Exploring the Use of AI in Sustainable Sourcing: Insights into the Impact and Potential of Artificial Intelligence

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Abstract: IKEA is a massive international conglomerate company, and the purpose of this exploratory qualitative research is to investigate how the burgeoning academic field known as "artificial intelligence" (AI) could assist IKEA in resolving some of the challenges that it is currently dealing with in relation to its efforts to source sustainable materials. According to the conclusions of this study, artificial intelligence has the potential to aid in the resolution of at least some of the issues associated with sustainable sourcing, at least to some degree. This was developed by mapping the issues, analyzing the potential for adopting artificial intelligence as a solution, and defining the components that are required for the efficient adoption of the technology. Several prerequisites need to be satisfied by businesses before artificial intelligence can be used around sustainable sourcing. In addition, several artificial intelligence constraints need to be addressed before the technology can be put into practice by the same businesses. In conclusion, the findings of this study offer some management implications and ideas for businesses that have the goal of sourcing in a way that is less harmful to the environment by making use of technological breakthroughs such as artificial intelligence. This can be accomplished through the utilization of innovative technologies.

Keywords: Artificial intelligence, machine learning, project management.

1. Introduction

In recent decades, companies and society as a whole have shown a growing interest in developing more sustainable practices. Internal factors, such as reputation, organizational culture, and competitive advantage, as well as external drivers, such as regulation, societal values and norms, and stakeholder pressure, are cited as reasons for firms' incorporation of sustainable business practices within the business sector [1]. As a result, many businesses are implementing sustainable practices to demonstrate their sense of responsibility, making this the new norm for doing business [2, 3]. The integration of sustainability into enterprises has a significant influence on supply chain management, especially sustainable sourcing [2]. However, sustainable sourcing may be defined as the coordination of supply chains toward economic, environmental, and social sustainability [4–6]. The notion of sustainable sourcing has gained more prominence.

Due to businesses' recognition of the environmental, societal, and economic impacts they generate not through their direct operations but rather spread throughout their entire supply chains, they have realized that sustainable sourcing is an integral part of becoming sustainable [7, 8]. Despite the increasing attention sustainable sourcing has received, the research reveals that businesses continue to struggle to source

sustainably, with numerous difficulties remaining unsolved. As illustrated by a recent case, global media uncovered how well-known companies with advanced sustainable sourcing programs were sourcing materials from suppliers active in a region with widespread human rights violations [9], confirming the existence of firms' unresolved sustainable sourcing issues. As businesses seek answers to sustainability-related concerns, artificial intelligence, or AI, has garnered growing interest as a way of ad- dressing them [10]. Multiple definitions are applied to AI. Most of them possess skills that were formerly exclusive to humans, including perception, decision-making, prediction, automated information extraction, pattern recognition, interactive communication, and logical reasoning [10]. In addition, research indicates that AI may aid in the attainment of sustainable development objectives [10], improve environmental governance, and facilitate the sustainability transition of businesses [11]. Even though there are numerous documented examples of how AI could promote, enhance, and enable sustainability in private companies, governments, and other organizations, the use of AI has generated considerable debate in academia, with some researchers questioning whether the benefits that AI can generate can be obtained in a sustainable manner [12]. Moreover, firms must also consider other elements for the effective implementation of AI inside an organization [13]. Consequently, while using AI for sustainable sourcing, businesses must also analyze the elements to guarantee the effective and sustainable use of the technology.

2. Literature Review

This article outlines the theoretical principles used over the course of this investigation. The notion of sustainable sourcing will be presented first, followed by a discussion of sustainable sourcing issues. Then, we will introduce the reader to the idea of Artificial Intelligence (AI), as well as examine its application areas, prerequisites, and limits. In conclusion, the important theoretical discoveries will be reviewed.

2.1. Sourcing

In the past, a firm's competitive advantage came from its internal capabilities, including intellectual property, information, and skills related to core tasks. Sourcing was considered a supporting, non-core service that ensured resources for manufacturing were accessible [14]. As a result of increased globalization and improved communication, a firm's competitive advantage has shifted from its internal capabilities to successful management of supplier networks with the goal of improved resource utilization, 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 supply chain success [14]. Previously, sourcing, procurement, and buying were used interchangeably to represent a straightforward buyer-seller process. Due to rising relevance, research, and knowledge growth, they each aim to find a niche in supply chain management [14]. Due to prior alternating use, these notions are still vague. According to [14], buying used to mean sourcing but now means acquiring a company's equipment, supplies, and services. Procurement comprises contract management, requirements formulation, and supplier quality monitoring [15]. Strategic sourcing, unlike buying, involves building and managing supplier relationships to satisfy business requirements and accomplish strategic goals [14]. This difference is exact, yet both terms are commonly used interchangeably [15].

2.2. Sustainable Sourcing

The [16] issued the "Guiding Principles on Business and Human Rights" to help enterprises incorporate social issues into their operations and supply chains. The 2005 UN global accord encouraged firms to integrate environmental, social, and governance principles into their supply chains, which advanced sustainable sourcing [17]. According to Agrawal and Lee [18], if a firm wants to sell sustainable goods, it must get the materials required to make them. Combining sourcing with sustainability doesn't help since various

companies have varied goals and scopes for sustainable sourcing. In literature, sustainable sourcing is occasionally replaced with responsible, ethical, and green sourcing. In this scenario, sourcing is used interchangeably with purchase and procurement, creating a misunderstanding that many recognize [17, 19]. This ambiguity prevents a universal definition. However, academia has recently recognized key framings that define and frame sustainable sourcing (or responsible sourcing, sustainable supply chain management, or ethical sourcing). Pagell and Li *et al.* [20] define sustainable sourcing as managing upstream operations to promote eco- nomic, environmental, and social sustainability (the "triple bottom line"). Reuter *et al.* [21] define it as incorporating the triple bottom line into supply chain management goals. Ahi and Searcy [5] define it as a voluntary coordinated effort throughout the supply chain to improve triple bottom-line performance by coordinating critical business systems and managing resources related to procurement, production, and distribution. Sus- sustainable sourcing involves all acts and attempts to enhance environmental, social, and economic concerns by coordinating supply chains.

2.3. The Development of AI

A vast and expanding corpus of literature has examined artificial intelligence (AI). Alan Turing, one of the academic field's pioneers, created a test in the 1950s for identifying people from artificial intelligence systems that are still in use today [22]. However, despite the enormous literature on AI, the concept's definition is a contentious issue in academia and the public since there is no clear-cut definition, and as a study demonstrates, AI may mean many different things to various individuals [23]. Nonetheless, writers attempt to define the notion. AI is classified by [24] into four basic categories: systems that act humanely, think humanely, act rationally, and think logically. According to the authors, research has focused mostly on AI's capacity to behave rationally or to do the right thing. According to the authors, the appropriate action relies on the AI application's programming. Others define it differently, and to show the variety of meanings, Table 1 provides a sampling of the AI definition uncovered throughout the literature research.

Table 1. AI Definitions

Author(s)	**Definition**
Copeland (2020) [25]	"Artificial Intelligence (AI) is the ability of a computer a robot controlled by a computer to do tasks that are usually done by humans because they require human intelligence and discernment" [25].
Haenlein & Kaplan (2019b) [22]	"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".
Gungor (2020) [26]	"Artificial intelligence (AI) is an umbrella term for various methodologies that are designed to provide computer with human-like abilities of hearing, seeing, reasoning and learning [26]".
Oxford English Dictionary (2021)	"The capacity of computer or other machines to exhibit or stimulate intelligent behavior; the field of study concerned with this. Abbreviated AI."
Vinuesa *et al.* (2020) [10]	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., the discovery of fake news articles in social media), interactive communication (e.g., social robots or chatbots), and logical reasoning (e.g., theory development from premises)' [10].
Canhoto & Clear (2020) [27]	"We define AI as an assemblage of technological components that collect, process, and act on data in ways that stimulate human intelligence" [27].

Collectively, these studies and definitions illustrate the inconsistent usage of AI in earlier research's

descriptions, which may indicate the difficulties of defining AI as a concept. As these definitions demonstrate, AI may be seen as an umbrella word encompassing a variety of software methods and approaches capable of learning, processing, interpreting, and thinking similarly to humans. Consequently, this definition will be adopted in this study.

3. Methodology

3.1. Research Strategy

Qualitative exploratory research was performed to address the research questions and complete this thesis. We chose explorative qualitative research since it met our goalsand preconditions best [28].

