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Analytics-enabled Green Supply Chain Management

Exploring the organizational challenges in the European fashion industry

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ABSTRACT (MAX. 200 WORDS):
The fashion industry with its complex supply chains deals with increasingly problematic environmental issues. IS and specifically analytics technologies are said to provide fashion companies with crucial insights to improve their environmental impact. However, these promises of this so-called analytics-enabled Green Supply Chain Management (GSCM) are not fully materializing in the European fashion industry. Guided by a conceptual model based on the TOE framework, this study critically explored the main organizational challenges fashion companies face in this context by conducting six qualitative interviews and contrasting the empirical findings with current academic literature. As a result, 55 challenges for analytics-enabled GSCM were identified of which 15 were considered highly relevant. Overall, a low technological maturity, the lack of awareness regarding the benefits of Analytics as well as the deficient visibility into the complex supply chain were identified as main issues for analytics-enabled GSCM. Based on these findings an IS research agenda is proposed.

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1 Introduction

The fashion industry is one of the largest, and most critical industries with regard to environmental pollution and sustainability impact (Peters & Simaens, 2020). Over the last two decades, fashion consumption has grown by 400%, where it has become the world's second most polluting industry next to oil (Chen et al., 2021). Moreover, this growth is only expected to increase (Nikolina, 2017; Shen et al., 2017) where it is estimated that by 2050 the fashion industry will singularly use up 25% of the world's carbon budget (Chen et al., 2021).

Altogether, these concerns have grasped the attention of scholars, consumers, executives, and policy makers, leading to increasing pressures on enterprises in the fashion industry to effectively lower their environmental impact, change their way of business and engage in sustainability practices (Chen et al., 2021; Nikolina, 2017; Peters & Simaens, 2020; Shen et al., 2017). However, while actors in the industry are getting more engaged in sustainability, and are increasingly making efforts to that end, many companies deal with major challenges in (effectively) reducing their environmental impact (Saha, Dey & Papagiannaki, 2021).

To that extent, it can be seen how the fashion industry in general, but especially the production processes, are reliant on polluting materials and vast amounts of resources, such as water, transportation, or chemical treat products – thus complicating companies' efforts to go green (Chen et al., 2021; Saha, Dey & Papagiannaki, 2021). In this context, one of the greater challenges can be found in the size and complexity of fashion supply chains and production networks (Ahmad et al., 2020) as well as information asymmetry and different goals among actors within these networks (Ahmad et al., 2020; Guo, Sun & Lam, 2020). These endeavors complicate companies' efforts to improve their environmental sustainability, since truly impactful improvements often fail to materialize when their supply chain partners lack a similar approach (Green et al., 2012). That is to say that companies' environmental impact is not only constituted by their own operations, but equally results from the materials/products they buy from partners, and the operations these partners conduct to provide these materials/products (Tseng et al., 2019a). Therefore, in order to achieve environmental goals, businesses must engage in green supply chain management (GSCM) and seek or foster environmental sustainability throughout their supply chain. Therefore, businesses not only require comprehensive insight in activities, along with accurate environmental decision-making throughout their production networks - but equally require a certain level of collaboration and coordination within these supply chains (Green et al., 2012; Tseng et al., 2019a).

Data is a key resource to manage these flows of information, services and materials along the green supply chain (Fritz, Schöggl & Baumgartner, 2017; Kuo et al., 2014). The Information Systems field (IS) is said to have "the particular competency to analyze such data" (Gholami et al., 2016, p.527). More specifically, IS can provide the analytics technologies, techniques, and knowledge to support organizations and individuals to make data-driven decisions, thereby enabling green practices (Loeser et al., 2017). Analytics - the corresponding IS sub-domain focusing on "[converting] data into actionable insights" (Delen & Ram, 2018, p.2) - is a highly

relevant topic in research and practice that is further gaining momentum (Davenport, 2018; Kappelman et al., 2021). Data-driven approaches such as Business Intelligence, Big Data or Artificial Intelligence are very popular in academic literature in the context of GSCM and are associated with a variety of environmental benefits in the areas of resource consumption, pollution, or waste (Ahmad et al., 2020; Giri et al., 2019; Tseng et al., 2019a). For example, Big Data Analytics - which refers to the analysis of massive amounts of heterogenous data – can enable the continuous monitoring and management of environmental parameters in an organization, such as greenhouse gas emissions or energy consumption (Chiappetta Jabbour et al., 2020). Furthermore, Artificial Intelligence can facilitate the discovery of hidden patterns in datasets, as well as the prediction of future trends. As shown by Giri et al. (2019) for example, these capabilities have been used in the green supply chain context of fashion companies to reduce overproduction and waste by predicting customer demand more accurately. Altogether, these different applications of analytics technologies for GSCM are combined under the name of "analytics-enabled GSCM".

1.1 Research Problem

Analytics-enabled GSCM has been gaining traction within the academic community over the last years. However, in this context little to no research exists that focusses on the fashion industry - even though it is often highlighted as one of the more challenging and demanding industries regarding sustainability improvements and GSCM (Majumdar & Sinha, 2018). At the same time several authors state that fashion companies are experiencing challenges to implement analytics technologies and attain their full benefits (Ahmad et al., 2020; Chuang et al., 2018; Kuo et al., 2014). Moreover, while the implementation of analytics-enabled GSCM can clearly be challenging for companies, current literature on this topic seems to be driven by enthusiastic and optimistic theoretical views where the focus is put on technological opportunities (Chiappetta Jabbour et al., 2020; Liu, Chen & Liu 2020; Pournader et al., 2021). More critical reflections on the development of analytics-enabled GSCM in organizations are currently lacking and the social-technical perspective is often ignored – both in general and specifically for the fashion industry. Consequently, this raises questions about the real-world situation of analytics-enabled GSCM for fashion companies.

Additionally, it can be seen how research related to analytics practices for GSCM in the fashion industry is rarely focused on European countries, but rather on manufacturing hubs in Asia (Ahmad et al., 2020; Tseng et al., 2019a). However, since fashion brands – who generally are the organizations with a stronger influence on supply chain operations - are often located in the EU (Agrawal et al., 2021) this perspective is deemed necessary to explore (Nikolina, 2017). At last, with the EU stating local production as one of the main objectives for the fashion industry, it is suggested that research contributions to analytics-enabled GSCM in European fashion companies are becoming increasingly relevant (Nikolina, 2017).

Finally, there is also a core issue from the perspective of IS academia. The IS community faces criticism for "not yet … [embracing] sustainability as an integral part of its research agenda" (Seidel et al., 2017, p.46) and failing to support organizations on their sustainability journey. While the concept of Green IS, which aims to enable sustainable practices in business and society through Information Systems (Watson, Boudreau & Chen, 2010) has already been discussed for more than a decade, the field is lacking meaningful contributions to tackle current environmental challenges (Gholami et al., 2016). The importance of sustainability for the IS field and the need for more research on the issue was further emphasized by one of the leading IS conferences; "ICIS" in 2021, which not only chose sustainability as its main theme but also defined IS-enabled Green Supply Chains as a promising topic (ICIS, 2021).

1.2 Research Question

To address the abovementioned problems and research gaps, this study focuses on the following research question:

"What are the main organizational challenges of analytics-enabled green supply chain management in the European fashion industry?"

1.3 Research Aim

This study aims to critically examine what limitations organizations experience when applying analytics practices for green supply chain management purposes in the European fashion industry. Therefore, this research will focus on investigating the real-world situation by adopting the socio-technical system perspective and exploring the main challenges of analytics-enabled GSCM in the complex organizational environments they occur in. To that extent, a set of qualitative interviews in combination with a broad literature review will be conducted, based on which a comprehensive overview of thoroughly explored challenges is provided. In this manner, it is aimed to contribute to this research domain with a more critical perspective, to thereby address the previously mentioned research gap, and lay grounds for future research into this increasingly relevant topic. Additionally, this research will attain practical relevance by providing thorough insight into the possible obstacles organizations face during the adoption of analytics-enabled GSCM. Finally, this paper further contributes to the IS field by addressing the under-represented issue of sustainability and proposing a research agenda that guides IS scholars towards meaningful contributions to solving GSCM challenges through Analytics.

To adhere to these research objectives, this paper is structured as follows:

- In Chapter 2, the theoretical background is explored where the fashion industry, GSCM and the analytics domain are reviewed, and potential challenges are outlined.
- Chapter 3 introduces a conceptual model in which the identified challenges are summarized using the Technology-Organization-Environment (TOE) framework as a structure.
- Chapter 4 presents this study's research strategy and the methodological approach revolving around the qualitative interviews and the data analysis.
- In Chapter 5 the empirical results are summarized and once again structured according to the conceptual model.
- Chapter 6 presents a discussion of the empirical results in the context of the collected literature, where additionally four topics are provided for the research agenda.
- Finally, Chapter 7 contains an outline of the overall findings and this study's concluding remarks.

1.4 Delimitations

Naturally, this research comes with a set of delimitations. It must be noted that the GSCM domain varyingly includes perspectives of circularity, thereby sometimes considering the consumer, retrieval and recycling of products as an integral part of the green supply chain (Tseng et al., 2019a). While this is a relevant subject in the domain of analytics-enabled GSCM, it is out of scope for this study, and therefore will not be discussed. Instead, this research focusses on the more conventional understanding where the concept of supply chain captures all activities from raw materials up to the consumer (Agrawal et al., 2021). Additionally, in this research focus is put on companies that operate closer to the consumer. To that extent, the perspectives of companies further down the supply chain, such as suppliers of materials or fabrics, are not included, which might require follow-up research to acquire deeper insights from their perspective. While it is acknowledged, that the fashion industry faces serious social issues (e.g., poor working conditions at manufacturing plants in developing countries (Fritz, Schöggl & Baumgartner, 2017)) this research focuses solely on environmental sustainability challenges, which is further explained in Chapter 2.1. Overall, challenges for analytics-enabled GSCM are explored on an organizational level, meaning that individual adoption barriers are not further addressed. In line with its explorative nature, this study focuses on identifying the most relevant challenges of analytics-enabled GSCM. Consequently, this does not include the development of solutions for these problems. Nevertheless, promising directions for further IS research based upon the findings of this study are presented during the discussion.

2 Theoretical Background

In the theoretic background the core-concepts that are substantial to this research question are explored. To that end, a literature review was conducted into the topics of sustainability, the fashion industry, GSCM, and IS/Analytics. Here focus was put on the challenges of implementing analytics, as well as GSCM practices in the organizational context of European fashion companies. The findings of this exploration are fundamental to the creation of the TOE-based model of the subsequent chapter. Moreover, this research background carried two aims: First, in line with the explorative nature of this study- a broad review of literature is presented to provide the reader with insight into the varying concepts that are necessary for an accurate understanding of this research question and outcomes. Secondly, since these core-concepts are varyingly interpreted throughout literature, and frequent use of buzzwords complicate their exact understanding, this chapter focusses on defining and distinguishing the concepts for this research context to eliminate ambiguity.

2.1 Environmental Sustainability

An essential prerequisite for discussing sustainability is providing a clear definition of the term as it is used ambiguously throughout academia and practice (Giovannoni & Fabietti, 2013; Lubin & Esty, 2010). The origin of the concept of sustainability can be traced back to the so-called Brundtland report published by the World Commission on Environment and Development (WCED) in 1987 (Cantele & Zardini, 2018; Kuhlman & Farrington, 2010). The WCED established the definition of sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (1987, p.41).

On this basis, the idea of the Triple Bottom Line (TBL) was established – a concept that values economic, environmental and social aspects as equal pillars of sustainability (Gimenez, Sierra & Rodon, 2012; Giovannoni & Fabietti, 2013). While the TBL has found extensive use in academic literature the “three-pillar model … deservers critical examination” (Hilty & Aebischer, 2015, p.11). Kuhlman and Farrington (2010) argue that the multidimensional view on sustainability of the TBL distracts from the main issue which lies with major environmental challenges like global warming, decreasing bio-diversity or the preservation of natural resources. This view is shared by Norman and MacDonald which accuse the TBL approach of “providing a smokescreen behind which firms can avoid truly effective … environmental reporting and performance” (2004, p.243). As the climate crisis – which is referred to by the United Nations as “the defining crisis of our time” (2021, p.1) – worsens, it becomes imperative to address environmental issues in research. This study embraces the view of these advocates of environmental sustainability. Therefore, the term “sustainability” will be used throughout this paper in the ecological sense.

2.2 Fashion Industry

The fashion industry, also referred to as the clothing, or apparel industry, is a competitive industry that plays a major role in the European economy. According to the European Commission (n.d.) it consists of 160 000 companies. All together this industry employs over 1.5 million people and generates a yearly turnover of around €162 billion. Additionally, it is stated that 90% of the companies are small enterprises with less than 50 employees, which in turn account for up to 60% of the total industry value. The biggest producing countries, which together cover three-quarters of all fashion production within the EU, are France, Spain, Portugal, Germany and Italy (European Commission, n.d.).

Moreover, it is stated that the industry is characterized by competitiveness, where this is said to drive high levels of innovation, better quality, and high-value-added segments of products and brands throughout the industry (European Commission, n.d.). At the same time this competitiveness is said to cause low profit margins. Additionally there is an increased international competition between European companies and those located in developing countries, where especially the higher costs resulting from sustainability-related regulations and standards in Europe can form a limiting factor to overcome this competition. As a result, it can be seen how the European fashion industry is characterized by complex production structures, where fashion supply chains often stretch a large geographical distance as a result of these market forces (Agrawal et al., 2021; European Commission, n.d.)

Looking at supply chains in the fashion industry, Figure 1 illustrates a generic fashion supply chain. However, in reality the fashion supply chain is "a network with numerous materials many possible permutations and complicated processes" (Agrawal et al., 2021, p.2). That is to say that all of the supply chain stages often consist of multiple partners which are rooted in an own sub-production network of upstream raw material suppliers; providers of add-ons such as buttons or zippers; or processing services such as chemical treatments or washing (Agrawal et al., 2021; Muthu, 2020). Due to this complexity, organizations are often limited to track monitor and manage the environmental impact of their own products.

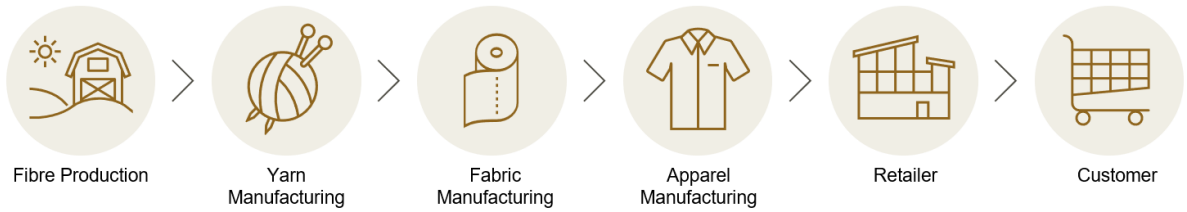


Figure 1: The typical fashion supply chain (Adapted from Agrawal et al. (2021))

2.2.1 Environmental impacts

As previously stated, the fashion industry has one of the highest environmental impacts (Peters & Simaens, 2020). To that extent, Panigrahi & Rao (2018) state that the fashion industry is characterized by exhaustive use of resources and outdated manufacturing strategies. In this

context, the greatest threats lie with the excessive use of fresh water, fossil fuels, and electrical energy (Muthu, 2020). More specifically the following activities and impacts seem to be the most harmful to the environment.

First of all, it is shown how massive amounts of electrical energy and oil are consumed during the processes of production of fibers, yarn, or during operations such as washing or drying (Muthu, 2020; Panigrahi & Rao, 2018). Additionally, another major concern can be found in the consumption of fresh water and the use chemical treat products. In this context, the production of one kilogram of textiles is said to require 200 liters of fresh water (Majumdar & Sinha, 2018) where several water sources around the world have visibly been drained and depleted for up to 90% over the last 50 years (Muthu, 2020). Moreover, wet processing operations and the vast use of chemicals form a major threat to the environment. To that end, huge amounts of water are used for processes such as desizing, scouring, bleaching, dying or printing (Brewer, 2019; Majumdar & Sinha, 2018) where chemicals e.g. pigments, inorganic salts or dispersing agents are used and often directly discharged untreated into water sources (Muthu, 2020; Panigrahi & Rao, 2018). In this context, some estimations suggest that the fashion industry is responsible for 17%-20% of global water pollution, leading to fresh water scarcity, soil and environment degradation (Brewer, 2019; Muthu, 2020). Additionally, the production of materials, and fashion supply chains come with high levels of harmful emissions. In this context, the fashion industry is not only said to be responsible for 10% of global carbon emission, but also emits high amounts of toxic chemicals such as N_2O, as a result of unproper production of synthetic fibers (Brewer, 2019; Muthu, 2020). Substantial to these emissions are the previously mentioned high-carbon transport networks and complex supply chains where (raw) materials travel through a variety of countries for the conversion into products. The latter has become an increasing problem due to the fast fashion culture which resulted in “just-in-time” management and a greater geographical spread of production networks (Brewer, 2019). At last, many authors emphasize the solid waste coming from yarn production, manufacturing processes, packaging, and the disposal of products (Resta & Dotti, 2015).

2.3 Green supply chain management in the fashion industry

Supply chain management (SCM) refers to the integrative approach of supply chain partners to agree on aspects of planning and control for all the activities that come into play between raw materials and the delivery of a product to a customer (Lummus, Krumwiede & Vokurka, 2001). However, due to the obvious wide applicability of the concept of SCM, a myriad of definitions can be found driving a wide variety of different foci (Ahi & Searcy, 2013; Lummus, Krumwiede & Vokurka, 2001). Nevertheless, within this array of perspectives, some recurring core-constructs, and thereby the essence of the concept of SCM can be found. To that extent, as shown by Ahi & Searcy (2013) the core definition of SCM revolves around the management of flows of materials, services, and information. Additionally, strong emphasis is often put on the coordination of operations within and between firms – as well as the management of relations – where the goal ultimately is to meet business and stakeholder needs. In turn, these business

and stakeholder needs mostly come down to improved efficiency, increased performance, or greater value creation (Ahi & Searcy, 2013; Lummus, Krumwiede & Vokurka, 2001).

2.3.1 Green supply chain management

Looking for SCM approaches that include aspects of environmental sustainability, two main paradigms can be found, namely "Sustainable SCM" (SSCM), as well as "Green SCM" (GSCM) (Ahi & Searcy, 2013). In this context, it can be seen how SSCM puts its focus on the triple bottom line perspective, i.e. economic, social and environmental sustainability (Carter & Rogers, 2008; Seuring & Müller, 2008) – where GSCM confines its focus to environmental sustainability (Srivastava, 2007; Zhu, Sarkis & Geng, 2005). Therefore, since this research scope lies with environmental sustainability, the GSCM paradigm is adopted. To that extent, a selection of the fundamental and leading articles revolving around GSCM shows the following.

Similar to the concept of SCM itself, the concept of GSCM is often shaped and demarcated based on the goals of the investigator (Zhu, Sarkis & Geng, 2005). However, one of the most highly cited definitions is given by Zhu, Sarkis & Geng (2005) who explain GSCM as an "archetype for enterprises to achieve profit and market share objectives by lowering their environmental risks and impacts while raising their ecological efficiency" (p.450). Additionally, Srivastava (2007) – another thought leader in the GSCM field – defines GSCM as integrating environmental thinking into SCM, i.e. making accurate environmental management choices in the decision-making process during the conversion of resources into products.

Regarding GSCM practices, three overarching categories of activities for the management of environmental damage can be extracted from Vachon (2007) - namely environmental damage prevention, control, and environmental management systems. In this context, *prevention* and *control* of environmental damages are structural improvements, where *management systems* are infrastructural improvements.

Environmental damage prevention refers to structural investments where damages are reduced or eliminated at the source of a product. This is often also referenced to as "eco-design" of products and manufacturing processes (Green et al., 2012, p.293; Vachon, 2007). In this context, products can be modified to minimize the required materials/resources, or to enable reuse or recycling of the products' components (Vachon, 2007). Additionally, processes to create these products can be modified to reduce the use of hazardous materials or resources that are needed for development (Green et al., 2012). Secondly, environmental damage control is proposed as another structural investment (Vachon, 2007). Here focus is put on correcting environmental impacts that were already made, through methods of disposal, reduction, containment or compensation (Vachon, 2007).

At last, environmental management systems are infrastructural investments that enable improved environmental performance – where internal environmental management, green IS, and collaboration/integration with supply chain partners are the main outcomes (Green et al.,

2012; Vachon, 2007). These infrastructural investments – such as system integration or certification frameworks - can enable the reduction of environmental damage through methods like planning, monitoring, optimizing or decision-making (Green et al., 2012; Srivastava, 2007). In turn these environmental management systems often go together with and steer the previously explained activities of control and prevention (Vachon, 2007). In this context Green et al. (2012) explain that improved environmental performance can be achieved once environmental sustainability has become a strategical imperative that is supported by top and mid-level managers. Additionally, the authors state that environmental management in an organization is a prerequisite for the implementation of green IS and collaboration.

As another crucial element of GSCM, the management of information and green IS are said to be necessary to make the GSCM efforts successful (Fritz, Schöggl & Baumgartner, 2017; Green et al., 2012; Tseng et al., 2019a; Zhu, Sarkis & Geng, 2005). To that extent, organizations' IS need to carry the capability to capture data related to the environmental efforts and impacts of the processes of production and manufacturing, purchasing, selling, and logistics. Based on this data, businesses can acquire insightful information regarding the environmental performance throughout their supply chain, ultimately enabling them to make the decisions that are necessary for improvement of their environmental sustainability – and manage these sustainability efforts in an economically reasonable manner (Fritz, Schöggl & Baumgartner, 2017; Green et al., 2012). Moreover, IS are said to be the enabling factor for another prerequisite of successful GSCM, namely collaboration, information sharing and integration among supply chain partners (Tseng et al., 2019a).

The concept of collaboration in GSCM refers to relationships between supply chain partners where increased environmental performance, as well as lower costs, higher quality of products, reduced risk and greater market value, are achieved through a mutual and reciprocal management approach (Gunasekaran, Subramanian & Rahman, 2015; Tseng et al., 2019a). In other words, collaboration within the supply chain is about supply chain partners - including suppliers, customers, and logistics service providers – aligning and integrating the flows of materials, services and information in order to complement one another's business and thereby improve the environmental performance throughout the supply chain. To that extent, IS facilitate the coordination of these flows through information sharing and analysis of this information, which in turn enables coordinated decision-making among suppliers and customers regarding the previously mentioned structural an infrastructural investments (Gunasekaran, Subramanian & Rahman, 2015; Vachon, 2007).

2.3.2 Challenges and barriers for green supply chain management

When looking at barriers and challenges of GSCM in the fashion industry, a wide variety of previous studies can be found. In this context, a selection was made of the most relevant papers, based on the number of citations or research focus. It can be seen how challenges and barriers are most often divided into internal and external challenges (Majumdar & Sinha, 2018; Mathiyazhagan et al., 2013; Oelze, 2017; Tseng et al., 2019a). Moreover, the internal and

external challenges can often be assigned to an overarching dimension they are most applicable to, such as financial or managerial-related challenges. To that extent, internal challenges are categorized as follows: managerial-related challenges; organizational challenges; collaboration challenges; financial challenges. Moreover, external challenges can be categorized into: collaboration-related challenges; government-related challenges; and market-related challenges. In the following sections, each challenge is marked with a code (e.g., SC1) for identification and referencing. A complete overview of all the challenges is presented in Appendix 1.

Internal challenges

First of all, internal managerial-related challenges mostly limit organizations in successful GSCM practices due to a lack of commitment of top and mid-level managers (Mathiyazhagan et al., 2013; Oelze, 2017; Tumpa et al., 2019). Moreover, it can be seen how the fear of failure or the lack of consumer recognition can cause managers to limit their organizations to engage in such practices (Gardas, Raut & Narkhede, 2018; Tseng et al., 2019a; Tumpa et al., 2019). Further results of the analysis of relevant papers are shown in Table 1.

Table 1: Internal managerial-related challenges

Challenges	Description	Sources
Lack of commitment of top and mid-level management (SC1).	Top and mid-level managers that are not committed to GSCM practices can result in a lack of empowerment and ability among employees.	(Majumdar & Sinha, 2018; Mathiyazhagan et al., 2013; Oelze, 2017; Panigrahi & Rao, 2018; Tseng et al., 2019a; Tumpa et al., 2019)
Inadequate management capacity (SC2).	Managers are committed but are not skilled enough to strategically plan, monitor, manage, and motivate employees for GSCM practices.	(Gardas, Raut & Narkhede, 2018; Majumdar & Sinha, 2018; Oelze, 2017; Panigrahi & Rao, 2018)
Lack of consumer recognition of GSCM (SC3).	Decision-makers become negligent of GSCM practices, since their brand image has not yet improved, which is said to be the result of insufficient marketing.	(Gardas, Raut & Narkhede, 2018; Tumpa et al., 2019)
Fear of failure (SC4).	Decision-makers and employees in an organization are unwilling of GSCM practices due to concerns for their personal or organizational success.	(Majumdar & Sinha, 2018; Mathiyazhagan et al., 2013; Panigrahi & Rao, 2018; Tseng et al., 2019a)

Next to managerial-related challenges, some challenges for GSCM can be found in the organizational context. It can be seen how improper training of employees is a strong factor of influence (Gardas, Raut & Narkhede, 2018; Mathiyazhagan et al., 2013) as well as the overall level of environmental literacy within an organization (Majumdar & Sinha, 2018). A shortage

of these factors can strongly limit organizations' capabilities in GSCM. Table 2 provides an overview of these organizational-related challenges that emerged from academic literature.

Table 2: Internal organizational-related challenges

Challenges	Description	Sources
Lack of employee skills & knowledge for environmental practices *(SC5)*.	Employees are improperly trained; do not possess the skills and knowledge for environmental reporting; or do not understand green practices such as eco-design.	(Gardas, Raut & Narkhede, 2018; Majumdar & Sinha, 2018; Mathiyazhagan et al., 2013; Oelze, 2017; Panigrahi & Rao, 2018; Tseng et al., 2019a; Tumpa et al., 2019)
Lack of employment stability *(SC6)*.	The lack of a standard consequent workforce limits businesses to get employees' skills and knowledge to the right level.	(Mathiyazhagan et al., 2013; Panigrahi & Rao, 2018)
Lack of environmental knowledge *(SC7)*.	Deficient eco-literacy among decision-makers and employees, leading to negligence of GSCM practices.	(Gardas, Raut & Narkhede, 2018; Majumdar & Sinha, 2018; Mathiyazhagan et al., 2013; Oelze, 2017; Panigrahi & Rao, 2018; Tseng et al., 2019a; Tumpa et al., 2019)
Resistance to change in organizational culture *(SC8)*.	Employees lack the general ability to adapt; or are ignorant and negligent of new environmental practices as the result of discomfort.	(Majumdar & Sinha, 2018; Tumpa et al., 2019)
Lack of specific environmental goals *(SC9)*.	Both managers and employees lack personal and organizational environmental goals, due to lack of awareness or inadequate management.	(Majumdar & Sinha, 2018; Panigrahi & Rao, 2018)
Lack of green innovation *(SC10)*.	Organizations lack ambidexterity and are unable to provide innovative solutions for sustainability challenges.	(Gardas, Raut & Narkhede, 2018; Majumdar & Sinha, 2018; Oelze, 2017)

Additionally, many papers discuss how organizations are often limited to engage in - or successfully execute - GSCM practices due to financial constraints (SC11). In this context, scholars often strongly emphasize how the cost of eco-design, or system implementation strains budgets and can discourage organizations, leading to an inadequate approach to GSCM (Oelze, 2017; Panigrahi & Rao, 2018). Moreover, organizations might perceive a lack of financial benefits (SC12) (Gardas, Raut & Narkhede, 2018; Mathiyazhagan et al., 2013; Tumpa et al., 2019).

While collaboration is repeatedly addressed as one of the crucial elements of GSCM (Green et al., 2012) it simultaneously forms one of the greater challenges. From the internal perspective,

challenges for collaboration and GSCM can be found in the alignment of information systems strategies with GSCM objectives (Gardas, Raut & Narkhede, 2018; Tumpa et al., 2019). Additionally, organizations can also be limited to collaborate as a result of insufficient control mechanisms to coordinate operations with partners, such as relationships or reward systems (Panigrahi & Rao, 2018; Tseng et al., 2019a). These collaboration-related challenges are shown in Table 3.

Table 3: Internal collaboration-related challenges

Challenges	Description	Sources
Lack of green IS *(SC13)*.	Businesses information systems do not provide the tools to manage the flows of information, materials and services in a sustainable manner.	(Gardas, Raut & Narkhede, 2018; Majumdar & Sinha, 2018; Tseng et al., 2019a; Tumpa et al., 2019)
Lack of control of supply chain partners' operations *(SC14)*.	Organizations lack insight into suppliers' environmental performance; have insufficient relationships to achieve a mutual approach; lack reward systems to provide value of GSCM practices for suppliers.	(Gardas, Raut & Narkhede, 2018; Majumdar & Sinha, 2018; Mathiyazhagan et al., 2013; Panigrahi & Rao, 2018; Tseng et al., 2019a)

External challenges

However, challenges to collaborate with partners become greater when looking at the external factors. The complex supply chains of the fashion industry in general are a limitation for collaboration due to the challenging traceability of materials (Gardas, Raut & Narkhede, 2018). In other words, organizations can lack insight into who their supply chain partner are and therefore cannot collaborate with them. Moreover, organizations often can be limited to collaborate with partners due to a lack of trust among partners or partners' inability to engage in GSCM (Mathiyazhagan et al., 2013; Oelze, 2017; Panigrahi & Rao, 2018; Tseng et al., 2019a). Table 4 provides an overview of these collaboration-related challenges.

Table 4: External collaboration-related challenges

Challenges	Description	Sources
Lack of collaboration due to complex supply chains *(SC15)*.	Long and complex supply chains limit organizations' ability to build relationships with supply chain partners.	(Gardas, Raut & Narkhede, 2018; Tumpa et al., 2019)
Lack of integration throughout the supply chain *(SC16)*.	There's too little use of tools for coordination of flows, such as green IS, which limits effective integration among supply chain partners and thus GSCM success.	(Gardas, Raut & Narkhede, 2018; Mathiyazhagan et al., 2013)

Lack of supply chain partners' (ability to make) sustainable efforts *(SC17)*.	Supply chain partners lack organizational resources to engage in GSCM practices, thereby limiting effective collaboration.	(Mathiyazhagan et al., 2013; Oelze, 2017; Panigrahi & Rao, 2018; Tseng et al., 2019a; Tumpa et al., 2019)
Lack of awareness of supply chain partners *(SC18)*.	Supply chain partner lack awareness, commitment or belief in environmental sustainability and therefore do not engage in GSCM practices, thus limiting collaboration.	(Mathiyazhagan et al., 2013; Panigrahi & Rao, 2018; Tseng et al., 2019a)
Lack of (access to) partnerships with environmental responsible suppliers *(SC19)*.	Organizations are part of production networks where the level of engagement in environmentally sustainable practices is too low for GSCM practices.	(Gardas, Raut & Narkhede, 2018; Majumdar & Sinha, 2018)
Lack of trust among supply chain partners *(SC20)*.	The level of trust among partners limits collaboration and integration of flows.	(Majumdar & Sinha, 2018)
Lack of interest and awareness of stakeholders *(SC21)*.	Stakeholders, including customers, consumers and investors, lack awareness and interest in environmental sustainability, thereby limiting organizations to engage in GSCM practices.	(Gardas, Raut & Narkhede, 2018; Majumdar & Sinha, 2018; Panigrahi & Rao, 2018; Tumpa et al., 2019)

Another prominent external barrier and challenge for GSCM in organizations is the lack of governmental regulations, legislations, incentives and laws bound to the fashion industry (SC22). In many cases scholars emphasize the inadequacy of these governmental aspects, leading to an deficient approach to GSCM on an industry level (Gardas, Raut & Narkhede, 2018; Tseng et al., 2019a; Tumpa et al., 2019). At last, as another external challenge, high market competition can form a limitation for organizations to engage in GSCM and innovate business models since such practices are perceived as risks (SC23) (Majumdar & Sinha, 2018; Oelze, 2017).

2.4 Information Systems and Analytics

As discussed in the introduction, the Information Systems field (IS) is being criticized for "not fully … [embracing] sustainability as integral part of its research agenda" (Seidel et al., 2017, p.46). The existing research on environmental sustainability does not draw from the full potential that the IS field offers (Gholami et al., 2016). Therefore, IS scholars are encouraged to address environmental challenges and provide impactful solutions to enable sustainable practices in business and society (Gholami et al., 2016; Seidel et al., 2017).. To that end, this chapter will present the concept of Green IS and explore technologies and practices from the Analytics domain which enable the implementation of GSCM in the fashion industry. Moreover, challenges and barriers emerging in this context will be highlighted.

2.4.1 Green IS

The idea of integrating sustainability into IS research and practice gained momentum circa 15 years ago. Early thought leaders started to investigate how IS could be employed in organizations to pursue environmental sustainability (Chen, Boudreau & Watson, 2008). During that time, sustainability initiatives were still seen by many mangers as expensive stunts without tangible benefits for the business (Standing & Jackson, 2007). However, with increasing awareness for environmental issues in society the concept of Green IS emerged. It describes "IS-enabled organizational practices and processes that improve environmental and economic performance" (Melville, 2010, p.2). Green IS is often used interchangeably with the term Green IT; however, these two concepts have a distinct scope. Green IT focuses primarily on optimizing the environmental footprint of computing hardware such as servers, computers or network infrastructure throughout the whole lifecycle (Harmon & Moolenkamp, 2012). Green IS on the other hand is a more holistic concept that encompasses Green IT and further incorporates business processes, people and organizational capabilities (Watson, Boudreau & Chen, 2010; Loeser et al., 2017).

Chen, Boudreau and Watson (2008) describe how Green IS can enable environmental sustainable practices within organizations through enacting the roles of automation, information and transformation. IS-enabled automation of highly manual business processes increases the operational efficiency and leads to reduced resource consumption. IS can further provide relevant information about the sustainability impact of business operations to stakeholders and support environmental-conscious decision-making. Finally, the authors state that IS can be an enabler to completely transform an organization, its business model, or its product offering. Overall, the adoption of Green IS cannot only lead to environmental benefits, but also be a "source of innovation that can ultimately bring competitive advantage" (Baggia et al., 2019, p.13).

Out of the three areas mentioned above, providing information to support data-driven decision-making has been demonstrated to be especially effective to tackle sustainability challenges (Nishant, Teo & Goh, 2013; Standing & Jackson, 2007). Indeed, data and information are key resources to tackle sustainability challenges in the organizational context (Loeser et al., 2017). This includes a broad spectrum of data such as environmental performance indicators, data streams from IOT devices or social media content. Gholami et al. (2016, p.527) note, that the "the IS discipline has the particular competency to analyze such data" and turn it into actionable insights. This competency stems from comprehensive and longstanding research on Decision Support Systems (DSS), which form a central pillar of the IS field (Power & Sharda, 2009). The digitalization of business and society, exponential growth of available data and technological innovations have advanced and expanded the classical DSS field which is now more commonly known as Data Analytics (Delen & Ram, 2018). Today's Analytics technologies and techniques allow the aggregation and evaluation of heterogenous data sources across the organization to provide decision-makers with relevant insights through visual dashboards which enable data-driven decision-making. These capabilities make Data Analytics a prime candidate within the IS field to address GSCM-related challenges in the fashion

industry. As a result, current Data Analytics practices take center stage in this research. These will be comprehensively explored in the following section.

