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High-risk supply chain mapping for ABB Robotics

Investigating why, what, and how to map in terms of human rights and environmental issues.

Hemanth Rangaswamy
Karthik Shivakumar

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SERVICE MANAGEMENT AND LOGISTICS

CHALMERS UNIVERSITY OF TECHNOLOGY
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HEMANTH RANGASWAMY
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KARTHIK SHIVAKUMAR

Report no. E2023:136
Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000
Gothenburg, Sweden 2023

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KARTHIK SHIVAKUMAR

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Abstract

In a landscape where many speaks upon sustainability there is also an increase in regulations, ethical obligations that must be followed from the organizations due to global interconnectedness. Meanwhile, in the present landscape of global supply chains, the need for thorough understanding, visibility, and mitigation of risks has never been more critical. This places organizations in a position where they must identify and mitigate the various risks hidden in their supply networks. As a result, this thesis begins an investigation into the arena of supply chain mapping in the upstream supply chain, with an emphasis on ABB Robotics.

The overall aim is to investigate why, what, and how ABB Robotics should map their high-risk supply chain in terms of human rights and environmental issues. The investigation steers through a variety of legislations and their counterparts. These regulatory frameworks, demanding transparency, and due diligence, indicates a new era of accountability and sustainability, compelling organizations to extend their scrutiny beyond Tier 1 suppliers, to the far-reaching levels of Tier n. Further, implicating the focus on high-risk categories within ABB Robotics to empathize while adhering to the compliances of regulations diligently.

Drawing inspiration from the Accountability Framework Initiative (AFi), a comprehensive framework encompassing human rights and environmental considerations, this research yields a multi-dimensional mapping approach. The proposed framework rests on three pillars: Supply Network Maps, Supply Chain Maps, and the innovative Supply Chain Network Structure. These components collaboratively decode the sophisticated circle of supply chain interactions, combining macro-level insights with micro-level granularity.

Furthermore, the thesis delves into the practical complexities of multi-tier mapping. It unravels the step-by-step methodology, urging ABB Robotics to embark on a journey from stakeholder identification to supplier engagement and comprehensive risk assessment. As the study delves into data sources and tools, it underscores the potential of digital technologies, such as blockchain, artificial intelligence, and big data analytics, to enhance the accuracy and agility of supply chain mapping. These transformative tools have the capacity to elevate ABB Robotics ability to trace materials, validate suppliers, and ensure compliance across the complexity of its supply chain.

This thesis outlines an initiative-taking approach to supply chain mapping, enabling ABB Robotics resilient in the face of dynamic regulatory environments, ethical considerations, and sustainability obligations. Through the comprehensive adoption of multi-tier mapping, ABB Robotics can enable its commitment to identify, assess, prevent, and mitigate the human rights and environmental issues in its upstream supply chain.

Keywords: Supply Chain Mapping, Human Rights, Environmental issues, Legislations, Transparency.

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1 Introduction

1.1 Background

The supply chain mapping of the corporation ABB Robotics serves as the backdrop for this master's thesis. The firm has a full and integrated portfolio including robots, Autonomous Mobile Robot (AMR), and machine automation solutions - created and coordinated by value-creating software. ABB Robotics is one of the world's top robotics and machine automation providers. ABB Robotics has about 100 facilities and employs over 11,000 people worldwide (ABB, 2023). The highest corporate responsibility and sustainability standards are important to ABB (ABB, 2023).

ABB Robotics being a global leader in industrial robots manufacturing must ensure that as an organization they are liable to act in meeting all the legal requirements and regulations in its upstream supply chain. In addition, supply chain visibility is also required to increase supply chain resilience and the ability to act quickly before any potential disruptions materialize (Tara and Cliodhnagh, 2019). Furthermore, ABB Robotics should meet these obligations and comply with these regulations and legislations to be sustainable along with the integration of supply chain risk and disruption. As a result, ABB Robotics intends to have better visibility, transparency, and traceability in their supply chain for which mapping plays a key role.