The lack of transdisciplinary research on AI and sustainable sourcing prompted a qualitative explorative study. Thus, qualitative explorative research was selected since testing hypotheses, the starting point for quantitative and confirmatory investigations [28], was problematic. To answer the study questions and complete this the- sis, respondents needed in-depth information, viewpoints, and insights. Qualitative research, according to Bell *et al.* [28], is more descriptive and provides a deeper under- standing of the phenomena researched. Thus, an exploratory qualitative research technique allowed us to examine an understudied topic and get the in-depth information required to answer the research question(s) and achieve the study's aim [28]. This study's goal is to give an in-depth knowledge of the difficulties and possible solutions, and since it's exploratory, we discovered that non-numerical reasoning would better explain and reason about these areas that are absent today, fulfilling the study's aim. Qualitative research utilizes non-numerical thinking, according to [28]. Bell *et al*. [28] describe abductive research as interpretative research because it enables researchers to analyze empirical evidence and reference existing ideas repeatedly. Using this iterative method, we gained new perspectives from the literature and responses. This enabled us to examine and comprehend the case company's sustainable sourcing concerns and AI's ability to solve them. Inductive qualitative research uses facts to generate theory [28]. However, we feel that the abductive technique allowed us to blend multiple perspectives into a full representation by alternating theoretical and empirical data while interviewing respondents from the case firm, companies, and experts in the industry. This helped us achieve our goal and find the best explanation(s) for our study topic(s).

3.2. Research Design

Several research design frameworks govern data collection and analysis [28]. This thesis uses a single-case study, which Bell *et al.* [28] define as an in-depth and exhaustive investigation of a particular example, such as IKEA's sustainable sourcing. Case studies focus on the case and its daily setting [28]. We sought an exploratory research design to comprehend the study object and find solutions. Case studies provide in-depth knowledge, according to [28]. This study's purpose matches this research design. Case studies are also used to address "how" or "why" inquiries. Yin [29] uses a case study research design to investigate how AI can help solve sustainable sourcing challenges and why they exist. The research questions supported such a design. Researchers may choose between single- and multiple-case studies. This study's goal is to solve sustainable sourcing's most complex problems, which cannot be solved by traditional methods or technologies, by understanding their essence. Thus, by focusing on IKEA's sustainable sourcing, we were able to understand its complex issues. As previously stated, and as indicated by various writers [28, 29], an in-depth investigation is like a single case study. A multiple-case study would have evaluated many situations, resulting in a larger number of sustainable sourcing difficulties that better represented the entire environment. However, the single case study appears to be the best option due to the complicated difficulties and the necessity to comprehend them.

Elliot [29] distinguishes unique, critical, revelatory, typical, and longitudinal cases. This decision affects

external validity, a quality metric addressed [28]. IKEA may be distinctive and representative without explanation. Its sustainability efforts make it one of the world's most sustainable companies. Thus, this research may provide limited insights for other firms. However, it might be representative. Like many businesses, IKEA wants to enhance its sustainable sourcing. As a longtime sustainability leader, the company's current issues will be many firms' future challenges, making it a model for others to follow. Thus, this paper's advice and solutions may help others. This research will demonstrate advanced sustainable sourcing problems using IKEA's sustainable sourcing enterprise. The difficulty did not determine the firmness of the case. Initially, the case company was contacted. After initial meetings, a practical problem was chosen. This was accomplished by comparing the highlighted regions to IKEA's potential as a case study basis. After finding the issue, we considered studying alternative firms.

Because of its size, experience, and high sustainability goal, IKEA, like few other organizations, can bring scientific value and insights into complex sustainable sourcing issues. As the delimitation states, the research focuses on organic raw resources like agriculture and forestry. IKEA uses forests as its main raw resource [30]. We also found thatagriculture affects forestry issues, so we included them under "organic raw."

3.3. Research Method

This study used primary and secondary data to address the research question. Interviews provide the main data, whereas secondary data uses existing information [28]. IKEA's sustainable sourcing difficulties were identified via case business interviews. We then questioned AI practitioners to see whether AI could solve these problems. Narrative literature and document analysis provided secondary data. In the abductive technique, interviews lead us to relevant literature, while relevant reading helped us comprehend ideas, and construct interviews, and the topic. Thus, fresh information or a forthcoming interview deepened awareness of sustainable sourcing and AI's potential in the sector. This article collected primary data through qualitative interviews. As Bell *et al.* [28] noted, the respondents' perspectives helped us comprehend this study's issue. Interviews with IKEA were necessary to fully explain some of its sustainable sourcing issues. Due to technical advancement, we wanted to interview AI developers to acquire an updated perspective. Reviewing the literature alone would have been impossible since research may be obsolete or unpublished. Thus, this study needed to interview AI practitioners with current expertise to answer its research questions and achieve its goal. We controlled the content, addressed the study question, and collected high-quality data through interviewing. Since this study aims to provide an in-depth explorative understanding of AI's potential in sustainable sourcing and IKEA's current challenges, we started by collecting data through semi-structured interviews, which allowed us to both ask predetermined questions and be flexible in asking additional questions if any interesting themes, relevant to the study, emerged during the interviews. We also used semi-structured interviews to compare respondents' replies [28] to find interlinkages between IKEA's present suggestions, solutions, and issues. To answer the study question and achieve the goal, the interviews required structure and leadership. Since this study uses an abductive technique, we may always add interview material to promote or explain the results.

Semi-structured interviews have drawbacks. Interview topics are a major downside. These may influence candidates to accept the interviewers' challenges. We avoided preoccupation by letting topics arise throughout the interviews. Utilizing the interview guide questions and allowing the candidate outlines the pertinent difficulties, decreasing confirmation bias throughout the interview. Still, an unstructured interview technique might have decreased prejudice and offered a better understanding of respondents' worldviews [28]. However, an unstructured strategy may have yielded data that were not comparable or consistent with our study aims, making them irrelevant to our thesis. Un- structured interviews took longer to conduct and analyze than semi-structured ones.

Semi-structured interviews were better. This study employed purposive sampling, which according to [28]

selects respondents relevant to the research subject. This research did not draw general generalizations about all business scenarios or suggest that interviewees may be random. Thus, Bell *et al.* [28] suggested purposive sampling. According to Bell *et al.* [28], snowball sampling is a sort of purposive sampling that uses respondents' missed contacts to gather empirical data and analysis. When interviewing IKEA respondents, we also requested contact information for other relevant respondents who may aid us with our research. It helped us reach many relevant responders, but its use must be questioned. Respondents' connections may give biased opinions based on shared beliefs. The abductive technique partly alleviated this bias since our empirical findings were regularly contrasted against literature insights. However, convenience sampling selects respondents based on their availability and accessibility [28].

Convenience sampling saves time, but it didn't mesh with our interviews' goal of obtaining insights from respondents with relevant expertise to answer our research questions and complete our thesis.

This research included data from sourcing difficulties and AI responders. Based on their classification, we solicited prospective responders in two ways. To choose the right responses, we gave them some information about our topic so they could comprehend and either refer us to others or chat with us. This assured that respondents' expertise and insights would meet our requirements and assist us answer the study topic. Bell *et al.* [28] noted that the number of interviews required to saturate theoretical knowledge might vary. This implies we couldn't have known how many people to interview at the start of our investigation. However, we saw when thoughts began repeating and no new insights were generated by questioning more individuals, reaching theoretical saturation. We started our initial data gathering by identifying IKEA's sustainable sourcing issues. Thus, we initially chose company responders with deep knowledge of the forestry and agricultural areas. According to the case study methodology, respondents required in-depth information to identify and comprehend sourcing difficulties. Thus, we inter- viewed forestry sourcing professionals first. As the relationship between forests and agriculture became clear throughout the interviews, we included respondents who operate with this raw resource. The thesis reader should be aware that the increased proportion of respondents with forestry backgrounds affects the empirical outcomes. However, the people we interviewed at the case company were mostly working in the same area, the forestry department, but in different roles, giving us an in-depth understanding of their specific work challenges and allowing us to understand the company's raw materials' sustainable sourcing challenges. Table 2 lists the study participants.

Table 2. IKEA Respondents

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	Team	50 minutes

To explore the possibility of AI in sustainable sourcing, we identified AI-savvy companies and responders. Due to the constant technological development of AI, interviewees were required to have current knowledge of this subject and, ideally, some sourcing expertise to address the positive and negative effects of AI on this field. Several firms were contacted, and four companies and some responses from them were obtained (Table 3). While the opinions of these respondents may not perfectly mirror reality, they nonetheless give some

insight into how AI may possibly contribute to resolving difficulties associated with sustainable sourcing. Importantly, these businesses do not "specialize" in organic ingredients. Due to the novelty of the field being studied and the fact that we use organic raw materials merely as a delimitation criterion, we believed that by interviewing general AI respondents, we could also obtain general answers that would help us understand how AI can be used to solve sustainable sourcing challenges outside of forestry and agriculture.