2.4.2 Analytics

The domain of data-centric practices within the IS field consists of many different overlapping concepts with sometimes varying definitions and blurred boundaries, which can lead to confusion (Mashingaidze & Backhouse, 2017). However, Delen and Ram state that "the common denominator of all of these definitions is … Analytics" (2018, p.2). They define (Data) Analytics as "the encapsulation of all mechanisms that help convert data into actionable insight for better and faster decision-making" (Delen & Ram, 2018, p.2). Therefore, this term will be employed throughout the paper. To provide a simple taxonomy of Analytics Delen and Ram (2018) suggest three different types of analytics which built upon each other:

- Descriptive Analytics: The simplest form of analytics which focuses on aggregating data of past business activities to provide comprehensive insights
- Predictive Analytics: Includes advanced analytic techniques to predict future trends and developments
- Prescriptive Analytics: The most sophisticated form of analytics, which proposes optimal courses of actions for complex business problems.

The evolution of the Analytics domain can be divided into three eras which correspond to the main technological concepts of Business Intelligence (BI), Big Data, and Artificial Intelligence (AI) respectively (Davenport, 2018). This does not mean however, that more recent concepts such as AI have replaced classical BI, which has been employed by organizations for more than two decades. Instead, these concepts supplement each other by following different approaches and relying on distinct technologies and techniques to generate insights from data (Davenport, 2018). Consequently, all three concepts are highly relevant both in academia and practice. Despite the distinct characteristics of BI, Big Data and AI (which will be explored later in this chapter), organizations can face similar challenges throughout the adoption and usage of these Analytics approaches. These common barriers are presented in the following section. Each challenge is marked with a code (e.g., A5) for identification and referencing. A complete overview of all the challenges is presented in Appendix 1.

The most obvious challenges for analytics are related to data issues. Data is the key resource of analytics, and challenges in the context of availability, quality or quantity have severe impact on analytics (Delen & Ram, 2018). Since BI, Big Data and AI approaches face distinct data challenges, these will be explored later in this chapter. Even if the necessary data is available, it can be challenging to define performance indicators that are business-relevant and also adequately represent environmental impact (A1) (Hristov & Chirico, 2019). Besides data, another main challenge of any analytics endeavor is a lack of management support (A2). Continuous sponsorship from executives is needed to obtain the resources required for developing analytics capabilities and integrating them into business processes (Alsheibani,

Cheung & Messom, 2019; Yeoh & Koronios, 2010). In addition, managers need at least basic knowledge of analytics and possess the leadership skills to steer a cross-functional team of data analysts and domain experts (Coleman et al., 2016; Davenport & Ronanki, 2018). To successfully integrate analytics, organizations need to establish a data-driven culture (A3) and perform a paradigm shift from making decisions based on experience and intuition to data-driven decision-making (Cetindamar, Shdifat & Erfani, 2020). In this context, several challenges can arise such as reluctance of change or fear of eroding responsibilities of employees (Delen & Ram, 2018). Another common barrier for analytics results from data security and privacy concerns (A4) (Moktadir et al., 2019). Fear of revealing sensitive business data may inhibit organizations from fully embracing analytics (Coleman et al., 2016). Furthermore, "combining personal information with other data sources can create numerous legal and ethical challenges" (Alharthi, Krotov & Bowman, 2017, p.288).

Analytics solutions employing BI, Big Data or Artificial intelligence techniques are sophisticated systems. Therefore, organizations need to establish the required knowledge and skills by hiring analytics experts. However, the shortage of analytics talent on the labor market confronts companies with major challenges to do so (A5) (Benbya, Davenport & Pachidi, 2020; Coleman et al., 2016). As the required skill set for BI, Big Data and AI differs, these challenges will be explored more in-depth later in this chapter. The complexity of analytics solution is also connected to challenges regarding the return of investment (ROI) of analytics initiatives (A6). Developing and integrating analytics solutions is not only very expensive (Haupt, Scholtz & Calitz, 2015; Moktadir et al., 2019) but the return of analytics is often neither tangible nor immediately realized and therefore hard to quantify in numbers (Delen & Ram, 2018). As a result, decision-makers might be reluctant to approve such projects. Time constraints present another key barrier to analytics in organizations (A7) (Moktadir et al., 2019). If employees are overwhelmed with their day-to-day workload, they won't be able to get familiar with innovative analytics tools and practices, resulting in low interest and adoption (Cetindamar, Shdifat & Erfani, 2020). Finally, organizations and especially SMEs also face challenges when evaluating and choosing suiting products and services from analytics vendors (A8) (Lacity & Reynolds, 2014; Moyo & Loock, 2020). This results from the plethora of available options, inconsistent definitions of analytics technologies and the overall high complexity of the topic. Therefore, organizations might be discouraged to invest in analytics technology or acquire products and services which do not effectively address their needs.

These general challenges can be serious inhibitors to the strategic and structured adoption of analytics techniques across organizations. In that case, employees often address the gap in analytics capabilities, by resorting to ad-hoc solutions created with spreadsheet tools such as Excel (Lennerholt, van Laere & Söderström, 2020). However, this approach leads to further challenges for organizations, as it creates information and data silos which are not subject to any governance as well as inefficient self-made solutions that require time-consuming maintenance (A9) (Lennerholt, van Laere & Söderström, 2020).

After having explored general barriers to Analytics the following sections will focus on the three main concepts BI, Big Data and AI, as stated by Davenport (2018), and their specific

challenges. A comprehensive definition of these terms is further given to provide a solid understanding for the remaining paper.

2.4.3 Business Intelligence

Business Intelligence (BI) is an umbrella term for technologies and techniques which integrate structured data from different enterprise systems into a central repository and provide insights to business users through visual dashboards (Mashingaidze & Backhouse, 2017; Pearlson & Saunders, 2013, p.327). It enables descriptive Analytics allowing organizations to evaluate past business activities and comprehend business outcomes (Delen & Ram, 2018). The concept of BI emerged in the 1990s and is well-established in today's businesses (Davenport, 2018).

A BI solution usually consists of several components structured into three logical layers. The first layer is the integration layer, which is tasked with aggregating and aligning data from enterprise systems such as ERP or CRM systems and other relational databases (Negash & Gray, 2008). Data from these source systems follows predefined tabular structures and is therefore called structured data (Salinas & Nieto Lemus, 2017). The subsequent core layer contains the heart of the BI architecture: the data warehouse. This integrated relational database stores all the business data aggregated in the integration layer and provides a single point of truth for further data analysis (Negash & Gray, 2008). The final presentation layer consists of a data visualization platform such as Power BI, Tableau or Qlik (Richardson et al., 2021). These tools enable business users to create visual and interactive reports to support decision-making (Negash & Gray, 2008). The empowerment of casual users without a technical background to be able to create insightful reports in an efficient and intuitive way is central goal of BI (Lennerholt, van Laere & Söderström, 2020).

Benefits of BI for GSCM

The organizational benefits of BI have been thoroughly researched. BI and the insights it yields for decision makers are also an enabler for GSCM. However, the findings of studies in this domain are usually presented in a generic and abstract way. Petrini and Pozzebon state for example that BI systems "serve as a tool for collaborators to learn, discover and exchange information regarding … environmental actions taken within the organization" (2009, p.190). The authors further state that the monitoring of environmental indicators through BI solutions enables organizations to continuously optimize their sustainability initiatives. Chen, Boudreau and Watson (2008) further emphasize the transformative potential of BI, which can foster ecological innovation and alter product and service offerings as well as business models. Few previous studies focus specifically on BI as an enabler for GSCM in the fashion industry. Ahmad et al. however, conducted a comprehensive qualitative study on this topic and concluded that BI "improved the resource utilization in terms of business processes, energy consumption, and material usage with better alignment of processes across the textile and apparel industry that lead to improved … environmental sustainability" (2020, p.15).

Challenges of BI

Besides the general analytics challenges mentioned in the previous chapter, organizations can also encounter additional barriers specific to BI. In the context of data-related challenges, lacking data availability, resulting from information silos, and poor data quality of legacy enterprise systems can especially constrain the realized value of BI (A10) (Lennerholt, van Laere & Söderström, 2020; Yeoh & Koronios, 2010). Another common challenge is the alignment of BI solutions to business requirements (A11). The BI tools available to business users are often not adequate to meet their needs due to deficient user involvement during the implementation/procurement phase (Haupt, Scholtz & Calitz, 2015; Mungree, Rudra & Morien, 2013). Even if the BI tools are capable, they can be difficult to use for casual users with low IT skills despite promises of intuitiveness by the vendors (Lennerholt, van Laere & Söderström, 2020). This can lead to business users showing little interest and engagement in these analytics tools bringing the BI adoption to a halt (A12) (Haupt, Scholtz & Calitz, 2015) Finally, BI initiatives suffer from a lack of BI Talent (A13): As BI operates at the intersection of business and technology the experts need a corresponding broad skillset ranging from database management to subject matter expertise (Mungree, Rudra & Morien, 2013)

2.4.4 Big Data

The concept of Big Data has witnessed a tremendous hype over the last decade and is omnipresent in academic literature regarding analytics. Big Data has an ambiguous meaning and describes both vast datasets characterized by high volume, velocity, and variety, as well as the complex scalable infrastructure required for efficiently process this data (NIST Big Data Public Working Group, 2019). High volume refers to the most obvious characteristic of Big Data which represents the huge datasets that are being processed and analyzed. Velocity describes the speed at which data is generated and analyzed enabling real-time analytics scenarios (Maroufkhani et al., 2020). Finally, variety indicates the highly heterogenous nature of Big Data. This not only includes structured data but also a broad range of unstructured data in textual or non-textual form such as sensor data from IOT-devices, documents, social media content, e-mails, images or videos (Inmon, Linstedt & Levins, 2019). Contrary to popular belief, the most challenging aspect of Big Data is not the data volume, as this is primarily a problem of computing power and storage which can be solved by scaling the infrastructure (Kimball, 2011; NIST Big Data Public Working Group, 2019). Instead, the variety of unstructured data is the key driver of complexity (Inmon, Linstedt & Levins, 2019). At the same time the integration of structured and unstructured data through Big Data approaches allows for more in-depth descriptive analytics and provides the foundation of predictive analytics (Delen & Ram, 2018).

While following the same goals and overall logical architecture as BI, Big Data Analytics requires more sophisticated technologies and techniques to store and process data (NIST Big Data Public Working Group, 2019). Computational frameworks such as Hadoop or Apache Spark offer scalable parallel data processing and form the core of the Big Data architecture

alongside vast cloud-based storage solutions called data lakes (Kimball, 2011; Nargesian et al., 2019; Salinas & Nieto Lemus, 2017). Due to this immense complexity Big Data Analytics is geared towards a more technical audience and is often not readily accessible for business users.

Benefits of Big Data for GSCM

Big Data is a very popular topic in academic literature in connection with GSCM. Many scholars praise the manifold potential of Big Data to solve a wide range of organizational and environmental problems. This suggests that Big Data Analytics is a key capability that is widely used to solve supply chain-related challenges. However, it is striking, that the benefits of Big Data are mostly presented in abstract terms without explaining how exactly they were achieved. In a study of the Taiwanese textile industry for example, Tseng et al. conclude that " Big Data was found to possess great potential for promoting [GSCM] performance in terms of impact, economic benefits[and] operational risk" (2019b, p.770). Belaud et al. (2019) offer slightly more specific findings, stating that Big Data improves sustainability assessments across green supply chains due to the comprehensive collection of different types of structured and unstructured data. This also leads to a more accurate assessments of environmental impacts of supply chain activities such as air pollution or greenhouse gas emissions (Chiappetta Jabbour et al., 2020). Big Data Analytics further enables data exchange between supply chain partners and allows for governance of sustainable practices (Raut et al., 2019). As a result, it can be used to "identify unsustainable … activities or any other environmental misconduct" (Mageto, 2021, p.10) within the supply chain. Furthermore, this data-driven collaboration also promotes emerging supply chain concepts such as the circular economy (Gupta et al., 2019). Finally, Big Data also plays a key role in making precise sales forecasts, which can reduce stock and waste and consequently saves resources and energy (Mani et al., 2017).

Challenges of Big Data

As Big Data expands on the concept of BI, most of the challenges listed in the previous section are also applicable in this context, including data availability, business alignment or data-driven culture. On top of that organizations may face additional challenges specific to Big Data. The complex and heterogenous nature is the main data-related barrier of Big Data (A14) (Alharthi, Krotov & Bowman, 2017). Different data types require individual approaches for access, integration, and processing, posing significant problems for organizations. As a result, companies must again face the challenging competition for analytics talent and skill (A15). In contrast to BI, Big Data professionals need advanced knowledge in the areas of data engineering, cloud solutions and parallel computing (Cetindamar, Shdifat & Erfani, 2020). Coleman et al. (2016) state, that identifying beneficial use cases of Big Data can be especially challenging for SMEs (A16). Use cases presented by technology vendors or digital service providers often do not fit the specific organizational requirements, according to the authors. Another major barrier of Big Data is infrastructure readiness (A17) (Alharthi, Krotov & Bowman, 2017). Organizations often struggle to develop and integrate the vast infrastructure required for massive parallel data processing (Cetindamar, Shdifat & Erfani, 2020; Delen & Ram, 2018). In addition, such an infrastructure is extremely costly to maintain (Moktadir et al.,

2019). Finally, organizational Big Data initiatives are inhibited by a lack of intuitive tools (A18) (Moktadir et al., 2019). In contrast to the matured BI software market, where a plethora of options are available, organizations are often faced with complex solutions for Big Data Analytics (Coleman et al., 2016).

2.4.5 Artificial Intelligence

The hype revolving around Big Data is matched or even surpassed by the promised potential of Artificial Intelligence (AI). The AI domain has witnessed rapid advances in practice and academia over the last years fueled by increasing computing power and the novel sources of information provided by Big Data (Duan, Edwards & Dwivedi, 2019). Practitioners and scholars alike are making bold predictions regarding the disruptive power and importance of AI. Entire industries are said to be facing disruptive transformation (Davenport & Kalakota, 2019; Lee, 2020). In this context, Iansiti and Lakhnai state, that "firms built on a [AI-enabled] digital core can overwhelm traditional organizations" (2020, p.7). AI can be broadly defined as intelligent machines/systems which can perform human-like cognitive tasks such as solving complex problems or decision-making by sensing their environment and learning from data (Benbya, Davenport & Pachidi, 2020; Russell & Norvig, 2021). Organizations can employ AI to automate repetitive processes, engage with customers through digital assistants or generate insights through Machine Learning (ML) (Benbya, Pachidi & Jarvenpaa, 2021). ML is a central pillar of the AI domain and enables predictive as well as prescriptive analytics (Delen & Ram, 2018). Therefore, it is a promising approach to analytics in the green supply chain context. The ML domain consists of algorithms and techniques which learn from vast amounts of data to detect hidden patterns or predict future developments (Benbya, Davenport & Pachidi, 2020).

While an in-depth explanation of ML and its enabling technologies is out of scope for this overview of Analytics practices, a short overview of the ML workflow shall be given. Solving classification problems is common use case for ML (Chicco, 2017). A fashion brand might want to screen potential suppliers and rate them regarding their sustainability practices (e.g., bad, good, excellent) based on their characteristics such as number and type of certifications, location, size, or manufacturing process to find the most suitable partner. To that end, a ML algorithm can be trained with data of suppliers, where the sustainability rating is already known. Such information might be available from past business activities or environmental organizations. The result of this so-called training process is a ML model (Russell & Norvig, 2021). This model can then analyze previously unknown suppliers and propose a suiting sustainability rating.

Benefits of AI for GSCM

Similar to Big Data, AI is attributed in academic literature with a range of broadly defined benefits for GSCM including increased transparency, faster decision-making and precise forecasting (Cioffi et al., 2020). However, there is also a variety of more nuanced and detailed studies regarding GSCM in the fashion industry. A literature review of applied AI articles in

the Fashion industries conducted by Giri et al. (2019) shows that there are many opportunities for AI and especially ML throughout all the supply chain stages from yarn and fabric production to distribution which can positively influence environmental sustainability. AI can also enable green supplier selection by evaluating potential suppliers based on a variety of criteria (Pournader et al., 2021). This allows companies to find appropriate partners that match their level of sustainability practices. Yildirim, Birant and Alpyildiz (2018) outline a variety of ML use cases to predict different product quality aspects such as seam strength or the effect of detergents on fabric properties. These approaches can enable the selection of more durable materials and optimized production techniques which increase the longevity of clothes making them more sustainable. Demand and sales forecasting is another popular use case for AI in the fashion industry (Giri et al., 2019). Based on historical sales data and garment characteristics, ML models can predict the sales volume for a fashion item (Nayak & Padhye, 2018). This way, organizations can order the right number of items reducing potential waste.

Besides these proposed benefits however there are also critical voices regarding the impact of AI on sustainable supply chains: Dauvergne (2020) argues that organizations are exaggerating the sustainability benefits of AI and are primarily interested in taking advantage of potential efficiency gains to increase production and sales and therefore their profit margins. He further states that "portraying AI as a force of sustainability is legitimizing business as usual" (2020, p.1) without addressing any substantial environmental challenges.

AI Challenges

Like BI and Big Data, AI requires advanced technical skills (A19) (Benbya, Davenport & Pachidi, 2020). In the case of AI however, the "required knowledge to embed learning algorithms … goes beyond the traditional analytics skill set" (Davenport, 2018, p.74). As the result, it is especially challenging for organizations to develop AI know-how. Organization can also face huge barriers in the context of data when trying to implement AI. Especially data quality is an essential issue for developing ML solutions (A20) (Benbya, Davenport & Pachidi, 2020). ML algorithms trained on flawed or incomplete datasets can develop biases in their predictions (Chicco, 2017). If left unchecked these can lead to severe financial losses or damage to the company image (Dastin, 2018). While organizations are excited about the possibilities of AI, it can be challenging to find a use case within the own business context (A21) (Alsheibani, Cheung & Messom, 2019). This can result from a lack of understanding or insufficient organizational readiness in terms of data or infrastructure.

Besides these common Analytics barriers AI faces some distinct challenges compared to BI and Big Data, due to its predictive capabilities. The introduction of AI into organizations can lead to tensions with employees who fear losing responsibilities or even being made completely redundant (A22) (Alsheibani, Cheung & Messom, 2019). While current research points towards AI augmenting instead of replacing human jobs, employees might still reject it (Benbya, Pachidi & Jarvenpaa, 2021). Another central challenge of AI is related to transparency (A23). Advanced ML algorithms (especially Neural Networks, which belong to the subdomain of Deep Learning) are not only hard to understand even for experts but also don't provide an explanation why a

particular output was found (Asatiani et al., 2020). This black-box behavior can be unsuitable for critical decision or highly regulated environments (Davenport & Kalakota, 2019). Furthermore, the above-mentioned bias of ML algorithms can lead to ethical challenges if the outcomes disadvantages certain groups of people (A24) (Benbya, Davenport & Pachidi, 2020). Following up with the example of ML-enabled supplier selection, it should be critically questioned whether the algorithm rejects certain suppliers because of their origin or cultural background. Lastly, organizations face barriers when trying to deploy their AI prototypes into a productive environment as the required integration into the existing enterprise architecture and adaption of organizational processes can be extremely costly and take a long time (A25) (Benbya, Davenport & Pachidi, 2020).

3 Conceptual Model

The theoretic background provided a comprehensive overview of the relevant literature to understand the core-concepts relevant to the research question. To that extent, the main sustainability problems of the fashion industry were identified, as well as the challenges to engage in GSCM and analytics practices. This chapter is focused on condensing these findings into a more abstract overview where the identified organizational challenges for analytics-enabled GSCM are summarized in a conceptual model. To that extent, several IS models regarding technology adoption were explored. As this research concentrates on organizational challenges, several well-established models from the IS domain such as the Technology Acceptance Model (TAM) family are not suited, due to their focus on the individual perspective of technology adoption (Venkatesh et al., 2007). Therefore, the Technology-Organization-Environment (TOE) framework was selected for its organizational focus, level of abstraction, and the flexibility it provides in structuring findings (Baker, 2012). Other technology adoption models with an organizational focus were rejected due to the level of complexity such as the Fit-Viability Model (Larosiliere & Carter, 2016; Liang et al., 2007). In turn, the resulting model of this chapter provides a structured approach and clear guidance for empirical inquiry, as well as a framework for discussion of the results of this study.

3.1 TOE Framework

The Technology-Organization-Environment Framework (TOE) was developed by Tornatzky and Fleischer (1990) and is a well-established and proven model in the IS field (Hameed, Counsell & Swift, 2012). It is designed to provide insights into the adoption of (technological) innovation in organizations (Baker, 2012). Technology adoption is a multi-step process ranging from the organizational awareness of a need, over selecting a solution and acquiring/developing it, to the acceptance and use of the innovation by the users (Hameed, Counsell & Swift, 2012). TOE builds upon the main idea that the organizational technology adoption is influenced by several dimensions (Tornatzky & Fleischer, 1990). These include the Technological, Organizational and Environmental contexts – each consisting of different factors. In his comprehensive review of the framework, Baker (2012) defines the three aspects as follows:

- Technological dimension: Includes technologies used by an organization as well as relevant technologies which are not currently employed
- Organizational dimension: Consists of companies' resources, organizational structure, values, and capabilities.
- Environmental dimension: Encompasses the industry structure, competition, partners and the regulatory environment.

The TOE provides a fitting structure to synthesize the findings of the literature review due to the mentioned flexibility as well as its simplicity. This way, the relevant factors and dimensions

can be organized in an understandable manner. Furthermore, the dimensions of the TOE mirror the comprehensive approach of the IS field which is not only concerned with technology but also its wider business context. By adhering to the framework, this IS perspective is further enforced in this research.

3.2 Model Overview

In this research the TOE framework is used to gain insights into the adoption of Analytics in a GSCM context. To that end, the challenges identified in the Analytics and GSCM literature are matched to one of the three dimensions. To combine the barriers found in the two research domains, challenges within a dimension that cover similar areas are grouped to form clusters. In turn, these clusters are labeled with the overarching topic. By following this bottom-up approach 14 clusters are created. They are the core of the conceptual model and act as cornerstones throughout this research. The resulting model is shown in Figure 2. In the remaining chapter, each cluster including their main challenges will be presented. The challenge IDs established in Chapter 2 (e.g., A1, SC3) are used for a more concise presentation. A comprehensive overview of all challenges and their categorizations is shown in Appendix 1.

Figure 2: Conceptual Model with challenge clusters

3.2.1 Technological Dimension

Data
Challenges: A10, A14, A20[1]

Academic literature presents distinct data challenges for BI, Big Data or AI. Overall, a lack of data availability – meaning that internal or external data sources cannot be easily accessed – or quality, referring to inconsistent, faulty, or messy data, are main challenges for all Analytics approaches and therefore central to this cluster. In addition, complex heterogenous datasets require challenging processing steps before they can be used within analytics tools.

IT Talent
Challenges: A13, A15, A19

Analytics requires a broad range of skills and knowledge which can be challenging for organizations to develop. These include basic data literacy - "the ability to understand and use data effectively to inform decisions" (Mandinach & Gummer, 2013, p.31) - and data visualization skills as well as more advanced technical know-how in the areas of data engineering and data science for Big Data and AI solutions.

Strategy & Alignment
Challenges: A1, A9, A11, A16, A21, SC10

This cluster is more heterogenous and encompasses challenges regarding the integration of Analytics into business strategy, environmental practices, and day-to-day processes. It is an essential foundation for a successful adoption process. The main challenges revolve around providing analytics solutions, that fit the business requirements, defining relevant performance indicators, or identifying use cases for advanced technologies like Big Data and AI.

Security & Ethics
Challenges: A4, A23, A24

Security concerns are always present when working with Analytics solutions. Ethical questions also come into focus when personal data is processed, or when decisions are taken by ML algorithms. The corresponding challenges grouped in this cluster must be addressed in accordance with data security policies and regulations.

Infrastructure
Challenges: A17, A25, SC13

To enable analytics-enabled GSCM, practices such as BI, Big Data and AI require a sophisticated technological backbone to query, process, or store data. Building this infrastructure and establishing an operating model can be highly challenging for organizations.

[1] These challenges are described more thoroughly in the theoretic background. A comprehensive overview can be found in Appendix 1.

In addition, enterprise systems currently in use might lack the capabilities of processing sustainability information or appropriate interfaces.

3.2.2 Organizational Dimension

Management
Challenges: SC1, SC2, A2, SC7, SC9

In the organizational context, several important challenges for analytics-enabled GSCM can be found in the management cluster. To that end, the environmental performance of an organization is fully dependent on the decision-makers within that organization. In other words, when these decision-makers lack the motivation or capacity to nurture green operations, improvements to that are not achieved.

Perceived Benefits
Challenges: SC3, A6, SC12

In line with the abovementioned challenges from the management cluster, benefits of (visible) improved performance steer decision-making. In this context, when these benefits are not perceived, this can form challenges for any further conduct of analytics-enabled GSCM practices. Challenges in this cluster revolve around tangible financial benefits or the ROI of Analytics.

General Resources
Challenges: SC6, A7, SC11

A shortage of general resources, such as time, liquidity, or human resources can form challenges for an organization to engage in, or successfully propagate analytics or GSCM practices.

Culture and Change
Challenges: A3, SC4, SC5, SC8, A12, A22

People in an organization can form a limiting factor for that organization's successes in technological implementations and environmental practices. To that end, for example the organizational culture, and employees' susceptibility to changes in this culture, are a determining factor for challenges that might occur in analytics-enabled GSCM practices.

3.2.3 Environmental Dimension

Software Market
Challenges: A8, A18

This cluster is comprised of challenges raised in Analytics literature. It describes the barriers organizations face when searching for Analytics solutions on the market that not only meet their individual requirements but are also intuitive to use for a wide user base.

Supply Chain Partners
Challenges: SC17, SC18, SC19

Challenges for analytics-enabled GSCM can lie with an organization's supply chain partners. In this context, as shown in Chapter 2.3.2, the environmental performance of an organization is dependent on the actions of their suppliers or buyers - since the environmental impact of certain products is constituted through the impact of every action by any actor in the supply chain revolving around the creation of this product.

Supply Chain Collaboration
Challenges: SC14, SC15, SC16, SC20

Successive to the challenges found in the supply chain partners cluster, the cluster of supply chain collaboration consists of a set of higher-level challenges for analytics-enabled GSCM. In order to successfully utilize analytics for GSCM, organizations must take an integrated and collaborative approach to that end. However, this approach is often one of the greater challenges to establish.

Market-driven Forces
Challenges: A5, SC21, SC23

Forces such as a lack of interest in sustainable business from stakeholders or consumers, or scarcity in technical skills in the labor market, can strongly challenge organizations to engage in practices of analytics-enabled GSCM. These challenges found both in the analytics domain, and the GSCM domain are bundled in the market-driven forces cluster.

Regulatory Environment
Challenges: SC22

A lack of governmental regulations – one of the stronger drivers to engage in sustainability practices - can challenge organizations in undertaking actions or successfully executing them. The reasons for this can be found in a lack of governmental incentives, or a lack of regulation throughout the industry, limiting individual companies to improve their impact through the absence of an industry-wide sustainable transition.

4 Methodology

This chapter outlines the methodological approach of this research towards exploring the main challenges for analytics-enabled GSCM in the fashion industry. Starting from the philosophical stances of this research and a presentation of the overall research strategy, the main data collection technique – qualitative interviews – as well as the data analysis through coding is explained. Moreover, ethical considerations and scientific quality are discussed. The previously developed conceptual model acts as a foundation for both data collection and analysis and guides the development of the interview guide as well as the coding strategy.

4.1 Research strategy

The aim of this study was to answer the question: "What are the main organizational challenges of analytics-enabled green supply chain management in the European fashion industry?". Therefore, the interpretive philosophical paradigm and a qualitative methodology were applied.

The reason for the selection of the interpretive paradigm lies with the subject of interest. As stated in the problem and aim, the topic of analytics-enabled GSCM is a nascent research domain that so far has mostly been focussed on optimistic opportunities. However, a more critical perspective focussing on the challenges of analytics-enabled GSCM has not yet been explored, and therefore asks for fundamental and in-depth knowledge. According to Goldkuhl (2012) and Recker (2013) this can most appropriately be acquired through interpretive methodologies. In other words, this research aims to assess the (possibly overly optimistic) theoretical and technological views currently present in this research domain and give a more realistic/ "real-world" perspective. In this context - ontologically approaching reality as being socially constructed - interpretively observing peoples' subjective experiences of the challenges can provide this real-world perspective, as well as the in-depth and critical knowledge that is currently needed in the analytics-enabled GSCM domain (Bhattacherjee, 2012; Patton, 2015; Recker, 2013; Walsham, 2006). At last, this study aims to gain a more realistic perspective by evaluating challenges in practice. Therefore, the interpretive epistemological viewpoint is well suited, as it enables continuous and iterative improvement of the researchers' knowledge through interaction and collaboration with their informants from practice (Carson et al., 2014).

Other philosophies such as positivism or pragmatism, were rejected for the following reasons: First, positivism would cause for an objective approach which pursues generalization instead of a deep, phenomenological understanding of subjective experiences - and therefore is not suitable for this research aim (Recker, 2013). Thereafter, as shown by Goldkuhl (2012) the pragmatic approach, focuses heavily on actionable knowledge. In this context, this would lead to an overly practical conduct and outcome as this paper focuses on creating deeper and interesting knowledge that can offer novel grounds for future research.

Successive to the philosophical foundation of this study, a qualitative methodology was selected. From the interpretive viewpoint, the challenges for analytics adoption and GSCM are a product of interdependent and dynamic factors resulting from or leading to human perception and behavior (Patton, 2015). To assess this socio-technical perspective, a qualitative methodology offers approaches to recognize and research these underlying factors, perceptions and behaviors, in relation to the complex organizational environments they occur in (Patton, 2015; Recker, 2013). Additionally, as shown by Mansour & Ghazawneh (2009) the socio-technical perspective is essential in the IS domain and a key factor for the practical usefulness of IS research (Baskerville & Myers, 2017). Therefore, a qualitative methodology offers the most suitable approach to research the challenges for analytics-enabled GSCM as part of a socio-technical system, where it can provide detailed data/information on the challenges of analytics-enabled GSCM (Patton, 2015; Recker, 2013). Thereafter, this data can be analyzed and compared with other data, to generate results that in turn provide more generalized answers to the research question (Patton, 2015). Thus, based on a qualitative methodology this research will assess the perspectives employees of fashion companies have on the organizational challenges of adopting analytics for GSCM.

At last, this research will also carry a hermeneutic approach regarding the research design and the handling of empirical data in order to enable empirically steered iterative improvement of this study (Cole & Avison, 2007). To that extent, the seven principles for conducting interpretive field studies in IS by Klein & Meyers (1999) are used as guidance to ensure the quality of this research. This is described more thoroughly in Chapter 4.5.

4.2 Data Collection

To explore the main challenges related to analytics-enabled GSCM two main data collection approaches were pursued. First literature was reviewed to establish the theoretical foundation based on the current body of scientific knowledge. Secondly qualitative interviews were conducted to address the research question and advance the body of knowledge with insights and personal experiences from experts in this domain. Both approaches are presented in this chapter. However, the qualitative interviews are the primary data collection instrument in this research and are therefore presented more thoroughly. This includes a brief introduction to the chosen method, the design of the interview guide, sampling strategies and the guidelines applied during the interview.

4.2.1 Literature Review

The goal of the literature review is to provide "a firm understanding of where [the] body of knowledge currently stands" (Recker, 2013, p.39). The goal of the literature review is to provide "a firm understanding of where [the] body of knowledge currently stands" (Recker, 2013, p.39). As this understanding is needed for planning and structuring the research (Recker, 2013), the literature review was conducted during the early stages of the research process. To achieve a

comprehensive overview of both the analytics and GSCM domain, including the organizational challenges faced in theses contexts, a wide range of literature had to be analyzed. The framework for effective literature review proposed by Levy and Ellis (2006) was used as guidance for this time consuming task. By following a concept-centric approach instead of searching for literature chronologically or based on specific authors, the risk of missing essential works was minimized (Levy & Ellis, 2006). The numerous overlapping terms and definitions in the analytics and GSCM domain made it difficult to identify all the relevant papers. To address this challenge, the keywords and search strings were iteratively refined based on the new knowledge obtained during the literature review. Furthermore, general search engines such as Google Scholar and LUBSearch were used to obtain results across academic databases without limitations, following the recommendation of Levy and Ellis (2006).

In this research special emphasis was put on gathering high-quality and peer-reviewed works from established publications. This undergirds the validity of this research as well as the reliability of the findings (Levy & Ellis, 2006). The quality was ensured by searching for known journals with a reputation for scientific quality, comparing citation scores across search engines, and discussing questionable sources within the research team. For the selection of IS literature, journals from the "Basket of Eight" were primarily targeted (e.g., Journal of AIS or MIS Quarterly). These were complemented with works from well-established as well as emerging IS publications. Levy and Ellis (2006) further note that IS researcher should examine conference proceedings to gain a comprehensive overview. Therefore, papers published at conferences related to the Association of IS such as AMCIS (see Alsheibani, Cheung and Messom (2019)) were also explored. Since analytics technology advances at a rapid pace, a balance had to be struck between wells-established papers with high citation scores and contributions from less known publications which were published more recently.

In the area of GSCM this research team had less experience regarding reputable sources. After an extensive search the journals "Sustainability" and "Journal of Cleaner Production" were identified as leading publications in this domain. These journals were then searched for promising papers. As GSCM is a more mature topic driven by many multidisciplinary perspectives, it was deemed important to identify the fundamental works in this domain that serve as a common reference point. Therefore, a backward reference search was conducted (which entails iteratively reviewing the references of high-quality papers (Levy & Ellis, 2006)). In this way, the knowledge on this previously unfamiliar topic could be expanded and central works such as the work by Zhu, Sarkis & Geng (2005) were identified. Performing a forward reference search based on these papers yielded additional high-quality results from other GSCM-related journals.

4.2.2 Qualitative Interviews

Based on the interpretive foundation and the qualitative research approach, interviews were chosen as the primary method to collect data in this study. Interviews are the most common technique to generate qualitative data in the IS domain (Walsham, 2006) and the extensive

literature on the topic offers valuable guidance for novice IS researchers. To explore the challenges of analytics-enabled GSCM in European fashion companies, personal and detailed experiences of supply chain and sustainability experts need to be gathered. This can be accomplished by conducting "Descriptive Interviews" which, according to Recker (2013), focus on collecting subjective views and assessments from multiple interviewees to gain comprehensive insights into a phenomenon. Schultze and Avital concur with Recker, stating that interviews "generate deeply contextual, nuanced and authentic accounts of participants' … experiences" (2011, p.1). Alternative interpretive methods such as a case study or ethnography may also offer interesting research opportunities, but were not suited for this research due to the considerable amount of time and organizational involvement required (Klein & Myers, 1999).

