understandings of certain areas inside sustainability, like biodiversity, and the consequent absence of universal sustainability definitions and metrics. This makes it impossible for AI to assist due to contemporary AI's scope residing within the knowledge limits of humans. In other words, AI can only assist us where humans have a solid underlying understanding of cause and effect. Furthermore, unsustainable practices may occur under cover of sustainability without proper definitions that could further threaten the achievement of a company's sustainability program.

6.3. Implications & Recommendations

Based on this study's results, several recommendations can be made. Firstly, as evident from the results of this study, the availability of applied AI solutions for sustainable sourcing challenges is somewhat scarce, and other technologies may be more relevant for the identified challenges. AI as a technology does not exist inside a vacuum and has to compete with other technologies and approaches used to solve challenges. As indicated in the results, adopting AI can be costly, and as with any adoption of technology, companies must always balance the benefits with the costs of adopting it and explore the potential return on their investment. This means that all of these different technologies and solution approaches need to be compared and their net-benefit evaluated to see if AI is the best solution. Thus, we advocate that firms not solely investigate the fit between AI and the challenges that companies want to solve, but how different solutions, either technological or other, can solve firms' challenges. Here we also stress that companies have to be realistic with expectations of what AI can deliver, which challenges it can solve, and not just adopt AI based on its hype and hypothetical benefits.

Secondly, companies must ensure that certain preconditions are met if they find a match between an identified problem and AI. In the case of AI, available data is the main obstacle and enabler of AI adoption. If all the needed data is available, or at least possible to measure or obtain, AI becomes a realistic possibility inside this area. On the other hand, if even basic definitions of sustainability are missing and the underlying mechanisms not understood, usable data cannot be gathered, and AI cannot aid firms in those areas. Another precondition to consider is the current lack of AI knowledge, and its asymmetrical distribution, inside firms. The technological knowledge asymmetry within firms increases the need for simple adoptable solutions and demands time to train the employees who lack the needed skills. This, however, is often the case with changes in general and not exclusively connected to new digital solutions, like Artificial Intelligence. To improve the technological knowledge, it is recommended to either educate staff on the basics of AI or hire new staff who already possess the knowledge. This could potentially help employees understand when, how, and if companies should adopt AI or other technologies or not. However, it should be remembered that other organisational challenges could arise if hiring external people. The new systems acquired must also be evaluated not to harm existing organisational values and strategies. In addition, the new potential systems address the particular sustainable sourcing challenge that the firm struggles to address. Consequently, to understand AI fully, and adopt it successfully, additional time, costs, and labour will be required.

Finally, due to the newness of AI, its overall applicability for sustainable sourcing challenges is somewhat limited. Nonetheless, due to AI's great potential, it is crucial that companies continuously explore the opportunities that new iterations of AI offer and other technologies for sustainable sourcing to not miss out on the opportunities that the technology can deliver once adopted.

To summarise, we are providing the following recommendations:

- The point of departure should always be the challenge at hand, and AI should be only one of the possible solutions.
- If there is a match between AI and an identified problem, firms must ensure that certain preconditions are met before adopting the technology.
- AI's benefits and the value it creates should always be weighed against the incurred costs.
- Due to the newness of applied AI and the vast potential it represents, firms should continuously evaluate its potential.
- Firms should educate their staff about AI's possibilities, and account for digital literacy when hiring new staff, to develop a broad organisational understanding of when, how, and if AI should be adopted. However, firms should also consider the additional resources needed for organisational alignments, such as if new staff are hired and the implications on the overall organisation.

6.4. Limitations of the study

Several limitations must be considered when reading the results and implications of this study. Firstly, the challenges themselves are related to two raw material areas: forestry and agriculture, which can potentially impact the identified challenges in this study. Consequently, this also impacts the task characteristics in the framework. In addition, if other challenges had been identified, such as talking with other departments, there could be more areas for a fit between AI's characteristics and the challenges.

Secondly, it is also essential to bear in mind when reading this thesis that the authors are not from engineering, or forestry, background, and therefore might lack of profound knowledge in the technical sides of artificial intelligence and forestry. This can impact the overall results and insights retrieved in this thesis.

Thirdly, the methodology itself could somewhat be criticized as the interview sample is somewhat low and may not reflect all the available challenges and AI solutions or reflections available by others not interviewed. Moreover, due to the usage of a single-case study design, the ability to make general conclusions that apply to a wide range of firms is not possible. Nonetheless, firms in similar situations can find it helpful to see how AI can assist them in achieving sustainability and all the preconditions and limitations that need to be considered. Moreover, the absence of widely recognised definitions for both Artificial Intelligence and sustainable sourcing could potentially impact respondents' interpretation and our results. However, despite these limitations, the study offers valuable insights into how AI can aid in solving sustainable sourcing challenges and what aspects must be considered before adopting such technology.