Table 3. AI Respondents

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

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3.4. Data Analysis

In the next part, the study's topic analysis will be explained. In addition, we will ex- plain the analytical framework used to structure the study. In general, qualitative research uses less rigorous analytical methods than quantitative research; rather, it focuses on uncovering patterns [288]. We opted to employ a theme analysis as our analytical framework to create scientific value in terms of providing insights into sustainable sourcing difficulties and how they may be handled by AI. The purpose of thematic analysis is to identify, examine, and differentiate patterns within data. According to Bell *et al.* [28], there are several qualitative analysis methods, including grounded theory, narrative analysis, and discourse analysis. Aside from the degree of method codification, all are comparable to theme analysis in that they all seek to identify patterns [28]. The benefits of theme analysis being less time-consuming and more flexible than a grounded theory [28] were two strong reasons for selecting the thematic analysis framework for data analysis. In addition, it enables us to get an overall structure of the empirical data, which assists us in outlining sustainable sourcing difficulties, the potential of AI to assist with these, and the prerequisites and constraints that must be

addressed when using AI. The risk of subjective bias and a lack of replication was higher in thematic analysis [28], because there wasn't a systematic way to look at the data. To reduce this, we always conducted the various aspects of the theme analysis in pairs, notably the coding phase, where we both independently assessed the findings and then compared them to confirm that comparable interpretations had been formed. The first phase of the study was a thorough examination of the data acquired via the interviews, which began with the transcription of the interviews, i.e., the handling of the raw data [28]. After each interview, the transcription was completed, encompassing all of the information from the interviews and enabling us to have a comprehensive grasp of the material being studied, which therefore assisted us in becoming acquainted with the data. We did not delete any data from the recorded material, reducing bias and ensuring that no significant findings were ignored. Atlas.ti, a qualitative software analysis tool, was used to aid in our theme analysis. The transcribed content was added to this application, and we also used it to color-code our data. The color coding was performed immediately after each interview to ensure that the memories were fresh and to prevent misinterpretations. The coding was based on both codes derived from the actual data and predefined codes derived from a survey of the relevant literature. This enabled us to be exploratory in the sense that new areas of interest may arise from the data while remaining focused on the aims of the research. After coding all of the texts, we organized the codes into multiple sub-themes depending on their qualities, and then we aggregated them into several themes. Based on this, we found various problems outlined in the analysis and discussion sections. This may be something of a biased procedure since it is subjective, and the risk of leaving vital material out of the research is clear. To adjust for this, we constantly discussed the various codes and themes, completed the analysis individually and then jointly, utilized the literature when required to back up specific themes, and used the transcribed material when in doubt.

3.5. Quality of the Study

There are several methods or criteria, such as validity, replicability, and reliability, for evaluating the overall quality of research, and there are numerous academic disputes over the best appropriate criterion for qualitative studies. Although the usage of validity, replicability, and reliability has been the subject of considerable debate, as these are measures of a study's quality that are typically associated with quantitative studies and not qualitative ones [28], these measures will be used in this thesis as they are well-known and familiar to many. Therefore, the following parts will explore relating these ideas to the research to assess its quality.

Validity encompasses a spectrum of principles that are generally relevant to qualitative research. External validity, often known as the generalizability of findings, is the most important term for a qualitative investigation out of all the others. External validity relates to the overall generalizability of a study's conclusions, and the external validity of single-case studies is often poor since they only analyze one instance. Consequently, it is debatable whether a single example may yield universal insights applicable to more than just that situation [28]. This study's generalizability might be questioned since it examines just one company's sustainable sourcing strategy and the related problems. However, as emphasized by [31], such generalizations are not the primary purpose of case studies. Nevertheless, even though the research methodology shows a low degree of generalizability for the results, other businesses experiencing comparable difficulties may acquire useful insights from this study's findings and maybe implement them. This suggests that despite this study's poor generalizability, it may have a high degree of universal applicability. Nevertheless, it should be highlighted that this is not the major objective of this research, and organizational variations may make it impossible to apply identical methods; thus, this should be carefully evaluated. Due to the practical nature of the case company's challenges, the primary goal of this thesis is not to provide generalizable findings, but rather to provide insights into the challenges faced by one company with a long history of actively working towards sourcing organic raw materials sustainably, as well as recommendations, and how these

challenges could potentially be solved through artificial intelligence. Reliability and replicability denote two quality-related notions. Reliability may be defined as the degree of variation in measurements and ideas, and it is particularly crucial in quantitative research [28]. Due to the qualitative nature of this study and the inconsistency and ambiguity of the concepts, definitions, and interpretations by different researchers, researchers attempting to replicate this study may obtain very different results, depending on the individuals they interview and how they interpret the concepts. To improve the reliability of this study, we Nonetheless, due to the qualitative character of this research, its dependability should be somewhat low. Replicability is the capacity for other researchers to do identical studies and reach the same conclusions [28]. To do so, researchers must provide a detailed account of the methods used to conduct the study [29]. Therefore, all the actions taken in this research have been thoroughly explained, justified, and defined in the methodology section, and they are highly replicable. Because we are just performing a single-case study on a firm and studying the sustainability issues of this organization, it may be difficult for researchers to get repeatable findings if they analyze other companies. Consequently, the reproducibility of this investigation is somewhat compromised.

4. Results

4.1. Sustainable Sourcing

The interviews with seven case-business representatives yielded various themes and subthemes. These themes show IKEA's sustainable sourcing from respondents' perspectives and better reflect the discussed issues than the problems. This research uses sustainable and responsible sourcing interchangeably; however, this part uses "responsible" since most respondents used it. All respondents addressed blockchain and artificial intelligence (AI) acceptance and use at the law firm. However, it is unclear how well these technologies can help the corporation overcome its biggest challenges. Respondent 3 showed how AI is used in the interviewers' regular jobs, but Respondent 1 said he had little AI expertise. Respondent 6 liked new technical options for ethical sourcing but stated firm management frequently overestimates what can be done. Interviews highlighted information-collection technologies and how to use the fresh insights received from their processing. Respondent 2 remarked that current technology might alleviate certain responsible sourcing issues, but it cannot handle complicated data. Respondent 3 recommended automating analytic processes and real-time warning systems. IKEA's fiscal 2020 sustainability report emphasizes the necessity of assessing corporate ethics, children's rights, food security, land rights, biodiversity, land use, traceability, and traceability.

Respondents stressed the need for examining raw material extraction and production holistically [30]. According to Respondent 6, more firms are adopting IKEA's comprehensive approach. Biodiversity is extremely context-specific and depends on what and where firms obtain it, making general definitions and measure problematic. New and complicated insights need to be managed, and planning and organizing a comprehensive strategy may save resources. Definitions and indicators are crucial to sustainable sourcing, the respondents said. Respondent 1 underlined the necessity of determining what a corporation stands for and supporting global interpretations applied locally. Respondent 5 said that global knowledge of a subject requires a universal definition for some features and that offsetting techniques to compensate for sustainability are not always achievable. Respondent 7 advised including all stakeholders in definitions.

Respondent 3 highlighted precision and overall sustainability evaluations. Respondent 1 said that no big multinationals have comprehensive supply chain sustainability im- pact evaluations. Respondent 4 said that corporations risk inventing their own definitions and impact assessment methods if they don't initially define sustainability. Respondent 6 also claimed that current impact assessments should be utilized but are costly and don't usually cover all the necessary elements.

Interviews emphasized being performance-focused rather than process-focused. Respondent 4 said they

are pressuring their certification partners and IKEA to become less process-oriented. Respondent 1 questioned if statutory compliance is a sustainability goal, while Respondent 4 asked rhetorically what traceability is for. The answer specified whether it should promote consumer transparency, satisfy their curiosity, or minimize environmental damage and guarantee sustainable product manufacturing. Respondents 5 and 6 emphasized transparency to help customers make better decisions. However, the responder noted that too much information may make it hard for buyers to choose the "better" product.

Respondents addressed agriculture, forestry, and raw material sources. Respondent 3 indicated that many of IKEA's sourcing challenges are structural rather than related to raw commodities. Respondent 4 blamed agriculture for deforestation, whereas Respondent 2 cited rapidly expanding food demand and infrastructure growth. Respondent 3 suggested working with local landowners to promote ecosystem services and forest retention. Respondent 6 proposed using a landscape or ecosystem strategy to get raw materials rather than sub-optimizing supply networks.