Conducting interviews, while offering the above mentioned benefits, does not assure the generation of relevant and truthful insights (Schultze & Avital, 2011). Common challenges include biases of the researchers (Walsham, 2006), misrepresented information (Recker, 2013) or ulterior motives of the interviewees (Schultze & Avital, 2011). A comprehensive interview approach which also enables flexibility is required to effectively address these challenges. Therefore, the interviews will be conducted in a semi-structured manner. This approach builds upon an interview guide with predefined questions but encourages the interviewer to ask follow-up questions (Recker, 2013). As a result, potentially ambiguous statements regarding the challenges of analytics-enabled GSCM in the context of the European fashion industry can be clarified directly during the interview. In addition, yet unexplored research areas that might emerge during the interviews can be further investigated.

The interviews are approached with a "romantic" perspective as described by Schultze and Avital (2011, p.4). Thus, the interview is viewed as a conversation, where the researcher and interviewee explore the interviewee's experienced reality together. According to the authors, this approach can produce more authentic insights from the perspective of the interviewee. Schultze and Avital further note however, that "trust and a sense of equality" (2011, p.4) are essential requirements for an information-rich interview. To achieve this, the guidelines presented by Myers and Newman (2007) were applied: Throughout the conversation appropriate language was chosen that reflects the level of knowledge of the interviewee to minimize social dissonance. In addition, mirroring was used actively in the conversation, which refers to picking up terms and phrases from the interviewee and incorporating them into questions and comments of the researcher (Myers & Newman, 2007). Moreover, the role of the researcher as active listener was acknowledged which entails listening as well as guiding and encouraging the conversation partner (Myers & Newman, 2007; Schultze & Avital, 2011). This includes a flexible reaction to the emotional attitude of the interviewee such as boredom, shyness, or over-excitement to steer the conversation back to a productive path.

To facilitate the following data analysis the interviews were recorded after consent was given by the interviewees. This freed up the researchers from excessive note-taking and enabled a greater focus on the conversation (Walsham, 2006). If possible both researchers were present during the interviews, where one led the conversation while the other one focused on

notetaking. As the experience of the research team regarding qualitative interviews in practice was limited, this allowed both to focus on a sole task. Further, this approach enabled the interpretation of the whole interview from multiple perspectives.

4.2.3 Interview Guide

The interview guide ensures that the most relevant questions for the research topic are pursued across each interview and supports the time management of the researcher (Patton, 2015). It is therefore a key artifact of the interview process and should be designed carefully. In this paper, the framework and guidelines presented by Myers and Newman (2007) guided the development process. The general structure of the interview guide is shown in Figure 3. In accordance with the authors, the interview begins with an opening, introducing the goal of the research as well as the researcher and the reassurance of confidentiality. Next, the interviewee is given room to present himself/herself as well as the organization he/she works for. This is an important step to "minimize social dissonance" between interviewee and researcher (Myers & Newman, 2007, p.16). Nevertheless, the advice from Walsham (2006) to be aware of time constraints and not unnecessarily prolong the opening, was also considered, resulting in a concise set of questions.

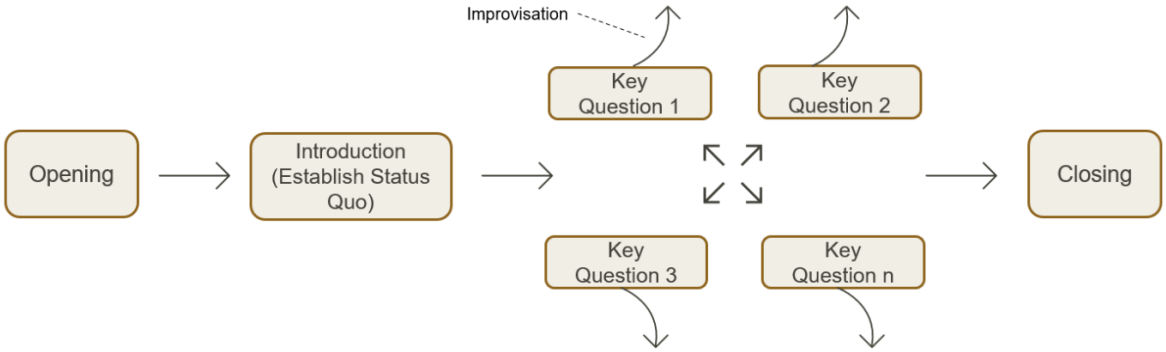


Figure 3: Structure Interview Guide

After the opening, Myers and Newman (2007) suggest asking some introductory questions which set the stage for the following key questions. In the interviewees, these questions aimed to establish the status-quo of analytics-enabled GSCM in the context of the interviewee. This included questions regarding key environmental issues within the supply chain, the role of data to address these issues as well as the use of analytics tools. The questions were formulated in an open and general way encouraging the interviewee to provide extensive descriptions ham

Recker, 2013). The goal was to obtain a comprehensive overview and to identify information-rich challenge clusters which could be addressed next.

The key questions which comprised the core of the interview (Myers & Newman, 2007) are based on the identified challenge clusters in Chapter Conceptual Model3. To increase the possibility of gaining relevant insights and use the limited time efficiently, the questions were designed to cover several challenge clusters at once. To further incorporate the guideline of "flexibility" proposed by Myers and Newman (2007), into the interview process, the key

questions were not asked in a linear manner but instead prioritized based on their potential to yield relevant result for this research. This prioritization was based upon the answers from the introductory questions.

Finally, in accordance with Myers and Newman, the "close" of the interview (2007, p.14) provides time to address any questions or doubts from the interviewee, reassuring confidentiality and explaining how his/her answers will be further processed in the research process. The complete interview guide is shown in Appendix 2.

4.2.4 Interviewee Selection

To find interviewees for this study, a purposeful sampling strategy was employed where candidates were chosen based upon their potential to present interesting and in-depth insights (Patton, 2015). The primary target were European fashion companies that integrate environmental sustainability into their strategy and value proposition. More specifically, the focus was put on organizations located close to the consumer such as fashion brands as these are directly affected by the pressure of some consumers segments to adopt green practices (Shen et al., 2017). Large multinational fast-fashion brands were excluded from the selection as their immense environmental footprint outweighs their sustainability initiatives which are often criticized as attempts of greenwashing (Henninger, Alevizou & Oates, 2016; Kim & Oh, 2020). The opposing "slow fashion" trend, which focuses on environmental sustainability, is predominantly pursued by premium brands as well as SMEs or even micro brands with less than ten employees (Štefko & Steffek, 2018). Therefore, these organizations were primarily contacted.

Sustainability Rating platforms such as "good on you" (www.goodonyou.eco) were used to identify a set of suiting companies which were then researched in detail based on their corporate responsibility reports. To minimize language and cultural barriers, organizations from the Nordic countries, the Netherlands and Germany were primarily targeted due to accessibility and the high English proficiency among the population. Overall, around 40 fashion brands were contacted through several channels in parallel, including mail, phone and by looking up and contacting employees directly via social business networks such as LinkedIn. Overall, the response rate was very low. The few brands that responded cited a high workload or an overload of requests for academic interviews as reasons for rejecting the interview invitations. While challenges regarding the acquisition of interviewees were anticipated, such a low turnout was not expected. Therefore, additional measures were taken.

First, a snowball sampling approach was incorporated into the strategy which included asking respondents which had agreed to join an interview as well as contacts that had rejected the offer for referrals to colleagues within their network that might be suitable for this research (Patton, 2015). Secondly, after studying the fashion industry in detail, it was determined that the initial scope of target companies was too narrow. In line with the guideline presented by Myers and Newman (2007) it was aimed to represent more varied perspectives. To complement the limited

view of individual fashion brands, intermediaries such as service providers, business associations or digital platforms were also contacted which could provide a macro perspective on the challenges regarding analytics-enabled GSCM within the fashion industry. These measures proved to be successful. Table 5 summarizes the interviews conducted for this research. All interviews were conducted using a video-conferencing tool, due to the geographical distance between researchers and interviewees. Each interviewee is associated with an ID for referencing purposes and the company names are further anonymized. Six interviews were conducted with employees from five different organizations, where two representatives from Organization B were questioned.

Table 5: Summary of conducted Interviews

ID	Organization	Organization Type	Interviewee Role	Date	Duration	Language
A1	Organization A	Micro Fashion Brand	Co-Founder	19.04.22	30 Min	English
B1	Organization B	Trade Association	Member of the Board	19.04.22	45 Min	English
B2	Organization B	Trade Association	Head of IT	03.05.22	60 Min	English
C1	Organization C	Medium Fashion Brand	CSR Manager	22.04.22	30 Min	German
D1	Organization D	Platform Provider	Sustainability Officer	22.04.22	50 Min	English
E1	Organization E	Large Fashion Brand	CSR Manager	28.04.22	30 Min	English

The organizations are presented briefly in the remaining chapter to provide some context for the upcoming exploration of the empirical results.

Organization A is a micro-sized fashion brand with less than ten employees located in the Netherlands. The organization sells premium outdoor fashion through their e-commerce platform and retail mainly in the Netherlands but also in neighboring countries. Environmental Sustainability is a at the core of Organization As' strategy which is reflected through initiatives to minimize the carbon footprint, achieve the usage of 100% recycled materials as well as several environmental certifications.

Organization B is a large international trade association with over 2000 organizational members. It focuses on advancing green practices within the supply chain among its members which are predominantly from the fashion sector. To that end, Organization B provides several services such as, sustainability audits or training for organizations to drive sustainability awareness. In the last years, Organization B has invested heavily into developing a digital sustainability platform for its members. Through its extensive network, the organization is at the forefront of tackling challenges in the context of analytics-enabled GSCM.

Organization C is German fashion SME with around 300 employees that offers a diverse brand portfolio targeting a wide audience from children to business customers. Bags are the

companies' main products, although it has recently introduced its first apparel collections. Environmental sustainability is a core value of Organization C, and the company provides a transparent overview of their green practices through a comprehensive sustainability report. These practices include the use of recycled materials, extensive collaboration with certification agencies as well as carbon neutral operations.

Organization D is a Dutch start-up with around 20 employees that provides a digital marketplace to connect sustainable fashion brands and manufacturers from the European Union. More than 3000 organizations have already joined the platform. The company collaborates closely with both manufacturers and brands to promote waste reduction, optimized transportation, product quality and sustainable energy sources which reduce the environmental impact. As a result, Organization D is gaining comprehensive insights into the challenges these organizations are facing in the context of GSCM.

Organization E is a large international fashion company with several thousand employees that offers well-known premium brands. Due to the high price point of the products these are not considered fast fashion. The company tackles sustainability issues with a broad range of initiatives to reduce carbon emissions and eliminate waste. Creating innovative solutions to enable circularity is a core objective of Organization E. The perspective of a large fashion company is a valuable addition to this research and complements the views of the smaller brands.

4.3 Data Analysis

This chapter details the approach taken to analyze the data collected through the qualitative interviews. It includes a description of the transcription as well as the coding process. Coding comprises most of the data analysis phase and is based upon the conceptual model developed in Chapter 3. As both processes are acknowledged to be highly interpretive (Patton, 2015) they are described in detail to enable traceability and reflect the scientific rigor applied in this research.

4.3.1 Transcription

An essential step towards data analysis is the transcription of the recorded interviews (Recker, 2013). This is usually very time-consuming and therefore debated in literature (Walsham, 2006). Considering the short time frame available to carry out this research, it was decided to rely on AI-enabled transcription services to accelerate the process. To transcribe the interviews held in English a service provided by Otter.ai (www.otter.ai) was used. It allows for real-time transcriptions during the interviews. Afterwards the transcribed text was reviewed by the researchers and adjusted in case words were not identified correctly. As Otter.ai only works for conversations in English another approach had to be selected for the German interview. Therefore, that interview was transcribed using Sonix.ai (www.sonix.ai). and later translated

through an automated service (www.deepl.com) to minimize the influence of bias by the researchers. The results are presented in Appendices 3-8. Overall, the transcripts were kept as close to the original recordings as possible. Only in very few occasions some words were omitted to facilitate comprehension. However, this was only done if the meaning of the phrase in question was not altered.

4.3.2 Coding

The transcription process leads to huge quantities of data which have to be analyzed (Recker, 2013). In order to improve this process of analysis, the coding method can be applied to reduce the data into a manageable set (Skjott Linneberg & Korsgaard, 2019). As comprehensibly defined by Recker, coding "refers to assigning tags or labels as units of meaning to … words, phrases, paragraphs, or entire documents" (2013, p.92). Coding is an interpretative technique (Walsham, 2006) which fits the philosophical foundation of this research. Furthermore, the use of coding facilitates the collaboration within a research team (Skjott Linneberg & Korsgaard, 2019). While dedicated software can be used to create codes, several scholars highlight the potential risks connected to this approach such as excessive amount of generated codes or high expenditure of time (Patton, 2015; Skjott Linneberg & Korsgaard, 2019; Walsham, 2006). Therefore, the codes were added manually to the transcript next to the corresponding text section as proposed by Patton (2015). This is shown in Figure 4.

Since coding is a "subjective process" (Walsham, 2006, p.325) measures have to be applied to ensure that the results are in line with scientific quality standards. Consequently, the coding process used in this research incorporated several best practices from the literature. First, an iterative coding approach was employed which enables researchers to better identify hidden patterns and common themes in the transcript as stated by Patton (2015). Skjott, Linneberg and Korsgaard (2019) further suggest that combining individually assigned codes from multiple researchers increases the reliability of the results and creates more comprehensive results due to the different perspectives.

Based on these two measures the coding process combined inductive and deductive techniques. This is also known as a "blended approach" and well-established in the qualitative research community (Skjott Linneberg & Korsgaard, 2019, p.264). The applied procedure in this paper was centered around the proposals from Patton (2015): He suggests starting with a deductive approach by creating a few high-level codes based on the previous literature review and identifying matching sections in the data. For this research the challenge clusters developed as part of the conceptual model in Chapter 3 were used as labels for this first phase. In this way the challenges extracted from scientific literature as well as the model itself could be validated against the individual experiences of the interviewees. To that end, one code was created per cluster. Each code includes a reference to the corresponding dimension through a prefix. The codes are shown in Table 6.

Table 6: Challenge Clusters with codes

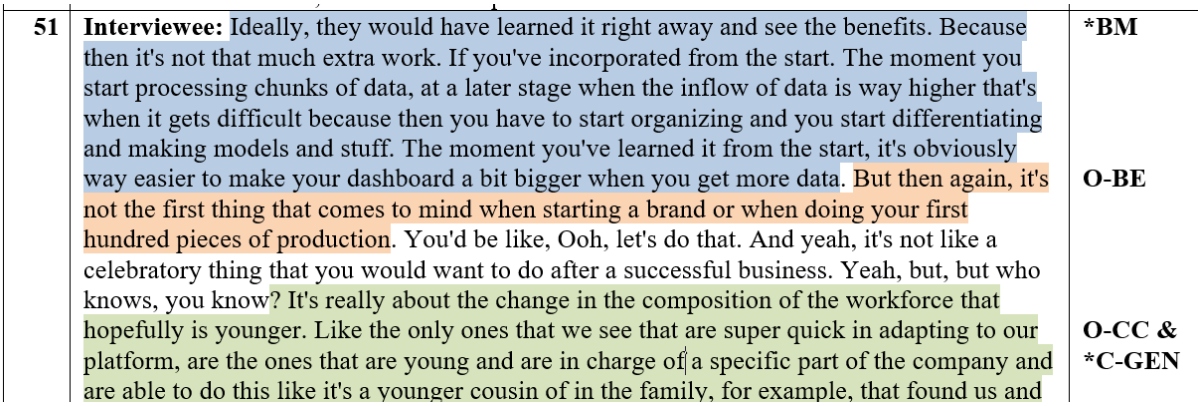
Dimension	Cluster	Code
Technology	Data	T-DA
Technology	IT Talent	T-TA
Technology	Strategy & Alignment	T-SA
Technology	Infrastructure	T-IN
Technology	Security and Ethics	T-SE
Organization	Management	O-MA
Organization	Perceived Benefits	O-BE
Organization	General Resources	O-GR
Organization	Culture and Change	O-CC
Environment	Supply Chain Partners	E-PA
Environment	Market-driven forces	E-MA
Environment	Supply Chain Collaboration	E-CO
Environment	Software Landscape	E-SW
Environment	Regulatory Environment	E-RE

After both researchers labeled the transcripts individually, the results were compared and discussed. As the background of both researchers involved in this paper is quite different, the labels were set in distinct ways. In line with the prediction of Skjott, Linneberg and Korsgaard (2019), the resulting discussion not only led to the discovery of new parts of the transcript that had to be labeled but also enabled a deeper understanding of the qualitative data. The latter was an essential prerequisite for the next phase of the blended coding approach: In line with the iterative nature of the process, the data was reviewed again to inductively generate further codes stemming from the data. This allowed the researchers to identify novel themes and concepts which may not have been covered in previous research (Patton, 2015) and therefore further advance the body of knowledge regarding analytics-enabled GSCM. The inductive coding process was performed "open-minded" (Skjott Linneberg & Korsgaard, 2019, p.263) and guided by the principles of a "grounded" approach (Patton, 2015). After several iterations and discussions between the researchers seven new challenges, which were not covered in the theoretical background, were identified as well as five novel themes that emerged during the interviews. Themes include new topics in the context of analytics-enabled GSCM which were highlighted by several interviewees and are deemed relevant for this research. The inductive codes were prefixed with a "*" while the newly discovered challenges were further marked with a "C-" prefix. An overview of the inductively generated codes is shown in Table 7.

Table 7: Newly emerged codes

Description	Code	Type
Intermediaries / 3rd party Guidance	*INT	Theme
Low Tech Maturity	*LTM	Theme
Business Models	*BM	Theme
Analytics Interval / Frequency	*FRE	Theme
Generational Shift	*GEN	Theme
Too many certifications	*C-CER	Challenge
Educate Consumer	*C-EDU	Challenge
Lack of Automation	*C-AUT	Challenge
Data Reliability	*C-REL	Challenge
Prioritization	*C-PRI	Challenge
Visibility	*C-VIS	Challenge
Internal Sustainability Communication	*C-COM	Challenge

During the coding process phrases that were associated to deductive codes were highlighted in orange while sections that yielded a novel inductive code were marked in blue. Phrases that had both an inductive as well as a deductive code attached to them were highlighted in green. Figure 4 shows an excerpt from the coded transcript including the color highlights.



51	**Interviewee:** Ideally, they would have learned it right away and see the benefits. Because then it's not that much extra work. If you've incorporated from the start. The moment you start processing chunks of data, at a later stage when the inflow of data is way higher that's when it gets difficult because then you have to start organizing and you start differentiating and making models and stuff. The moment you've learned it from the start, it's obviously way easier to make your dashboard a bit bigger when you get more data. But then again, it's not the first thing that comes to mind when starting a brand or when doing your first hundred pieces of production. You'd be like, Ooh, let's do that. And yeah, it's not like a celebratory thing that you would want to do after a successful business. Yeah, but, but who knows, you know? It's really about the change in the composition of the workforce that hopefully is younger. Like the only ones that we see that are super quick in adapting to our platform, are the ones that are young and are in charge of a specific part of the company and are able to do this like it's a younger cousin of in the family, for example, that found us and	***BM** **O-BE** **O-CC &** ***C-GEN**

Figure 4: Excerpt from transcripts with codes and color highlights

4.4 Ethical considerations

This research applies interviews as the main method of data collection. As shown by Patton (2015) and Walsham (2006) the application of qualitative methods – with an emphasis on interviews - asks for strict ethical and moral considerations. The reason for this lies with the participants exposing themselves on certain subjects, which thereby increases their vulnerability in many possible ways with the potential to harm (Patton, 2015; Recker, 2013). These kinds of information might bring the participant, the organization, other stakeholders, or even the interviewer at risk, and therefore should be treated properly - while maintaining the quality of the research (Patton, 2015; Walsham, 2006). To that extent, in this research the following ethical considerations were emphasized during the processes of inquiry and analyses.

First of all, Patton (2015) and Bhattacherjee (2012) state the necessity of disclosing the purpose of an inquiry transparently and clearly. In this regard, the research aims and practical implications were explained to the interviewees, while expected research outcomes were omitted in order to not influence participants and their answers (Patton, 2015). Secondly, Patton (2015) states that possible risks to participation must be explained. To that extent, possible risks were assessed - such as the fact that this work will be shared with other participants after completion - and communicated with every interviewee. On top of that, Patton (2015) shows how anonymity or confidentiality can lower the risks of participants (Patton, 2015). Therefore, in this research complete anonymization was offered to the interviewees, where all typical data of participants and organizations, as well as statements that can be traced back to these were anonymized (Walsham, 2006). Moreover, information on where or how long data will be stored, as well as the rights and ownership of this data were communicated transparently to every participant (Patton, 2015).

4.5 Scientific quality

Scientific quality encompasses both the application of rigorous scientific methods and the production of high-quality research findings. Qualitative research often carries the stigma of being vague or inaccurate (Patton, 2015). Recker (2013) acknowledges that the available instruments to measure quality might not be as precise compared to the quantitative research domain but refers to well-established guidelines which are more adequate to evaluate the rigor, validity and reliability of qualitative inquires. A set of guidelines that is well suited for this research context and methodological strategy are the seven "principles for conducting and evaluating interpretive field studies in information systems" by Klein and Myers (1999).

The first principle, *The fundamental principle of the hermeneutic circle* forms the basis to the following principles and explains how all human understanding is formed by iterative cycles in which the interdependencies between perceived parts and wholes are evaluated (Klein and Myers, 1999). In this research this principle was guarded by recognizing and evaluating this iterative cognitive process of the reader throughout the different phases of this research, where it was aimed to achieve textual comprehensiveness of the researchers' understandings.

The second principle, *The principle of contextualization,* states that the current social context as well as the historical context must be described thoroughly, to provide the audience with insight on how the current situation under investigation emerged (Klein and Myers, 1999). This is deemed important because social structures are constantly moving and therefore also change in meaning. To that extent, the findings were situated by describing the context they emerged from, be it a source of literature in the theoretic background, or a specific interviewee's organizational environment during discussion.

The third principle, *The principle of interaction between the researchers and subjects,* states that research materials and data are also socially constructed and should therefore receive critical reflection (Klein and Myers, 1999). In this context, multiple researchers' critical

perspectives were applied throughout this study to mitigate possible biases one researcher might carry (Patton, 2015). Moreover, a set of ethical considerations and practices are applied to mitigate possible defaults in validity or reliability, as shown in Chapter 4.4.

The fourth principle *The principle of abstraction and generalization*, states that since interpretive research is idiographic, it leads to specific and subjective results. Therefore, these results must be put in context of theory and concepts to achieve abstracted and generalizable outcomes (Klein and Myers, 1999). To that extent, the results of this study are based on a blended approach of inductive and deductive reasoning based on the findings from literature, as well the empirical data.

The fifth principle, *The principle of dialogical reasoning*, states that in hermeneutic interpretivism a researcher must become aware of his/her prejudices through which the research was designed and executed (Klein and Myers, 1999). To that extent, the researchers' prejudices were evaluated and after completion of the data analysis, the previously defined biases were contrasted with the findings to locate possible mistakes in reasoning.

The sixth principle, *The principle of multiple interpretations*, states that a researcher must be aware of how different interviewees have their own interpretations which can lead to different explanations of the same subject (Klein and Myers, 1999). To that extent, the semi-structured interview and the interview guide that was designed with flexibility in mind, offer the option to follow-up on questionable interpretations.

The seventh principle, *The principle of suspicion* states that a researcher must be aware of possible distortions or biases in the explanations given by participants (Klein and Myers, 1999). Therefore, the same approach is applied as in the abovementioned sixth principle.

4.6 Limitations

The methodology applied in this study comes with a set of limitations that should be noted. While the chosen data collection method – qualitative interviews with different sized fashion companies that carry sustainable value propositions – yielded interesting findings, it is recognized that an in-depth case study with a medium- to large-sized fashion brand might have provided more extensive insights. However, the short time frame available for this research did not allow for that. Additionally, the interpretive nature of the conceptual model that was used in this study must be acknowledged. In this context, possible biases of the researchers that developed this model might have had an influence on its formation. At last, while Kvale & Brinkmann (2009) show that a number of six interviews can be sufficient for explorative qualitative research - it is believed that additional interviews, especially with organizations located in production tiers, could have benefited this study with regard to theoretical saturation and generalizability (Patton, 2015).

5 Empirical Results

The insights gained through the interviews with representatives from fashion brands (A1, C1, E1) as well as intermediaries in the fashion industry (B1, B2, D1) are outlined in this chapter. To that end the empirical results regarding the challenge clusters of the conceptual model (described in Chapter 3) are presented individually. The newly identified challenges are addressed within their corresponding clusters. After examining the three model dimensions and their clusters, the emerging themes which were identified during the inductive coding process are presented. In this way, the chapter builds the foundation for the following discussion.

5.1 Technological Dimension

Data

Data was an often-discussed topic during the interviews and several challenges were mentioned by the respondents. Overall, the fashion brands (e.g., A1, C1 and E1) stated that their data environment was not satisfactory and did not fulfill all their requirements (A1: 34; C1: 8; E1: 14, 21). Data Availability seemed to be the main challenge for the Interviewees especially in the context of their upstream supply chain partners (B1: 6). When discussing the water usage of their indirect suppliers (meaning the suppliers of their suppliers) C1 stated for example:

> *To be honest, we have no idea how much water is used there. To get this information directly from the supplier would of course be ideal for us (C1: 10)*

E1 and B1 further stated that the available data was usually on a high-level and did not possess the necessary granularity for precise analytics in the context of GSCM (B1: 27; E1: 15). To counter the lack of data availability the fashion brands resort to average values from partners and extrapolation (C1: 7,8) as well as modeling to calculate sustainability KPIs:

> *And that's a problem because you don't have the accurate data all the way back into the supply chain. … .I think that's really a key challenge. So then, in order to be able to get some figures, you need to work with the best data you have. And … you have to start modeling or use estimations (E1: 21,22)*

However, D1 warned that average values provided by external partners (such as certification organizations) can be unreliable and are not generalizable to every business context (D1: 30). He presented the example of the average water footprint of regular and biological cotton, which can vary significantly in different geographical locations. Using a single average value for calculating the impact of all cotton regardless of the origin, can therefore distort the calculated performance indicator (D1: 30).

Besides data availability challenges, data processing barriers were also reported by E1. These challenges were not mentioned in a big data context but referred instead to different file formats

such as PDF documents that inhibited the extraction of sustainability information (E1: 24). During the analysis of the transcripts a new data-related challenge in the context of GSCM could be identified: Data Reliability. A1 emphasized the uncertainty surrounding data from geographical distant supply chain partners:

> *One of the major difficulties in the in the fashion industry is that often production is done abroad, sometimes very far abroad, and you're not always there. So regardless how sophisticated ... the data is, it's usually always reliant on a person supplying that on the other side. And that means also the data is as reliable as the person who gives it to you (A1: 34)*

B2 also highlighted this risk and added that suppliers tend to oversell their sustainability practices (B2: 11). Furthermore, he stated that there is a need for a neutral party that objectively verifies sustainability claims (B2: 27). Therefore, the sustainability platform that is developed by B2 aims to address these challenges by offering triangulation and benchmarking services to evaluate the sustainability practices of suppliers. In contrast to the fashion brands, B2 did not report data challenges but instead described a sophisticated data environment that integrates vast amounts of data from different sources (B2: 18, 25).

IT Talent

The issues of IT Talent were discussed with the majority of the interviewees with the exception of C1 and B2, although specific challenges were rarely mentioned. D1 stated that their SME partners lacked general IT skills and analytics knowledge as their focus was primarily on product development:

> *[Analytics] is something completely not in their line of business, that they suddenly have to do because society asked about it …So we're asking creatives on the brand side to suddenly start doing like accountancy and reporting and we're asking family-run factories to start using technology that they never know how to use while they love cutting clothes. (D1: 28)*

In line with this statement, A1, co-founder of a micro fashion brand, also emphasized that none of their co-founders had a background in IT or IS and that their primary responsibilities lie with product development as well as marketing and financial accounting (A1: 8). B1, the board member of an international trade association, further highlighted the importance of addressing these lacking IT skills in the fashion industry through trainings (B1: 1). In contrast to the reported IT talent challenges at SMEs, E1 reported that the analytics knowledge and the skills regarding corresponding tools such as Tableau was sufficient in their sustainability team (E1: 36). However, she acknowledged that in her case that might be a result of her financial background and that employees without such experience, might struggle to employ analytics in their daily work (E1: 36).

Strategy and Alignment

Issues in the context of strategy and alignment were the most frequently identified within the qualitative data and discussed by all interviewees. The presence of analytics technology within the business strategy varied greatly between the organizations. Most of the interviewees expressed how factors of alignment are challenging for their organization. When discussing sustainability performance indicators, D1 explained, that their SME production partners had no "systemized way to track their performance ... apart from the electricity bill" (D1: 26). C1, representing a fashion company with around 300 employees, also stated that they have "still very, very large gaps" in the area of performance indicators but hailed the progress the company had made in tracking carbon emissions (C1: 7). In contrast, E1, a CSR manager of an international fashion brand, presented a more structured approach towards sustainability KPIs which focused on covering all the different aspect in the supply chain including material use, manufacturing operations, transport and packaging (E1: 14).

All fashion brands regardless of their size stated, that Excel was a central tool to their analytics practices (A1: 24; C1: 23; D1: 42; E1: 15). At the same time, they acknowledged the challenges which resulted from this approach:

> *Excel files are messy. So, it's ... useful, but it's also quite easy to make mistakes and different people have access to it (A1: 24)*

Of all the fashion brands, only E1 reported to use a more sophisticated analytics solution, namely the BI platform Tableau (E1: 19) Nevertheless, E1 also emphasized the challenges to adapt commercial off-the-shelf (COTS) analytics solutions into their business strategy:

> *[An analytics solution] needs to find a connection to our business. And when we cannot create that connection to our business or our supply chain, we can't use those solutions (E1: 22)*

In line with this statement, A1 and C1 stated, that GSCM frameworks supported by intuitive web-based platforms played a central role in their sustainability strategy (A1: 14; C1: 7). However, these platforms are not full-fledges analytics solutions and instead calculate or estimate performance indicators based upon a survey answered by the organizations. Besides these analytics tools, none of the interviewees representing the fashion brands mentioned any use of Big Data or AI solutions. When explicitly prompted by the researchers, C1 and E1 responded, that they had not come in contact with any of these advanced analytics solutions yet (E1: 47; C1: 29). In addition, both respondents were not aware of any use cases of these technologies for their GSCM (E1: 40; C1: 29). C1 stated:

> *I can't think of any points of contact [with advanced analytics]. I would say no. So, sure, somehow the blockchain might be the furthest thing now, but artificial intelligence? No. Give me an example of what you could imagine. (C1: 29)*

B2, the head of IT solutions at the international trade association Organization B, again outlined a different situation: To develop its GSCM analytics platform for businesses in the fashion industry, Organization B employs Big Data as well as AI approaches including sentiment analysis and classification techniques in a cloud-based environment (B2: 16, 33, 37).

Infrastructure

IT infrastructure for analytics and its corresponding challenges were seldom mentioned by the interviewees. A1 and D1 (both employees of a startup) did not discuss the topic, while B2 and E1, which work for globally operating organizations, shared insights into their IT infrastructure. E1 stated that her organization had a dedicated analytics team that managed their data systems (E1: 19) However, she added, that these capabilities were primarily used for financial reporting and that their GSCM-related analytics practices still needed to take full advantage of the possibilities (E1: 19). B2, the head of IT solutions at the trade association, presented a sophisticated architecture based on the Google Cloud Platform including AI components (B2: 23). C1 on the other hand, described their long-standing challenges related to the development of a unified data platform:

> *We've grown very, very rapidly and in part perhaps also unhealthily and our systems haven't kept up with our growth and we now have to somehow sort it all out a bit. And I think we are now in the process of creating a general data basis so that there is somehow a single point of truth. (C1: 35)*

A lack of automation within the analytics processes was identified as a novel challenge within the transcribed data. All brands regardless of their size, as well as D1 reported that their analytics activities were still very manual and time-consuming (A1: 16; E1: 24; C1: 25,; D1: 16). A1 further highlighted the lack of integration between web-based sustainability platforms and internal analytics processes (A1: 16). In addition, E1 shared an example of a lack of automation in their workflow:

> *One of the challenges which we noticed is that ultimately, it might be possible to find out things better, but it's based upon PDF files that are uploaded. So then what we experience is that people need to manually fill in the information that's on these PDFs into a system in order to be able to use the numbers. (E1: 24)*

Finally, B1 and B2 emphasized the importance of automation for analytics-enabled GSCM to achieve scalability (B1: 10; B2: 23).

Security and Ethics

Issues relating to Security and Ethics did only emerge during the Interview with B2. He reported on his experience with fashion manufacturers from China, which were reluctant to disclose their suppliers, out of fear of being bypassed by their customers:

> *Because … in the moment that you disclose this information, then everyone is afraid that I jump over your head to this … guy and that … we make [revenue] disappear. (B2: 11).*

This inhibits a transparent analysis of the sustainability impact along the supply chain according to B2. Data Privacy issues are also a main concern in the development process of the sustainability platform of the trade organization.

5.2 Organizational Dimension

Perceived Benefits

The benefits of analytics for GSCM were seldom explicitly mentioned by the interviewees. Instead, two respondents from fashion brands stated their satisfaction with the status quo, while others focused on the challenges to provide tangible value through analytics. B1 stated that sustainability data is only beneficial to analytics-enabled GSCM if it creates positive (business) impact (B1: 7). On top of that, D1 emphasized that green practices are often still seen as a cost driver and therefore best implemented when other financial goals can also be achieved (D1: 18). In this context, E1 suggested that quantifying environmental sustainability impacts as monetary values allows to "translate sustainability knowledge to business language" (E1: 42). According to D1, the lack of the financial perspective on sustainability was a reason why analytics for GSCM does usually not play a central role in emerging fashion companies:

> *[Analytics] is not the first thing that comes to mind when starting a brand or when doing your first hundred pieces of production (D1 51)*

This sentiment is shared by A1, which - although the company's analytics practices are mostly based on Excel – states:

> *We're still a small business and quite satisfied with the tools we use now (A1: 34)*

C1 further reports that advanced analytics solutions such as Big Data or AI "are not a major issue at the moment" (C1: 35) even though the CSR team is facing challenges in regard to their analytics practices. E1 was the only interviewee who shared some insights into the benefits of analytics for GSCM, more specifically the use of interactive dashboards, highlighting how environmental impact can be communicated more easily to decision makers and integrated into business strategy:

And now we have a dashboard for it so we can in real time get an estimation where we see how we progress. What we now have, at the end of every season, we do a reflection moment with these numbers, with the right business owners to have a look at the results. So:... 'what is the total amount of sustainable materials from the last season?' and we set targets for the next season. And they get a very good sense of where they are right now. (E1: 30)

Management

Challenges related to the management cluster were seen during the majority of the interviews. Interviewees generally expressed their experience that actions of managers could limit the (effective) conduct of analytics-enabled GSCM. In this context, for example during a discussion about IoT and Big Data applications to upscale environmental performance measurement capabilities, B1 answered:

No that would be too complicated I would say. Usually if there is a problem, the problem is with management. (B1: 12)

B1 continued to explain that environmental knowledge, managerial motivations, and different business objectives ultimately lead to differences in interests in sustainability compliance (B1: 12). Moreover, C1 expressed that their management handled the rapid growth of their company inadequately regarding their tech strategy resulting in a deficient central data management system (C1: 35). Additionally, E1 showed that managers and decision-makers are often reluctant to invest in analytics capabilities for GSCM, when the monetary value is not clearly visible (E1: 34). To that extent, E1 emphasized that the communication about these sustainability objectives and their business value through the use of dashboards is the key to more sustainable decisions among managers (E1: 28). At last, both B1 and B2 stated that their data shows that when women take part in the decision-making of a business, the environmental compliance of that business generally turns out to be higher (B1: 12; B2: 35).