1.1.1 Supply Chain Risk

Supply chain risk is described as "unwanted negative outcomes occurring from various events or natural activities" in the study by Shahbaz et al (2017). Moreover, he states that "uncertain occurrences or a combination of circumstances may emerge that might have a negative impact on the accomplishment of the company's objectives and result in the loss of the organization or individuals" (Shahbaz et al, 2017). Giunipero and Aly Eltantawy (2004) mention several factors that emerge as a risk in the supply chain i.e., product availability, labor markets, industry capacity, and technology change. ABB Robotics procures several parts from their suppliers to manufacture ABB robots. And some of the procured parts may have a high or low risk for environmental & human rights due to the manufacturing process behind it or the region they are being manufactured/sourced.

1.1.2 Supply Chain Mapping

The definition of supply chain mapping is "the connectedness of activities, actors, location, and resources to guarantee that the movement of goods, raw materials, and information is clear to all three streams of the supply chain, upstream, midstream, and downstream" (Mubarik et. al 2021). These three streams are described as follows and illustrated in figure 1: the upstream supply chain includes the company's network of suppliers and sub-suppliers; the midstream supply chain includes the process that involves turning raw materials into value-added products; and the downstream supply chain includes the flow of information and goods to the final customers (Mubarik et. al 2021).

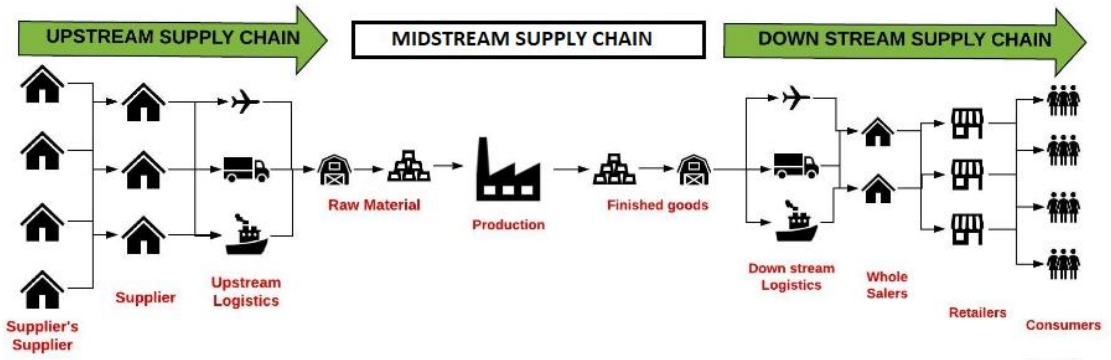


Figure 1: Illustrates the flow of Upstream, Midstream and Downstream Supply Chain

Supply chain mapping is understanding the many parts of a supply chain and how they interact (B.L. MacCarthy et al., 2022). Thus, knowing the suppliers, manufacturers, distributors, retailers, customers, and other supply chain actors is key, and as-is understanding how they interact is an add-on. "Supply chain mapping is the fundamental solution to increase the company's visibility and improve network integration helping to provide shared perspective on different stakeholders" (Mubarik et. al 2021). Lack of transparency, bad partner relations, and challenging production processes cause issues in the supply chain (Andry et, al 2022), leading to high risk. B.L. MacCarthy et al (2022) state that being aware of the numerous practices, technologies, and methods helps the supply chain.

Companies in the manufacturing sector must get ready for technological advancements, particularly in the areas of information exchange, supply chain performance, and supply chain integration. Based on the risks encountered, a supply chain mapping is conducted to identify the obstacles and potential improvements (Andry et, al 2022). The supply chain is the top risk for many organizations, governments, and policymakers because of this (B.L. MacCarthy et al., 2022). As a result, supply chain mapping becomes essential for tracking and addressing the many difficulties present in the supply chain environment of today. These difficulties serve as the cornerstone for building an organizational structure of supply networks and are crucial elements for designing mapping techniques at different supply chain levels.