IKEA and its 1600 direct suppliers must follow IWAY, IKEA's code of conduct, and establish processes to assure conformance, do risk assessments, and gather important documents. IKEA now covers supply chain participants in its code of conduct. Respondents 1, 3, and 6 stressed the necessity of interacting with suppliers and other stakeholders along the supply chain to gather information and improve. IKEA also intends to educate and grow local staple food types for its suppliers to meet and exceed policy objectives. Changes need market acceptability.

Respondent 3 noted corporations' poor connections with local sources, such as farmers producing and gathering raw resources. Respondent 1 said that the existing system focuses on individual suppliers, but forestry wants comprehensive supply chain audits down to the forest. Respondent 3 said that the most thorough information for responsible sourcing was obtained by traveling between supply chain levels. Respondent 2 said that IKEA and its suppliers depend on supplier documentation, but they sometimes cannot check it, which is a worldwide problem for many organizations. Suppliers may have diverse, unstructured systems, which slows data collection.

Sustainable sourcing requires traceability and transparency, the respondents said. Respondent 5 stressed staying and making a difference, whereas Respondent 4 stressed supplier collaboration. Respondent 3 advocated for completely segregated and verified supply chains to improve traceability, but he worried that this would hurt suppliers and force many enterprises to leave countries without these requirements. Respondent 4 emphasized the importance of traceability in the global forestry industry, citing the fact that many nations and areas continue to manage forests in an unsustainable manner.

The respondents noted the contrasts between a simple and more complicated supply chain in the forestry sector and how some supply chain setups require IKEA and its suppliers to properly trace raw materials. Manufacturers expand suppliers and sources to reduce shortages and price spikes, diversifying and complicating the supply chain. This makes it difficult to trace and verify supplies and sub-suppliers. Since the fiber is combined and comes from numerous suppliers, items made with blending ingredients are hard to track. IKEA demands information from suppliers for tracing, but the supplier' willingness to use procedures varies. IKEA is simplifying information collection and implementing new joint reporting systems to assure supplier accuracy and efficiency.

4.2. Results from the Interviews with the AI Companies

The empirical results from interviews with company representatives from several firms offering artificial intelligence and other digital solutions provide insight into the characteristics of artificial intelligence (AI). Respondents mentioned the difficulty of defining AI, and the lack of a universal definition can cause problems as potential AI adopters cannot assess if the system, they are adopting is AI or conventional software. Respondents 11, 12, and 13 agreed with this definition, defining the starting point as algorithms that can do

advanced operations that humans traditionally perform. Respondent 10 compared contemporary applied AI with humans due to AI's current limitations, comparing its current capacity to insects rather than humans. A basic understanding of AI at companies could help in finding the relevant AI application areas.

The respondents stressed the importance of viewing AI as a tool that aids people in their day-to-day work but cautioned that it may not be able to solve all tasks. Respondents 8 and 9 stressed that AI is only a tool that supports people and will not replace them and that AI is often complemented by other programs, systems, and tools. Respondent 9 said that people are overestimating what AI solutions can solve, while Respondent 10 said that AI can solve complex and precise problems, but identifying such problems is some- times difficult. AI is often portrayed as a solution to solve problems that humans cannot, but it requires substantial time and energy to develop correctly and achieve satisfactory results. Companies are often requesting AI solutions because it is the latest buzzword, but there are often more straightforward, more accessible, and cheaper solutions than AI.

Additionally, many firms get stuck when developing AI solutions due to a lack of AI experience and knowledge. Programmers and computer scientists noticed that using the word "AI" increased the chance of getting them approved, even though they sometimes do not contain any real AI components. The current and historical development of AI was discussed during the interviews. Respondent 10 highlighted the lack of AI-related courses and university programmes and the rapid development of AI as a field. The current and future potential of AI was also discussed, with Respondent 10 noting that AI has become impressively good at dealing with large amounts of data, but there are still doubts about its potential. In the literature review and when discussing AI applications and possibilities, a common theme emerged: the various preconditions needed for the successful adoption of AI and the barriers obstructing it.

The most important details in this text are the availability of data that AI programmes can use and its quality. Respondents 8 and 9 agree that companies need to have data be- fore they can even start a project, and Respondent 11 agrees that data availability and quality are the points of departure and boundary for employing AI. Data availability and quality issues are common barriers to AI adoption, as without good-quality data, AI users will not get reliable results. An example of this is the collection and aggregation of decentralized data from suppliers with different collection practices and different collection extents. Data availability also affects the location of the relevant data, creating incentives for the trade of data and extensive collaboration. However, this can create conflicts with the privacy interests of the individuals on whom the data is based, demanding clear legislation on how and when data can be shared and handled.

The most important details in this text are that, even with good-quality data, output reliability can initially be inadequate and that some solutions may not be feasible to implement in practice due to impracticality, cost, or low added value. Additionally, the field of applied AI is relatively new, and experienced professionals are scarce. Additionally, decision-makers inside firms are often less adept with technology and have a limited understanding of AI's capacity and its applicability, leading to additional barriers and misconceptions about AI adoption. Finally, when firms adopt various AI solutions, miscommunication issues can occur when employees with a business background and a technical background communicate with each other, creating alignment issues.

When discussing the application areas of AI, all respondents agreed that defining the problem before applying any solutions is highly important. Respondents emphasized the centrality of the challenge when discussing AI adoption, emphasizing that the problem should be the point of departure when implementing or adopting AI solutions. They also stressed the importance of precaution, as the same solution may not possess the same value for companies with similar challenges, and the need to understand the challenge, define it, and decide what and how to measure it. Additionally, trust is a barrier to adoption, as users of AI solutions often do not entirely trust the produced results, demonstrating the importance of good data quality,

validating results, ensuring they match expected outputs, and ensuring trust for the solution and its usage in firms. Finally, humans' capacity to understand which basis an AI application made certain decisions on is limited due to the so-called "black box effect" of AI, making it difficult for humans to understand potential misjudgments made by AI applications.

The most important details in this text are that regulations are needed to fully utilize technologies, like AI, in an ethical way and that AI can help with blurring different objects, including faces and other privacy-sensitive information. Additionally, firms should ensure that their solution providers feed their data to their AI applications and that it is not being accessed by any third parties. Finally, the potential benefits of adopting AI for sustainable sourcing at companies include cost savings, time and labor savings, and increased productivity.

The potential benefits and business value of AI vary and are context dependent. One of the respondents mentioned a project that uses satellite imagery and AI to verify production sites. AI can provide complete aerial overviews, guaranteeing the trustworthiness of the information due to the data's objectivity. Another benefit is the knowledge built into AI applications, making them accessible for the firm and creating opportunities for continuous improvement. AI's ability to create new insights, such as through monitoring, structuring, and analyzing livestock surveillance footage, can help companies act upon these new insights and improve their work. AI can also be used to detect product defects. The most important details in this text are the benefits of AI, such as decreased monitoring costs, increased reliability, and its ability to be objective. AI is primarily used inside continuous monitoring but is also integrated with other systems, programs, and tools, providing wholesome benefits. Geographic information systems are the most frequently mentioned systems that integrate well with this AI functionality, such as satellite imagery of forests combined with artificial intelligence, an AI-based application, which was used to monitor the bark beetles spread into Sweden. Other solutions combining imagery and AI for wildlife and animal welfare monitoring were discussed, such as monitoring catfish populations, albatross nesting grounds, the habitat extent of different larger animals through GPS tracking, and livestock welfare monitoring.

Satellite imagery was also used to identify and verify solar module locations. One of the practical problems discussed was identifying product origins through tracing, and scoring systems were discussed. 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. Respondent 10 also mentioned a case where AI was used to recognize critical deviations based on CO_2 variation. AI has the potential to make continuous predictions, an attribute closely related to monitoring.

However, humans must first be able to train AI applications for it, understand these complex occurrences, and build up a model that incorporates all these aspects. Respondents discussed the opportunity of using AI applications for predicting supply chain performance, such as tracking supply chain reliability, disruptions, and resilience, and evaluating a supplier's ability to deliver. Additionally, AI can be used to predict potential disruptions in the supply chain, such as tree-growth cycles inside electric distribution networks, land-use change monitoring, deforestation prediction, sea-level rise due to global warming, and predicting environmental impacts. AI can also be used to monitor mining operations, their environmental impacts, and the occurrence of critical events.