Moreover, in the management cluster a new challenge arose from the interviews that was not identified during the literature review, namely the challenge of managerial "prioritization". In this context, D1 stated that sustainability often is an objective in companies, but recurringly gets overruled by matters that are perceived as more important. This is exemplified in a case of sustainable sourcing of materials versus surviving the current energy crisis (D1: 18). In line with this, C1 stated that when Covid required a restructuring of the business, sustainability departments were the first to get their budgets cut (C1: 43). Moreover, during the abovementioned discussion about IoT and Big Data applications for environmental performance monitoring B1 highlighted the challenge of prioritization:

those ways to have monitoring are primarily to get data to improve the productivity - Not the quality or the sustainability. (B1: 12)

Additionally, E1 showed that investments in their company were focused on other activities rather than sustainability through the following statement:

> *So we have never had really a big sustainability team. Which basically means there's not been so much invested in sustainability. And there are hundreds of people in finance. And then with sustainability, there's just a small team. (E1: 34)*

General Resources

Interviewees frequently referenced to a lack of general resources as a challenge to engage in analytics practices for GSCM. In this context, C1 stated:

> *approaches in terms of transport and optimization, we already have them on our radar, and if we had the time we would work on it. (C1: 39)*

Additionally, C1 stated that they only calculate their impact once a year, since otherwise it would be too time-consuming (C1: 21) Moreover, both D1 and B1 emphasized that, in contrast to large enterprises, SMEs often lack the resources to hire expertise, control their supply chain (D1: 49) or even to become aware of their own environmental impact (B1: 6). To that extent, B1 emphasized that SME's need help in that regard (B1: 6). In line with this, A1 stated that they need an external framework for monitoring their sustainability impact and improvements since they're a small business and lack the time and capabilities to single-handedly set up such a framework (A1: 16). Moreover, E1 suggested that it is too costly for their company to hire more sustainability experts (E1: 49). Additionally, it was stated that the filing processes of partners' sustainability data was too time consuming and expensive (E1: 11). At last, B2– who represented one of the most technologically advanced interviewed organizations – stated that to effectively enable GSCM through analytics they have to invest 40% of their budget into IT capabilities (B2: 37).

Culture & change

Related to the cluster of Culture and Change both expected, as well as unexpected observations were made. First of all, E1 stated the following about analytics-enabled GSCM:

> *Everybody wants it. But everyone is wondering how? So just because they don't know how, it stops them from trying to look for the answer. (E1: 40)*

E1 explained that employees often stay away from analytics practices for GSCM due to the complexity, a lack of knowledge and a fear of failure (E1: 40, 36). On top of that, E1 stated that they greatly lack people with the specific skillset that can combine sustainability and analytics practices (E1: 32). In line with this, D1 stated that a lack of environmental knowledge often leads to a lack of motivation within companies to pursue sustainability (D1: 28). Moreover, B1

stated that they experienced a lot of resistance from fashion companies to adopt their services because the companies thought it was too complex for them (B1: 31). In turn, when companies adopt their services, it is often a great challenge to nurture a data-driven mindset (B2: 9). Further, B1 emphasized that SMEs usually don't have the environmental knowledge, awareness, and skills in their organization, leading them not to consider or implement analytics for GSCM (B1: 6). Moreover, C1 reported that there can be resistance to sustainability practices because people prioritize other business operations (C1: 43). Additionally, as shown by D1 producers can often resist the implementation of analytics technologies for GSCM, since this would require them to change their way of business, and this interferes with their personal motivations to practice their craft (D1: 26, 48).

At last, a rather interesting new challenge arose during the interviews that seems to be potentially significant for this research question, namely "internal sustainability communication". To that extent, E1 explained that their adoption of analytics-enabled GSCM was limited as a result of deficient communication among employees, supplemented by the following statement:

> *So then they start talking and they lose the connection with other people easily because of how they communicate, what they communicate, the technical analysis, the knowledge that they use, it doesn't resonate at all with the business. (E1: 32)*

In this context, E1 stated that certain people with a specific skillset are required to translate technical sustainability information into business knowledge that is understandable and of value to the business, but specifically the business decision-makers. However, due to a lack of this specific capability in their organization, this information often fails to gain momentum and to leverage changes in processes and operations (E1: 28, 32).

5.3 Environmental Dimension

Supply Chain Partners

Challenges of the supply chain partners cluster occurred rather infrequently during the interviews. Nevertheless, B1, a board member of the trade association, stated that many of their new members were limited to improve their sustainability impact due to inadequacies of their supply chain partners, as well as a lack of access to production opportunities elsewhere (B1: 7, 16). Additionally, C1 stated:

> *next year we'll try to convert a factory completely to renewable energies … . But sometimes, to put it bluntly, they flip us the bird and say, 'Hey, we first have to somehow make sure that we survive with Covid. We can't tackle a project like that here now'. (C1: 12)*

Along with this statement, C1 explained that they are sometimes limited to improve their sustainability impact, due to a lack of supply chain partners' (ability to make) environmentally sustainable efforts. In line with this statement, D1 explained how the differences in competencies, motivations and knowledge between supply chain partners can cause for a mismatches in reporting, which in turn limits collaboration between these partners (D1: 47).

Market-driven forces

In general, the interviewed companies did not often talk about market-driven forces being a challenge for analytics-enabled GSCM. However, B1 stated that it is hard to find the right people, since analytics expertise is currently scarce and expensive (B1: 2). Additionally, B1 mentioned that stakeholders of a business, whether these are shareholders, banks, or local authorities, can sometimes limit or postpone organizations in analytics-enabled GSCM practices based on their own objectives (B1: 6). Moreover, D1 explained an interesting insight that longer established businesses often experience a greater challenge in convincing stakeholders or re-negotiating with them to invest in sustainability, where this is said to be easier for start-ups (D1: 60).

While challenges of the market-driven forces cluster were rather low in occurrence, a new challenge emerged from the interviews with B1 (17, 19), D1 (75) and A1 (26). To that extent, all three emphasized the significance of educative communication with the consumer, in order to increase demand for sustainable fashion and to further enable the sustainable transition of the fashion industry. In this context B1 stated:

> *But also if the consumer is not well educated, their interest in the environment is pretty low. If they have no money to spend, then environmental issues are a luxury. … So the there are many things that, if you look at the broad picture, need to be done beyond industry (B1: 19)*

Supply chain collaboration

Challenges from the supply chain collaboration cluster formed a prominent discussion topic throughout the interviews, providing the following results. First of all, the characteristic complexity of fashion supply chains – a topic that arose during every interview - seemed to be the greatest barrier to effective collaboration and improved environmental performance. In this context, E1 stated:

> *"And we talk about a lot of numbers, a lot of complexity, because every material again has also a different supply chain. Polyester has a different chain, and then nylon, or cotton, or leather. So it gets complex very quickly" (E1: 24)*

Next to that, B1 stated that the increased complexity of supply chains, has made conventional systems for evaluation and control of partners ineffective (B1: 9). Moreover, B2 explained that currently too many companies are not managing their data, where they find a great challenge in fostering a data-driven mindset within these companies. As result, this obstructs collaboration and an integrated flow of information throughout the supply chain (B2: 9, 30). In this context A1 went one step further and stated that data and information of suppliers is only as good as the people who provide it, thereby exemplifying the importance of trust among supply chain partners (A1: 30, 34). Moreover, C1 expressed a lack of control of their partners (C1: 8). This is affirmed by D1, who stated that particularly smaller businesses often lack the ability to leverage control throughout their supply chain (D1: 23).

During the interviews another challenge was found in the context of supply chain collaboration, that functions as an extension of complexity, namely: Visibility. While this challenge goes hand in hand with supply chain complexity, and is seemingly related to data availability, it is worth its own mention due to its high occurrence, and the fact that it was specifically addressed several times by interviewees. Where complexity refers to companies' general challenges for GSCM as a result of unstructured production networks, the challenge of visibility specifically refers to not being able to trace upstream supply chain partners, or to acquire information of their operations. To that extent, E1 explained the challenge of visibility in the following way:

> *One of the challenges is that we know that a large part of the impact lies further down in the supply chain. Where we have less direct visibility on exactly how things happen. … And that's a problem because you don't have the accurate data all the way back into the supply chain. While at the same time you know that a large part of your actual footprint, including those three lies in that, further down in the supply chain. I think that's really a key challenge. (E1: 21)*

Additionally, D1 and C1 affirmed this by stating that as a result of fragmentation and complexity, companies lose visibility on their supply chain, inhibiting them to collaborate with supply chain partners and to get insight into their true environmental performance (D1: 42; C1: 10,17). At last, B2 also recognized this problem of visibility, and tries to solve this by providing a digital platform. On this platform, companies can digitalize their information and integrate with their producing partners, by means of cumulative "self-onboarding" (B2: 27).

Regulatory environment

The majority of statements that were related to this cluster focused more on its enabling effects, rather than the challenging factors. To that extent, B1 for example stated that legal frameworks are powerful, and in this case sometimes necessary tools to drive change in the fashion industry (B1: 17). Nevertheless, D1 explained how the current regulations for environmental reporting only focus on large enterprises and thus are failing to incentivize and regulate smaller businesses (D1: 23). Moreover, D1 stated that certified indexes, such as the HIGG index, can

sometimes be lacking with regard to generalizability or representativeness (D1: 30). At last, D1 is positive about the effect of legislations on reporting, but critical on the level of support - e.g. in the form of tools - that governmental institutions offer fashion companies to that end (D1: 80).

Additionally, during the interviews a new challenge emerged namely the barriers resulting of "too many certifications". In this context, A1 stated:

> *As you know there are [myriads] of certificates in the industry. It is difficult to choose which one is what or which one is best. (A1: 16)*

As a result of this fragmentation, fashion companies collaborate with a variety of certifiers and adopt different sustainability objectives, which in turn makes the goal of an aligned and collaborative sustainability approach a greater challenge (A1: 36). B1 affirmed this and stated:

> *There is no universal agreement. And that is part of the problem. So everybody is doing something. (B1: 6)*

Software Landscape

The topic of the software landscape and its associated challenges were touched by most of the interviewees but not discussed extensively. Overall, the respondents were not remarkably familiar with the available analytics solutions on the market. As mentioned above, only E1 reported using a BI platform (E1: 19). When A1, the co-founder of the micro fashion brand, was asked about the use of the three leading analytics tools Power BI, Tableau and Qlik (according to (Richardson et al., 2021), he stated:

> *I don't know any of the tools you mentioned (A1: 26).*

D1 suggested that analytics components of e-commerce platforms might provide an introduction for small fashion companies into the world of analytics (D1: 62). A1 further added that their company preferred a sustainability framework with strong guidance over a universal analytics tool (A1: 26). When discussing the available analytics tools on the market, E1 highlighted overselling by the vendors who were eager to show their "super fancy screenshots" but failed to provide an analytics tool that was tailored to their needs (E1: 22). The trade association represented by B1 and B2 seemed to be aware of challenges in this context as both interviewees described their organization's efforts to develop an intuitive and unified analytics platform for GSCM (B1: 2,6; B2: 7).

5.4 Emerging Themes

Besides the newly discovered challenges, novel themes, which are relevant to this research but did not emerge from the literature review, were also identified in the data. In this context, the themes that emerged in at least two of the interviews were included. As the themes often span several challenge clusters or dimensions and therefore do not fit seamlessly into the conceptual model, they are presented separately in this section. Nevertheless, challenge clusters and new themes will be discussed together in the following discussion chapter.

Low Technological Maturity

Overall, it was noticeable, that most of the interviewed organizations presented a low maturity in terms of analytics technologies. This was particularly apparent in the widespread use of Excel as a central tool for data analysis among the fashion brands (A1: 24; C1: 23; D1: 42; E1: 15). Only E1 reported using a BI platform to create dashboards for their GSCM (E1: 19). However, she also stated that the sustainability team needed to use these capabilities more extensively (E1: 15). D1 reported, that their SME partners generally don't use analytics tools, while A1 stated that he was not familiar with the leading BI solutions (D1: 42; A1: 26). The few discussions regarding the companies' data infrastructure, that emerged during the interviews, further indicated that this technological aspect is not very advanced within the organizations. In this context, C1 stated that their company was still struggling to create a unified data environment that could act as a "single point of truth" for their analytics initiatives (C1: 35). Finally, the low technological maturity was reflected particularly by the lack of Big Data or AI practices employed by the fashion brands. Furthermore, none of the fashion brands stated that developing such practices was a priority for them at the moment. D1 further expressed doubts if it was feasible for small and established fashion companies to implement these advanced analytics technologies (D1: 60).

Data Driven Business Models

During their interviews both E1 and D1 discussed new data-driven business models with a positive environmental impact and provided a look into the future of the fashion industry. E1 described how she worked on the development of a circular business model for one of their premium brands which included refurbishing old and used garments and offering them again through their sales channels (E1: 10). D1 presented several ideas for data-driven business models including using enhanced traceability of raw materials as an USP for lower tier suppliers in the supply chain (D1: 75, 82). In addition, he outlined the integration of NFC tags in fashion items to capture information about daily usage and overall lifetime via smartphones, as well as offering free fashion repairs to gather data about the customer and the product wear (D1: 84, 85). In addition, D1 hinted, that sustainable fashion companies that incorporated analytics approaches early in their business journey could scale their data-driven practices more easily at a later stage (D1: 51).

Interval of Analytics

Different viewpoints emerged during the interviews regarding the interval or frequency in which sustainability KPIs are or should be calculated. C1 and A1, both employees of fashion SMEs, stated that they calculate their environmental performance indicators only once a year – usually in the context of the annual CSR report (A1: 18; C1: 21). D1 also confirmed that their SME partners only analyze their sustainability KPIs once a year (D1: 28). While A1 expressed his satisfaction with their current practices (A1: 34) C1 addressed the laborious nature of the annual analysis:

> *we calculate everything only once a year so far, because it is always so time-consuming. So, when we prepare [our CSR report] we have to plan at least two weeks of full working time. And we can only do that once a year (C1: 21)*

In contrast, E1 emphasizes the importance of "real-time data" for analytics practices in GSCM:

> *That external Corporate Responsibility report is not going to provide any help for [informing decision makers]. It needs to be more real-time data (E1: 15)*

Benefits of real-time analytics presented by E1 include better transparency into environmental impact of business decisions, the possibility to correct developments throughout the year and increased relevance for senior (E1: 30). B2 also stated the importance of "continuous improvement" of sustainable practices and analytics in GSCM (B2: 25)

Role of Intermediaries

The theme of "intermediaries" appeared in every interview that was conducted. This theme applies to any reference of relevance of third parties that play a complementary and guiding role in achieving analytics-enabled GSCM throughout the fashion industry. To that end, organizations that function as platforms and/or provide certifications, measurement frameworks, software, training, expertise, inter-enterprise communication, or a combination of these, all apply to this theme of intermediaries. What stood out was the significance that the interviewees gave to these third parties in achieving their goals. In the general opinion of the respondents, the fashion companies are dependent on these third parties to fulfil one or more of the abovementioned functions – as well as to enable analytics practices for an improved environmental impact throughout the supply chain. In this context, A1 stated that they base their selection of supply chain partners on the certifications these partners earned, which ensures them of a certain sustainability standard throughout their production (A1: 14). B1 stated that they, as a trade association, support fashion companies with tools and training, but also lobby at governments and work together with other intermediary entities, to enable a sustainable transition in the fashion industry (B1: 2). Moreover, D1 explained that through them as a digital marketplace, smaller organization have a platform to find and source partners with a sustainability guarantee based on external certifications – regardless of their buying power (D1:

12). When looking at larger organizations, E1 said that they were still partially reliant on numerical estimates of third parties, such as the HIGG Index, to calculate their impact (E1: 14). Finally, B2 believes that the value of the intermediary function lies with neutrality, and they are confident that the third party trend will continue and become the future perspective (B2: 27, 37).

Generational shift

Interviewees in some cases mentioned the aspect of age when discussing analytics and GSCM practices. In this context, B1 stated that they expect that change towards a greener supply chain might be accelerated by younger generations (B1: 19). During a discussion about technology adoption in fashion companies, D1 further explained:

> *"It's really about the change in the composition of the workforce that hopefully is younger. Like the only ones that we see that are super quick in adapting to our platform, are the ones that are young" (D1: 51).*

This is affirmed by B1, who stated that new generations are more susceptible to analytics-enabled GSCM practices than older ones (B1: 19).

6 Discussion

The purpose of this chapter is to present and discuss the empirical findings in context of the literature. The discussion follows the structure of the conceptual model, where findings and insights are presented per dimension and cluster. Based on the findings, all challenges along with their relevance for analytics-enabled GSCM in the fashion industry are summarized in their corresponding dimensions. The assigned relevance level (Low, Medium and High) reflects the frequency of occurrence within the interviews, the stated relevance by interviewees, or the inhibiting effect on analytics-enabled GSCM resulting from the discussion. Consequently, the barriers marked with a "high" relevance are considered the main challenges. Finally, an IS research agenda consisting of four new research avenues which emerged from this study are presented.

6.1 Technological Dimension

The theme of "Low Technological Maturity" identified in the qualitative data is present throughout the entire technological dimension. It is a central issue for the interviewed fashion brands. While a deficit of analytics technological maturity of the SMEs was anticipated - as it is well known that the adoption of new technologies is a general challenge for these organizations (Ahmad et al., 2020; Vásquez et al., 2021) – Organization E, a large international fashion company, also fell short of expectations. This indicates the general difficulties for fashion brands that focus on sustainability to introduce analytics into their GSCM. Organization B, the trade organization developing a sustainability platform for their members, presents a stark contrast with its use of advanced analytics technologies. Consequently, this chapter will focus primarily on the perspective of the fashion brands (including Organization D) to discuss the most relevant technological challenges for analytics-enabled GSCM.

Strategy and Alignment

A lack of technological maturity is particularly apparent when examining the Strategy and Alignment cluster. While Giri et al. (2019) or Chiappetta Jabbour et al. (2020) praise the benefits of Big Data and AI, and implicitly convey the idea of broad adoption of these advanced analytics technologies, the interviewees presented a different perspective: None of the fashion brands had incorporated AI or Big Data practices into their strategy so far. It seems that the era of AI-enabled "Analytics 4.0" proclaimed by Davenport (2018) is still out of reach for these organizations. Thus, challenges to identify Use Cases for AI and Big Data are highly topical issues for GSCM. Instead of sophisticated analytics platforms the interviewed fashion brands and Organization M reported a widespread use of Excel solutions for analyzing sustainability data. In this context, common challenges with these ad-hoc solutions such as a time-consuming maintenance and error-proneness (Lennerholt, van Laere & Söderström, 2020) were reported by A1 and C1. While discussing environmental performance indicators, none of the inter-

viewees explicitly mentioned any challenges regarding their definition as stated by Hristov and Chirico (2019). However, the responses from A1, C1 and E1 indicate, that the level of sophistication of the used KPIs increases with the company size. Therefore, SMEs in the fashion industry might benefit from additional support to develop environmental indicators relevant to their business.

Only E1, representing the fashion brand with the most advanced analytics practices and tools, echoed the difficulties as well as the importance of aligning analytics tools to business needs stated by Mungree, Rudra and Morien (2013). C1 and A1, which mainly work with Excel, did not report the issue. This indicates that challenges in this context inhibit analytics-enabled GSCM, as soon as organizations look beyond spreadsheet-based tools for analytics. Technology-based Innovative ideas for environmental issues (e.g., use of digital labels for clothes) were only presented by D1. While this could be interpreted as a Lack of Green Innovation by fashion brands (Majumdar & Sinha, 2018), it rather seems that these organizations have not yet build the necessary foundation for innovation. Further integrating analytics into business strategy and thereby accumulating more environmental data can be an enabler to that end according to D1 and should therefore be prioritized. Overall, the shortfalls regarding the analytics strategy and alignment at fashion brands strongly influence the relevance of challenges in the following clusters of the technological dimension.

Data

While Data Availability is always a barrier for Analytics (Delen & Ram, 2018), most of the interviewees stressed that the complex supply chains of the fashion industry complicate the issue even further (A1: 34; C1: 8; E1: 14, 21; B1: 6). Data Availability is therefore deemed the main data-related challenge limiting GSCM. On the one hand this barrier could be the cause for a lack of analytics within GSCM, as without the right data it might be difficult identify Analytics use cases. On the other hand, deficient data availability could be the result of lacking GSCM, as insufficient analytics practices and infrastructure limit the available data. Furthermore, the Data Reliability challenges reported by A1 and B2 indicate that many fashion companies are still struggling with essential data-related prerequisites to develop analytics capabilities and are therefore still at an early stage of their journey towards analytics-enabled GSCM. Another data-related challenge regarding the integration of complex and heterogenous datasets, described by Alharti, Krotov and Bowmann (2017) is only partly reflected by the interviewees. E1 did discuss the challenges of integrating different file formats into their analytics workflow, but these intents cannot yet be classified as Big Data, due to their small scale. Nevertheless, it indicates that fashion companies with a higher analytics maturity are starting to explore Big Data for their GSCM practices. Finally, challenges regarding Data Quality for AI solutions were not mentioned by the interviewees. While deficient data quality is a major inhibitor for advancing AI practices (Benbya, Davenport & Pachidi, 2020), the current lack of use cases in the interviewed companies, result in a low relevance of this challenge for now.

Infrastructure

It was expected to identify data processing challenges in the context of Big Data infrastructure as reported by Cetindamar, Shdifat and Erfani (2020). However, C1 emphasized that their company was still struggling with establishing a "single point of truth" (35) for their data, which is more closely related to the Data Warehouse of a BI solution (Negash & Gray, 2008). In line with the theme of low technological maturity, data processing challenges should not only be addressed for advanced analytics but also focus on more fundamental BI scenarios. Furthermore, none of the interviewees except for E1 described the use of an integrated Information System that enabled the management of flows of sustainability information. This reflects a lack of Green IS as stated by Gardas, Raut and Narkhede (2018). A1 and C1 described how sustainability frameworks and corresponding web-based platforms offered them an intuitive way to analyze environmental data. While these platforms seem to provide important support for SMEs questions remain regarding their flexibility to specific business requirements and long-term scalability. In this context, a lack of automation within the analytics practices resulting in time-consuming manual work was also reported by several interviewees (A1, E1, C1, D1). This barrier was not addressed in the reviewed literature, as the authors seemed to be focused on more sophisticated challenges of advanced analytics (Davenport, 2018; Delen & Ram, 2018). Still, B2 emphasized that automation is a key enabler to tackle lacking data availability in a complex supply chain. Consequently, this essential challenge needs to be addressed.

Security & Ethics

Due to the low technological maturity and lack of AI use cases, AI-related security and privacy challenges presented in literature such as ethical issues or lacking transparency (Asatiani et al., 2020; Benbya, Davenport & Pachidi, 2020) do not seem to be a priority for fashion companies at the moment. Even B2, the IT manager at the trade association Organization B, who discussed the use of ML components within their sustainability platform, did not mention any challenges in that regard. However, B2 echoed the argument of Coleman et al. (2016) by emphasizing that data privacy challenges need to be addressed to convince all stakeholders in the supply chain to share environmental data. Overall, AI-related security and privacy challenges might be more relevant at a later stage in the context of novel data-driven business models in the fashion industry that incorporate more personal data as mentioned by D1.

IT Talent

The challenges of lacking IT talent which were described by most of the interviews can be attributed to a low technological maturity and deficient integration of analytics into business strategy. However, it must be acknowledged that none of the interviewees had an IT or IS background, which might be another reason. Overall, it seemed that the Sustainability Teams at fashion companies, represented by A1, C1, E1 and D1, were primarily comprised of sustainability experts. However, as analytics practices are taking a more central role in business operations it is essential even for non-IT professional to develop the necessary skills (Delen &

Ram, 2018; Fountaine, McCarthy & Saleh, 2019). General analytics skills related to BI solutions such data-literacy or the ability to visualize data and communicate findings (Mungree, Rudra & Morien, 2013) should be prioritized. Even though most of the interviews stated that advanced analytics technologies were not a core issue for them yet, it might further be beneficial to at least develop basic knowledge of AI and Big Data to identify potential use cases for these technologies more easily.

Summary

A summary of the challenges discussed in this section as well as their relevance for analytics-enabled GSCM in the European fashion industry are shown in Table 8. As stated in the introduction of this chapter, the assigned relevance level (Low, Medium and High) reflects the frequency of occurrence within the interviews, the stated relevance by interviewees, or the inhibiting effect on analytics-enabled GSCM resulting from the discussion.

Table 8: Summary of technological challenges with relevance ranking

Cluster	Challenge	Relevance
Data	Data Availability	**High**
Data	Data Reliability	**High**
Data	Integration of heterogenous/ complex datasets	Medium
Data	Data Quality for AI	Low
IT Talent	BI Skills: Data Literacy, Data Visualizations	**High**
IT Talent	Big Data Skills: Data Engineering, Infrastructure	Low
IT Talent	AI Skills: Data Science, ML algorithms	Low
Strategy & Alignment	Isolated ad-hoc Analytics Solutions	**High**
Strategy & Alignment	Business IT Alignment	**High**
Strategy & Alignment	Identify Big Data Use Cases	Medium
Strategy & Alignment	Identify AI Use Cases	Medium
Strategy & Alignment	Identify Key Performance Indicators	Low
Strategy & Alignment	Lack of Green Innovation	Low
Infrastructure	Lack of Automation	**High**
Infrastructure	Develop Data Processing Infrastructure	Medium
Infrastructure	Lack of green IS	Medium
Infrastructure	Deploy AI solutions to production environment	Low
Security & Ethics	Data Security and Privacy	Medium
Security & Ethics	Transparent AI algorithms	Low
Security & Ethics	Ethical Issues with AI	Low

6.2 Organizational Dimension

In the organizational dimension the theme of the generational shift emerged. In this context D1 and B1 stated that currently – especially among smaller producing companies -decision-makers of more senior generations, sometimes limit the adoption of analytics and environmental practices. On the other side, they showed that the amount of younger people in an organization can cause a positive effect. In this context, the result suggests that currently some sectors of the

fashion industry are subject to aging, where the increase of younger generations is expected to accelerate the use of analytics technologies for improved environmental performance throughout fashion supply chains. Moreover, another theme emerged, namely the interval of analytics. This captures the different viewpoints of interviewees on the frequency that sustainability KPIs are or should be calculated. Here it stood out that some respondents only calculated their environmental impact once a year, usually for the purpose of the annual CSR report. On the other hand, E1 emphasized the need for real-time data in the context of analytics-enabled GSCM in order to provide information to decision-makers, further stating that an annual CSR report is insufficient to that end.

Management

In accordance with literature the results showed that management can form a limiting factor for analytics and GSCM practices (Green et al., 2012; Majumdar & Sinha, 2018; Panigrahi & Rao, 2018). To that extent, Green et al. (2012) proposed that improved environmental performance can only be achieved when sustainability has become a strategical imperative that is supported by managers internally. Additionally, this carries high relevance for analytics-enabled GSCM, since internal environmental management is stated to be the prerequisite for the crucial functions of green IS and supply chain collaboration (Green et al., 2012). In this regard, all interviewees showed that they are challenged by their management. Here, a lack of commitment and support from managers are generally shown to be the main issues, for example due to a lack of environmental or technical knowledge, general business objectives lying elsewhere, or the nascency of the previously mentioned generational shift. In this context, the view provided by Alsheibani, Cheung & Messom (2019) and Majumdar & Sinha (2018) was confirmed, where this lack of managerial commitment, knowledge, or support, leads to negligence, a lack of empowerment, or even inability among employees to engage in analytics and GSCM practices. Additionally, C1 showed how their managements' capacities currently are inadequate to improve their lagging green IS strategy. Thereby, he echoed Gardas, Raut and Narkhede (2018) who illustrated that managers can be committed, but still lack the capabilities to strategically plan such practices. Moreover, another challenge was discovered, where managers are committed and have the necessary knowledge for analytics-enabled GSCM, but limit this by prioritizing other operations over their businesses' sustainability objectives, e.g. as a result of crisis or greater financial benefits.

General Resources

As shown during the literature review, a shortage of general resources, such as time or financial budget, or a lack of employment stability can form challenges for analytics-enabled GSCM practices. To that extent, many papers strongly emphasized how for example the cost of eco-design, IT infrastructure, or system implementation often outgrows organizations' resource capacity (Moktadir et al., 2019; Panigrahi & Rao, 2018). In this context, D1, B1 and E1, affirmed that financial constraints were a major factor limiting analytics and GSCM practices in their organization. However, the cost of hiring technical expertise seems to be the greatest challenge, rather than other costs that were expected based on the literature review, such as that

of analytics tools or recycled materials. Additionally, while the topic of employees was discussed thoroughly in every interview, the challenge of employment stability – referring to circulation of employees - given by Mathiyazhagan et al. (2013) was never mentioned or confirmed. Nevertheless, in accordance with Moktadir et al. (2019), C1, A1, D1, and E1 showed that many organizations perceive a lack of time and workforce availability to be a rather prominent limitation, often inhibiting the adoption of new analytics tools for GSCM. As shown by, D1, C1, and A1, this is especially the case for SMEs. Altogether, B2, provided an interesting perspective, stating that to develop advanced analytics capabilities they spend 40% of their budgets on IT.

Culture and change

Changing an organizations culture is shown to be a complex challenge. To that extent, scholars emphasize that organizations often struggle to establish a data-driven culture, as well as the required level of environmental literacy and skills that is needed for sustainability reporting and GSCM (Cetindamar, Shdifat & Erfani, 2020; Tumpa et al., 2019). First of all, it could be seen that the majority of interviewees, B1, E1, B2, D1, all specifically talked about a lack of knowledge and skills with regard to environmentally sustainable practices. In this context, D1 showed that a lack of knowledge often leads to a lack of motivation. To that end, intermediaries with a macro perspective on the industry (such as the organizations represented by D1 and B1) showed that many fashion companies – often located in production tiers - are simply unaware of environmental impacts or practices, and rather frequently do not even consider improving them without strong encouragement. In this context the emergence of the generational shift can also be a factor of influence. Moreover, B2 explained that when companies become aware of their necessary environmental improvements, nurturing a data-driven mindset within the organizations is often another main challenge. In line with this, E1 provided an interesting insight, where the combination of environmental and analytics skills turned out to be a rather specific set, which is scarce and hard to learn. In addition, literature showed that during these cultural changes several other challenges can arise, such as a lack of employee engagement in these new analytics and environmental operations (Alsheibani, Cheung & Messom, 2019) as well as a fear of failure, or even an intended reluctance for the required changes (Delen & Ram, 2018; Majumdar & Sinha, 2018). To that extent, both B2 and E1 confirmed that many employees do not engage in analytics practices since they fear it is too complex for them or their organization. Additionally, C1 and D1 showed how people sometimes ignore or resist analytics or environmental practices, because they prioritize other operations and lack interest. At last, a new challenge arose from the empirical data, where people in organizations don't have the capacity to translate sustainability data into information that is relevant for a business. As shown by E1, when this information is not sufficiently translated into business knowledge, an organization and its decision-makers can lose interest in environmental issues or analytics opportunities.

Perceived Benefits

Surprisingly, the high investment costs associated with developing and maintaining analytics solutions (Haupt, Scholtz & Calitz, 2015) was seldomly mentioned in the interviews, when discussing the ROI of Analytics for GSCM. Instead, it seemed that especially the small fashion brands were not aware of the additional value they would achieve by upgrading their current fragmented solutions to a more sophisticated analytics platform. This also relates to the newly identified theme of the "Interval/Frequency of Analytics": It was striking, that C1 and A1, both employees of SMEs, stated that they only calculate environmental performance indicators once a year. Thus, it seems that these companies have not yet fathomed the potential of analytics besides annual sustainability reporting to stakeholders. The existence of tangible benefits of real-time analytics for GSCM was however emphasized by E1. This is a key challenge to analytics-enabled GSCM: If SMEs in the fashion industry don't even see a need for regular analyses of their environmental impact they won't invest in more sophisticated analytics solutions and consequently will not reap its benefits.

Besides the intangible returns of analytics, the lack of financial benefits of green practices in general is also a major barrier to GSCM (Gardas, Raut & Narkhede, 2018). This is confirmed by D1, who stated that especially SMEs don't have the financial freedom to focus on (presumably) non-value-adding activities. E1 and B2 also stressed the importance to specifying a monetary impact of green practices to give additional weight to sustainability issues within the business strategy. As implied by B2 and D1, linking these issues to emerging themes such as Supply Chain Resilience may be an opportunity to define a more tangible monetary impact of green practices. Finally, a lack of consumer recognition of GSCM practices was not reported by the interviewees. Overall, brands seem to be successful to convey their sustainable mission to their customers.

Summary

A summary of the organizational challenges discussed in this section as well as their relevance ranking for analytics-enabled GSCM in the European fashion industry are shown in Table 9.

Table 9: Summary of organizational challenges with relevance ranking

Cluster	Challenge	Relevance
Management	Lack of commitment of top and mid-level management	**High**
Management	Management support	**High**
Management	Inadequate management capacity	Medium
Management	Lack of environmental knowledge	Medium
Management	Managerial prioritization	Medium
Management	Lack of specific environmental goals	Low
Perceived Benefits	ROI of analytics	**High**
Perceived Benefits	Lack of financial benefits	Medium
Perceived Benefits	Lack of consumer recognition of GSCM	Low
General Resources	Financial constraints	**High**
General Resources	Lack of time	Medium
General Resources	Lack of employment stability	Low
Culture and Change	Lack of employee skills & knowledge for environmental practices	**High**
Culture and Change	Lack of data-driven culture	Medium
Culture and Change	Fear of failure	Medium
Culture and Change	Resistance to change in organizational culture	Medium
Culture and Change	Internal sustainability communication	Medium
Culture and Change	Business engagement	Low
Culture and Change	Fear of change	Low

6.3 Environmental Dimension

In the environmental dimension the theme of the importance of intermediaries emerged. It was striking, that the complementary function and guiding role of third parties in achieving analytics-enabled GSCM was perceived as highly relevant by the respondents. To that extent, A1, D1 and C1 showed how organizations for standards and certificates play an important role by providing tools for environmental performance measurement such as sustainability platforms, but also function as a medium to validate, select, monitor, and collaborate with supply chain partners. In line with this, B1 and B2 emphasized that, as a trade association their role is to guide companies in improving their own environmental impact. Altogether, the value of these third parties can be found in the neutrality of their assessments as well as the expertise, guidance and tools they provide in operations which go beyond single fashion companies' capabilities, but which are necessary for analytics insights and GSCM. To that extent, it became apparent that the intermediary function these third-party organizations fulfill is essential to overcome the challenges found in this study, and a high-potential enabler of analytics technology adoption and GSCM throughout the fashion industry.