1.1.3 Human Rights and Environmental issues

Human rights are referred to as the fundamental rights and freedoms that every person is entitled to, irrespective of race, religion, gender, nationality, and language (United Nations [UN], 1945, Article 1.3). Furthermore, it was followed by the Universal Declaration of Human Rights (UN, 1948), which is considered an essential document in the field of human rights, encompassing both civil and political rights, as well as economic, social, and cultural rights, forming the foundation of modern human rights.

Miller and Spoolman (2019) defined environmental issues as "the problems that arise from the interaction between humans and the natural environment." The several articles of the European Convention on Human Rights clarify the convention's provisions for the preservation of basic liberties and human rights. According to article 3 "No one shall be subjected to torture or to cruel or degrading treatment or punishment", whereas article 4 specifies that "No one shall be kept in slavery or servitude or to do forced or involuntary labor" (European court of human rights). The United Nations Human Rights states that "Protecting Human rights protects the

environment.” Hence, forced and child labor along with environmental issues in the supply chain are of high risk linked to certain regions/areas or commodities that could have an impact on sustainability while complying with the regulations and legislations.

To continue a significant aspect of ABB Robotics commitment to ensuring sustainability involves comprehending and managing the potential risks and impacts associated with its supply chain. A key focus is on identifying upstream suppliers' involvement in human rights issues like forced and child labor, as well as environmental concerns. ABB Robotics sustainability strategy revolves around the comprehensive mapping of its supply chain, aiming for improved visibility, traceability, and transparency throughout the entire supply chain. However, the critical challenge lies in assessing the risks posed by forced and child labor, as well as environmental issues within the supply chain and understanding their consequences.

Furthermore, it is essential to navigate the diverse regulatory requirements and meet compliance standards, which are central to this research. ABB Robotics is steadfast in its dedication to monitoring and improving conditions within its supply chain. The company is resolute in its stance not to engage with any suppliers that exploit forced or child labor, thereby upholding its commitment to ethical and responsible supply chain practices.

1.1.4 Supply Chain Visibility

The “capacity to access or exchange information across the supply chain" is referred to as supply chain visibility (Caridi et, al. 2011). Supply Chain Visibility offers organizations to gather and share information with customers and shareholders. According to Somapa et al (2016), supply chain visibility (SCV) is a collection of information on the organization of product production, the acquisition of raw materials, the delivery of materials to manufacturers, the movement of materials by freight forwarders and ocean carriers, inspections and customs clearance, and the inland transportation of goods to their destination. The first characteristic is "accessibility for shareholders across the supply chain," the second is "accuracy of the information," the third is "timely availability of information," and the fourth is "usefulness of the information in terms of manning and improving business and performances" according to the author (Kalairasan, 2022)

The focus of the current company’s supply chain management is sustainability, which includes social, economic, and environmental factors. One of the key criteria used to assess a company's success is its sustainability (Pereseina et al, no year). Because of growing public awareness of environmental issues such as supply chain-related climate change, pollution, and global warming, more stringent laws, regulations, and reporting requirements are being placed on companies every day. Supply chain mapping is a barrier of things that can be recognized, examined, and utilized as a tool for communication between organizations from numerous elements that may be influenced by future global warming and climate change (B.L. MacCarthy et al., 2022)**.**

1.2 Aim and Research

The overall aim is to investigate why, what, and how ABB Robotics should map their high-risk supply chain in terms of human rights and environmental issues. This is achieved in

consideration of other parameters such as sustainability, and environmental aspects, risks of the supply chain, tier-n suppliers, and the impact of other regulations and legislations in relation to ABB Robotics supply chain.