The most important details in this text are the opportunities for applying AI to sustainable sourcing. Respondent 11 mentioned that the increasing amount of data available creates new opportunities for using AI in different fields. Respondent 13 said that advanced AI systems can model the consequences of different events, such as climate change or disruptions along supply chains. Respondent 12 suggested that scenario modeling could be used to predict future occurrences, such as flooding or hurricanes. Respondent 10 noted that many processes within the area of sustainable sourcing are data-driven and that non-AI digital solutions

could be used for sustainable sourcing. Fig. 1 is a model for assessing how well a technology suite suits a particular task. It is based on the idea that the best technology for any given task depends on both the nature of the task and the capabilities of the technology. The framework assesses the fit between task and technology using four criteria: complexity, affordability, integration, and security. Each criterion is weighted according to the importance of each to task. The overall score represents the degree of fit between the task and the technology. The framework provides a way to objectively evaluate technology options for a given task, enabling organizations to make informed decisions about which technology will best meet their needs.

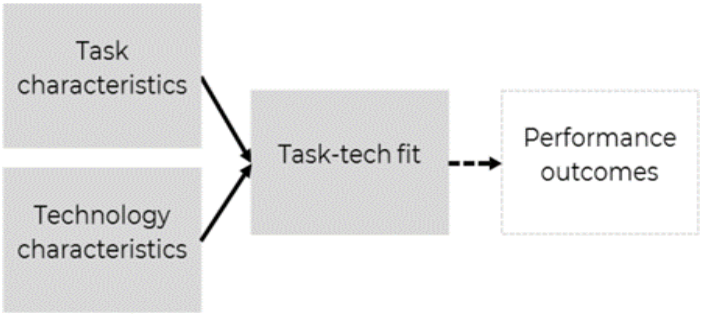

Fig. 1. Task-technology fit framework.

5. Analysis & Discussion

5.1. AI-Technology Characteristics

Insights concerning AI's capability that resulted from the study of the interviews include its applicability for identifying and monitoring diverse events in a vast array of domains. According to the findings section and the literature section, when an event is well understood,

AI may be taught to recognize the patterns of these events and then search for and identify them in everyday real-world data if the patterns are well-understood, quantitative, and data-rich. Several application areas, such as detecting and monitoring deforestation or the expansion of spruce beetles and recognizing tree species groups, were high- lighted in the empirical findings and the literature. As shown by empirical evidence, AI generates novel ideas that would be too difficult or costly for humans to produce. Moreover, as shown by the findings and literature, with extra time and data, monitoring may be replaced by predictive capabilities, where AI begins to recognize the beginning patterns of an event. These include, as shown by the empirical data, the monitoring and forecasting of three growth rates, and the prediction of deforestation. Similarly, a survey of the relevant literature reveals that AI is being used for more basic predictive functions, such as demand forecasting, as well as more complex instances, such as rainfall prediction.

AI's ability to enhance scenario planning by monitoring and anticipating real-time happenings is another capability applicable to sustainable sourcing. As described in the literature and shown by the empirical results, AI may be taught to predict distinct occurrences and their probabilities using accessible data.

An intriguing conclusion from the empirical data cited by several responders is that, because of these characteristics, AI can aid in the modeling of many situations, as validated by the literature consequently, although humans must choose which scenarios to follow and which risks to take, AI may provide people with the potential consequences of their actions. Moreover, according to one respondent, growth in the number of accessible smart devices increases the overall amount of data and permits the integration of these characteristics into new domains.

Literature and empirical findings demonstrate that AI can automate several manual operations that would otherwise need human interaction. In addition, by training algorithms using AI techniques such as ML to accomplish certain jobs, AI may drastically lower the costs associated with this sort of labor. Moreover, as

demonstrated by the literature and empirical findings, AI can deliver these results faster, more accurately, and at a lower cost than humans can, owing to its scalability and ability to continuously process large amounts of data, which boosts the overall productivity of a business. Fig. 2 outlines the process of Machine Learning. It begins with an input, either collected from data or generated from the user. Once the input is provided, the machine learning algorithm can learn from it and start to make predictions. The output of the machine learning process is a set of predictions that can be used to make decisions. The process of machine learning involves analyzing the data, identifying patterns, and making predictions based on those patterns. It is a powerful tool for data analysis that can be used for a variety of tasks, from predicting customer behaviors to uncovering hidden trends in large data sets. The machine learning process is an important part of the data analysis and decision-making process. It can help to provide more accurate insights and reduce the complexity of analyzing large data sets. By using the machine learning process, businesses can make better decisions and gain a competitive edge in their respective fields.

Fig. 2. Machine learning process.

5.2. Applied Framework

The empirical data and literature study highlighted three sustainable sourcing challenges: supply chain difficulties, information overload, and effective evaluation and projections. In the following sections, AI traits and the task will be assessed.

IKEA interviewees highlighted supply chain concerns as a major issue. As several IKEA respondents stated, due to the inherent complexity of current supply chains caused by their increasingly globalized and diverse supply chains, with countless sub-suppliers and often without direct contact with suppliers at the raw materials' origin, IKEA and its suppliers must spend a lot of money and time to understand where their raw materials are coming from. Many IKEA respondents say this complexity hinders IKEA's traceability and transparency. Literature also links multi-tier supply chains to poor IKEA respondents who acknowledge that many enterprises have trouble mapping their supply networks, partly owing to their tendency to employ complicated supply chains and partly due to sophisticated traceability requirements in certain areas, notably the EU's lumber regulation. Some IKEA responders say this problem doesn't affect all goods. Wood planks have simpler supply chains and are easier to monitor, offering more traceability and transparency. Thus, supply chain complexity and opacity, which rely on product raw materials, affect traceabilityand transparency.

Businesses must account for the costs and benefits of their operations for traceability and resource allocation, which makes resource balancing tough. Some respondents said that sustainability employees struggle to determine whether the information is useful. Empirical research suggests resource balancing concerns when legislative mandates that may have little beneficial effects on sustainability incur huge expenses that might have been employed on enterprises that greatly influence sustainability.

One IKEA responder noted that suppliers typically focus on compliance and miss out on environmental activities.

The responder further noted that providers may be tempted to fabricate papers due to these time-consuming traceability requirements. In conclusion, traceability is essential for sustainable supply chain practices [17], but as shown by empirical data, the demands traceability places on companies, especially for

harder-to-trace raw materials, can lead to disproportionate resource allocation compared to their sustainability impact. As indicated in the empirical data, guaranteeing sustainability from the local source to the focus company is vital since most environmental harm occurs there, a conclusion backed by literature [7]. Thus, measuring, and mitigating sustainability consequences necessitates long-term supply chains all the way to the final provider.

According to several respondents, organizations that IKEA does not have direct legal connections with are tougher to target for traceability and sustainability projects since IKEA cannot place as much pressure on them as on its direct suppliers, which makes traceability difficult and time-consuming. Sander *et al.* [7] note that many organizations lack direct legal contracts with suppliers in multi-tier supply chains, making it difficult to implement sustainability programmes. As noted in the empirical chapter, IKEA typically relies on supplier documentation that traveled across levels or had to be obtained by contacting suppliers on other levels, which raises the potential for mistakes or intentional misbehavior. Some IKEA respondents noted that entering data into origin tracking systems manually is time-consuming and error-prone. A previous study acknowledged this issue.

Verifying the tracing documentation is another empirical hurdle. One IKEA responder said suppliers have varied internal information reporting systems and processes, sometimes even relying on paper documentation, which increases verification documentation collection time and quality. The empirical findings also suggest that some suppliers are reluctant to disclose all the essential information since it puts them at risk of being bypassed or undercut. This limits IKEA's traceability and transparency. The literature also notes that enterprises struggle to acquire data from their suppliers, which makes it difficult for them to create sustainable supply chains. IKEA's sustainable sourcing approach is hampered by verification and information sharing.

AI has many traits that match the first sustainable sourcing difficulty: supply chain difficulties. As mentioned above, IKEA struggles to gather information, which affects traceability and transparency and leads to a lack of useful data. As some AI respondents noted, using AI's ability to monitor certain aspects and developments at and around sup- pliers' operations could create the possibility of monitoring development on the ground, such as deforestation monitoring, mining operations, etc., allowing firms like IKEA to access previously difficult-to-obtain information and even verify supplier information. This might assist organizations in detecting and addressing misbehavior, minimizing the risk of non-compliance, and increasing sustainability in the real world. Other AI solutions that gather end-to-end data might help ease traceability by collecting data along the supply chain. While this solution does not directly address the challenge of gaining access to some information that certain suppliers are unwilling to share and the problem with falsified documents remains, it does circumvent those challenges by delivering some of the needed information without the possibility of tampering and giving IKEA real-world insights.

Many AI responders said alternative technologies can help firms with these difficulties.

AI benefits from its scalability and empirical outcomes.