Supply Chain Partners

The literature review showed that organizations can be limited in analytics-enabled GSCM by their supply chain partners when these lack organizational resources, awareness, commitment or belief in environmental sustainability and therefore do not engage in these practices (Panigrahi & Rao, 2018; Tseng et al., 2019a). In this context, B1, D1, and A1 affirmed these statements, where all three said to be challenged by the limitations of their partners. To that end, a logical proposed solution would be to partner with different suppliers. However, Gardas, Raut and Narkhede (2018) as well as Majumdar and Sinha (2018) stated that organizations sometimes lack access to partners, or the ability to source materials that are more in line with their sustainability goals. In turn, this was confirmed by B1, who additionally stated that companies often lack the ability to assess and select new partners based on their sustainability performance. At last, it must be noted that overall, the challenges of this cluster were mentioned rather infrequently, and often leaned stronger to challenges of supply chain collaboration. To that end, it is suggested that the interviewed companies already manage their supplier selection rather adequately, where their greatest challenges for improved environmental performance in this dimension lie with collaboratively optimizing these partnerships.

Supply Chain Collaboration

It became apparent that collaboration with supply chain partners is a crucial element for analytics-enabled GSCM. It is the determinant for environmentally sustainable flows of materials and services, as well as the enabler of information flows, and thus the key to environmental performance data and optimization. However, the results indicate that the challenges from the supply chain collaboration cluster simultaneously are perceived as several of the strongest barriers for analytics-enabled GSCM. To that extent, scholars emphasized how the complexity of fashion supply chains can limit organizations to build relationships with partners, as well as to manage their flows of information, materials and services (Gardas, Raut & Narkhede, 2018; Tumpa et al., 2019). In this context, the results from the interviews strongly affirmed both above-mentioned limitations. Due to this complexity, the lack of visibility of supply chains – referring to traceability of materials or transparency of information - was perceived as one of the greatest challenges to analyse sustainability impacts by E1, D1, B1, and C1, where it was often explained as the antecedent for many other challenges. In this context, in accordance with Majumdar & Sinha (2018) and Mathiyazhagan et al. (2013), B1 showed how this in turn complicated integration between, and control of, supply chain partners' operations. B2 provided another reason for this lack of integration and control, namely that currently too many fashion companies are not managing their data, which limits organizations' to establish integrated environmental management systems and get insight into partners environmental performance. However, as explained previously, B2 also showed that when organizations manage their data, they can sometimes still be reluctant of sharing this data out of fear of being overleapt by their buyer, thereby confirming the challenge of a lack of trust among supply chain partners (Majumdar & Sinha, 2018).

Market-Driven Forces

In general, challenges of market-driven forces were not specifically stated by interviewees. However, some insights can be extracted from the empirical data. To that end, the challenge of a shortage of available analytics talent, given by Benbya, Davenport & Pachidi (2020) and Coleman et al. (2016) was echoed by B1. Additionally, the previously discussed scarcity of the specific skillset that includes analytics and environmental capabilities, as well as the high costs of hiring expertise affirm this challenge. Next to that, Majumdar and Sinha (2018) as well as Panigrahi and Rao (2018) explained how the influence and interests of stakeholders can challenge an organization in achieving their sustainability objectives. In this context, D1 provided an insight where it seems that younger businesses often experience more flexibility from their stakeholders than longer established organizations. In this context, a new challenge emerged, namely that of educating the consumer on sustainability. To that extent, D1, B1, and A1 emphasized the importance of this since it is necessary in order to increase demand for sustainable fashion and thereby take away other industry-wide limitations for investments in analytics-enabled GSCM. At last, literature showed that high market competition can be a limiting factor for organizations due to the perceived risks of innovating business models and analytics practices for GSCM (Majumdar & Sinha, 2018; Oelze, 2017). However, this challenge was never specifically mentioned by any of the interviewees.

Regulatory Environment

While in literature the lack of governmental environmental regulations, legislations, incentives and laws are stated to be one of the main barriers (Gardas, Raut & Narkhede, 2018; Mathiyazhagan et al., 2013; Oelze, 2017) the empirical data points in another direction. It can be seen how most of the respondents rather focused on the positive impacts of governmental interference, which leads to the suggestion that policy makers are improving their role as drivers of the sustainable transition of the fashion industry. To that extent, it can also be seen how the European commission recently released the “EU Strategy for Sustainable and Circular Textiles” which focuses on stronger information requirements and traceability of materials and products through digital passports (European Commission, 2022). Nevertheless, some inadequacies in the current regulatory landscape were found that still form a challenging factor for analytics-enabled GSCM. To that end, B1 stated that the lack of governmental support, e.g., in the form of tools, still forms a challenge for many companies. Additionally, D1 showed how current regulations only focus on large enterprises and brands, and thereby insufficiently address the impact of smaller companies which account for a large proportion of the fashion industry (European Commission, n.d.). Additionally, the intermediary function of third parties has shown to be a rather crucial part of the regulatory environment, where these organizations help to align sustainability approaches and information throughout fashion supply chains. Nevertheless, in this context a challenge arose from the interviews with A1 and B1, where currently there seem to be too many certifications. In turn this results in a fragmented landscape of sustainability approaches in the fashion industry that consequently threatens to complicate supply chain collaboration. Especially in the case of smaller companies this can form a

challenge, since these are often reliant on these certification structures to manage their supply chains.

Software Market

Moktadir et al. (2019) described the lack of intuitive and suitable tools as a major inhibitor to the adoption of Big Data. E1 expanded on that claim by stating that analytics tools in general are often not sufficiently scoped towards the requirement of GSCM. A1 and C1 further emphasized the importance of intuitive tools and guidance provided by sustainability platforms. That seemed to be a reason for them to opt for web-based sustainability platforms instead of sophisticated analytics solutions. Consequently, Analytics platform vendors should refine their value proposition towards fashion companies with complex supply chains. This might also address challenges from the Perceived Benefits cluster. Challenges in context of choosing and evaluating analytics tools on the market presented by Moyo and Loock (2020) were not reflected by the Interviewees. Instead, it seemed like there was a lack of awareness regarding the available options and A1, the co-founder of a small fashion brand, emphasized that they were satisfied with their current analytic capabilities and not looking for new tools. As fashion companies develop Analytics skills and improve their technological maturity this challenge might gain relevance at a later stage.

Summary

A summary of the environmental challenges as well as their Relevance for analytics-enabled GSCM in the European fashion industry are shown in Table 10.

Table 10: Summary of the environmental challenges with priority ranking

Cluster	Challenges	Relevance
Supply Chain Partners	Lack of supply chain partners' (ability to make) environmentally sustainable efforts	Medium
Supply Chain Partners	Lack of environmental awareness among SC partners.	Low
Supply Chain Partners	Lack of (access to) partnerships with environmentally responsible suppliers	Low
Market-driven Forces	Labor market	Medium
Market-driven Forces	Educating the consumer	Medium
Market-driven Forces	Lack of interest and awareness of stakeholders	Low
Market-driven Forces	High market competition	Low
Supply Chain Collaboration	Lack of control of SC partners' operations	Low
Supply Chain Collaboration	Complexity of supply chains	**High**
Supply chain Collaboration	Lack of visibility in the supply chains	**High**
Supply Chain Collaboration	Lack of integration throughout the supply chain	Medium
Supply Chain Collaboration	Lack of trust among supply chain partners	Medium
SW Vendor Landscape	Lack of intuitive tools in vendor landscape	**High**
SW Vendor Landscape	Difficulty to choose/evaluate providers.	Low
Regulatory environment	Too many certifications	**High**
Regulatory Environment	Lack of governmental regulations, legislations, incentives and laws bound to the fashion industry	Medium

6.4 IS Research Agenda

After discussing the most relevant issues of analytics-enabled GSCM of European fashion companies it is evident that the industry and its complex supply chains present some unique challenges which are yet to be solved to further develop green practices. Consequently, this offers several research opportunities for IS scholars to address environmental issues. In this way, the demands for a more prominent role of sustainability in IS research, spoken of in the research problem, can be met (Gholami et al., 2016; Seidel et al., 2017). To guide scholars towards meaningful contribution in the context of environmental challenges, a research agenda comprised of four key issues is presented. While this agenda is not claimed to be exhaustive, it is based upon the most salient findings from this study and should therefore provide a good starting point to advance analytics-enabled GSCM as well as IS research.

GSCM platform optimization and adoption

The importance of intermediaries in the fashion industry emerged as a central theme in this research. GSCM platforms developed by digital service providers seemed to be especially popular with smaller fashion brands as they offer an intuitive way to analyze their environmental impact. While these platforms only provide limited analytics capabilities outside their sustainability framework, they are a good starting point for more advanced analytics practice. In addition, B2 emphasized that more sophisticated GSCM analytics platforms can tackle challenges in the context of data availability and supply chain collaboration, if adopted by lower tier suppliers in the fashion industry. As these platforms benefit from network effects of a large user base (Zhu & Iansiti, 2019), IS scholars should target GSCM platforms with their research to identify optimization potential and enable adoption. Technology adoption is already one of most mature research fields within the IS domain (Venkatesh et al., 2016). Consequently, the knowledge and proven models should be applied to investigate barriers and drivers of GSCM platform adoption throughout the fashion industry.

Dependencies between GSCM Challenges

In this study it has become apparent that challenges for analytics-enabled GSCM often are dependent or related to each other. While a close examination of these dependencies was out of scope for this research, some of these dependencies are described in the discussion, e.g., how the lack of visibility in the supply chain leads to a lack of integration or data availability. Another example could be how the lack of general resources can lead to a lack of workforce availability, which in turn can cause high workload, resulting in a lack of time that can be invested in analytics or GSCM practices. While in this study the TOE framework was used to present challenges in a structured and comprehensive manner, it must be noted that these dependencies can cross clusters and dimensions, as illustrated in the above-mentioned example. As an addition to the findings of this research, a successive study focusing on these dependencies between different challenges is considered a highly relevant contribution to practice and the nascent research domain of analytics-enabled GSCM. To that extent, the

method of Interpretive Structural Modelling (ISM) developed by Warfield (1974) is a suggested approach to investigate the causal links between challenges as shown in Hughes et al. (2016).

Tangible benefits of Analytics for GSCM

While literature presented many general advantages of Analytics (Chiappetta Jabbour et al., 2020; Davenport, 2018), small fashion brands seemed to be unaware of tangible benefits for their GSCM which they can achieve through the use of analytics solutions. As discussed in the previous chapter, this key issue regarding perceives benefits must be resolved to enable a broad adoption of analytics and improve green practices. According to E1 and A1, fashion brands expect a value proposition of analytics solutions that is tangible and scoped to the unique needs of the fashion industry. This topic has not yet been sufficiently covered in academic literature. To address this research gap, a more practice-oriented approach might be required. Consequently, well-established research methods from the IS field such as an in-depth case study (Walsham, 1995) of a fashion company or an Action Design Research approach, which focuses on "addressing a problem situation encountered in a specific organizational setting by … constructing and evaluating an IT artifact" (Sein et al., 2011, p.40) appear promising.

Data-driven business models

During the data analysis the need for innovative data-driven business models which enable green practices in GSCM and accelerate the adoption of analytics by fashion companies was identified. The development of new business models in the fashion industry is already extensively discussed in academic literature (Arrigo, 2021; Stål & Corvellec, 2018). However, these discussions are often missing an IS perspective and a focus on data-driven approaches. Since IS research is known to be well suited to enable the development of innovative business models (Osterwalder & Pigneur, 2013), it is paramount for IS scholars to address this issue in the fashion industry. In addition, there seem to be many opportunities in that regard. Expanding on the ideas presented by D1, fashion companies could for example sell garments with NFC tags at a discount if the customer accepts to share usage data. This data could in term be used to better understand consumer behavior to develop more sustainable products tailored to customers' needs.

7 Conclusion

The aim of this research was to provide a more critical perspective on the topic of analytics-enabled GSCM in the European fashion industry; to give a comprehensive overview of the organizational challenges to that end; and to contribute to IS research by addressing the under-represented issue of sustainability. This final chapter focuses on concluding this study's findings and providing an answer to the following research question:

"What are the main organizational challenges of analytics-enabled green supply chain management in the European fashion industry?"

To answer this research question a thorough literature review was conducted resulting in the identification of 48 potentially relevant challenges for analytics-enabled GSCM. These challenges were then summarized in a conceptual model based on the TOE framework. The model with its challenge clusters provided a structure and guidance for the data collection and data analysis processes. Six semi-structured qualitative interviews were conducted with three European fashion brands of different sizes as well as two intermediary organizations in the clothing industry to evaluate the challenges within the conceptual model and explore novel themes from multiple perspectives. During the blended coding process seven new challenges were identified as well as five general themes which have not been covered comprehensively in previous literature. Through an extensive discussion, the empirical results were contrasted with current academic literature on Analytics and GSCM in the fashion industry to identify the most relevant challenges in that domain. Finally, four promising directions for future IS research were outlined to advance analytics-enabled GSCM.

7.1 Key Findings

In this study, a total set of 55 challenges was identified based on the literature and empirical findings. Through an interpretive valuation based on qualitative insights, fifteen high priority challenges across the three dimensions were identified as shown in Tables 8, 9 and 10. This selection reflects the contemporary main issues for analytics-enabled GSCM in the European fashion industry, and are suggested as the topical focus for scholars and practitioners. Based on these challenges and findings, this research presents six key insights which provide a comprehensive summary of the state of analytics-enabled GSCM in the fashion industry:

Technological dimension

- **Excel instead of AI and Big Data**
  Fashion brands seem to struggle with a low technological maturity and a lacking integration of analytics into their business strategy. As a result, highly manual ad-hoc solutions based on spreadsheet tools are still central to their GSCM. Advanced analytics

technologies such as AI and Big Data on the other hand have not been fully embraced by the industry yet.

- **Basic Data challenges are still a limiting factor**
  A lack of data availability resulting from the complex fashion supply chain strongly inhibits the analytics capabilities of fashion companies. To approximate environmental performance indicators, average values and extrapolation are commonly used. Furthermore, the reliability of the data provided by geographically distant suppliers remains a concern for European fashion brands.

Organizational dimension

- **No awareness of the benefits of analytics and GSCM practices**
  Decision-makers in fashion companies often lack awareness of possible benefits of analytics and GSCM practices. Since they lack insights into the value that these practices can offer, the general level of interest and commitment for such practices is low. As a result, investments in analytics technologies and environmental practices are often not prioritized, and sustainability budgets are often the first to be cut when there is a need to economize.

- **Low level of environmental literacy and skills in organizations**
  Besides selected experts, people in organizations generally lack knowledge and skills for environmental practices. In turn this has a strong influence on employees' ability or motivation to that end. It sometimes occurs that fear of failure leads employees to stay away from analytics and GSCM practices. In producing and manufacturing tiers organizations are often even unaware of the environmental impact they have, and therefore don't consider analytics for GSCM.

Environmental dimension

- **Overcoming complexity and achieving visibility**
  Visibility of the supply chain forms the greatest challenge to collaborate with supply chain partners and enable GSCM through analytics. Fashion companies face challenges in the traceability of their materials and indirect supply chain partners, where they are unable to attain information of the sustainability performance revolving around these materials and production processes.

- **Fragmented certification landscape**
  While intermediaries play a crucial role in the enablement of GSCM and guide organizations in improving their analytics capabilities, the current certification landscape has become somewhat fragmented. A great number of associations currently drive a variety of sustainability approaches in the fashion industry. Consequently, achieving alignment of sustainability strategies and requirements throughout supply chains forms a challenge for fashion companies.

7.2 Contributions and Future Research

This research contributes to the academic body of knowledge in several ways. General challenges in the areas of analytics and GSCM could be confirmed within the context of the European fashion industry, supporting prior research on the topic. However, discrepancies between the academic literature and practice were also identified, especially regarding the technological maturity and the use of advanced analytics solutions. Therefore, this paper adds a more realistic perspective to the theoretical analytics-enabled GSCM domain, which encourages researchers to shift their focus to the more topical questions with relevance for practice. Furthermore, this study advances the highly-relevant but underrepresented issue of sustainability within the IS domain (Seidel et al., 2017). Driving analytics-enabled GSCM in the fashion sector - one of the industries with the highest environmental impact (Chen et al., 2021) - can empower green practices and lead to great sustainability benefits. Therefore, this research not only advances the academic IS field but also provides relevant insights for practitioners.

While this research yielded interesting findings and valuable contributions to academia, some limitations must be acknowledged. To that end, it is believed that the inclusion of different perspectives within the supply chain, rather than a focus confined to companies located close to the consumer, would have provided greater depth and generalizability of the findings. Unfortunately, due to time constraints attempts to include these perspectives of producing or manufacturing fashion companies were unsuccessful. Moreover, due to the multi-faceted nature of this research topic, it was rather challenging to comprehensively discuss all constructs in the short time-frames respondents could offer for interviews. This might also have had an influence on the depth and theoretic sufficiency of certain findings. At last, since this research focussed on a critical perspective on analytics-enabled GSCM, the findings and discussion might present an overly negative undertone. However, it must be noted that both scholars and the interviewees also described promising developments which emphasize the potential of this field.

Future Research

This explorative study provides a substantial foundation for future research. The identified main challenges (see Tables 8,9 and 10) are a good starting point to conduct research with a valuable sustainability impact. Additionally, consumer-centric stages of the fashion supply chain, which have not been thoroughly discussed in this research, offer high potential for further research into analytics-enabled GSCM. Finally, the four research avenues outlined in Chapter 6.4 are especially promising for IS scholars. These include the exploration of GSCM platform adoption among fashion production companies; an analysis of the dependencies between the identified challenges; a longitudinal study into the tangible benefits of Analytics technology for fashion brands; as well as the development of new data-driven business models in the fashion industry. Overall, the topic of analytics-enabled GSCM offers opportunities for new and interesting research.

Appendix 1 - Overview Challenges

Overview of the challenges identified in the scientific literature and their assigned IDs

Technological Dimension

Cluster	Code	Challenge
Data	A10	Data Availability.
Data	A14	Process heterogenous datasets.
Data	A20	Data Quality.
IT Talent	A13	BI Skills: Data Literacy, Data Visualizations.
IT Talent	A15	Big Data Skills: Data Engineering, Infrastructure.
IT Talent	A19	AI Skills: Data Science, ML algorithms.
Strategy & Alignment	A1	Identify Key Performance Indicators.
Strategy & Alignment	A9	Isolated ad-hoc Analytics Solutions.
Strategy & Alignment	A11	Business IT Alignment.
Strategy & Alignment	A16	Identify Big Data Use Cases.
Strategy & Alignment	A21	Identify AI Use Cases.
Strategy & Alignment	SC10	Lack of Green Innovation.
Infrastructure	A17	Develop Big Data Infrastructure.
Infrastructure	A25	Deploy AI solutions to production environment.
Infrastructure	SC13	Lack of green IS.
Security & Ethics	A4	Data Security and Privacy.
Security & Ethics	A23	Transparent AI algorithms.
Security & Ethics	A24	Ethical Issues with AI.

Organizational Dimension

Cluster	Code	Challenge
Management	SC1	Lack of commitment of top and mid-level management.
Management	SC2	Inadequate management capacity.
Management	A2	Management support.
Management	SC7	Lack of environmental knowledge.
Management	SC9	Lack of specific environmental goals.
Perceived Benefits	SC3	Lack of consumer recognition of GSCM
Perceived Benefits	A6	ROI of analytics.
Perceived Benefits	SC12	Lack of financial benefits.
General Resources	SC6	Lack of employment stability.
General Resources	A7	Lack of time.
General Resources	SC11	financial constraints due to costs of systems implementation or eco design.
Culture and Change	A3	Lack of data-driven culture.
Culture and Change	SC4	Fear of failure.
Culture and Change	SC5	Lack of employee skills & knowledge for environmental practices.
Culture and Change	SC8	Resistance to change in organizational culture.
Culture and Change	A12	Business engagement.
Culture and Change	A22	Fear of change.

Environmental Dimension

Cluster	Code	Challenge
Supply Chain Partners	SC17	Lack of efforts of third parties for recollection of used products.
Supply Chain Partners	SC18	Lack of environmental awareness among SC partners.
Supply Chain Partners	SC19	Lack of supply chain partners' (ability to make) environmentally sustainable efforts.
Market-driven Forces	A5	Labor market
Market-driven Forces	SC21	Lack of interest and awareness of stakeholders.
Market-driven Forces	SC23	High market competition.
Supply Chain Collaboration	SC14	Lack of control of supply chain partners' operations.
Supply Chain Collaboration	SC15	Complexity of supply chains.
Supply Chain Collaboration	SC16	Lack of integration throughout the supply chain.
Supply Chain Collaboration	SC20	Lack of trust among supply chain partners.
Software/Vendor Landscape	A8	Difficulty to choose/evaluate providers.
Software/Vendor Landscape	A18	Lack of intuitive tools in vendor landscape.
Regulatory Environment	SC22	Lack of governmental regulations, legislations, incentives and laws bound to the fashion industry.

Appendix 2 – Interview Guide

Opening

- Please present your company briefly.
- What is your role at the company? What is your background?

Introduction

- What environmental sustainability issues do you focus on in your supply chain?
- How do you **measure/monitor** these sustainability issues?
- What types of data/information do you use to measure or monitor these issues?
- What tools do you use for analyzing this sustainability data/information?
    - How would you rate your skill level with these tools?

Key Questions

Data

- How satisfied are you with the current analytics possibilities you have?
- What are the biggest challenges when it comes to analyzing sustainability data?

Supply Chain Management

- How do you collaborate with your supply chain partners when it comes to sustainability (data)?
    - What strategies do you use to ensure sustainable production processes behind your products?
- How would you compare the environmental actions taken by your suppliers compared to yours?

Advanced Analytics Technologies

- Are you using any advanced technologies, like AI (or Big Data) for your analyses?
    - What do you use it for? / Why not?
    - What inhibits you to use these technologies?

Management and Culture

- Is your management actively supporting the use of new/ advanced analytics tools for sustainability?
    - What are the reasons?
- How does your management foster a sustainability oriented and data-driven culture?

Appendix 3 – Interview Transcript A1

Organization A (Micro Fashion Brand), Interviewee Role: Co-Founder

19.04.22, 30 Minutes, Language: English

Nr	Transcript	Code
1	**Interviewee:** Well, let's start. We thought that it would be good if Lucas asked the questions today to prevent the open door feeling right? And as you might know, we're doing research into analytics enabled green supply chain management in the clothing industry. And therefore, we're interviewing companies to see what the challenges are to that end. So what limits them to engage in such analytics practices? And, of course, analytics in this context is taken a bit loosely if that's if you can say that way. We're actually looking at information. So how do you handle information coming from actors along your supply chain? To make it more sustainable?	
2	**Interviewee:** Yeah okay that makes sense	
3	**Researcher 2:** Yeah. Then I think Lucas can take over maybe I will make notes and sometimes jump in probably.	
4	**Interviewee:** Perfect.	
5	**Researcher 1:** [Interviewee Name], first of all, thanks for joining us and thank you for having the interview in English because I'm from Germany originally. My dutch is pretty bad. So before we start: We would like to record this interview so we can transcribe it later. Is that alright with you?	
6	**Interviewee:** Yeah, that's okay.	
7	**Researcher 1:** Perfect. Okay. We know you're on a tight schedule. Therefore, I keep the presentation to a minimum. I think Oliver already had a very good introduction, and it would be great for me to get a good understanding. So if you could just present your company and also your role at the company - that would be a great start.	
8	**Interviewee:** Yeah, so we have a business called [Company Name], and we focus on high quality outdoor clothing for skiing, hiking and daily use. Were in the sort of mid to premium segment in terms of quality. We focus on waterproof and breathable clothing that you can use in extreme environments, but also when you're just using them in the city, or when you go out for skiing once or twice per year. I started the company with two other co-founders four years ago, four and a half years ago, are focused mainly on ecommerce business and since recently also in in retail, mainly selling to the Netherlands. I think 60% of the sales are in the Netherlands, and the rest of the 40% is mostly in in Germany, Austria, Switzerland and some other countries. My responsibility are mainly focused on online marketing and financial accounting. And my other co-founders who are focused on product development and business and partnerships. We are with a team of around nine in total, including and we have a bunch of other people who help with contents, also sustainability, etc, etc.	**T-TA & O-MA**
9	**Researcher 1:** Okay, perfect. Thank you for that. That's a great, great overview. We've poked around a bit on your website and sustainability is a	

	core core topic for you. Could you just present the main issues? The main environmental sustainability issues you focus on?	
10	**Interviewee:** We focus on on multiple issues. For one, it's improving the sustainability angle in our products. That means the type of components we use in our products to make them as sustainable as possible. But also within the supply chain to find ways to improve the way these products are made, for example, with less water, or in a better circumstance for the people who actually make them. So that's one angle. That's basically how the products are made and from what components. The second angle is, is more focused on what we do with the profits of the company that can be distributing part of the profits to sustainability initiatives such as justdigit, which is initiative we support for regreening efforts on African soil, where each of our product supports a certain amount of meters that gets regreened. So we have different types of sustainability angles and mostly focused on on those two.	
11	**Researcher 1:** Okay. I also saw that you talked about your co2 footprint that you were actively measuring that, Is that still a current issue for you?	
12	**Interviewee:** Yeah, that's been part of the footprint that you try to reduce. An example of this is that in the beginning we flew in a lot of the products by using air freight and we would like to focus more on sea freight because that has a lower footprint. Aside from that, it also depends on the lifecycle for products. So if a product has a longer lifecycle, then another product that means the footprint in total is a bit better or at least gets divided over a longer period. So multiple angles on that as well.	
13	**Researcher 1:** Perfect. Thanks for that. Now, let's go a little bit more into the data and information direction. How do you measure or monitor the sustainability issues you just mentioned?	
14	**Interviewee:** Depends a bit. So we have sort of an internal way of measuring and using just excel files. Quite recently, we've become a B Corporation and they actually provide a framework for us to measure our sustainability. As you might know, they give a score to each organization that receives a certificate and they they give grades basically on the amount of efforts on sustainability you perform in different angles. And you basically upload information there. So they have provided for us, basically the framework in which we measure sustainability, and this is part of what you give back to people what you give back to society, how you treat your employees. And within that framework, you receive points for how sustainable you are. That is our internal measurement system of the sustainability of [Company Name]. Aside from that, we also have our suppliers who we monitor and that's a little bit less in terms of a framework system. It's more that we monitor the certificates they have received from suppliers, in terms of the recycled components, how good their factory is. What we do is we request those certificates from the certificate suppliers in order to verify whether they have been assessed and verified.	**T-SA & *LTM E-RE & *INT** **T-SA** **E-CO & *INT**
15	**Researcher 1:** Okay, so we have these two angles: you have the cooperation - the B Corp framework you called it - and the supplier certificates. Talking about the first one, the B Corp framework: Could you just walk us real quick through the process? You said you had an excel sheet so is that something you built yourself based upon this framework? Or do	

	they have some sort of web portal where you just upload specific information? How does that work?	
16	**Interviewee:** Yeah, both. The main thing is their web portal and their they structure a company's sustainability in multiple angles. So for example, people, environment, product, and within those specific segments, they have questions on how sustainable you are within those compartments. There we upload the information on our business. And once we have done that and answered all questions, sort of a grade you can call it rolls out of it. To see how sustainable you are. It's fairly nice especially for for us as a small business to have an external framework that we could use to monitor our improvements and our current status basically. As you know there are shitload of certificates in the industry. It is difficult to choose which one is what or which one is best. We eventually went for for B Corp because it's becoming more widely known and offers a quite straightforward way of measuring it that is quite transparent, but also verifiable. So their organization actually monitors us, verifies the organization, the things that we upload. They have an online portal, and you can extract the online portal to an Excel file and that's what we use.	**T-SA** **O-GR & T-TA** **E-RE & *C-CER** ***C-AUT**
17	**Researcher 1:** Besides the B Corp and also the certificates you check from the suppliers do you have any very specific KPIs? For example that you say okay, we as a company we want we want to output only this amount of tonnes of co2 in our supply chain. Is that something you monitor too?	
18	**Interviewee:** Not specifically regarding the tonnes of co2 but we have a specific measurement that we want to regreen 5 million square meters of land by 2025. I think we've done around 400.000 or 500,000. I need to check the exact number so far, but that is a an example of a measurement that we did - that we monitor yearly. Basically, we check our contribution each year, see how much meters we have regreened each year and try to work towards that goal. Another example is the amount of recycled components within our products. Currently, the entire collection is about 40% recycled. Yeah we want to move towards 75% in 2025 of recycled components within our products. Yeah, so those I think for us internally are the most important measures in terms of KPIs that we that we measure.	**T-SA & *FRE**
19	**Researcher 1:** okay. So you already touched upon different types of information, different types of data you use to measure could you quickly recap that for us? What are the most important types of data or information you use for your sustainability assessment? And also where does this data come from?	
20	**Interviewee:** So we have the regreening efforts. So how much do we regreen per year? We have the recycled components how what percentage of our components is recycled? And then we have the B Corp certification which is more an overview of a lot of different things. But it's it's quite a lot. If you want I can maybe show you and share the screen. So this is basically our B Corp assessment performance. We got a grade of 102. You need a minimum of 80 to become a B Corp. And here they have the framework that they use to assess a company's performance. So it goes from governance, workers, community, environment and customers. And within these segments, you have basically sub segments that show your	

	performance and below this area there are a lot of different questions about how you perform in such an area. Does that answer your question?	
21	**Researcher 1:** Yes. Perfect. Thank you. That's a great insight. I wasn't aware that the B Corp does provide that much support for you. Okay, so let's talk a bit about tools. You mentioned that you're using Excel, and also that you use of course, this visual dashboard from from the B Corp. Are there any other tools you use to analyze or track, monitor data?	
22	**Interviewee:** So it's a B Corp framework and an Excel file in which we monitored the recycle components for example, those tools are the ones we use.	***LTM**
23	**Researcher 1:** And how would you rate your own performance? So how satisfied are you with the information you're getting out of these tools?	
24	**Interviewee:** Excel files are messy. So, it's, it's useful, but it's also quite easy to make mistakes and different people have access to it. So, it's not the best, although it's practical and useful. I would say that the core framework is quite well done. A lot of companies use it so I would rate it very good for any type of organization basically. Do you need a specific grade for it for me?	**T-SA**
25	**Researcher 1:** No, that's, that's alright. Thank you. All right. So just a question and there's no right or wrong answer here. If you Google, for example, analytics tool you will find tons of very advanced analytics tools like Power BI or Qlik on Tableau or whatnot. And let me just ask you directly, why aren't you using any of these?	
26	**Interviewee:** Well, we wanted to have a framework. I don't know any of the tools you mentioned, by the way. We want to use a framework that allows us to have an internal assessment of how we are doing and how we can improve and to have something we can also use in communications to customers. Those two criteria were very important for us. And that is what we found in B Corp. So we believe in the movement they are doing. We believe that adds a lot also for our communication purposes. We see a lot of companies that are in our industry or are relevant for us also using this framework. And the combination of those factors basically decided us to choose the B Corp framework for our sustainability overview.	**E-SW & T-TA** ***C-EDU**
27	**Researcher 1:** So to me, it sounds like you are very satisfied with what you have and confident that this will also develop and go into the right direction. And that sounds like you are planning to stick with that tool. Is that correct?	
28	**Interviewee:** Yeah thats correct.	
29	**Researcher 1:** Perfect. Sounds great. If we talk about the different supply chain partners you have, how well to they engage with you when it comes to share sustainability data?	
30	**Interviewee:** So how this usually goes is that you work with factories who have been vetted by organizations that we trust. So that's for example, ISO or Oeko tex, so you try to have a first selection of partners that has already been vetted by those organizations. And that's basically the first step. The second step is, of course, visitation there, check out a factory looks, do a quality control there sometimes done by by an external agency. And then you move forward with a factory for us. Luckily, we don't do that every year because we work together with our suppliers for for a bit longer. That also builds a bit of trust when you know and have a working relationship	***INT E-CO & E-RE** **E-CO**

	with someone. So that's also another factor: Just a personal relationship aside from the data and the external organizations that vet.	
31	**Researcher 1:** Okay. Sounds great. So, just to just recap regarding the communication, this vetting organization you called it is mostly the intermediary and you talk with them or with the factory directly? How is the communication going?	
32	**Interviewee:** Yeah, you always talk with the factory directly. However, you work to verify the claims and the verifications that they have you communicate with the organizations that actually do these tests. So you have direct communication with the factory but also with the offending organization.	***INT**
33	**Researcher 1:** Okay. Understood. Now, let's have a look into into the future. In terms of very advanced technologies. I mean, I'm sure you've heard about all these cool new buzzwords on the market, big data, artificial intelligence. Has there been any thoughts on your side or any ideas, any use cases you've discussed? Regarding these such advanced technologies?	
34	**Interviewee:** Yeah, there's a lot of talk about it. But we haven't seen a tool that is really useful for us and also we haven't researched it a lot. We're still a small business and quite satisfied with the tools we use now. What we've seen, of course, maybe you can also talk to Herman about that, because they have some big data tools. I think that information remains always reliant upon the person that supplies it on the ground. And that's also one of the major difficulties in the in the fashion industry is that often production is done abroad, sometimes very far abroad, and you're not always there. So even though how sophisticated the algorithm or the data is, it's usually always reliant on a person supplying that on the other side. And that means also the data is as reliable as the person who gives it to you. So there is a challenge that is in the industry and that is difficult to solve by by big data or or AI. Yeah, and a lot of people are basically trying to find a solution for that.	**E-SW** **O-BE & O-MA** **T-DA & E-CO & *C-REL**
35	**Researcher 1:** Okay. Yeah, I can, I can understand. There's a lot of hype around these technologies. So did I understood correctly, that while the technology might be there, the context is still not up to date. There are other challenges, which have to be solved before being able to use these technologies, right?	
36	**Interviewee:** Yeah, yeah. Correct. And, yeah, there's the another downside that there is not one framework that everybody uses. So there are so many different ways of looking at sustainability. There are also just as much ways of measuring: one country has another view then another, even Yeah, one organization has another view then another, another person has another view than another, so it makes it quite difficult to to come to one tool that you use for everything. Yeah. Again, we focused it for now as much on the B Corp because it's an organization that we trust. But there are many of such organizations like the ones who you mentioned yourself, but I think they're a bit more focused on the big data side of it. So just supplying a lot of information and they create sort of a assessment or a sustainability measurement on that.	***C-CER** **E-RE**
37	**Researcher 1:** Okay, all right. Looking at the time. I think we're nearing the end. Oliver, Did I forget something very, very important?	

38	**Researcher 2:** I think you've covered it.	
39	**Researcher 1:** So that sounds great.	
40	**Researcher 2:** I think we got some interesting questions or answers as well, thanks.	
41	**Researcher 1:** Absolutely. Good. Any questions from your side? And things that are unclear?	
42	**Interviewee:** No, for me, for me, it's clear, let me know if you have any other questions. I'll be happy to to answer them. And for the rest. Good luck with the thesis. Thank you very much.	