6.5. Recommendations for future research

The findings provide several recommendations for future research, and these are highlighted next:

- The present study lays the groundwork for future studies on AI's role inside the sustainable sourcing field. For instance, researchers could investigate other raw materials to validate or contrast the results from this study.
- Additionally, other researchers from dissimilar disciplinary fields than ours could study this matter to provide deeper insights into the multidisciplinary field of AI and sustainable sourcing from their perspective. For example, it is recommended that researchers with an engineering background could potentially study this topic.
- A question raised by this study is the potential use of other technologies than AI within this area. For instance, blockchains or other technologies could be studied to explore how the identified sustainable sourcing challenges can be solved.
- Finally, this study was conducted through a single-case study. Therefore, future studies could research other companies, compare these challenges, or even evaluate the value generated from applying AI in a company where AI-based solutions have been adopted.

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Appendices

Appendix A: Interview Guide – case company IKEA

General Questions

1. Tell me about yourself, your background and your role at IKEA in short.

Responsible sourcing and forestry management

1. How would you describe responsible sourcing for you and IKEA in short?
    a. And why do you think it's important?
2. What are, according to you, the main challenges inside responsible sourcing of forestry raw materials?

Traceability

1. What challenge is IKEA facing in terms of traceability?
2. How does IKEA ensure that their products are sourced responsibly?
    a. (But) How does IKEA ensure it?
3. (So there are no) or (What are the) challenges that IKEA is facing in terms of retrieving the right information/monitoring from its suppliers?
    a. Probe: information overload.

Biodiversity

1. What challenges does IKEA face in terms of promoting biodiversity in its responsible sourcing and forest management?

Impact assessment

1. How do you assess and evaluate IKEA's sustsainability projects? Do you have any challenges related to this?
    a. How efficient would you say that IKEA's responsible sourcing and forest management practices/assessment methods are? What, if any, improvement areas can you see here?

Holism

1. What challenges is IKEA experiencing in terms of using a holistic approach in your responsible sourcing/responsible forest management?
    a. Probe: challenges lack of holism.
2. Is IKEA using any system when considering all the different variables connected to the holistic approach of responsible sourcing/forestry management? (to evaluate)
    a. Probe: challenges related to these systems.
3. How do you manage goals that go against each other (because of a lack of holism)?

Final Questions

1. Besides the challenges discussed, would you say there are any other challenges that we have not yet discussed?
2. Could we contact you if we have more questions?
3. Do you know anyone that we could interview?

Appendix B: Interview Guide – AI Respondents

General Questions:

1. Tell us a little bit about yourself, your educational and professional background?

Artificial Intelligence General Questions

How would you define artificial intelligence?

1. What are the main benefits, opportunities, or the strengths of AI, where does its value lie?
2. What should companies think about when adopting/choosing AI solutions?
3. What challenges or barriers exist for adopting/choosing AI solutions?
4. Which other aspects should be taken into consideration when (if) adopting/choosing AI solutions in general?

Artificial Intelligence and sustainable sourcing:

1. Do you see any clear cases for AI adoption in sustainable sourcing?
2. What IT solutions does your company offer for sourcing/sustainable sourcing/supply chain management?
    a. Which part, if any, of the solutions is AI powered?

Artificial Intelligence and IKEA's sustainable sourcing challenges:

1. Do you have any digital solution(s) that evaluates companies' impact from a sustainability point of view, like how their operations' impact, sustainability aspects, including biodiversity, climate change, deforestation etcetera?
    a. Which part, if any, of the solution is AI powered?
2. Do you have any digital solution(s) that holistically predicts future occurrences, such as climate change, biodiversity loss, and other sustainability aspects?
    a. Which part, if any, of the solution is AI powered?
3. Do you have any digital solution(s) inside supply chain traceability and transparency?
    a. Which part, if any, of the solution is AI powered?
4. Do you have any digital solution(s) connected to data collection and analytics applications that can handle a lot of data, in real time, and make automated analysis/reports on it?
    a. Which part, if any, of the solution is AI powered?

Final comments

1. Any other comments/things that we haven't discussed related to sustainable sourcing and AI that you would like to bring up?

Appendix C: Coding IKEA interviews

Technology	- Automation - Emerging tech - Old tech - Problem with AI - Technology knowledge - Usage of tech
Organisation	- Commitment - Conflicts - Holistic approach - Lack of collaboration - Lack of incentive - Lack of knowledge - Lack of system in place - Sustainability mandate - Slowness in organisation - Objectives - non-holistic
Suppliers	- Improved reporting - Monitoring - Risk mitigation - Supplier complexity - Supplier trust
Information	- Info sharing - Information overload - Traceability - Transparency
Resources	- Balancing needs and demand - Costs - Labour-intensive - Time-consuming
External pressure	- Climate change - Complexity - Compliance - Impractical expectations - Impractical legislation - Lack of legislative enforcement - Shift in legislation

Appendix D: Coding AI interviews

Preconditions and limitations	- Adoption - AI knowledge - Applicability - Data availability - Data quality - Novelty - Org. misalignment - Regulations - Supply chain complexity - Trust - Definition ambiguity - Expensive - Feasibility - Integration of aspects - Validation - Operationalising AI - Problem focus - Reliability - Traceability - Metrics
Benefits	- Alerts - Cost-saving - Effectiveness - Efficiency - Feasibility - Increased reliability - New insights - Objectivity - Precision - Prediction - Scalability - Timesaving
AI characteristics	- AI definition - AI hype - AI maturity - AI support
Sustainable sourcing solutions	- Collaboration - Digital solutions - Potential solution IKEA