AI's capability can be doubled, quadrupled, etc., but expenses rise just a little. This makes it possible to continually monitor full supply chains instead of inspecting a limited sample of vendors, boosting the possibility of discovering wrongdoing when data is available. AI's neutrality may also help organizations since it has fewer prejudices than people, reducing human error. Thus, AI can objectively check more sites than humans. These extra AI advantages may generate a clear opportunity for AI in sustainable sourcing, potentially benefiting organizations. Some AI responders said monitoring might become prediction, allowing companies to act before certain events. These predictive capabilities might be linked to strategic scenario planningsystems to help managers make optimal decisions [13].

The actual data showed that sub-supplier tracking was laborious. Suppliers often use different systems, so

they have to manually transfer data from their internal systems into IKEA's tracing systems, sometimes from unstructured data like handwritten paper sheets, which increases the chance of human error and makes it laborious, reducing the likelihood of getting all the needed data in good quality. As one AI responder noted, AI may free up resources for sustainability or value-added initiatives. AI-trained algorithms might harvest data instead of replicating it, automating certain monotonous, ongoing procedures. This suggests that AI might help suppliers improve, especially if they already have data in their internal systems that they manually upload to IKEA's tracing systems. AI-automated methods might save time and money [18].

Human mistakes may decrease when manual input decreases, enhancing data reliability. Supplier data limits all of this. This strategy would not work if suppliers used paper-based bookkeeping instead of digitized information systems, but other AI approaches that concentrated on unstructured data may. As shown in the empirical section, only a percentage of the required information can be gathered this way; hence, AI's ability to help enterprises collect all the essential information depends on their suppliers' and sub-suppliers' digitalization. Centralized systems may also solve this problemmore easily.

According to multiple replies, many organizations, including IKEA, are moving their supply chains from compliance to a more holistic development strategy that positively influences the actual world. In the empirical portion, corporate ethics, children's rights, food security, land rights, biodiversity, land use, traceability, and transparency are evaluated concurrently and in connection to each other when examining raw material extraction and production. Some IKEA respondents said this requires more data to be gathered, processed, and analyzed to guarantee that actions have meaningful and positive implications for sustainability. A more comprehensive strategy requires more data and the capacity to acquire and interpret it, as noted. As shown in the empirical section, identifying every sustainability factor is complicated, which complicates the holistic approach, as supported by the research. Another intriguing result from the data was that certain IKEA respondents felt a need for automated, rapid, and real-time analysis that can handle several variables and parameters, assess, and analyze this information, and allow action in real-time. However, as one IKEA responder noted, the information frequently gets too complicated, hindering action where it is required. One respondent said that the supply chain's structure, related to the preceding chapter on supply chain concerns, became exceedingly complicated and inter-twined, making it impossible to analyze and comprehend. According to [18], this creates vast volumes of data that companies must process, which may increase human mistakes.

Another probable match was found. AI's speed and pattern recognition make it handy here. AI-trained algorithms can accurately recognize multi-dimensional patterns that would normally require experienced people. IKEA's holistic approach re- quires more data to be assessed and analyzed, and AI's capacity to recognize patterns in vast volumes of data and provide unique insights should aid enterprises with the new dataflows, according to empirical studies. As shown in the empirical section, AI may help organizations analyze data and provide new insights that are readily under- stood and actionable. AI can also process data instantly. Some respondents claim AI cannot manage, rank, or act on these findings. As one commenter noted, AI systems may generate insights, but acting on them typically needs human engagement. In restricted AI applications, which need human interaction, AI cannot act on insights outside of its programmed scope.

IKEA respondents complain about the absence of effect evaluation and projection. As mentioned in the empirical part, owing to the complexity of certain sustainability issues, there are no uniform definitions or clear measurements, making real-world effect evaluations problematic. As demonstrated in the empirical findings, these impact evaluations often score company activities rather than assess their real-world implications. Several scholars have noted that comprehensive analyses of enterprises' environmental impacts are rare and frequently neglect key aspects. The absence of uniform criteria and metrics makes effective forecasting and evaluation difficult for businesses.

As other respondents noted, some organizations are inventing their own definitions of concepts and impact methodology, which might hinder sustainability since they can build their own individualized ways that may not be in accordance with a scientific, institutional understanding of sustainability.

Some respondents said it's hard to understand how complicated anthropogenic concerns like climate change would affect organizations' sourcing. One respondent under- lined that to cope with these complex difficulties, it is necessary to comprehend the future consequences of numerous sustainability-related concerns, such as climate change, to guarantee long-term, profitable, sustainable raw material procurement and management. This section discovered a possible challenge. Some responses suggested using AI for impact and prediction. AI may be taught to recognize patterns, search for them in daily data, and anticipate them by recognizing early signals of pattern recurrence. As shown in the empirical section, AI may be used to monitor deforestation and spruce beetle spread using satellite images, surveillance films, tracking devices, etc. This allows IKEA to continuously monitor the environmental implications of its supply chains and how its sustainability efforts affect them. As before, scenario modeling and predicted effect monitoring should be improved.

AI and big data might analyze the implications of climate change. The lack of standard definitions and measurements, as noted by IKEA and AI respondents, limits the ability to analyze benefits using AI or traditionally. IKEA responders showed that biodiversity definitions and measurements are still being developed. Without them, assessing outcomes' effects is difficult and inadequate, limiting AI's present use. Several respondents noted that data for these evaluations is a possible restriction, and the research emphasizes data as a key component of AI [13]. Thus, AI can only help with effective assessment and prediction in a small percentage of situations, which may be beneficial for certain organizations if those cases are worthwhile.

Some respondents claimed that AI can forecast future recurrent situations when difficulties are clearly defined, causes are recognized, and data is accessible and of excellent quality. AI, like other forecasting methods, cannot foresee non-regular events like the COVID-19 pandemic. Empirical findings reveal that humans still struggle to grasp events like weather forecasts; therefore, utilizing AI to anticipate their outcomes would likely provide similar results. As shown in the findings section, modern AI cannot address issues that even humans cannot grasp, but it may be an asset when causation, metrics, and historical data are available. Fig. 3 provides a summary of the theoretical findings regarding sustainable sourcing, artificial intelligence, and the lack of multidisciplinary research. Sustainable sourcing is defined as the practice of obtaining materials, products, and services from sources that are environmentally and socially responsible. This includes ethical sourcing, reducing environmental impact, and minimizing the use of hazardous materials. Artificial intelligence (AI) is a branch of computer science that deals with the development of machines that can think and perform tasks similar to humans. AI has the potential to increase efficiency, reduce costs, and improve decision-making processes in many areas. Finally, the lack of multidisciplinary research is a major challenge in sustainability as different disciplines often have different perspectives on the same issue. To effectively address sustainability challenges, researchers must collaborate across disciplines to gain a comprehensive understanding of the problem.

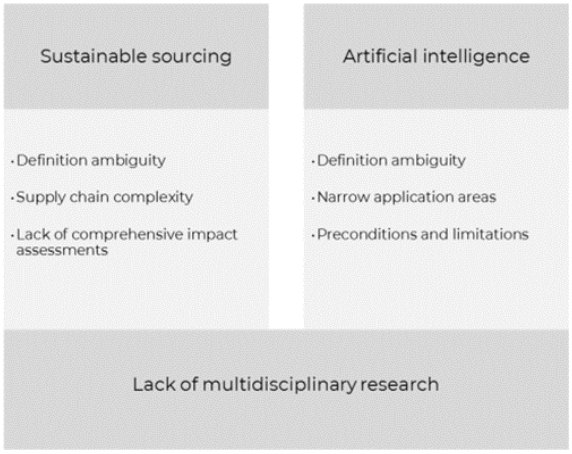

Fig. 3. Summary of the theoretical findings.

5.3. Overall Comments on AI in Sustainable Sourcing

Overall, both the empirical data and the literature demonstrate the absence of ready-to-use generic technical solutions adopted by a wide variety of players. In contrast, many accessible and proposed solutions were case-specific, and many of the AI responders mentioned additional technologies or solutions that may better meet the demands, therefore assisting businesses in overcoming the sustainable sourcing difficulties. Consequently, the substance behind the hoopla surrounding current AI may be questioned. Yet, AI has enormous promise when the qualities of the problem at hand and AI's traits align, as shown in earlier sections. Additionally, as acknowledged in the literature and the empirical section, there is new potential for AI in several domains, including sustainable sourcing, because of an increase in data and technical advancements. Fig. 4 illustrates the inclusion and exclusion criteria for articles published before and after 2010. Articles published before 2010 must meet the criteria of having at least two authors, being peer-reviewed, not being a duplicated publication, and not being a review article. For articles published after 2010, the criteria are largely the same, but they must also include a DOI number and be indexed in an international database. These criteria ensure that the articles are reliable and of good quality. Without them, the research published would not be as credible

Fig. 4. Inclusion and exclusion criteria.