The new regulation and legislation are pushing organizations to get more upstream transparency and visibility in their supply chain, implicating the different burdens on the supply chain actors (Tara and Cliodhnagh, 2019). As the companies are aware of their direct suppliers, there has been a new requirement which has emerged from consumers and regulators demanding the organizations to expand their horizon into operations and further down (Elaine et al., 2022). This drives the organizations to "Know-Your-Supply-Chain" (Elaine et al., 2022). Additionally, the legislations like UFLPA addressing forced and child labor, and EU member states like Germany, and France are concerned about modern slavery and human rights enforcement. Whereas the companies are worried about knowing its supply chain and the risks involved to ensure and prove that they are not sourced or produced with the involvement of forced labor (Felicia, 2021). This intends the organizations to care about these regulatory requirements and the liabilities that could have an impact on its supply chain.

Alexis and Leonardo (2019) mention that if an organization intends to have a transparent supply chain ensuring there is no human rights (forced and child labor) violation at the suppliers, sub-suppliers, contract manufacturers or to identify the source of materials: The 5 steps can be taken into consideration such as gauge risks and set goals, visualize the supply chain, collect actionable information, engage, and disclose. Supply chain mapping can be a good remedy for ABB Robotics to address diligently (Tara and Cliodhnagh, 2019).

As described earlier on SCV and environmental aspects it is a huge responsibility for the companies to monitor their suppliers with respect to human rights and environmental aspects (Ansari et al. 2015). For an organization to long-term enhance its sustainability, internal, societal, and environmental factors are all increasingly crucial (Ansari et al, 2015). Yet, there is a lack of understanding regarding suppliers and customers visibility that concerns human rights and environmental sustainability. When it comes to issues like forced labor and sustainability, the environment and respect for human rights are essential for businesses today (Ansari et al, 2015).

Creswell (2014) states that standards offer a set of principles and criteria to assure consistency, trustworthiness, and precision. Whereas methods offer specific techniques, tools, and procedures to collect and analyze data (Patten, 2018). Therefore, the standards and methods in supply chain mapping play a pivotal role to make sure that the process of mapping is thoroughly aligned. UN Global Compact (2017) describes the requirements as the companies must obey and follow certain rules and regulations with obligations to comply with the law in their operations along with the legal liability, Hence, the following subjects will be considered as research questions based on Why, What and How approach to address supply chain mapping.

RQ1: Why to map: What legalisations, in terms of human rights and environmental issues, require ABB Robotics to have upstream supply chain visibility?

RQ2: What to map: What are the high-risk supply chains for ABB Robotics in terms of human rights and environmental issues?

RQ3: How to map: What standards and methods are required for accurate and up-to-date mapping of ABB Robotics 'high-risk supply chain in terms of human rights and environmental issues?

Finally, the research will offer best practices and suggestions for ABB Robotics to enhance supply chain mapping, and sustainability, while complying with the regulations and legislations along with due diligence.

1.3 Limitations

As supply chains constantly evolve, it is impossible to map all supply chains. However, the focus will be on how ABB Robotics can identify, prevent, and mitigate the risks involved in the supply chain while minimizing the disruptions that affect the supply chain. The analysis will be narrowed down to the critical category of the products like raw materials, direct material suppliers, and specific sectors which are of high risk and delimiting the focus on the supply base to critical/risky suppliers. In addition, the conflict minerals such as Tin, Tungsten, Tantalum and Gold (3TG), Cobalt are excluded and geo-political risks in the supply chain may not be taken into consideration while mapping the supply chain.

2 Methodology

This study emphasizes a why, what, and how ABB Robotics map their high-risk supply chains, a leading manufacturer of robot products and a solution provider. The methodology highlights the research approach, ethical considerations, data collection methods and analysis, and literature review.

2.1 Research approach

Kovacs and Spens (2005), Dubois and Gadde (2002), and Bryman (2008) states three common research methodologies i.e., Inductive, Deductive, and Abductive. Kovacs and Spens (2005) mention that abductive approach is a mixture of both inductive and deductive approach. As specified by Bryman (2008) the abductive approach is an observation or explanation of a particular phenomenon and then collating it to evaluate the specific phenomena with the theory and empirical data. The research is conducted based on a pattern of qualitative research with an abductive approach (Bryman, 2008), including interviews where necessary, and analysis to deal with the research questions.