Appendix 4 – Interview Transcript B1

Organization B (Trade Association), Interviewee Role: Member of the board

19.04.22, 45 Minutes, Language: English

Nr	Transcript	Codes
1	**Interviewee:** It's an business association, which is based in Brussels. It's called [Company Name]. And it has about 2500 members worldwide, and it's mission is to enable the members to improve the sustainability of their supply chains in every manner, beyond the first year. Now, the spectrum or scope is rather wide. It's also the membership is very - is rather varied. It's from SMEs to multinational companies like in Europe, in Germany. Well, and the whole list we have, I think we have about three hundred, about 400 German members overall, it's 2500. It's spreads worldwide. So you also find a Canadian Tire, which is a completely different industry, but the Initiative was founded by retailers. big retailers in Germany, the Netherlands, and rather quickly also per food joint. But it got a bit out of hand due to the times. Yeah, so it's now about 2500 members, and I'm the chair of the of the board. But that's not a full time job. Because there's an executive team, they do the actual work, and I'm only on the sidelines shouting it has to be better. But yeah, that's it and the and that is just to give you a little bit of a background how we do it. Or let's say how how we support at this stage the members we support them with local audits of their supply chain. They are being audited. And based on those audits, an improvement plan is being provided and we support training for the suppliers also for the members. We do analysis of the of the aggregate data we provide let's say market analytics based on that.	**T-TA & O-CC T-DA**
2	We support the local authorities and also the European Union in the, with our advice on sustainability and improvement and how businesses can and should do better and how they as an authority or as an entity could support that. So it's not only direct to the business, the actual support, but it's also a bit of lobbying and and we keep the very close contact with the with other associations in the industry. We cooperate with them and the we are now going through quite quite a big change where we changed the we got a new platform, which enables us to do a lot more because it's the as you already mentioned the data is is what counts so we focus on enabling that within the association. But by far I'm not where we want to be. But we have data we have a lot of data and we we have to bind it properly to provide better, better advice, better guidance. But it's it's hard to get the right people of course to do the work because these they come at a price and so that but anyway that's a sidestep. This is basically what we what we try to do to enable in every every way. Whether it's in in supporting authorities with the legalization of what they aim to be doing. So with the human right to diligence law that is coming into into being now this is coming period. And this already in being in Germany, we support all parties, not just the members but also the the authorities who provide	E-RE & *INT E-SW, T-IN, E-CO *INT E-MA E-RE

	feedback on on the proposals of the law etc. So it's a very broad spectrum and it's not just Europe because the supply chain to give you an idea, we talk about two and a half thousand members and about 45,000 production sites first year, about five and a half million workers that it affects and it covers all continents.	
3	**Researcher 1:** that's pretty impressive.	
4	**Interviewee:** If you're doing right, yes. It can be pretty impressive. The impact we have is big.	
5	**Researcher 1:** So you touched upon a lot of very interesting points but I think we need to focus on a few and as Oliver said in the beginning, we are very interested in the technology and data situation can use from your point of view, what are the biggest challenges that fashion companies face? Or what are the problems that come they bring to you to solve this area?	
6	**Interviewee:** Well, usually we bring it to them! Because the most of them the bulk of the fashion companies, of course, are medium sized enterprises are not the big players, the big players have the ability to and the people and assets to be aware of what is going on and to to react to that with the help of the SMEs that's completely different. And a there you have to guide you have to take them by the hand and they don't come to you. You have to tell them about this. This is what's happening. Are you aware of that? And usually they say no, or if they say yes and what are you doing about it and then they say nothing. So you really have to help them, which means tooling, basically, which provide a translation of data into numbers and graphs that they can understand and use, to help them report on their business. And most of them are not aware that the environment is changing rapidly and that all stakeholders whether it's a shareholder, or a bank, or the local authority, they want to have feedback. They want to know what you're doing before they move forward. And they don't have the data. Generally speaking, they should but they don't and I have to admit it's also rather complex, because the complexity if you want to cover the full scope of sustainability, it's quite, that's quite impossible. So the companies will have to focus as well and they they are generally quite ok at a social compliance because that's started a lot earlier than the environmental and regarding the environment, it's it's not an easy one to do and how do you want to report it and many companies focus on co2 But there are also other ways you can do that. There is no universal agreement. And that is part of the problem. So everybody is doing something.	**O-GR & O-CC** **E-SW & *INT** **O-CC & E-MA** **T-DA** **E-CO & *C-CER**
7	What we as an association, in the stage where we are in, try to do this: Okay, your social compliance is pretty, pretty clear cut compared to the environmental part. We take that knowledge on board and we are looking at the environmental part and all the possible potential partners that could help bringing this about because we also, although we have is a big Association, it's I believe it's the biggest in the world. Although it's that big, it still cannot do everything because the competencies are just not there. So it's much smarter to go and find those farmers that that are few steps further ahead than you are and integrate them in your effort. That is what we are looking at at the moment. We are currently rewriting not	O-CC & E-PA

	really the strategy because the aim is clear but how we are going to how we want to get there and how we want to get there as quickly as possible. Then there's only one way: you have to work together with others. But yeah, so if you make it small, then you say all right, it's the awareness is one problem. How to do it. Most companies do not know have no clue. Do we have a clue? Yes. But can we in a broad spectrum? No. So also we need others to help us out and when we have data and then we still have to check with it. Not only whether the data is correct, but how relevant it is and can we really achieve something with it? What is actually the impact? Because if there's no no real impact yet, well, we better do something else. So that actually is the process where we are in. So it's complex it's broad. And we are moving towards that we probably by the end of the year will have more or less clear plan. How to tackle this but I if you tell me how you want to do it right now! hahah Does this help you a little bit of are you looking for something else?	O-BE
8	**Researcher 1:** No. That's I think that's very valuable. Thanks for this great insight. I will would like to steer it a bit more in direction of technology and data though you said that you the tooling and data you said that quite often are very important parts. are you collaborating with any sort of technology provider or any consultancy when it comes to these technological issues?	
9	**Interviewee:** Not in the sense that if you say do we, do we team up or do we hire consultants to guide us through this? No, because there are very few that are really aware of what they should do. Basically, we know it's not arrogance it's just a fact. We know better. But it gives us the right people and we currently have quite a quite a competent team. Then we can get that the members know what they want. We know what the members want. So that guides us as well. Besides the fact that we also know what the members tend to ignore, because it's, let's say too far-fetched - too complicated. Not for today, not for tomorrow, but maybe the day after. So we also look at the picture longer term here but no, that's that not the thing is that the it's getting more and more important to the actual action in the supply chain for the fashion industry, but it's not just the fashion industry, its farming, food, whatever, it used to be based on audits and those audits were physical. But it was somebody going to a factory or going to a farm and asking a lot of questions and the roller board and then what was filed and people started to do something with it or not. And then came another audit and then they found out oh, they didn't work hard enough or didn't work at all, or they were rather okay or whatever. With the way things are going and with more and more companies and part of the supply chain being involved. That's actually that's no longer practical. It wasn't practical, but it's even less practical now.	***C-PRI & O-CC** **T-IN & E-CO**
10	So the direction in which we are looking is how to collect data from the supply chain itself from the members or from the supply chain itself and benchmark that with the bigger data that we have to see where where there are whether it's something off, whether it's strange or odd, and then we have to look into it. Usually we find that if the data are aligned with what we know that we also then we also find that it has the same problems that we see elsewhere. If something is wrong, then usually they have done that	

	work properly or they have tried to to basically to change the outcome. And so the the essence of that is is that if we want to do it and improve the impact, increase the impact, it must be data-driven that we can acquire not only in the open source but also from the from the from the supply chain itself and we have to be able to assess that online with Afghani or somewhere. Yes, in your case you do that. It's very valuable. You should but definitely not in all cases. That is where in my view the market should be moving and we have to find ways to cross check data smarter and more clever and not asking only the obvious questions because then you get the obvious answers. But ask the same question in a different way. It's like a psychology test. When you go to, you want to apply for a job and you'll get a psychologist and they you get a shitload of questions and you answer them all. And some of them you'll recognize I asked them for their different way and some of them didn't. But at the end of the day, the result of it. In a broad sense, you can say okay, they come rather close to what you are. Don't know whether you agree with that, but but in my view what is being done right now is getting pretty close to the mark and that is the way we should the data in supply chain we have to ask for different questions, and then we can fine tune the data and and then we need less and less people to go there physically. And then you can scale it up. Because that's the new ultimate goal. To scale it to such an extent that it's easy to to audit 100 new companies in a week if you want to be close the computer is doing it for you.	**T-SA** ***C-AUT**
11	**Researcher 1:** So how would that look like? That sounds a lot to me as some IoT application where for example, we would connect centers to the machines in the factories, for example, they would they would generate some data that would be then aggregated on a big data platform. Is that the idea or was that	
12	**Interviewee:** Noo that would be too complicated I would say. Usually if there is a problem, the problem is with management. And you have to find ways to assess management differently. I'll give you a very rough example. If there is a private equity involved in the in the company, you usually can assume that their interest in sustainability is rather low because their horizon is relatively short. On the complete other side of the possibilities you have a privately owned company. It's a family company. Yes they have a longer vision. They have a far better way of dealing with the workers out of their own interest. But that's the same goes for their environment etc. And everything there in between it. It's not 100% True, but you go a long way in seeing that in reality it works out more or less in that line and then you have to find to where the problems are. And I'll give you another example. In companies where there are women in the management team, usually the interest in sustainability is bigger and the interest to comply is also stronger. Okay, so it's, as I said it's not 100% true they have very good man as well. Yeah, there are a lot of different ways you can look at data and if if the management is fine than at the end of the day, the farm / the factory, they'll be OK as well. And yes, you can move on to the individual worker. There are ways to do that and they are already there. But those ways to have monitoring are primarily to get data to improve the productivity. Not the quality or the sustainability.	**O-MA** **O-BE & *C-PRI** **O-MA** **T-SA & *C-PRI**

13	**Researcher 1:** Exactly.	
14	**Interviewee:** So yes, you can do that. But that doesn't help with putting a sensor on the machine. You put you have to put a sensor on the management.	**O-MA**
15	**Researcher 1:** That's a very interesting point. We haven't come across so far. I think that's very valuable to us. So thank you for that. Just one more question this area so if you now we've looked at at the past right we look at the or how the management is doing in the current situation. What What about forecasting, what role does forecasting or very exact maybe AI based forecasting play in the future what what is your opinion on that?	
16	**Interviewee:** Just off the cuff I would say a big role and then the next question is how and then I have to think. The more data we are we will be having the more exact we know what the situation is from the past. And yes. What you have to do is to find the trend, see where it's moving, and what would happen if it would continue in the same way or what if you were to treat it or force it in a different direction? What would happen that? Yes, there there could AI potentially help out? We are not that far yet at the moment. And I don't believe there are other associations organizations who do it better at this stage is that we use it to when we enter the unknown territory. For example, there is a new industry in a new country and one company wants to move its production elsewhere. Then based on our data, we can make a fair assessment. With fair I mean somewhere between the 80 and the 90 percent of how successful that from a sustainability perspective that could be, or if there is already production and haven't even seen it. But we have the basic data that they've submitted to us. We can give an estimate or which is also fairly accurate. How they will perform in the future. But that is different from if you want to look at how will how big will the impact be of the industry in the future?	**T-SA** **E-PA & T-DA**
17	I don't know in which direction you are looking. But if you see the sustainability impact of the fashion industry, it's pretty poor in the sense that it's one of the dirtiest industries in the entire supply chain which ends with the consumer because the environmental impact of the consumer in the fashion industry is also rather big. So the if you want to end the trend if you want to change that and yes that you should. That's in my view an Entirely different ballgame because the industry can change itself. I'm not saying they do but they could. If we forced them and sometimes you have to, the legal framework helps at times. You can come a long way but if what is much more important is that the end consumer is being educated properly. But that's not what you were looking for. You're looking at the data and how to use it. But sorry, but you're looking more at how to use an optimized data.	E-RE E-MA & *C-EDU
18	**Researcher 1:** Yeah, but that's also on the side of the company, right to make sure that a consumer uses it right. At least it's a part of their responsibility for which data can be used.	
19	**Interviewee:** Yeah. But also if the consumer is not well educated, their interest in the environment is pretty low. If they have no money to spend, then environmental issues are a luxury. That's right. So the there are many things that, if you look at the broad picture, need to be done beyond industry. but when you are looking at the industry itself, what can the	***C-EDU**

	industry do? A yes the industry can influence if they make the chain feasible, new generations are far more susceptible to it than than the older ones. And so yes, there is a there is a job to do but it starts actually with their own product, with what they deliver, whether it's a surface, whether it's a physical product, whether it's food doesn't really matter. That has to be to become right	**O-CC & *GEN**
20	**Researcher 1:** Allright. In the beginning you said you had already had a lot of data. What are the most important data sources or type of information you work with to enable more sustainability?	
21	**Interviewee:** At the moment? At the moment, we work with two kinds of data, the data from the supply chain, of course, because that gives you status that you can improve. Comparing that data helps members to see that oh, if I've changed this or that I do better. So it also guides the effort. And besides that, we of course use the data that comes from other associations who are more focused on a particular part of the fields. And be devoted industry could be whatever. And we bring it all together. And also, let's say the more science driven reports from universities, etc. Yeah, and then we throw it together, and make a nice biography that is able to present depending on the new audience in a different way, but the message basically remains the same.	
22	**Researcher 1:** Okay. And what we've seen is that there are some technology platforms who tried to develop a product development form, which basically they mark it as something which companies can use to share sustainability data with the overall goal to gain more transparency. What role will you think do you think will these technology providers play so for example, let's say Microsoft SAP one of the big players rolls out a product you think this can this could be a solution, or would you rather think it could be more of an individual solution?	
23	**Interviewee:** Okay, can be part of it, because the data is one thing, but you have to do something with it. And to do something is usually it's very hard to do it by yourself and to think of it by yourself. So, yes, that data is helpful, but it should then be presented in a way that you can share it with other data. So that at the end of the day, you have an integrated report on what the actual status is. The The big advantage of often an association as ours is that we do not only provide the data and provide the analytics tools to improve. We provide the training.-training in house for the brand to read that retailer or whatever it is, but also for the factory on the ground and for their workers, how they can improve. I don't see SAP or Microsoft do that very quickly. But yeah, they see a market which is obviously there. And that market is growing. So they tried to take something out of it. But the, I cannot imagine that the company only wants to use data. They want something to help them practically to do something to "do" something with the data. It's not only about dynamism, so about implementation. When you come to implementation, then SAP or Microsoft pointed companies are Yeah, well that that's your cup of tea. So you have to deal with that. So if you if you then say what is how that you go then they you need data that can be migrated easily and shared easily with other data. Like we will to do with other associations so that we can collect everything and bring it together. And if there is then a company that has	**T-SA** ***INT & O-CC & T-SA** **T-IN**

	SAP but it's also a member of [Association Name] then they want that brought together there must be a way to migrate it and to make it into one thing instead of just... well it's obvious.	
24	**Researcher 2:** Yeah, well, thanks for thanks for the insights. What I've been wondering is how is the status quo when it comes to data collection. So maybe specifically for supply chain, lucas, that was one thing I'm wondering about. You've talked about being a sort of connecting actor in clothing supply chains, and that you then collect data from different sides. Maybe you can describe the process of doing that. Or if are you aware of that? And you're talking to me? Yes, yeah.	
25	**Interviewee:** The process of collecting the data?	
26	**Researcher 2:** Yeah, or of gathering data throughout the supply chains.	
27	**Interviewee:** Yeah, we do that but we do that through our members and at the at the sites of the actual site in the off to supply chain so that can be can be a factory or farm or whatever. That is the data that we that we have. We have over a period of approximately 50 years. All this data available. And yes, we questions have changed. But the data is still there can still be used. So there is quite a lot and it's getting more accurate because it's more wider. At the moment with the growth of our membership. And that is yeah, that's basically the data that we use and what we do but that gets mirrored with the general aggregated industry data of that particular industry where we compare with industry associations that also have data. And then we see to what extent does it comply with what we find and what they say they have. But usually what the industry has is on a very high level. We can present it on the very high level, but we can provide also have very detailed information. For example in in Japan or India, the situation is so and so and so.	**T-DA**
28	**Researcher 2:** Okay, clear. Thanks. Then Lucas we're nearing the end of the interview timewise. I was wondering if you have any questions left, Lucas.	
29	**Researcher 1:** I was just checking. [Interviewee Name] you've been opening up a lot of avenues which I was busy writing down so I guess we'll have to look that up and all the different topics you mentioned, but from my side, no, no questions. No more questions at the moment.	
30	**Researcher 2:** All together a very interesting interview. [Interviewee Name], Thank you very much. Very good that this came out of out of nothing into the agenda. I think we can agree on that. Yeah, how good things can pop up. Are there any questions from your side? Maybe?	
31	**Interviewee:** No questions from my side. Happy to support you guys.	

Appendix 5 – Interview Transcript B2

Organization B (Trade Association), Interviewee Role: Head of IT

03.05.22, 60 Minutes, Language: English

Nr	Transcript	Codes
1	**Researcher 1:** We're very happy that we got the opportunity to talk to you. So thanks for making time. To give you a bit of context, I don't know if you've read the email that I sent you with the invite...	
2	**Interviewee:** I read it but it's still for me quite abstract, what the purpose is so if you can give me a little bit more context, then probably I can help you better.	
3	**Researcher 1:** we will. So actually what we're doing, we're both studying information systems here in Lund in Sweden. And we're currently writing our thesis on the topic analytics-enabled green supply chain management in the clothing industry. And what we see that in research and literature, is that well, there are a lot of big promises around analytics technologies, right? You probably read about them as well and hear about them. And also how these analytics technologies can be used for green supply chain management in the clothing industry. We call this green supply chain management because we focus only on environmental sustainability. But what we actually see is that in practice, all these great promises you read about aren't actually materializing. To a certain extent, some companies are better than others, where we think that I'm fully actually is a very interesting one and a very good use case on where it is applies to certain extent. So what we're doing is we're actually interviewing clothing companies to see what they do in this context, to see what the challenges are especially because everything is so optimistic. We are looking at the the other side of the story,	
4	**Interviewee:** And are you then looking, in particular in blockchain or something like that or ..	
5	**Researcher 1:** Not exactly. So what we're looking at is I think, how analytics can be used to overcome what is the complexity of the supply chain in the clothing industry and how clothing companies can actually achieve improved sustainability performance by managing their supply chain through these analytics practices. So could you tell us about your role at the company as well as the services you offer?	
6	**Interviewee:** All right, okay. Okay, so maybe I can start with the beginning. So, okay, I'm responsible at [company name] with everything that has to do with technology and I also have a background in what you guys are studying but 20 years ago. So yeah, first of all, if you look towards a service model, we are an association where members join each other, or communities each other to say, hey guys, we have a common problem. And the common problem is that supply chains are very complex. And in driving sustainability, or due diligence, whether social or environmental - so it's the same problem I'd say - we can better join each other and help each other. So	**E-CO**

	so that is more collaborative. And that is the reason why [Company Name] is existing. So this is, this is the main reason. And you hear already two things. It's about collaboration. It's about different stakeholders. And that means okay, we as a company here in Western Europe, we have a problem that we need to address. We need to report on that. But our problem is something which is out of or our reach, because it's our supply chain. And of course we have direct relationships. But yeah, the real challenge is to build these relationships upstream in the supply chain. So here, we're collaborative, you're different stakeholders. And that is of course, the existing reason was to provide services that help our members to drive this business and make sure that they trade with purpose. It's about how can we do trade and where not only money is important of course, at the end of the game, if you buy products, one of the main discriminators will be money..	**E-CO & *C-VIS** ***INT**
7	**Interviewee:** Yeah. But what we more and more get there is that there are now people that buy this product and they want to be sure that the product has a certain footprint. That it is that it is socially produced and so forth. As for the people that produce this - that they get paid. Yeah, this is also concerning GRI and so forth. So you hear a lot of these concerns. So we started with with, first of all, how can we bring software as a service so typically, the SaaS model, like you guys probably saw in some of your courses and providing a platform. A platform by default is collaborative, so different stakeholders, having different use cases organized on one tool. And the idea is that the one tool becomes a kind of one stop shop, meaning, if I need to do something around due diligence and environmental social governance then this tool should be able to help. And this is let's say, where [Company Name] took an kind of transformation coming from let's say, applications, into a platform and meaning "own your own data"- for us that is very important. Thinking about data security and so forth that "own your own data", meaning that the producer somewhere in China is also on the platform, administering his own data. And it's not any more the German member or the Dutch member or the Swedish member that types in the producer by name, no he can invite the producer and the producer is on the platform and the different stakeholders. And the producer will help you to gain performance. Or to gain improvement in the supply chain of this member. Because if this producer doesn't do anything, yeah, that then how you improve? That's for me the platform thinking. That is a journey that started here in 2017. Where we went live with the platform in 2020 was and this is yeah, typically software as a service.	**E-SW & *INT** **E-CO**
8	**Interviewee:** Now we go one step further, and that is the next part and that is bringing "data as a service". Because the next thing is, yeah, we have an operational platform where all the processes are managed. But how can we now steer these operations? Yeah, with some insights that you get out of the data and that is, that is the second data transformation, that we got to bring data as a service, meaning we don't need to have extra data, but what we can learn about our data. Yeah, that's one thing. So we got more and more insights, analytics, aggregation, comparisons with other databases in the world and with artificial intelligence to identify risk. We're, let's say in 2017, when we started, we had an application where the knowledge was an audit scheme. Yeah. And in this audit scheme, the idea is that an auditor	

	goes to a factory and does some audit. Gathering for example, the co2, the electricity consumption, all these kinds of things. reported in the system. It transformed. Okay, wait a minute. If you want to go to this factory, it's not only about the audit, but what can we do next? And how can we improve findings, which were on this audit, a continuous improvement.	**T-SA**
9	**Interviewee:** But now, yeah, this was 2017. And now how can we drive this kind of data driven thinking in businesses' supply chains. And if you look back and now we go back to the roots, what does all members, meaning the retailers, the retail shops and that you know, whether you're in Sweden or in Germany, or in Poland, and wholesale and all these and so forth from this world? And , what they need to do is, is is thinking about what is the purpose that they really want from our organization? Yeah, and that is risk management. Yeah. Because what they want to know is not only about environmental questions but in general, and to trade with purpose. And they say: I want to do business with the supplier. But I want to be sure that the supplier conducts to some legislation, conducts to some rules and human rights, thinking about human rights rules, thinking about legislation, concerning environmental problems. And what he wants to do is risk management. So companies wonder, if I do business with party X, how sure am I that party X, and what lies beyond party x, adheres to the preferred standards. So upstream the concern is data. So we are transforming our business now. In three steps. First risk analyzes, then risk assessment, and then risk mitigation. Yeah, and in 2017 an audit was let's say all board business but an audit tomorrow will be an instrument to do risk mitigation on the supply chain. Yeah, but the two steps in front of it meaning risk analysis, and then you read a lot of data, how do you know what kind of risk we have.	**E-CO & O-CC** ***RES & O-BE** **T-DA & *C-VIS**
10	**Interviewee:** That is done with artificial intelligence. That is done with checking some things: public data, non-public data, other data sources coming from the World Bank, from the UN, from other organizations that have also some indicators. And what we're going to do is really in the moment a member adds somebody in the supply chain, which is a direct contact. What we're gonna do is immediately give some risk analysis, and say, Hey, wait a minute, this kind of company, this kind of country in this kind of process - because it's also about the proven processes, which kinds of processes that they do in these factories - We know, from all the data that we have, and then the relationships that we have within this data, we're gonna give you some scoring on the different performance areas. And that can be social performance areas, whether it can be also the environmental performance areas and thinking about waste, emission, all the things biodiversity and all chemical management and all these kinds of we follow a little bit of GRI strategy there with those indicators that are mentioned there. And that is the risk analyzers that we got to do with the data. And then we say to the member, okay, and this is the risk. Now it's a little bit up to you. What are you going to do with this risk? Yeah, and then what you do in this collaborative way of thinking: some of these producers are already in a supply chain of another member. They are already managed so you know your risk is already - Yeah, I will say not minimized - But but it's	**T-SA** ***INT**

	already managed, because another member took care that this producer is there or that they're going upstream and you can follow that.	
11	**Interviewee:** Then the second thing is the risk assessment. Meaning Okay, wait a minute: How can we know that the what we analyze as risk, how can we assess this risk as being a ... wait a minute you need to do something to mitigate. We think we have a risk assessment and there we are going to use also different media. First of all, okay, I would solve questionnaires. We got specific questionnaires, so not general ones, but really specific ones. So that if we if we talk about a factory that that, that create T-shirts is different than a factory where, let's say, where chickens are for delivering eggs. And out of this, all of these questions, we go to mine data to say: hey, is this risk valid or not? But it is also compared to other assessments that we have because if you if you say: "Okay, how good are you?" Everyone is saying: "Yes, I'm the greatest guy." But it's of course invalid. Again, data is analyzed and we got to compare with other assessments in the same region, the same sector, worldwide, we can compare with different data sources. And then we go to give a risk assessment or risk analysis, saying this is okay. Yeah, or all risk analyses are not okay. So, so we give them information and then we go to this mitigation. But now we have a third question. And the third question is, how can we drive that in the supply chain? And in a supply chain with multiple tiers and where we get then some complexity. And one of the complexities there is: you don't know anymore your relationship because I have a relationship with you. And you have a relation with your colleague. Because it's upstream I don't know your colleague, and you have then the problem of competition. Because yeah, on the moment that you disclose this information, then everyone is afraid that I jump over your head to this to this guy and that we that we make money disappear. So it's very hard, especially in those countries to drive upstream. And of course, it becomes very, very hard for us as an organization to stand alone.	***C-REL** ***C-VIS** **T-SE & E-CO**
12	**Interviewee:** And that will be the next level. So between 2018 and 2021 - Let's say also during COVID - We were busy with this operational part, meaning software as a service. We are now today busy with this risk indication, risk assessment, risk mitigation and that is very, very hard. For example, you are from Germany. I understood that a German law is coming concerning human rights and environmental due diligence, namely Green Button, as they call it there. Then: Okay, how can we report on the supply chain, where is the risk and how do you analyze this risk and how do you manage this risk is very important. So that is data as a service. And now we come to the next phase and the next phase will be from next year. That is where we where we are heading to with also colleagues from other association where we will work together in order to make some more data. Yeah, a kind of place in the supply chain, where we have blockchain technology. Yeah. Where we use artificial intelligence of course and data, where we have blockchain technology that if people go into supply chain upstream, whether they have schema x y z Yeah, that you get some certification back from the platform but without getting all the data to you. But that we know: is it managed or not managed, it's fine or there are some problems. But that we for example, don't know, this party by name but that	**E-RE**

	we know in the supply chain in this proven chain, how does this evolve and that is the let's say, the latest phase and that we as [company name] will support that data as one big thing. And coming from software, going to data, going to let's say decentralized data using decentralized data without getting the data in your database or that if you if you are looking for databases.	
13	**Interviewee:** And then yeah, the future step will then be okay: Can we be part of an ecosystem? And because what you see it especially in the environmental area, you see that you have so many so many parameters or attributes that you need to manage and it goes from certain ambitions, to energy to ways to whatever and and that is the question: is [company name] The party that can manage all of them? No, of course not. We are only one. And then what you will see is the next phase. And then we are talking about this in a few years and then we come to ecosystems. And this is a journey which [company name] is making in technology and that's also how our services will be organized. So we will be part of an ecosystem. And yeah, we will provide information to that ecosystem but again, maybe decentralized - thinking about, for example, at blockchain architecture - in order to make that happen. And now I don't know if this also answers a bit your questions.	***INT**
14	**Researcher 2:** Definitely, thanks for this very extensive overview, I think you've touched a lot of very interesting points.	
15	**Researcher 1:** What I was thinking - as you were talking about the risk assessments that you do .. What wasn't clear to me was what data you base these risk assessments on. So where do you get this data from?	
16	**Interviewee:** We are of course, huge. data source, which is in the room and coming from, from from all the all the things that we are doing an we have been building up of course our own history, and other internal benchmarking, where we use analytics in general perspective, to find out what could be indicators to say hey, there is an issue with this kind of performance. But then in the meantime, we are linked with with several data sources, several Institute's, let's say, who are gathering data all over the world and I'm thinking about the World Bank is one of these institutions that bring every year some indicators concerning risks...	**T-SA**
17	**Researcher 1:** For example, I'm sorry for interrupting you, but am I imagining it right: If you then look, for example, at an estimation of a certain location and the water usage of that location?	
18	**Interviewee:** So for example, we have myclimate data for example, if you if you go there on myclimate.org I think it is they're gathering data, for example, what is the water consumption to create a pair of shoes for example. And this kind of data depending on the regions and depending on the process, is kind of what we want. And at the moment that the producer comes on board they are added in the supply chain, direct or indirect. Yeah, we go to calculate this risk saying okay, this producer identify himself in this location and identified himself as a certain producer. So we say okay, which kind of production processes are there and do a classification. And depending on this product classification, we identified what kind of areas environmental areas are at risk. Meaning, yeah, if you know that you do a product process where you don't have water consumption. Yeah. Okay. Than water will be probably not a problem. If you know that you have a	

	process where a lot of water is going on. And I mean, probably you have some things to do with water and then you go and check some things. We combine this data, for example, with regional data, thinking about water, water, intense risk areas. So water sensitive areas. We have world maps that explain on a GPS coordinate what the water sensitivity is.	**T-DA** ***RES**
19	**Interviewee:** So and that is that is where we compare of course the data and we say okay, there is a problem or there could be a problem with water. Of course, coming from our internal benchmarking, external benchmarking, there is a high risk that there is a problem with water. Then we go to assess and those assessments are, are in the first part questionnaires, questionnaires that are questions with answers, yeah. Documents that they need to upload that prove that the values that they provide are in the date. Then we gonna give them benchmarking and say okay, if they say okay for - imagine we are in a shoe factory and they say for a boat(?) full of shoes, we need this kind of energy consumption or this kind of water consumption, then we're going to give them directly feedback saying: Okay, how are you doing. In which kinds of areas are you and there we typically use the Gauss methodology to say okay, you are in the better part of the of the curve or you are in the worst part of the curve or you are on the extremes that can be also the case. And then we know okay, maybe when you are in this extreme good, then it's probably wrong data or extreme bad then probably high risk	
20	**Interviewee:** So with this questionnaire, and this questionnaire is of course, that is all knowledge. So [company name] is a knowledge center, and we're specialists here and our environmental specialists are grabbing those data points and make sure that they have those questions. And the goal is: How do we put some questions there together and how can you minimize the number of questions but get maximum value out of this? That's where [company name] is standing or that's what the assessment is. The assessment this eight year producer fill this question that in Yeah, I didn't contribute to that. And then we got to compare with the benchmarking and then we don't go to recommendation. Recommendation means your energy consumption is way too high compared to other people in the region doing the same stuff. We give them some recommendation out of the benchmarking what could be the next steps. Again, a little bit artificial intelligence there because what we're going to do is, we're going to measure, if you do this kind of scenarios, dear member, if you instrument that the producer do this kind of steps then you gain a profit in your supply chain, you gain a profit you have an impact.	**E-CO** **T-SA**
21	**Interviewee:** So that is typically what we also calculate for the member. What is in for the member? That the member can say: Okay, I have impact and what you need to report to the German law is, it's not about "I know what is going on". You need to know, how can you make sure that you have impact and that you need proof or evidence that that is very important. If you want to get to some norms, like Kyoto, then we need to do something. And yeah, we as a Western company, we have of course, some possibilities but again, where we can really win is in our supply chain. So this is why we are doing it. So for the risk assessment: That is a question that, of course getting the right questions is very important. Yeah. And getting them benchmarked against what other people or similar companies replied to	**E-RE**

	those questions, what similar products are, what indicators are telling. So we are giving some benchmarking there from what we can do recommendation. So this is this is the whole data flow	
22	**Researcher 1:** And the valuation of these questionnaires, and the data you get from these companies, I can imagine that's quite an HR intensive process, or is there some form of automation there?	
23	**Interviewee:** That's completely automated. So we are using the complete Google stack. So we have some artificial intelligence, built in the Vertex engine and giving benchmarking and risk analyzes is completely automated. Okay, we have a number of analysts but they are not in every point involved there because yeah, the scalability is not there. Today, we are 66,000 companies. So that's already quite a lot. And most of them are in China. We are talking about more than 70,000 users on that platform. We do assessments every day. We do audits every day. We do improvement plans and corrective action plans. So this is this is not with one or two per day, but this is with hundreds per day. Going to 1000s. Yeah, that means Yeah, you need to think how many let's say back office people you would need in order to maintain the process.	**T-IN & *C-AUT**
24	**Researcher 1:** And when you've done these assessments once to then give an advice to your members ..	
25	**Interviewee:** It particularly applies. So every company is in a circle of two years. So so they start with the assessment. We get the risk analyzed as a member and then they start with the assessment and then normally if the assessment goes well, yeah, then they go for mitigation and meaning audit meaning improvement activities, continuous improvement, and that feeds back into the risk analyzes: "okay, what are the improvements done?" "What is the impact on this risk?" But they have to sign a kind of code of conduct how they do this and they have a cycle of two years. So the idea is that every company every two years get get in a new cycle . So that we have data again, and we know what the trends are and we can see some trend analysis there. But yeah, we want of course, that people are obliged to put that in. This is also also what for example, the laws are saying: it's not only that you need to report you need to do that on a yearly basis.	***FRE** **T-DA**
26	**Researcher 2:** Very interesting aspects you're mentioning here. Could you maybe explain the onboarding process? What challenges do they aim to address with your platforms and with your tools?	
27	**Interviewee:** Every member, which is part of our community, what they want to get solved: is how can I get insights in in this due diligence, environmental social due diligence? How can I get insights there how my supply chain is working? So that is the biggest challenge of the company, that CSR departments suddenly are involved in procurement processes as a lot of these companies say okay, we can only do business if a fulfills some of these criteria. Yeah. How can you make sure that those criteria are objective, objectively checked? Because everyone can say hey, and we grade this and so forth. And that is what they search from us so that there is a kind of neutral party. Yeah, this is the process that those companies can do. And out of this process, you can sleep on both ears and know that everything is okay. So the member that comes to [company name] - and they are becoming more and more members and because the laws are saying	**E-CO *C-VIS** ***C-REL & *INT**

	this - they say: okay, how can I get insights in this in this topic? And that is what they ask. That is what we need to solve for them.	
28	**Researcher 2:** Then I was wondering, how do you motivate the companies upstream the supply chain because you said it yourself, they have to fill in questionnaires several times. How do you motivate them to take part or be a part of this platform?	
29	**Interviewee:** So the first year is the easy one, because it's very simple. As a company you say: if you want to do business with me, this is what you need to do. And that is, yeah, I would say pushed out with with let's say the hard way. Of course, upstream, it becomes more and more difficult, and all members have the same problem. The same thing is about this transparency and how can you drive it Yeah. And and how can you avoid that you disclose information? Because if you go for example to China and you talk to your first year those guys are not that happy to say okay, which parties they work behind, you're behind, but then if you go upstream to the primary for example, and how do we do that? And that is where we're let's say we took the decision in 2018 is to go with "own your own data", and there is a strategy behind that because all the systems that I know of which which are more competitors, they are often not with "own your own data", meaning: dear member you fill in the data for your business but you get the audit reports there - fine. Okay, then the audit is involved. But of course, that leads you to the first year the next year's becomes very difficult, because I don't know who is behind those things. And so what we are doing now is creating a value proposition there as well and making sure that we bring value because at the end of the game, whether you are a small company, whether you are a big factory, all of them, they know that the future will be that they need to be interested in these topics. Yeah, sooner or later they will be enforced.	**T-SE** **O-BE**
30	**Interviewee:** Well what we want to do with [company name] is make sure that they are on this kind of platform and that we can bring value to them. And by bringing value to them, we hope that they can engage in this kind of thing. So we are thinking now we are busy with marketing to for example, to think about how can producers become also members? Because currently a member is a Western company who has a product on the shelf and that needs to know okay, how is this product? Good. How is this product produced? Yeah, but those producers behind this product, let's say the end product they have also produces behind them. And in order to drive them maybe there are incentives there and to bring some of them really as a member on board because they have their own supply chain there. But therefore, you need to make sure that they that they manage their data, because otherwise it becomes a little bit silly. Yeah, that data of you or something that is by somebody else that you probably don't know. This is for us the "Own your own data".	**E-CO & O-BE** **T-DA**
31	**Interviewee:** I know I had a lot of resistance in the last few years from members saying Oh, it's too complex and so forth. But now since last year, summer, you see more and more members saying okay, we understand why you do this and and more and more are joining - last week was more than 200 companies coming on board. So this is the only way to make sure that you become a kind of value and that you can have impact that is "own your	**O-CC**

	own data". So this is for me the only strategy, saying "you manage your data" and of course we as [company name] need to bring value proposition. How do we bring value? It's knowledge. Because those people need to have trainings, need to have resources, resources in the sense of articles, in sense of how you can do, how you can improve, what are the ways to do it, where you need to think about if you want to do business with Western companies, if you want to create products for Western companies all of them are interested in in this kind of this kind of value, but also give them insights how their producers are working without disclosing this information towards the member. Wheter the member knows, okay, this party using this kind of producers - "kind of produces" not by name - but we know from our system that they are certified, they are on the platform and so forth. They are busy, they are audited, they are having certificates, and that's the way to grow that. So, so and then we are talking directly over more and more members. Yeah, but maybe another segment of members and so this is what what marketing is dealing with. Yeah. Okay	**O-BE** ***INT** **T-SE**
32	**Researcher 2:** I have maybe one or two more questions. First, the AI components. You said you use the Google stack for that and I heard these components were already in place. Is that correct?	
33	**Interviewee:** We have some of them already in place on others we are still building. It has to do with of course how do you do analytics, which kinds of patterns you use. For example, we are building now a sentiment analysis. That is something what we are doing today. Yeah. But we have already in place some classification patterns. So clustering, typically clustering patterns, that we can learn about how questions or questions answers are resonating and then where you see some discrepancies with benchmarking information. So this kind of clustering techniques we already have to identify risk. And because risk is also indicators with a probability and I'm bringing that together.	**T-SA**
34	**Researcher 2:** You also mentioned several data sources. Would you say that what you do qualifies as big data analytics?	
35	**Interviewee:** Yes, yes, you can. You can qualify that as kind of big data where here most is about getting external data sources. And also your internal data source with these external ones. So how can you compare your internal with the external world to identify: "Wait a minute, we see different things", or there are also some trends there, which we as [company name] encourage. And this can give you correlations which you sometimes don't expect. Let me give you an example. If a company is owned or managed by women, then you see in the trends, that sustainability is much higher or risk is much lower. That kind of trends. If you have answers by company led by a female or company and the same company in the same area, but led by a man. The answers might be identically in some performance areas but they can be interpreted differently because you know, you have some correlations, which you can understand. And this helps our members, because they need to spend the resources on the right risk. But of course it's the member that decides. So, we can we can give some advice, we can do some predictive analysis. Yeah. But yeah, this is how we do it. Yeah, it's it's a little bit different than Big Data.	**T-SA** **O-MA**