5.4. Preconditions and Limitations

AI development is a drawback. One AI responder noted that because of the novelty and fast growth, there are no general answers for business problems. Most AI solutions are narrow AI, far from general or super AI dominance, as the literature shows. One respondent questioned AI's potential, particularly because it doesn't always outperform humans. One interviewee said that humans must first grasp events like climate change

before AI can help with sustainable sourcing difficulties, regardless of AI's progress. One respondent indicated that although AI-based apps may be able to solve certain problems, the problems themselves are complicated and the cause-and-effect links are not always evident. Hence, although AI may advance, additional criteria must be addressed before applying these answers to the difficulties at hand.

AI may not be the optimal option even if all the prerequisites are satisfied, as shown in the preceding section. As many comments suggest, simpler and cheaper alternatives may also work. These results support the view that AI can solve certain issues but not all and that its power is frequently overstated. The literature and empirical section show AI's potential. Gartner's hype cycle for AI 2020 shows that AI is still underutilized. According to some respondents, AI application developers and adopters have overinflated expectations. One respondent noted that AI-enabled initiatives get larger funds. As revealed in the empirical data, AI typically works with other systems to completely operate. The empirical data shows that AI knowledge (described later) helps firms comprehend what AI can and cannot achieve. These findings indicate that enterprises should consider the downsides and limits of contemporary AI before adopting it, a perspective supported by empirical evidence.

As the literature study shows, AI may mean many different things to various individuals [23]. These findings support the empirical data, where many respondents said the concept of AI is still unclear. Some AI responses distinguish AI from conventional software by ramifying AI as human-capable software, some do not. According to the interviewees' widest meanings, humans have been utilizing AI for decades, while other respondents' more limited definitions say AI has just recently been implemented in practical settings. According to one respondent, organizations that use only powerful human-written algorithms may not realize the full potential of "new" AI. One respondent said that firms may embrace AI-based products without fully knowing their capabilities due to terminology uncertainty. So, defining AI is crucial to understanding itsbenefits, drawbacks, and prerequisites for corporate use.

The research shows that issue description is crucial before applying AI to an organization. All AI responders emphasize the importance of articulating the issue they want AI applications to address and not letting technology dictate the solution. As many AI responders noted, the issue frequently dictates the solution. AI cannot assist with undefined, unmeasured problems. These findings confirm past research that firms must establish challenges to utilizing AI. One respondent also said that the solution itself might determine the chance to use it, but the general rule is always to describe the issue and then apply the technology. One respondent said that firms should be careful when looking at more broad AI solutions since the same solution may not have the same value for many companies with comparable difficulties, and thus each company needs customized solutions and specific value assessments.

AI requires data quality and availability [13]. All the respondents stressed how important it is to have good data and a lot of it before AI can even be thoughtabout.

One AI responder noted that vendors in organizations' supply chains typically have diverse data-gathering procedures, lowering the quality of the data. In the empirical part, certain vendors' data-gathering systems are problematic. Some providers refuse to pro- vide data for competitive reasons. So, if an AI-based solution is used, suppliers' varied systems and willingness to exchange data may affect the quality of the outcomes.

Several responses debate data-collection options. One respondent said that firms may sell data, while another said that when data is impossible to measure, connected events can be measured instead. AI requires data, as stated in the literature and supported by empirical evidence. Data availability improves AI application results, according to one respondent. These results agree with those of other writers [13], who concluded that historical data is essential to train AI algorithms and that AI adoption would perform worse without it. However,

AI is also limited by data reliance. As one AI responder notes, AI uses previous data to make predictions,

judgments, etc., which limits the application's result. Hence, AI programmes can only predict past occurrences, which may restrict their applicability to situations.

One respondent noted AI's impartiality. Yet, skewed data biases findings and affects the outcome, as shown in the research. One respondent feels restrictions are necessary to responsibly handle data.

As shown in the empirical data, technology develops quicker than rules, so using AI ethically may not be adequate. Companies must consider ethically employing AI.

The digital revolution is changing how firms organize and function, and past studies have shown the necessity for technical competence, including AI. As shown in the empirical part, workers lack AI understanding and struggle to identify AI prospects in their organizations. IKEA and AI respondents said managers overestimate technology's capabilities, reflecting this knowledge gap. Some respondents stated that top managers push for AI deployment in their organizations despite their lack of substantive understanding. Several AI responders claim that due to AI enthusiasm at many businesses, individual projects start to arise inside enterprises, but they lack larger organizational integration and structure, and therefore they seldom succeed in being adopted within the organization. Consequently, corporations may invest in technology without seeing outcomes.

Knowledge helps workers trust AI output. One response stress that workers must trust AI to utilize it. According to the literature, the "black-box challenge"—employees' capacity to grasp an AI-based application's decisions—affects trust. When using AI, firms should consider employee trustworthiness, which is typically established by greater knowledge. The literature and empirical portions also demonstrate the necessity of spreading information within the firm. One AI responder also suggested spreading information around the organization to prevent confusion. Most respondents in this research believe this is essential; however, the IKEA interviews show that different departments have different levels of understanding. One IKEA respondent noted that the sustainability department had few individuals using advanced technical tools. Nonetheless, many IKEA and AI employees

They believe that most enterprises have varying degrees of technological abilities and expertise within their organizations, restricting their AI adoption.

When implementing AI, it's important to understand how organizational changes may affect employees' job duties.

Unlike the literature, neither AI nor IKEA respondents mentioned the worry of losing employment while addressing AI adoption. AI responders said AI will take over certain duties from people but assist humans since AI frequently doesn't solve a problem. Until now, AI can only do what people instruct it to do, emphasizing the need for human inter- action in AI applications and the limitations of AI's capabilities [32]. AI's limited capabilities may explain this. AI applications will only replace specific activities. All of this suggests that the concern of losing employment is mostly based on overinflated expectations of what AI can achieve since its actual use is restricted.

AI and IKEA respondents emphasized measurements and terminology. According to one AI responder, AI is impossible to implement without measures. Many IKEA respondents emphasize the importance of universally accepted measures and definitions, which are often lacking today. Some respondents say that companies creating their own definitions of sustainability aspects are dangerous because they may not align with the scientific, institutional view of sustainability. One IKEA respondent says that nature takes a long time to generate visible effects, making it hard to understand the effects of decisions. According to one AI respondent, some future events and their effects are hard for humans to comprehend. This may explain why impact assessments are difficult to complete. As stressed in an earlier section, AI cannot be applied where humans do not understand the underlying, sometimes complex, cause-and-effect relationships. One AI responder suggested training AI grasp these complicated interrelationships and construct models that

encompass all these factors. Hence, measurements and standards must be in place before employing any AI application to start measuring and collecting data, as previously indicated [13].

Empirical research also reveals that ecological systems are highly dependent. Several responders noted that raw resources are interconnected. One person noted that agriculture and rising food consumption cause deforestation. Consequently, the difficulties become interwoven, and recognizing these interrelationships is necessary to solve all sustainable sourcing challenges. One contributor noted that the sub-optimization of specific supply chains is incompatible with sustainable sourcing. To guarantee AI's sustainability, its drawbacks must be acknowledged.

6. Conclusion

6.1. The Potential of AI in Sustainable Sourcing

Addressing the research questions, this study presents its findings. Also discussed are management implications, constraints, and future suggestions send are management implications, constraints, and future suggestions. This exploratory project examined AI insustainable sourcing.

AI is being used to tackle numerous problems.

Multidisciplinary research on artificial intelligence and sustainable sourcing is lacking. Our study addressed this research gap and provided practical suggestions. This section discusses the following research questions:

RQ1: How can AI help a company with sustainable sourcing?

RQ1.1: What are the most sustainable sourcing problems for a global conglomerate? To address our first research question, we used RQ1.1 to identify some of the sustainable sourcing difficulties an extensive multinational corporation has and then looked at how AI may help solve them. Hence, we reveal sustainable sourcing's unsolved issues. Supply chain difficulties, information overload, and impact evaluation and forecasting were then classified. These sustainable sourcing difficulties help us understand how AI may solve them and contribute to sustainable sourcing research.

This research also examined how AI may help a multinational company with sustainable sourcing issues. AI can monitor, forecast, automate, and help prepare scenarios, among other things. The Task-Technology Fit Framework (TTFF) shows that AI might address certain sustainable sourcing concerns. When the conditions are satisfied and the sustainable sourcing problem meets AI's features, this applies.

This research found that utilizing AI to monitor supplier conditions may help firms acquire traceability and transparency data. AI's automation might help firms gather in- formation faster and reduce human mistakes, freeing up resources for other sustainability-related duties. This research also showed that various technologies are typically better for activities and sustainable sourcing difficulties, but that organizations may still struggle to obtain information that suppliers are unwilling or unable to disclose. The research also indicated that supplier digitalization may limit the use of AI for supply chain challenges. These findings suggest that AI may not always solve sustainable sourcing issues and that suppliers' digitalization levels limit firms' ability to employ technologies to solve them.

According to this research, AI can verify sites faster than humans and predict future events because it is neutral and can be scaled up. Ai’s ability to handle massive amounts of data and recognize patterns might help firms manage lots of data simultaneously. Several firms are adopting a holistic development strategy that incorporates numerous sustainability factors, which requires more data management. AI might help organizations interpret this data. AI's constrained application areas limit its potential, so humans must act on its insights and output. Moreover, previous data limits AI's ability to forecast, decide, etc.

AI can also help organizations comprehend climate change and its effects, monitor deforestation, avoid it, and forecast other repeating catastrophes, according to the report. The research also suggests that AI should

not be used to forecast future occurrences when humans cannot comprehend the fatalities, measurements are insufficient, and data is un-obtainable or of poor quality.

These findings show that AI might help IKEA address its sustainable sourcing issues. Due to its youth, AI's ability to help organizations solve sustainable sourcing issues is restricted. This research also reveals that there are few ready-to-use generic technologies solutions for this industry, and even when there are, there are doubts about the balance between costs and value and the practicality of adopting such a solution for a corporation.This may be because company-specific problems need company-specific answers.

As challenges vary across firms and drive the answer, AI solutions must frequently be customized, resulting in a lack of general solutions.

Our findings show that AI may offer considerable value in certain cases, but its prices must be considered, and other factors are considered before AI can help solve sustainable sourcing concerns. This research also showed that AI does not always solve problems, and in most instances, it only solves a portion of them. Hence, AI is not a "catch-all" technology for sustainable sourcing.

6.2. Factors to Consider

This study investigated the things a large multinational company should think about before using AI technologies for sustainable sourcing, as well as the things they can't do.

RQ2: What should a large multinational company think about before putting AI to use for sustainable sourcing?

This research indicated various preconditions for using AI and limits to consider be- fore deployment. Despite AI's promise, enterprises must recognize its limitations. As shown in this research, applied AI is young and limited; hence, general solutions are lacking. This restricts the technology's applications and problems. Despite this, many organizations rush to deploy AI without considering the costs. As this research shows, the net benefit of adopting any technology—AI or not—must always be evaluated since it frequently requires a lot of money, time, and labor. Consequently, these results suggest that trade-offs should constantly be examined when adopting new technology, and the net benefit of adopting such technology should always be assessed to guarantee that it meetsrequirements and wants.

When using AI, firms must consider AI knowledge, data availability, and quality. These results may explain the impracticality of using AI for sustainable sourcing difficulties, as IKEA and other companies with complicated supply chains struggle with data from several sources.

The data required for AI use also creates difficulties, since organizations that share data more freely may risk privacy issues while sharing data for sustainability work is important. Hidden prejudices should also be addressed and restricted. Competence development is necessary before implementing AI since many organizations lack the necessaryAI expertise to identify possibilities and grasp their limits.

This research raises problems about job supplements and verifies earlier findings that AI would first complement employees rather than replace them. This discovery might help firms overcome employees' digital skepticism. The difficulty of defining AI shows that organizations and AI practitioners still face many obstacles. As many firms can't de- fine AI or even know whether they're utilizing it, the technology may be challenging to completely implement. To avoid supply chain suboptimization, raw material interlink- ages must be assessed. Before addressing issues, they must be established. Yet, AI in sustainable sourcing has great potential. Further definitions, metrics, and measurement methods will likely be created over time. Companies that create their own standards and measurements may not follow scientific principles, undermining sustainability initiatives. Hence, more cooperation may be required to create these definitions and metrics. The spruce beetle monitoring program is one of the numerous new deployment areas in sustainable sourcing. Deforestation detection and monitoring are the most popular early adoptions. When more measurement methods are introduced, a more complete picture of environmental problems and

programs to ameliorate them should become achievable. Furthermore, the lack of theoretical knowledge of sustainability topics like biodiversity and the lack of uniform sustainability definitions and indicators may explain the general lack of AI solutions for the stated difficulties. Modern AI's reach is limited by human understanding, so it can't help. So, AI can only help people who comprehend cause and consequence. Without proper definitions, unsustainable practices may be disguised as sustainable, threatening a company's sustainability programmes.

6.3. Implications & Recommendations

This research suggests many actions. First, as shown by this research, applied AI solutions for sustainable sourcing difficulties are few, and alternative technologies may be better suited. Tech-based AI Technology competes with other methods for problem-solving. As seen in the findings, implementing AI may be expensive. Like with any technology, firms must weigh the pros and cons and consider the return on investment. To determine whether AI is the best answer, various technologies and solutions must be compared, and their net benefits assessed.

Consequently, we recommend that organizations study how multiple technologies or other solutions might tackle their difficulties, not just how AI fits. We also underscore that firms must be realistic about what AI can bring and which difficulties it can address,not only embrace AI based on hype and potential advantages.

Second, if AI matches an issue, organizations must meet specific preconditions. AI adoption is hindered and enabled by data. AI is conceivable in this domain if all data is accessible or can be measured. Nevertheless, without fundamental sustainability standards and methods, relevant data cannot be collected, and AI cannot help enterprises in those areas. The uneven distribution of AI knowledge in businesses is another requirement. Firms' technical knowledge imbalance necessitates simple solutions and time to teach untrainedstaff.

This is true of most changes, not just those involving AI. To enhance technical expertise, train personnel in AI fundamentals or recruit fresh AI experts. This may help workers decide whether, when, and how to use AI and other technologies. Hiring outsiders may provide additional organizational issues. The new systems must also not impair organizational values and strategies. The new potential systems also solve the firm's sustainablesourcing issue. So, understanding and using AI requires more time, money, and effort.

Third, since AI is young, its use for sustainable sourcing concerns is restricted. Due to AI's immense potential, firms must continually research new AI iterations and other sustainable sourcing technologies to avoid missing out on the benefits of using the technology.

We recommend: The difficulty should be the starting point, and AI should be one of several answers. Before implementing AI, organizations must meet specific pre-conditions and assess its advantages and value against its expenses.

Owing to applied AI's newness and great potential, organizations should continuously analyze its potential.

To build a wide organizational knowledge of when, how, and if AI should be deployed, firms should educate their personnel about AI's prospects and account for digital literacy when recruiting. But corporations should also consider the extra resources re- quired for organizational alignments, such as hiring new personnel and their effects.

6.4. Limitations of the Study

This study's findings and implications must be examined with some restrictions. Initially, forestry and agriculture are two raw material sectors that may affect this study's issues. As a result, the task's character is affected. If additional issues were recognized, such as talking to other departments, AI's traits might suit them better.

Second, when reading this thesis, keep in mind that the authors are not engineers or foresters and may

lack technical knowledge of artificial intelligence and forestry. This may affect this thesis's findings.

Lastly, the methodology may be questioned since the interview sample is small and may not represent all the difficulties, AI solutions, and perspectives of those not inter- viewed. A single-case research approach prevents generalizations that apply to many businesses. Yet, organizations in comparable circumstances may benefit from seeing how AI might help them achieve sustainability with all its preconditions and constraints. The lack of commonly accepted definitions for AI and sustainable sourcing may further affect respondents' interpretations and our findings. Despite these limits, the research provides significant insights into how AI may help solve sustainable sourcing difficulties and what to consider before deploying such technology.

6.5. Recommendations for Future Research

This study provides the framework for future research on AI's significance in the area of sustainable sourcing.

Also, other researchers from dissimilar disciplinary domains than ours might explore this topic to give additional insights into the interdisciplinary field of artificial intelligence and sustainable sourcing from their viewpoint. For instance, it is suggested that scholars with an engineering background investigate this area. This work raises the subject of the possible employment of technologies other than AI in this field. For example, blockchains or other technologies might be investigated to determine how to address the identified sustainable sourcing concerns.

Eventually, a single-case study was used to perform this research. Hence, future studies might investigate different organizations, compare these problems, or even assess the value gained by deploying AI in a business that has implemented AI-based solutions.

Conflict of Interest

The authors declare no conflict of interest.

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