36	**Researcher 2:** Yeah. No, I understand. Thanks for the explanation. It seems like you're doing a lot so I'm very impressed about that. . Just to get an idea. Can you roughly say like, very roughly how many people are working on this on this platform?	
37	**Interviewee:** We are here internally, I'm working with 16 people and I have externally another 20 people. In total we are with a group between 35 and 40 people working on this. But it's about everything. it's about quality assurance is about security. It's about infrastructure - all the different aspects of it. And you see today more than 40% of our budget goes to IT. Which is of course extreme for an Association. But on the other hand, that's what we do. That's all services to our members. That includes knowledge of course. But at the end of game, this always is implemented in tools and the tools that they need to use. So at the end of the game, you are a kind of software vendor or service vendor with software as a service, data as a service. I t sounds like other other companies doing this kind of things. So yeah, indeed it is quite important for this organization.	**O-GR & T-SA** ***INT**
38	**Researcher 2:** Okay, thanks for that insight. I think that's also explains why the small brands can't keep up with technology because of this budget. You can't spend 40% on IT if you're a small fashion brand - that's not viable.	
39	**Interviewee:** And that's also the thing so so we have small brands, thinking about the small batch retailer. But we have also the big brands and the big retailers that are thinking about all these that so there are various interest there. Of course for this big player, they have other interests and because they want to ask this automated, automated procurement processes and so forth, where this small retailer is thinking about: "Oh, wait a minute. If I do a contract, how can I be sure and so forth." And this big retailer, they trade every day. That is, yeah, that is common sense. And that is a different way than a small company thinking about okay, I want to make sure that my products are green products and that the footprint is less and so forth. You see that there are some interest and we as an organization, we are sometimes in a kind of balance. How can we teach the big ones to say hey, you need to little bit look to the smaller ones and the smaller ones: How can we give you some tools that support you as well?	**O-BE**
40	**Researcher 1:** Okay. Do you have any other questions, Lucas?	
41	**Researcher 2:** I'm just looking through it. Well, I think we covered everything from the tools to the technology and motivation Thank you very much for all this insight.	
42	**Interviewee:** Yeah, if you have still a question by meaning that you say God dammit, send an email. And then I will try to answer it as soon as possible.	
43	**Researcher 1:** Thank you so much. Overall, very interesting insights. We were the first ones that could really give us an insight in what the well how far the technology goes and what you will do with it. So really fill the gap as well with it. So thank you very much for that. And overall, a very interesting and nice conversation.	
44	**Interviewee:** All right, guys. Thank you,	

Appendix 6 – Interview Transcript C1

Organization C (Medium Fashion Brand), Interviewee Role: CSR Manager

22.04.22, 30 Minutes, Language: German

Nr	Transcript	Codes
1	**Researcher:** Okay so, I started the recording. And for the beginning it would be great if you could introduce your company as well as yourself and your role.	
2	**Interviewee:** Please. Okay, I'll start with me. I'm [Interviewee Name]. As I said, I've been working for [Company Name] in the Corporate Responsibility Team for two and a half years now. There are three of us - or rather there were three of us when I started - with me as a working student and two permanent employees. I'm now the second permanent employee. We have a new working student. So we still have two and a half positions, so to speak. We are divided a bit between ecological sustainability and social sustainability. Personally, I'm more responsible for social sustainability, but we're - Well, the topics are becoming very blurred. That's why I can now - I think you're concentrating more on the ecological perspective - That's why I hope I can actually say something about it. Exactly. I studied environmental sciences in the master's program, so I can somehow, so I see myself as rather competent in the ecological field, I would say. [Company Name] itself has been around for twelve years now. Of course, I've only been with them for a very, very short time in these twelve years. Sustainability has played a big role from the very beginning. Back then, we somehow started with recycled materials and were one of the first school backpack brands to implement this on the market. Since then, a lot has happened, both in terms of sustainability, but also with the company in general.	
3	**Interviewee:** Last year we still said seven brands. In the meantime, I would rather say five brands, because we're phasing out two a little bit right now. But yes, exactly, we now have five strong brands. Our concept is still “from baby to business”. In principle, this means that we want to cover the entire life cycle of a person with backpacks. We are also moving forward, always into new areas. So, we haven't kind of stuck to backpacks, but are now also doing more and more apparel and other accessories. We	

	see ourselves as a platform for everything, in principle. So there are no limits for us, but of course our core business is still backpacks. Last year, we transformed ourselves a bit, that is, we built a holding structure. One company became three, there's a holding company that manages the other holdings, so to speak, and we're now in [Company Name], which is called [Company Name]. But we are responsible for the Kids Brands, that is [Brand Name], [Brand Name] and [Brand Name]. And then there's [Company Name]. This is now the one that manages the lifestyle products [Brand Name] and [Brand Name].	
4	**Researcher:** You've already touched on a few areas of sustainability. What are the primary challenges in the area of environmental sustainability that you are focusing on?	
5	**Interviewee:** Well, since we basically process or manufacture a textile product, we have defined four main areas for us. On the one hand, there is the climate in terms of emissions - emissions are of course a very big issue for us and are also becoming increasingly important. Then there is the issue of water, especially wastewater and water use, particularly in dyeing processes. So much water is used, which of course makes it a very big issue for us. We also see it in the supply chain. There are more and more places in the global south where there is a lot of textile industry that really have very big water shortages. And the third issue in terms of environmental sustainability for us is chemicals. Of course, we also use chemicals for dyeing, for whatever. And of course we have to take special care that the chemicals that are used are somehow well filtered out so that they don't end up in the wastewater or somehow endanger people, and that of course there are no more dangerous chemicals in the product. We work mainly on children's products. That is, of course, one of our most important credos. The fourth point, which is perhaps not so important for you, is of course the people themselves. The textile sector is still a sector that has a lot of manual labor and therefore this is of course a very, very big lever for us.	**O-CC**
6	**Researcher:** Thank you. I had seen that in the CSR report you also have very nice overviews of what you have saved and how. And that brings me to my next question: How do you measure or monitor these aspects that you just mentioned?	
7	**Interviewee:** Exactly, there are definitely still very, very large gaps here. That's why you somehow have a very, very good field that you are	**T-SA**

	currently researching, I think. I would say that we've only made the most progress in the area of emissions in the last two years. We are now working closely with Climate Partner I don't know if you know them yet. It's a consulting firm for topics like CO2 offsetting, but also CO2 savings. And so on. And with them we started, two years ago I think, or three years ago for the first time to create a corporate carbon footprint, to record all our corporate emissions, so to speak. We have now also offset these for the first time this year, so we can now also call ourselves a climate-neutral company. But what we also learned last year is that our product carbon footprint, which has to be seen separately, i.e. all the emissions that are generated by our products, is much, much, much higher and that's where the real leverage is. And that's exactly who we're working with. They have a tool and an online tool where we have to enter all the data where we think emissions could occur. Of course, this is then largely our use of resources, our logistics. Yes, and we enter that there and they then work with databases, average values and then basically give us a CO2 footprint at the end. So we do all the preliminary work, which is a lot, and then they convert - let me give you an example - 1 million kilos of recycled PET plastic into emissions. They do that for us, so to speak.	***INT** **T-DA & T-SA & *INT**
8	That's the tool we use to calculate and then, based on that, we sort of plug in our emissions and try to reduce them, of course, and if we can't reduce anything else - as an interim solution - we also look at offsetting, of course. For emissions, I would say that we have developed relatively well in the last two years, so that we can now be quite specific. When it comes to wastewater or water in general, water use and chemicals, we rely very heavily on our partners. We work together with Bluesign. I don't know if you are familiar with that. We mainly work with Bluesign system partners. So our factories are system partners and you can only become one if you can somehow demonstrate a resource-saving use of water, if you can demonstrate a good wastewater management system and so on. And we rely on these partners, but we can't really track that yet. What we do, of course, is that many of our materials are made from recycled PET bottles, and we always extrapolate that. But this also results in certain water savings, and we can then extrapolate approximately how much water we have used through the use of these recycled materials. And of course we also track this a little bit. But of course there is much, much more that we could track, which is super difficult at the moment.	**E-RE & *INT** **E-CO** **T-DA**

9	**Researcher:** Give an example or two of what you're missing there.	
10	**Interviewee:** Yes, for example how much water is now used for a dyeing process at our Tier 2 suppliers? That is then mainly not Tier 1 where we sew, but Tier 2 is more or less where, for example, dyeing takes place. To be honest, we have no idea how much water is used there. To get this information directly from the supplier would of course be ideal for us. Then we could also start there and say, "Hey, what could we do to maybe save that even more?" I mean we always try to do that on the product itself. So, for example, at [Brand Name] we introduced a fabric that doesn't have to be - normally the fabrics are thrown into a big drum, then dye is added, and then it's washed forever. But there are also ways of adding the pigments directly to the yarn, so to speak, so that it becomes a “Spin Yarn Dye”. In any case, this is already a method of dyeing without using very much water. So we already have such possibilities. But we can't say at the moment how much water we actually save by doing this.	**E-CO & T-DA & *C-VIS**
11	**Researcher:** Okay, that means that the exchange of data between your suppliers, especially in Tier 2 and Tier 3, is still a bit stagnant, and instead you focus on working with these meta-organizations that have already audited these production sites or these partners beforehand. And then you rely on them.	
12	**Interviewee:** Yes, exactly. In general, I would say that in terms of environmental sustainability, perhaps even a bit of social sustainability, but in terms of environmental sustainability even more so, it's generally an issue - in other words, the exchange between suppliers. We produce mainly in Asia where we have long-term partnerships and so, but we are already facing issues that we want to optimize now, where they are still trying to build up their production or so and do not yet cope with it at all. For example, next year we'll try to convert a factory completely to renewable energies, because we've seen that there's a lot of leverage in terms of electricity consumption. But sometimes, to put it bluntly, they flip us the bird and say, "Hey, we first have to somehow make sure that we survive with Covid. We can't tackle a project like that here now". Somehow, the exchange is always very difficult and laborious.	**E-CO** **E-PA & O-GR**
13	**Researcher:** I can, I can understand. But you said that you already upload data to this one platform? What kind of data is that? Where does it come from?	

14	**Interviewee:** That's exactly the data that we gather a bit internally in the company. For example, they are based on material forecasts and our purchasing department prepares a material forecast every year, i.e. "how many of which materials will we order this year? We then take that and can say - we just had an example of 1 million kilos of recycled pet bottles - they were used for all our backpacks. That is, of course, a super important data set for us. We do the same with our accessories. That means somehow we extrapolate how much a zipper weighs, how many zippers were used for all our products and then we can say how much metal was used. That's the most important data, I would say, what materials we use, because based on that Climate Partner then also calculates the supply chain back and then says how much electricity was used to produce this metal part? How much does it cost or how many emissions are caused by the mining of metal, etc. So that's all in there. We have also done this ourselves and when we worked with Climate Partner, we worked a lot with the HIGG index.	**T-SA**
15	**Interviewee:** I don't know if you're familiar with it, but it's the big standard when it comes to our emission factors, especially in the textile supply chain. That's exactly the kind of data we enter there. Then, of course, we enter transport routes. So from where to where are our products delivered? On the one hand, of course, our finished products, then somehow, for example, from Vietnam to Germany by sea freight. How many kilometers are there, how many tons were transported, but also in the upstream supply chain. That means raw materials that get from A to B, from China to Vietnam. And so on. We have to try to track all of this - sometimes it doesn't work as well as it could. So when we don't know exactly where everything comes from, which route it takes, and so on, Climate Partner also calculates a lot with average values. That has to be said quite clearly. I believe that this is the case for all companies. You can often only calculate emissions with average values and you can't record them precisely at specific points.	**E-CO & T-DA *C-VIS**
16	**Researcher:** You are now using this one platform. What other tools do you use for data analysis?	
17	**Interviewee:** Yes, I mean, we have the problem that our backpack consists of up to 200 components, some of which come from different suppliers. And they in turn obtain parts from different suppliers. So we have a huge network and it's quite difficult to keep track of it all. Therefore, we have	**E-CO & *C-VIS *INT & T-SA &**

	been working with a startup for almost two years. It's called retraced - from Düsseldorf. Their mission is to make supply chains in the textile industry more transparent. In principle, it works in such a way that we enter all of our data there at the beginning and then we basically bombard our suppliers and say, "Hey, use this tool, too. And then they can tell us, for example, what I just mentioned - it's very easy and we don't have to ask them by email or anything like that, but the system reminds them once a year to upload their electricity consumption or their water consumption, for example. And the start-up is also working on storing certain emission factors in the emissions and converting them into emissions and so on. So we are tracking our entire supply chain and can then also understand "where is the bluesign certificate still missing?", "where could electricity perhaps be saved? I have to say quite clearly that we are not that far yet. We are still rather at the certificate/audit level and are trying to make our entire network somehow transparent. Also for our customers. But in the future, it will probably be the case that you can then enter your entire supply chain. This is also based on blockchain technology. I would say that this is more of a sales argument from them. I don't think it really has to be based on blockchain technology, but of course it sounds good in today's world.	***C-VIS**
18	**Researcher:** It's another matter how relevant Blockchain is. But it's always a good way to build up capital.	
19	**Interviewee:** Good marketing is always very important.	
20	**Researcher:** You just mentioned another important keyword, and that is the interval at which you measure. You said that this tool reminds the suppliers, for example, annually to enter the information. So then my question is: At what intervals do you aggregate data? From "we have the numbers daily" to" we need the numbers once a year for the CSR report". Where do you stand?	
21	**Interviewee:** Once a year - for the fiscal year, it has to be said quite clearly. Especially now with regard to emissions and so on, we calculate everything only once a year so far, because it is always so time-consuming. So when we prepare our PCF and our CCF, we have to plan at least two weeks of full working time. And we can only do that once a year. So and also the other data, I would say the recycling data we calculate once in the fiscal year.	**O-GR & T-SA & *FRE**

22	**Researcher:** You had said that you still do a lot of data processing yourselves. Is Excel then the holy weapon?	
23	**Interviewee:** Yes - Lots of big Excel spreadsheets.	**T-SA**
24	**Researcher:** Yes, half of Germany runs on Excel. But it also sounds like your data preparation and analysis is more manual than automated?	***C-AUT & *LTM**
25	**Interviewee:** Definitely.	
26	**Researcher:** Of course, it's also understandable when you say that all the suppliers aren't ready yet and this platform is just being built.	
27	**Interviewee:** Exactly. Yes.	**E-PA**
28	**Researcher:** Okay. Let's take a big leap now towards the future and technologies that might be helpful to you. You already mentioned blockchain. Have you somehow already come into contact with the topic of artificial intelligence?	
29	**Interviewee:** I'm just thinking... so right now, I can't think of any points of contact. I would say no. So, sure, somehow the blockchain might be the furthest thing now, but artificial intelligence. No. Give me an example of what you could imagine. Then I can tell you whether that would be realistic for us or not.	**T-SA**
30	**Researcher:** Exactly, one brand from Denmark, for example, told us that they use artificial intelligence for their forecast models. In order to predict even more precisely what they will sell on the basis of measurement data, in order to then reduce waste to a minimum. That would be an issue, for example.	
31	**Interviewee:** Yeah, it sounds exciting, but it was definitely a bigger brand still than this, right? So a bigger company or?	
32	**Researcher:** I would say, in the same categories. But you've just touched on a lot of important topics again. Let me briefly explain why I am now focusing on artificial intelligence. If you google a bit or look at scientific literature, AI is always touted as a miracle weapon. And when you read that, you might think that we're practically all already using it from front to back. But we are also trying to find out a little bit what reality looks like? And the reality is, as you just described, that there are often still few points of contact and that the use cases are often missing. That you don't know exactly: "What can I use this for?"	
33	**Interviewee:** There is certainly still a certain skepticism in the whole topic. I've often heard the opinion (which I don't agree with myself), but	**O-CC**

	some people are perhaps afraid that they will be replaced by artificial intelligence. So I can imagine that this is also a big point that somehow plays into it.	
34	**Researcher:** Yes, absolutely. That's exactly what people always say. In that context: What is the use of technology like in general? How is that anchored in your strategy? Is your management pushing you guys and saying, "Hey, we need to incorporate more technology to deliver more accurate numbers?" Or is that not such a big issue?	
35	**Interviewee:** I would say that this is not a major issue for us at the moment. It might be interesting to talk to a purchasing colleague. But what I'm getting from them is that it's not really an issue right now. We've been working on this for five years now - and it's a big, tiresome topic for us - to introduce a general product data management system. And that's already such a big issue, that we have everything digital, because we're a company, we've grown very, very rapidly and in part perhaps also unhealthily and our systems haven't kept up with our growth and we now have to somehow sort it all out a bit. And I think we are now in the process of creating a general data basis so that there is somehow a single point of truth and so on. We're trying to implement that right now, and I think it would be a bit far-fetched for us to think in the direction of artificial intelligence, and that would also be met with skepticism from management. I think the managements main task right now is to realize that there is no functioning data management system in our company at all.	**O-BE** **T-IN & *LTM** **O-MA**
36	**Researcher:** Yes of course, the basis must first be created.	
37	**Interviewee:** Yes	
38	**Researcher:** Then another completely different topic. We have now focused very much on the suppliers in the supply chain. What does it look like when you look in the direction of customers in terms of sustainability and sustainability data? Do you have a few initiatives or approaches there?	
39	**Interviewee:** Well, we have very basic approaches. I would say that now. We send our parcels with DHL Go Green, and I would also say CO2-compensated. That's the least we can do. But approaches in terms of transport and optimization, we already have them on our radar, and if we had the time we would work on it. But right now we don't really have any approaches. And where we are also working on a lot right now. which of course also has a very, very big impact on ecological sustainability - is the circular economy and producing a product that can be recycled. That it's not thrown away after use, which is probably what's happening with most	**O-GR & *C-PRI**

	of our backpacks right now, but that you can create something new from it. That's a very, very big topic for us right now.	
40	**Researcher:** I had seen that you are also trying to act sustainably internally, so to speak, as a company itself. What approaches do you have internally? How do you try to be a role model?	
41	**Interviewee:** In terms of mobility, I can fill you in. We conducted a survey at the time and asked "what would be incentives that would convince you to come more by bicycle or to switch from the car to the bicycle?" And many interesting measures came out of it, which we then also tried to implement. Whether it's offering a bicycle workshop or a job bike, better bicycle parking spaces. So we want to create incentives. We also want to work a bit with nudging, which is more or less setting small incentives so that people become more sustainable, for example, that they take the stairs rather than the elevator. We do a lot in the cafeteria. Now we've managed to get them to serve only one meat dish a day, and otherwise mainly vegan food. These are small initiatives that we implement in order to set an example to the outside world. And of course we also notice that many people start with us because they think or because they come with the conviction that [Company Name] is a sustainable company, but many don't anymore. In the past, people thought that we would only get the same people with the same spirit. But now, with 300 people, you also represent the entire society and not just the small bubble. And we try to spread sustainability further into the company, and we do that on a regular basis. Every new employee gets a lecture where we first try to "brainwash" them and tell them what's important. To put it bluntly, these are small measures that we carry out.	**O-CC** ***C-COM**
42	**Researcher:** In this context, how would you assess, let's say, sustainability awareness among employees?	
43	**Interviewee:** Yes. So, as I said, I think we also attract people in recruiting who really live this issue and therefore also want to join us. That's why I would rate our awareness as high compared to other companies. But not just exclusively. So we often encounter resistance. Not resistance, but I think it was noticeable during Covid that we were one of the first departments to have our budget cut because people think, "Hey, we have to keep the company going now. We can still do sustainability at some point." Yes, you do get that. There are no completely sustainable companies, but where the topic is really anchored in the core, that might not be the case.	**O-GR & O-CC** ***C-PRI**

	I've already heard that from other companies. We are still somehow a company that is focused on growth.	
44	**Researcher:** Super. Philipp, I promised you half an hour, it's just about up now. A lot of very interesting, exciting topics raised that coincide very well with what we wanted to hear. So, I didn't have to steer that much at all. Thank you very much for that.	

Appendix 7 – Interview Transcript D1

Organization D (Platform Provider), Interviewee Role: Sustainability Officer

22.04.22, 50 Minutes, Language: English

Nr	Transcript	Codes
1	**Researcher 2:** Okay. Shall I give you a short introduction to our research?	
2	**Interviewee:** Yes, please do this.	
3	**Researcher 2:** So that we do research as you know, in the area of information systems, which is the interface between enterprise and it, or enterprise IT and its users. And we see that the IS field still lags behind when it comes to ecological sustainability, a topic which we all find important, of course. And we want to start at this point and examine how we can better support European fashion companies that are developing green supply chain. And what we see in the literature is that the key to green supply chain is data of course. And this is where data analytics bi and those kinds of practices come into play, actually. And our research is focused on understanding the challenges that come up when employing these analytics technologies. For the sake of green supply chain management. And we got quite a broad scope. So we actually look at the early phases of analyzing information as well as the more advanced stages of using these technologies all the way to artificial intelligence practices. Yeah. So that's that. With you, we'll try to focus the interview on your experiences what you see in companies in the clothing industry. So it's not per se focused on the activities of [Company Name] itself. Maybe how you complement those companies but more on what you see in those companies. We record this interview to transcribe it if that's okay with you. We'll do this in a confidential manner. Of course, we'll try to anonymize everything that can be sensitive. And we'll send you the transcription of this interview afterwards. Yeah, so that you can go over it to validate it and to see if we should take something out or anything.	
4	**Interviewee:** Yeah. Do you do that manually or you have a bot.	
5	**Researcher 2:** We have otter AI that is currently going over. quite good stuff.	
6	**Interviewee:** Yeah. Yeah, it's works well. Yeah. I remember it was it was a thesis intern that was doing it manually at us. Like what? Yeah, you're doing like double the time of the actual interview? Yeah. On top of the interview, yeah.	
7	**Researcher 2:** Make make it triple.	
8	**Interviewee:** Yeah, yeah. That’s crazy. That's it. No, smart smart.	
9	**Researcher 2:** So then, Lucas, and I will try to ask the questions. Lucas do you want to take over?	
10	**Researcher 1:** Yeah, sure. First of all, thanks for joining us here today. I am really looking forward to your input. And since Oliver, of course, knows you a little bit better it would be great if we could start by you presenting [Company Name] and also your role and your background at the company.	
11	**Interviewee:** Yeah, sure. So I'm [Interviewee Name] and I was always interested in fashion, but started off working in plant based protein, which in terms of production cycles is quite similar to fashion. But actually, during the time got more interested in fashion because there was no real solution for it yet. In terms of the roadmap of how to get it to a singular world consumption. Let's put it that way. And then found [Company Name] around, I think almost a year ago, a little bit less. invested in them first with like, 500 euros, I think, in the crowd funding and then saw like, Oh, what the heck, why don't work at them or tried to get a sense	

	what they're doing. And luckily, they thought the same and they were like, Hey, we were actually looking like someone like you who has a bit of like a sustainability focus, but inherent focus, and has some background knowledge, but not too much that it is too expensive, but that I can basically go out and be their sustainability officer more for the sake of finding people who know more about it, and creating partnerships and finding subsidies. So that's like my day to day tasks. [Company Name] is creating impact analysis on the current operations we have finding subsidy or grants that would apply to us to our business case or to either those of our clients. And along with that, we're doing some research projects on things that could apply on the platform.	**O-GR**
12	So the platform operates basically as a sourcing agent. brands come on our platform, order 300 T-shirts with all kinds of specifications, factories that match those specifications within Europe, get a notification they can reply and start a conversation with them. And then at the completion of an order, we get a 5% commission fee. So that's the basic sourcing thing. Then on the side of our why we think that Europe is the best sort of focus area, because we think that for SMEs to find the sourcing partners is way more difficult because you don't have the buying power. So that's where we saw a common problem what the founders experienced themselves. And there is a lot of lack of information on both sides about how to start their sustainability journey. So on the brand side, it's a lot of information by design, material choice, but also logistics. And on the factory sides, it's more project based, so helping them find grants for solar panels for more energy efficient machinery, teaching them the first lessons about labor ethics. And those are all in collaboration with partners, because we're basically software platforms. We're not going to execute a lot of these things that's out of our scope. But think about like the fairtrade foundation helping us with the labor ethics a subsidy consultants working with the factories once we've identified that there's a possibility and on the brand side we'll do webinars. And a couple other things too. We have a discord channel we tried to create like communities. Basically, yeah, help them educate E-guides, stuff like that.	***INT** **T-DA** ***INT** **E-MA**
13	**Researcher 1:** Okay, so your main focus, like you said is sourcing - matching the brand and production facilities, but also you have additional services. All that stuff to move the companies which are in your network into a more sustainable direction.	
14	**Interviewee:** Yeah, it's basically Yeah, first of all, getting a grip on their production process and then looking at every segments, where can they improve and how can we help them and then if the end we've basically identified the key pioneering partners in each segments, which are doing the, the most ecologically friendly service that currently available and then they can basically also decide to choose them as they're operating. And in terms of measuring impact, it's not an easy task, because you're sort of seeing like a how many people use a service? What is the impact of that? With packaging, for example, you can analyze it, but with like, doing their own impact analysis on the garment like we didn't know if they changed and their decisions based on that impact analysis, like they can just use it and then have it but like, how do you measure the impact of them using an impact analysis to write or, for example, one solar project you can estimate but then again, there's a lot of difficult tasks. So that's why your thesis should be quite interesting.	**E-CO** **O-BE**
15	**Researcher 2:** We hope it is	
16	**Interviewee:** and fragmented haha.	
17	**Researcher 2:** Okay, well, you already talked about that. It's challenging to measure certain impacts right. But still, when you look in the industry, then what	

	do you see as companies? What do you think are the main environmental sustainability issues that companies tend to focus on in their operations,	
18	**Interviewee: T**he brands focus on materials and some do collection recycling initiatives, which they think is within their scope of like, this is what we can do. Then obviously, the trend we see that people shift production to Europe. They think of nearshoring as more of a resilience issue, the resilience of their supply chain that they need to increase, but at the same time, it's a nice sort of add on that sustainability is associated with nearshoring. So that's why they like you know, that's why we're changing and labor ethics for for obvious reasons of h&m scandals and stuff like that. So that's, that's the brand focus and on the manufacturing focus, it's not necessarily an interest in sustainability. It's more of a cost reduction strategy in terms of energy usage. So they do if they're a bit more developed to do with acknowledge of materials, they tried to get it from reliable sources, but most of them I would say, 90% are all interested in how the heck are we going to survive this energy crisis? And what are the possibilities of Yeah, it's obviously the first time that in Holland we have the word "duurzaamheid", which means expensive last thing if you if you sort of translate it directly, and that's our word for sustainability. That's what people obviously associate with it. But yeah, most of them are like this is actually a cost saving solution. So they're all very interested in solar panels. And new machinery. Not so much all the other things.	**O-BE & *RES** **O-BE** **E-MA & O-GR & *C-PRI** **O-BE**
19	**Researcher 2:** Oke. And then they have these objectives, right, that they want to do for sustainability. And then an important part for us is how they tend to measure or monitor the sustainability performance in these issues, right. So, there are some broad lines that you can see that are widely applied or some specific examples that may be very interesting.	
20	**Interviewee:** So, the most common way brands look at it is that they will give information based on the different choice of materials that they make. So, they would say something is 20% recycled, and they've got data probably from a bigger brand that's using the same strategy about like how much water that saves. Then it's obviously no child labor, those kinds of things, the more obvious things. It's not that hard to measure, but because they say they produce in Europe that they assume that that doesn't happen. There is still some slave labor in Europe, but it's yeah, that's not something that they're actively managing and measuring for the factories, close to none because the scale which we work with, like if you consider measuring your environmental sort of impacts it like measuring your electricity bill. You know, that's the closest thing. And that's just by chance that you have to measure that and pay the bill. That to have that data.	**T-DA** **O-CC & T-TA**
21	But even that is like something where they say "Oh, we have to look that up" like, "yeah, we pay the bill, but we don't really know". Just because it's cost related they find it and sort of … they have no technological implementation on water, like waste. But because we're only working with tier one, it's like big knitting machines, sometimes washing machine if it's it was change related. And that's super energy intensive and the opposite of wastewater. as well. But they don't have any sort of system in place that measures these these type of things. And then you obviously have auditors that come by to the bigger ones or some that have had auditor once or twice in their history in recent years. And they have a record of something but it's nothing that being followed up or stuff like that. So there's no systemized way to track their performance. Apart from the electricity bill.	**T-IN & T-SA** ***FRE** **T-SA**
22	**Researcher 2:** Okay, so that's coming from a lack of motivation and what was the other one again?	
23	**Interviewee:** Not Yeah, it's I think it's a lack of information and a lack of demand. Okay. I think the biggest part is the lack of demand of reporting. They just	

	don't have to … most of them are below a certain level of revenue that they don't apply to European law. Which because obviously, if you are quite small the amount of reporting you have to do and according to EU standards, you have to hire a full time person to do that. So that's why the EU says from this level, we don't have to do all the extensive reporting. So that's why they don't do it and the brands don't ask that information. So there's a big, big, big, quick win in terms of educating brands to ask the right questions. Because the moment brands ask the questions, the fact that we're sure I'll look it up, I'll spend an extra hour but they have to ask in abundance, right? That's the whole thing with a small brand is not able to give the push the sort of the push to factory to change but with 10 brands, they do think that it might be interesting to change.	**E-MA & E-RE** **O-CC** **E-CO**
24	**Researcher 2:** Lack of control.	
25	**Interviewee:** Yeah.	
26	**Researcher 2:** Okay. We covered this part you think Lucas or can we go on? Can we go on?	
27	**Researcher 1:** I wanted to ask you another question. Based on the feedback we got from previous interviews. And what I found very interesting is that a lot of brand and by a lot I mean, the two we had in our interviews, told us that they were measuring these KPIs mainly on a yearly basis, and I was very surprised by that. I thought it would be interesting to have monthly or weekly, daily analysis. I mean, that's what the technology is able to do. But I was very surprised to hear that we were working on a yearly basis. Do you do you see the same trend with the companies you work with? And can you explain why that is the case?	
28	**Interviewee:** The ones that do? Definitely, it will be the end of the year - sort of - Yeah, the accountancy that you have to take it into account as well. They're obviously more pioneering brands that would do it way more frequent and bring up reports and stuff like that. But those are not within our scope at the moment, because they probably have their own factory and stuff like that, like they don't need that. But yeah, it makes sense. You really have to think about: "what are they good at? What is their core business? And what are we asking them to do in addition?" It's something completely not in their line of business, that they suddenly have to do because society asked about it, and that they don't really ask about it, like we asked about it. That's because we are quite knowledgeable on the subject, but a lot of people don't ask about it. So we're asking creatives on the brand side to suddenly start doing like accountancy and reporting and we're asking family run factories to start using technology that they never know how to use while they love cutting clothes. Right? So it's a completely new industry that they suddenly have to be an expert in because we require them to do the report. So if they're gonna do it, then they have to do it once a year and not work because they don't necessarily like to do it.	**T-SA & *FRE** **O-CC & T-TA**
29	**Researcher 1:** Okay, yeah. Thanks. Thanks for the insight. And, Oliver, I want to ask regarding the impact analysis, do you think that fits here? Because [Interviewee Name] at the beginning, you said that you were also doing a lot of impact analysis. Could you walk us through that process? How does that work from your side?	
30	**Interviewee:** Yeah. So first we looked at Okay, can we look at order-based impact? So can we get more details on the materials that then brands use can we make an estimation on, like benchmarking relative to standard order in Europe or in Asia? What is the difference in [Company Name]'s orders to them? But that's quite complicated because there are some indexes covering materials. But the underlying data, how the materials impact are calculated are not representable. For example, the stainable apparel coalition or the HIGG index, they did measurements on bio cotton versus normal cotton in two different places. So you're doing	***C-CER T-DA & E-RE**

	an analysis on water usage in a place where it rains a lot more than in the others. So this is completely not representable. Apart from that it would also require a lot, a lot of extra software and steps. And then we looked at certificates. Can we benchmark how many certificates people had and say like, Okay, our platform covers so many certificates. It's all a bit like making makeshift benchmarks and see what's already out there because we're not going to reinvent the wheel, right? We're not going to make a new certification. We're not a standard. We just want to educate and show what's out there compared to them.	
31	Then we basically decided now recently that we're just going to calculate the impact of nearshore. Because basically, that's the core what our platform is now enabling is to find a partner in Europe, relative for you to go on Alibaba and find something in China or Pakistan. So that's now the impact analysis I'm currently writing. And then there are some things that you can measure, for example, what are the energy sources? So is it coal fired energy in that country? Or what's the energy mix? Because that's the largest underground impact difference between Europe and Asia, right. But there's still going to be a very big like, estimate. Based on okay. 70% of all manufacturing business in China is coal fired. And in Europe, it's 35 coal 20 gas, and then the rest is renewable or hydro or nuclear, whatever. And then you have to make an impact assessment based on that.	**T-DA**
32	**Researcher 2:** Is that the only parameter or do you also use other parameters that you look at?	
33	**Interviewee:** So these are the parameters that I identified that are measurable for us based on available data about energy usage in certain industries. But I'll show you. Can you see that? Yeah, so basically, you're looking at raw materials, what are the things in red are very hard to measure, but do have an impact? And the difference between Europe and Asia is things in orange are a little bit easier to measure but still hard and they do have a very different method in each of the continents. And then the things in green are the ones that we are able to measure and also have a significant difference between the two locations. And then one that is a bit tricky, but it's very interesting is the change of demand driven production for a supply based production. So in Europe because you're way more agile. You are way less ordering way more based on demand relative to forecasting orders. You can't do it in China because the shipment takes way longer and production too, right? So you have a lot less overstock but to pinpoint the exact effect of that, that's difficult, right? So you have to see like a there's 15%, less overstock. What does that mean? But that will be great to know.	***RES**
34	**Researcher 2:** Do you think it would be necessary to go deeper into these difficulties of pinpointing Lucas?	
35	**Researcher 1:** No, I mean, sure if you have a question, but for now, I'm soaking it all in. Very, very interesting. Very interesting topics. Thanks, [Interviewee Name] for that. I got a question though for your company. What kind of tools do you work with when it comes to data analysis?	
36	**Interviewee:** So we have our own software platform where we see the orders coming through. The only thing we currently integrated as a software management, like like for environmental purposes, is we have a co2 calculator on the transport. So we calculate based on weight, distance and type of transportation, we can automatically see what the impact is that that order had. But that's only transportation in terms of textiles, transportation is only like 50% of the impact of the total garments. So it's small.	
37	**Researcher 1:** But I mean, besides your platform when you start to calculate some KPIs. Is that a big Excel sheet you're using or do you have other other dashboard tools?	

38	**Interviewee:** No dashboards tools. No, like I write the report myself based on like other articles and things and then basically look at the amount of orders in a platform as a measurement, but these are things that we would like to develop further especially also in the decision making process over brand when they when they choose the specification of their order. That's where I want to really start Yeah, giving them an indication how good or how bad their order is. But that's that's very technical. Still quite far away. Yeah, within a year maybe. But not yet. So it's first manually seeing if it works, the demand is there and then it's doing a roadmap for software development.	**T-SA**
39	**Researcher 2:** Okay. So little use of tools, I understand.	
40	**Interviewee:** Yeah, yeah. It's more manual figuring out what's the demand of the factory, whatever projects can we do with them? And then the moment we realized our first solar project, for example, you know, that's when we then we would add KPIs on basically how many projects we realized, what is the energy mix that we change? There are definitely things we'll start modeling. But there are in in progress these projects so we can say exactly the change that we made.	***C-AUT**
41	**Researcher 2:** And when we shift the focus back to your partners or the what is it the suppliers to factories. The ones that are keeping busy with these analytics practices, or at least are a bit digitized. Do you know what tools they might use? How do they work? Do they only work with Excel? Are there some companies that already use something else? Maybe some dashboarding or anything?	
42	**Interviewee:** No, no. So if they use it, they use Excel or they use a personal auditor that is from one of the certifications or from a Yeah, other body. But it's they won't be doing it themselves through a through a plan. Because like for example, in financial services, there's all these analytics tools that you can use based on your payments, right but in fashion, because it's so fragmented, and you have the different layers, that only financials is going to be completely representable from what your impact actually is. You can obviously say like, oh my employees fly this much, but 90% of my emissions come from my production, which you can't put a number on. So yeah, Excel is what they used to do most of the stuff but it's mostly auditors from external parties to come and write a report. And that's, that's industry standard.	***LTM & *INT** **E-CO** ***C-VIS** **T-SA & E-RE**
43	**Researcher 1:** Yeah, that's also what we heard that these external audits are really a way to, like, like a connector between the brands and the factories which might be somewhere else to like, the glue that keeps it all together. So it seems like they play a big role.	
44	**Interviewee:** Yeah, exactly. As I explained before, in terms of the it's not part of the expertise that they have themselves. So rather somebody else comes in does the reporting for them gives them a nice reports. You know, it makes so much more sense than they educating themselves to be able to do it. Unless you have some of the brands obviously, that start a brand with the idea, I'm going to be sustainable, but then that already is the first mistake. Don't start a brand haha. Unless you're not using raw materials or whatever. But yeah, even those people get stripped of their claims.	**T-TA**
45	**Researcher 1:** I got a quick follow up-question. Did I understand you correctly that you said it makes more sense for all the actors to go to third parties when it comes to sustainability assessments instead of building up the knowledge themselves?	
46	**Interviewee:** Yeah, like in an ideal scenario, you would like them to be learning it themselves so they can apply it and then it becomes an inherent part of their business operations. But in terms of really the sort of the level of information and technological adaptation that they have. And the complexity that we're asking as sustainability reporting bodies. I don't think it's feasible. And there might be an	**T-TA & O-CC**

	extra role for these auditors to also educate them while they're doing the audits. But then again, it's yeah family run businesses with focus on craftsmanship and with production sites- they have to learn a whole new trade. So it's yeah, the combination will be ideal, but from my personal experience, I wouldn't say that we can put the burden on suddenly knowing everything about environmental reporting.	
47	So that's, that's also the trick. What the EU now is going to face is that they're putting all the legislation on the brands in terms of what they have to be able to report and then the brands are going to ask the factories to basically do that for them. But then they don't know what they do. So they're going to have a huge mismatch of suddenly reporting that they have to do and knowledge that they need to have and brands are going to look at the factory and the factory is going to look back down and they're like, but who's gonna help us? Right, especially if they can't afford it auditor because all those are aren't cheap. So yeah, that's that's where the big bottleneck so in	**E-RE** **E-PA**
48	**Researcher 1:** So it sounds like analytics isn't worth the trouble. It sounds like the trouble outweighs the benefits at the moment, at least	
49	**Interviewee:** For SMEs - I think so, unless you have tech savvy newcomers in the company that are able to quickly learn that's, that's where I put my hope on as well. But for the bigger companies, it's definitely the way forward because they have the ability to push and say like, you know, if you're not doing it, then we're gonna go so they have to change and they have to hire people and they are able to hire people. And that's for SMEs. It's a whole different story. Like you can't suddenly just hire an extra person which is not creating extra revenue.	***GEN** **T-TA** **O-GR**
50	**Researcher 1:** That's also something of course we're seeing like it's like you say: the focus for the small companies is on on the manufacturing on the process on the design, but the technical the it aspects comes in way, way later. So normally, we don't have an IT expert in the original team. But what that what happens then I just talked to the other guy. It's like a 300 person company. In Germany, focusing on on backpacks. And they say that they grew pretty rapidly over the last years, and but are now at a point where their data environment is a mess. It's a complete mess, so they don't have the skills to fix it. And it seems like they likely didn't choose the right point in time to get into the technological skills to solve this problem. So now they have all these problems, and really don't know where to start. So might be interesting to pinpoint when exactly they get through that scale.When is the right time for for startup for a smallest or SME brand to incorporate more analytics into their for their workflow? Yeah, let's start with questions.	
51	**Interviewee:** Ideally, they would have learned it right away and see the benefits. Because then it's not that much extra work. If you've incorporated from the start. The moment you start processing chunks of data, at a later stage when the inflow of data is way higher that's when it gets difficult because then you have to start organizing and you start differentiating and making models and stuff. The moment you've learned it from the start, it's obviously way easier to make your dashboard a bit bigger when you get more data. But then again, it's not the first thing that comes to mind when starting a brand or when doing your first hundred pieces of production. You'd be like, Ooh, let's do that. And yeah, it's not like a celebratory thing that you would want to do after a successful business. Yeah, but, but who knows, you know? It's really about the change in the composition of the workforce that hopefully is younger. Like the only ones that we see that are super quick in adapting to our platform, are the ones that are young and are in charge of a specific part of the company and are able to do this like it's a younger cousin of in the family, for example, that found us and then super quickly figured	***BM** **O-BE** **O-CC &** ***C-GEN**

	out like well, this is such an easy way to find new customers. But it's not going to be the old uncle with the paper Excel sheet. That we are going to be able to convince	
52	**Researcher 1:** Oh yeah, that's true. IT skills and the generational shift play a big role here.	
53	**Interviewee:** Yeah, and that's where the with the craftsmanship thing in like, like textiles which is already a dying profession right	
54	**Researcher 1:** What do you mean?	
55	**Interviewee:** Well, it's it's more like the cutting and the really didn't nice fabric parts are all the knowledge is at the at the older generations. Like I like if you know anyone who's in sewing or something like that. It's not going to be someone of our age that is jumping to become a knitter of our sewer. But hopefully there are some.	
56	**Researcher 2:** Oke	
57	**Researcher 1:** we of course had a great interview guide in place but we jumped around so much so that it's ..	
58	**Interviewee: ..** gonna be great. transcripting Yeah. A lot of fun.	
59	**Researcher 1:** Okay, so Oliver What do you think? What should be next? Yeah, let's talk about that. Maybe. So, when we look at the literature, scientific literature, and also if you look through some business magazines regarding technology, the buzzwords come real quick. So all of a sudden we talk about big data and how you can use Internet of Things to monitor machines and factories and get real time analytics and then drop AI on top of that to analyze the demand and optimize the production capacity. How do you see - these let's call them advanced technologies - How do you see them being applied in your context?	
60	**Interviewee:** Well, I think the good example of that would be the newly opened production facilities in Germany of C&A, which has the highest technology factory that probably is in Europe, in terms of the scale, at the scale they are and for the segment that they cater to, because there might be smaller scale like AI technology, printing, 3d printing stuff, and then have AI in it. So there is a huge upside potential as you probably read, in terms of creating minimal waste, learning about orders, all that kind of stuff, using less and less and less materials to create the same garment. Water all those things are Yeah, sort of zeroed out hopefully. But yeah, for the smaller, long time operating people that's not feasible. It's because you've already created such a business with such long traditions of doing things. A certain way. The change we are asking is not realistic. So it's more for new capital intensive or like fast growing companies that can make this shift and it's super, probably financially lucrative for them as well after the investments, but for already established brands that don't necessarily have exact capacity or are able to invest. But it's going to be in every case, right? So the ones that have extra cash to spend on innovation that you want to be but yeah, in theory, it would definitely help.	**O-CC** **O-GR**
61	**Researcher 2:** And on the side of brands, maybe do you see some practices there that improve either financial or environmental performance? Say things as demand forecasting those kinds of things.	
62	**Interviewee:** Yeah, so I guess the ones that work with the Shopify analytics and have mastered that part can definitely see their analytics as a core sort of revenue driver. But on the other hand, other technology like, like design, 3d design, can be a huge cost saver because you're skipping sampling, right? So it's another spectrum, obviously	**E-SW**
63	**Researcher 2:** What is 3d design?	
64	**Interviewee:** Yeah, it's, it's basically, you're completely skipping the sampling phase. And do it on 3d Like modeling, that some brands are doing that already.	

	And then basically, you skip all the because our sampling usually works is that when it arrives and you say certain things are wrong, you don't ship it back. But they just ship new stuff, and then some stuff, which was good might be wrong now. So you're doing like eight nine, on average, like we've done some surveys with our clients, rounds of sampling. And these things are expensive for brands, especially small school, if you want to do only just one piece, because they have to make the mold and all these things. And there's a huge cost efficient saver if we adapt more to digital design, and that's, I think, a way more feasible step because it's they're already working with like cutting and pasting Photoshop kind of things. But if they just do that in a software program, and then send it to the factory, and they're like, Oh, wait we can literally print this it saved a lot. Okay. So there is a possible solution that might be a bit closer on the horizon.	
65	**Researcher 2:** This is to you Lucas I think the supply chain related questions are a bit out of context after all these answers.	
66	**Researcher 1:** You [Interviewee Name] you really touched, on a lot of points where we want to talk about making a good master thesis. Yeah. Looking through it, Oliver, I think we have most of our things we want to we want to ask.	
67	**Interviewee:** I think your question about how do supply chain partners or lack of actions limit you to improve sustainability impact of your products. … No, that's the one about technological adaptation, willingness to change .. the drivers, right .. that's one the most important questions that would find a solution to IT systems, right. But there's, there's the big problem.	
68	**Researcher 2:** That's what limits it in the first instance, right?	
69	**Interviewee:** Yeah, exactly. It's where the solution is, but it's also where the limitation is and that's why people are so struggling around the same problem. And that's in this old production. So like I didn't know if you're also interested in in consumer like, information technology,	
70	**Researcher 2:** you mean use cycle, or, use phase?	
71	**Interviewee:** yes because because like, obviously, you're going to optimize to a certain extent - if all the theory works out and people adapt. You're gonna get to a certain extent. And then obviously, it's about the use phase and how to measure that and how to optimize that cycle because that's where the real problems are. If you look at the amount of people washing and using and not using, but this is more about back end analytics, right?	
72	**Researcher 2:** Maybe but I don't know if we want to go deep into the use phase Lucas?	
73	**Interviewee:** You can put it in your thesis as for further research hahah. If you don't want to go into it, that's a big discussion.	
74	**Researcher 1:** But if you compare these two approaches one time, the user perspective to get more analytics into that part or looking back to the production. What do you think will come first? What's easier to achieve?	
75	**Interviewee:** Well... Good question. I think implementation of production, in theory would work a lot easier, because it makes economic sense for them to do it, to track it to optimize you know, that supply chain management is optimize, optimize, optimize, well, this will help them with that. And in terms of law and reporting, they will have to, at some point, maybe not on the scale of micro companies I work with but the ones that are you know, the ones everybody looks at, have to. But on the consumer side, right, your phone is an extension of your brain. So if you integrate clothing as a as a digital part with your phone, and the use of clothing then it's not that far from your bed show. That's what we call it. Right? It's just a way to fit it into your already busy schedule, using your phone to get the analytics of the using of your clothing and how many times you wear something. What's the value of your product, right? So like if you buy a Primark	***BM** ***C-EDU**

	thing and you wear it three times the cost per wear might be higher than if you were a like a Obey piece the for 20 times. Right. So it's easier to think in terms of consumer triggers that drive them to consumer behavior change than it is to do a manufacturer because you have to explain the manufacturer Why the hell he has to report the things is because the brand was something that the consumer asked the brands to do is like, you have to explain them all the steps of reasoning, whereas the consumer you just give them what they want to see money and sort of feel good are the drivers	
76	**Researcher 2:** and what about legislation? (that is something else By the way) What about legislations for the factories then or on the further tiers in the supply chain?	
77	**Interviewee:** Yeah, so that's that's now like I said before it's implemented on the brand side. And then they have to ask the factory about it. Yeah.	**E-RE**
78	**Researcher 2:** So there's no legislation for water use or energy use or ..?	
79	**Interviewee:** no, there's just reporting. that's now in France. It started this January. They have to give the chemical composition of their garments. Yeah. So this is all for recycling purposes. So the EU really much focuses on how can we help the recycling industry better and manage this. Here everybody gets a statistic. So much clothing only 1% gets recycled. It's not even 1% Right? They just say it because it sounds small. Nobody has actually measured 1% The way they want to do this is to create more information on that label that eventually when something gets to the end of life, it can be repurposed because you know what's in it. Only thing is that 62% of the people rip the label out of the clothing. So the moment it gets through the sorting center, they're like What the fuck is in it? You have no clue. And if there's polyester in it, you're like, Well, okay, that's that, but you don't know. So you might even put it into a recycling machine that that can handle polyester and then you fuck up a whole batch.	**E-RE**
80	So I think most of the stuff actually gets thrown away. I don't exactly know but yeah, this was reasonably explained to me and I was like, What the fuck? That's quite some information. So yeah, the legislation parts will definitely have an effect on reporting. But the ways that they report that still a big question like they're not giving them any tools for you to use to facilitate that reporting. So that's also something we're looking at is like, can we be that solution in terms of easily being able to identify the production locations or that's also going to be a law that you have to show the previous steps. And this is the beginning with this chemical stuff from this year and next year, it's more information than the year after it's all digital product passport you have to give. And that's yeah, now they're being forced to do these things. So like the change has to come.	E-RE
81	**Researcher 1:** But just to thinking out loud, couldn't production companies use this as a USP for brands saying, Hey, we have supreme environmental data analytics, we can give you all you want, you can share them with your customers who is that something you think might be a selling point or is?	
82	**Interviewee:** Yeah, so so there are a couple of raw material suppliers that are showing them this USP. You have this company called [Partner Name], which basically has this combination of this collection of farmers in India that do regenerative methods and they can show you exactly the farm. The cotton came from another collection of farms complicated from you have waste2ware, which is another company that that basically does PET recycling, and can show you exactly where the PET came from, right? So there are companies that are showing like oh, we were with them and they can trace it back and it's definitely a selling point. But then again, there are many many more that just know where there are factories that produces their end garments. And I have no clue what what the backhand is.	***BM**

83	**Researcher 1:** I saw there is the German company "armedtangels" they had some some prototype project where they inserted some NFC tax very small ones. In the shirts. So the idea for well, all the information is on the NFC tag and if one day the shirt goes back, full circle circle to recycling they would be able to analyze it. And of course it sounds like a smart idea, but I guess it's connected to quite a cost	
84	**Interviewee:** Yeah, yeah, it doesn't cost that much. We're also looking at it as a solution for RFID or NFC, right? All these kinds of tags that you can implement, because there's this increase of information that you have to start giving on the labels of the clothes. You have to start looking at digital options - even the EU is saying that right? - because the label if you're not going to have a booklet in your shirt, right. So they're definitely looking at that and if you can measure use phase things in it that's you know, going five steps ahead. That will be insane. Right we're also trying now to use RFID chips in closing and with your phone check how many times you wore an item based on proximity of the of the phone and the chip within half an hour. You can measure that. Okay, somebody has worn it that day. But yeah, and there there's also a big information part that you can give the consumer. Like where does it come from? What's the story behind the garment?	***BM**
85	Patagonia is really focusing on storytelling of garments. They're doing repairs, which they say "well we do it for free because the information that we get from the client the moment he comes in with the repair is more valuable". We know where the wear is, so where the most pressure on the garment is. We can use that for future garments. We get their email we get the date they purchased this, we get the moment that it broke down. We get his address. We know what type of person he is. Why does he come for repairs? It's worth way more than five euros in cost to pay the wage of the person that's preparing it for about 20 minutes right? So it's pretty, pretty cool. I was on the phone with the COO of Patagonia, Europe and he told me that they have a deal with [E-Commerce Store] where they basically get insight to all the consumer data of the whole [E-Commerce Store] for three weeks per year to analyze what they're like the market segment that they're not able to reach. I think the mechanic… oh, somebody is in front of the door Hello Yeah, okay, that's an electrician. So I have to open door.	*BM
86	**Researcher 2:** How long will it take or should we cut it of now?	
87	**Interviewee:** Yeah. Yeah, I have to explain to him for like 15-20 minutes.	
88	**Researcher 2:** Okay. Then [Interviewee Name] thank you very much.	
89	**Researcher 1:** Yeah. Very nice insight. Thank you, [Interviewee Name].	
90	**Researcher 2:** Very interesting insights [Interviewee Name]. Thank you.	
91	**Interviewee:** all right. Take care guys.	

Appendix 8 – Interview Transcript E1

Organization E (Large Fashion Brand), Interviewee Role: CSR Manager

28.04.22, 30 Minutes, Language: English

Nr	Transcript	Codes
1	**Researcher 1**: Hi (Interviewee name), how are you?	
2	**Interviewee**: I'm doing great!	
3	**Researcher 1**: Good. That's a good thing to hear. Thank you for helping us with this. We're very happy that you found the time to talk to us. I think it would be smart to jump into it because we heard that you are on quite a tight schedule at the moment.	
4	**Interviewee**: Yes with this short weeks it's a little bit hectic. Yeah, but I'm here. I'm happy to give my input.	
5	**Researcher 1**: Okay, to give you a short insight on what we're actually doing were studying information systems here in Lund. And we're doing our thesis at the moment. And we're looking at how analytics technologies can help in establishing environmentally sustainable supply chains in the fashion industry, right. And we see that in literature there are all these great promises, AI, business intelligence, etc. And that it seems not to be materializing at the moment in practice, right. So we're actually looking at what the challenges might be to that end in practice. So actually, that's the context in short, and we think that we can get some good insights of you, because we heard that you are well, engaged in some reporting throughout the supply chain and even some analytics practices, if I'm right. Yeah. So we're curious to what you have to say. And then from here, I think Lucas can take over if you're okay with jumping or diving into it directly?	
6	**Interviewee**: Yeah! very much okay with, Yeah.	
7	**Researcher 2**: One more thing. First of all, thanks for joining us today. We're really happy as Oliver said. We would like to record this interview or transcribe it. So we can analyze it later. And, of course, everything will be anonymized. If you want to we can send it to you for feedback.	
8	**Interviewee**: Perfect.	
9	**Researcher 2**: So Oliver did a very short introduction of us. So I think it would be great for the beginning. If you could just introduce yourself real quick and tell us, what is your role at the company?	
10	**Interviewee**: Yes. So my name is (Interviewee), I've been in this company for about eight years. When I started working, I worked in the strategy department where I was actually a lot involved with the numbers so reporting kind of to the CFO. Of course, the numbers are mostly business financial figures. And yeah, I learned really well how the company is managed and overseen from the top-management layer. And then after a year or four, I was, it was a personal motivation to move to the sustainability side of things. My mission idea was really to help move the company in a more sustainable direction, especially with where I was located and the world I was operating in, I didn't see sustainability very much in the numbers and in that world. And I saw that that would be the opportunity it was not tapped into. So I made the switch. First thing I did was actually work on the (company project name) business model. It's a circular business model that is launched I think about two years ago. So it has everything to do with taking old products back and putting them back on them,	***BM**

	repair them, clean, and bring them back on the market to create like a new business. With my background in finance, I could really build a business model. As soon as that was kind of standing. I went back to my original idea to put numbers on the C suite level, to be able to to track and progress on sustainability better, and I think that relates very well to what you're looking for. Yeah, so there's much to say about that. I think as we proceed,	
11	**Researcher 2**: perfect. So what are the environmental sustainability issues that you mainly focus on in your supply chain?	
12	**Interviewee**: So how I see it is that we are familiar to look at GHG emissions very much. It's a figure that comes first. But I in my perspective, we should look we should look not just at that. So we need to also look at impacts like water, water scarcity, water pollution, and land use. There are other categories that need to be taken into account as well. So in my idea those should be considered there. Yeah.	
13	**Researcher 2**: Okay. So how do you measure and monitor these issues then?	
14	**Interviewee**: At the moment how we do this is that we, we have standards, or let's say we have a couple of steps in our supply chain. It's divided into different parts. One is our materials so the materials we use. The other is the factory's facilities we work with. Then we have our transport. And, yeah, the packaging part. At least that's how I also kind of divide it, and I think these are a bit the standard parts in general GHG Emission calculation. And how we get the numbers right now is, if I for example talk about materials, we have a way to estimate our total material consumption. I have to say is never completely accurate, but it's a good estimation. And then we apply actually, we multiply that with the HIGG, MSI, you might be familiar with. So it's a very useful tool for us to be able to get to an estimation of our footprint. And then for the facilities. So the factories we work with, we also work with the HIGG FEM. It's, you probably can see what they can do for us. There are a lot of data that have been gathered from suppliers. And then yeah, for transport, we have visibility of the transport of our finished goods, and not so much further down in the supply chain because that happens through all these third parties. But for our own logistics, or the inbound as we call it from the factories to our warehouse, we have very good visibility because we own that logistics part. And packaging depends.. it's a bit scattered because there's different business processes. But we have onboard product packaging, which fits into our product data system. And then we have inbound packaging, outbound packaging. Yeah, so they have different systems. And it's not for all it's not, the data is not for everything optimal or available. Hope that answered your question.	**T-SA** **T-DA** ***INT** ***C-VIS & E-CO** **T-DA**
15	**Interviewee**: So we have different ways. So we have we have our CR report. Which is the external report which shows our yearly progress, it has to comply with certain standards right. In order to comply with the standards. There's a lot of still quite some manual work involved. So then it's an Excel tool, mostly. I would say, to really be able to use environmental reporting as a tool to change the business; to inform business decision makers, that external CR report is not going to provide any help for that. It needs to be more real time data, it needs to be more not so high level, but really it needs to be more specific for individual business owners, to learn how they perform. And for that we internally have data systems. We have a data analytics team internally that creates dashboards. Not just for environmental purposes, but for business purposes. And I think that's where we need to work in environmental reporting as well.	***C-AUT** **T-SA & *LTM** **T-DA & *C-COM & *FRE** **T-IN**
16	**Researcher 2**: You know which tool that is that? Power BI, Qlik, Tableau?	
17	**Interviewee**: Tableau.	

18	**Researcher 2**: But did I understand you correctly that you as the sustainability team are not yet using Tableau reports?	
19	**Interviewee**: Partly, we do. So for example, talking about the materials that I mentioned earlier. That is a dashboard in Tableau.	**T-SA & E-SW**
20	**Researcher 2**: Okay, thank you. So, these were kind of some overview questions for us to get to know where you are right now. And now we would like to dive more into the challenges. And therefore we would just like to ask you openly: What do you think are the biggest challenges when it comes to analyzing sustainability data?	
21	**Interviewee**: One of the challenges is that we know that a large part of the impact lies further down in the supply chain. Where we have less direct visibility on exactly how things happen. So, we have direct contact with the people who create the end product; they in the end buy the materials; the material maker buys the cotton from somewhere; and then it becomes very difficult to get full transparency of your supply chain. And that's a problem because you don't have the accurate data all the way back into the supply chain. While at the same time you know that a large part of your actual footprint, including those three lies in that, further down in the supply chain. I think that's really a key challenge.	***C-VIS E-CO T-DA**
22	**Interviewee**: So then, in order to be able to get some figures, you need to work with the best data you have. And make a note that you have to start modeling or use estimations. Um, I think that's I would call the biggest challenge because any AI or Google analytics tool where they show super fancy screenshots of how the planet is changing. It needs to find a connection to our business. And when we cannot create that connection to our business or our supply chain. We can't use those solutions. So it starts with getting our internal data of our supply chain as good as possible. And that is difficult. For example, the location of where the cotton was grown exactly, the ones that we are using; there are so many players involved, where in the end is probably a mix of cotton from India and from Turkey and from the US and yeah, in the end the impact on the planet is way higher in India than in Turkey for example. That's why you need to know, but that is super hard to know.	**T-DA E-SW & T-SA *C-VIS**
23	**Researcher 1**: If I may ask, have you made attempts and if so, in what way have you made attempts to get grip of these production processes? Or these production networks actually.	
24	**Interviewee**: So there's a lots of attempts ongoing at the moment in our supply chain. It's not driven by sustainability, but really by our supply chain teams, and traceability teams. One of the challenges which we noticed is that ultimately, it might be possible to find out things better, but it's based upon PDF files that are uploaded. So then what we experience is that people need to manually fil in the information that's on these PDFs into a system in order to be able to use the numbers, because you can't really work with these PDF files. So yeah, and that cost a lot of extra money and resources and it doesn't make sense to hire people to just file numbers over into into a system. And then they're starting to look into these tools that enable data to be retrieved from a PDF automatically. So these are, yeah, there's a lot of things happening in our world at least on this. But you notice it takes quite a lot of efforts to really get it into shape. And we talk about a lot of numbers, a lot of complexity, because every material again has also a different supply chain polyester has a different chain and then nylon or cotton or leather. So it gets complex very quickly.	**T-DA & T-SA & *C-AUT O-GR E-SW T-DA & E-CO**
25	**Researcher 2**: So you say there's a lack of automation in the data process?	
26	**Interviewee**: Also yes.	***C-AUT**

27	**Researcher 2**: As you said earlier that at the moment, you're mostly focused on the CR report, which comes out yearly and you said that you'd like it to be more real time and more detailed. Why do you think this would be a benefit to your company?	
28	**Interviewee**: Yeah, like I said, in the end the business decision makers; when they get the information at the right moment in time. And that is when they have to make decisions. They are the ones making the decisions. And when you provide them with the right information, the moment they need to make a decision, they can make better decisions. So that is why those dashboards need to really connect well with the ultimate business decision makers.	**O-MA & *C-COM**
29	**Researcher 2**: Sorry to press you in that regard, but because that's something we've heard from a lot of Interviewees, could you give us a more concrete example? Like, what decision would be positively influenced if you had more sustainability data?	
30	**Interviewee**: So I think an example on materials; at our work, we have a focus on using more sustainable materials. Currently, we have targets using more sustainable materials. We've categorized the materials and we say okay, within cotton, we need to move to 100% more sustainable cotton, which means replacing conventional cotton with organic cotton or regenerative cotton. And now we have a dashboard for it so we can in real time get an estimation where we see how we progress. What we now have, at the end of every season, we do a reflection moment with these numbers, with the right business owners to have a look at the results. So: "how did we end up?" "what is the total amount of sustainable materials from the last season?", and we set targets for the next season. And they get a very good sense of where they are right now. And they know what they have to work towards. And still it happens in our case that we did not progress in the right direction. And because we have these numbers now real time, the numbers can go back to senior management, they see hey, we actually dropped here. And then the questions that are being asked are why did it drop? And then it turns out, okay, there was something with the prices that influenced the fact that we didn't achieve our targets. And now then the discussion gets to a whole different level. And we're going to have the right discussions and everyone is thinking along look, we need to achieve those targets. But only because we have the dashboard that we can have the discussion that I as a sustainable business person can also hand it over to other people to drive it instead of me having to drive it because I'm focusing on making sure that the numbers are right and that they're in the system that other people can start working with them. Because it's a lot of work actually. Before that it would not have been possible and yeah, we put our time and attention are really commonly ensuring that we're moving into a better direction. Does that answer your question?	**T-SA & O-BE** ***FRE** ***C-COM**
31	**Researcher 1**: What about internal challenges? Lucas? I don't know if you had a question you wanted to ask. But otherwise, otherwise? Perfect. We've been focusing on external challenges, if we can call them that, mainly right now throughout the supply chain, for example, or the production networks. But are there any internal challenges within the company that limit well, the application of analytics to make your operations more sustainable?	
32	**Interviewee**: I would say we really lack the capabilities and the knowledge of environmental impact reporting skills. So there's really very little people with LCA experience, who really have a thorough understanding of sustainability. And if they do often they don't have knowledge about the business. So these are very isolated knowledge experts. And actually I have one person in my team who's really an LCA expert. He has been working on it for five years.	**O-CC**

	And for him, the business is a blackbox still. So he needs to learn about that. Well, I think he's quite good already in explaining the complexity of LCA's. He's only able to communicate in a clear way because he's been working on it for five years and he understands it thoroughly. So let alone people who have not so much experience with LCA. They often can make things very much complex. So then they start talking and they lose the connection with other people easily because of how they communicate, what they communicate, the technical analysis, the knowledge that they use, it doesn't resonate at all with the business. So that is an internal challenge, and we it's not easy to solve that.	**O-CC & *C-COM**
33	**Researcher 1**: And how come that there is a lack of these people at the moment?	
34	**Interviewee**: Because it's not been, the team is not big enough. So we have never had really a big sustainability team. Which basically means there's not been so much invested in sustainability. And there are 100 Hundreds of people in finance. And then with sustainability, there's just a small team. Which has grown really fast, but you need people who can, even within the world of sustainability you also need the other people still, so then it's the investment side. I think it's costly for businesses.	**O-GR & O-MA & *C-PRI**
35	**Researcher 2**: Oliver, if I may. (Interviewee), you said your company has sustainability knowledge, business knowledge, but what about the technical knowledge? So let's say the IT skills to use tools like Tableau; how are these skills in your team?	
36	**Interviewee**: So the person in my team is, is good with that. Actually for him, it is where his main experience lies. Myself, I think my benefit is I studied econometrics. And I during my graduation I modeled one of the most complex financial derivatives on the markets. And that made me never afraid of any calculation model. I think that's the kind of confidence that gives me certainty while I'm on this journey, that I know how to handle whatever may come my way. But not everyone has this background. I am sure.	**O-CC T-TA**
37	**Researcher 1**: So you think it's also that people stay away from it because they think it is too complex for them?	
38	**Interviewee**: Yes	
39	**Researcher 1**: Okay interesting	
40	**Interviewee**: I'm sorry, I just want to jump in on the last thing you said like you think people are staying away from it by because it's complex, right? That was how you summarized my finding right. I think. I think the main question people have is, everybody wants it. But everyone is wondering how? So just because they don't know how, it stops them from trying to look for the answer. They just don't believe it's possible they don't know that. Yeah, that's I think it. Because there are also not so many examples out there of companies who do it. For me, (other company name) is a good example. With their e p&l.	**O-CC** **T-SA**
41	**Researcher 2**: Who was that?	
42	**Interviewee**: (Other company name) It's a company. For me, they are really an example where they use environmental; they call it the environmental profit and loss statement. So they bring in an additional maybe complication of also putting a monetized value on environmental impact, but that way they bridge the gap with finance. So for me, I think they're really a good example of how can you translate that environmental knowledge to business language. Plus, coming back to one of the first things you said, like at which environmental impact are you looking at; through monetization, you can include all these different environmental impacts, other than just looking at one. Because they're all in the same nominator, you can just add them up. And that's why I'm looking at them. I think it's a great example.	**O-BE & *BM**

43	**Researcher 2**: We'll have a look at that thankyou.	
44	**Researcher 2**: We're really nearing our half an hour so maybe as a final question. Lets hava a look at future technologies. Have you come in contact with AI or any of these advanced technologies in any way?	
45	**Interviewee**: *thinking*	
46	**Researcher 1**: or machine learning models, otherwise,	
47	**Interviewee**: machine learning… Nothing in direct relation to where we are, I think, yeah not.	**T-SA**
48	**Researcher 2**: Why is that you think?	
49	**Interviewee**: Well I think for the challenges that I mentioned earlier with the fact that we first need to understand our own supply chain to understand exactly our own business data. Get that up to speed before we can...	***C-VIS**
50	**Researcher 2**: Apply something on top of it right?	
51	**Interviewee**: Exactly. Yeah. And if the answer is that machine learning can help to get more transparency, traceability of our own supply chain that I have not been come across .. but it might be there.	
52	**Researcher 2**: It would be great if it would have right.	
53	**Researcher 2**: I think with that, Oliver, we're done.	
54	**Interviewee**: Yeah. Okay. I was hoping also from my end, it would be really great to also learn the outcome of your results. I'm very curious.	
55	**Researcher 1**: Will do that for sure, but thank you very much (Interviewee name). Very insightful, really. I think we heard a lot of things that we were hoping to hear and that we were looking for. And we really fill the gap as well with this interview so super helpful.	
56	**Interviewee**: Great I'm glad it was useful.	
57	**Researcher 1**: I hope this was fun for you as well. And we're definitely going to send you all the results that we find.	
58	**Interviewee**: All right. Great. Thanks a lot. Good luck with the thesis.	

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