2.2 Ethical considerations

The ethical dimension of the research process is of prime importance in sustaining the credibility and validity of the study. Prior to commencing data collection, informed consent was obtained from all participants, adhering to ethical principles and guidelines (Bryman, 2016). This transparent process ensured that participants were aware of the study's objectives, methods, potential risks, and the confidentiality of their responses. The practice of informed consent serves to safeguard the rights and well-being of participants, while fostering a culture of voluntary engagement (Bryman, 2016). Therefore, the information was shared with the

participants prior to their participation about the research study and their response will be used in our research wherever necessary. The access to several internal documents from ABB was enabled, shared, and approved for retrieval from an official channel, employees within organization for utilization of this study wherever required.

2.3 Data Collection and Analysis

The data is gathered using a variety of techniques, including literature reviews, internal sources of ABB Robotics, and semi-structured interviews, as recommended by Bell et al. in 2019. Primary data and secondary data will be the two main types of data collected for this project. Semi-structured interviews with stakeholders, online reports, and other web-based resources are all examples of primary data that may be used to answer our research questions RQ1 and RQ3. Along with the main data, secondary data in the form of academic publications on issues pertaining to human rights, such as forced and child labor, as well as environmental issues, will be utilized to answer RQ2. To gain a deeper understanding of the collected data, it is crucial to assess and evaluate the qualitative information, as advocated by Thornhill et al. in 2009.

To effectively carry out our research and address the research questions, we adopted a comprehensive approach involving a variety of data collection methods and sources. To gain insights into the due diligence practices of different countries, we conducted thorough reviews of articles and explored the official websites of these nations. This allowed us to acquire a holistic understanding of how specific countries implement due diligence processes. Our goal was to ensure a well-rounded and precise representation of these countries' approaches to due diligence by examining a wide range of sources. In addition to our findings from articles and websites, we also took legislative factors related to human rights and environmental risks into account. We referred to pertinent articles that discussed applicable laws and regulations, contributing to a thorough analysis of the legal framework surrounding these issues. The inclusion of legislative information aimed to enhance the depth and accuracy of our research results.

We use frameworks from appropriate research to help the organization of our study and its conclusions. The frameworks gave us a strong theoretical grounding and a methodical way to examine the facts we gathered. Incorporating the frameworks into our study helped us convey a more complete picture of the topic while also offering insightful observations. Overall, we used a combination of publications, interviews, and desktop research in our research strategy, which enabled us to acquire distinctive viewpoints, and a comprehensive analysis of the relevant studies and issues. Table 1 presents the data collection and analysis method to address the research questions.

Table 1: Data Collection and Analysis method

Research question	Data collection method	Data analysis method
RQ1	● Journals, Online resources regarding legislations linked to human and environmental rights, upstream supply chain visibility	● Legislation Analysis (Table 2)

RQ2	● Literature, Scientific articles, Online resources regarding high-risk supply chain, human and environmental rights	● Accountability Framework Initiative (AFi)
RQ3	● Journals, Online resources regarding best technology, standards & methods for supply chain mapping, web pages of industrial partner, Linkedin. ● Journals, Online resources for methods and standards for up-to-date supply chain mapping related to human rights and environment.	● Supply Chain Network Structure Model ● Accountability Framework Initiative (AFi) ● Hierarchy for supply systems mapping

2.4 Literature review

The literature review is performed with a semi-systematic approach as described by Snyder (2019) to attain a good quality. Snyder (2019) specifies this approach is most suitable while mapping the theoretical arena. The first step is to study and understand the implications of regulations and legislation on the supply chain. This is performed in addition to existing literature study, and semi-structured interviews with key stakeholders in the supply chain. The literature review will include relevant subjects such as touching upon supply chain risk management but more focusing on the forced and child labor act, and environmental aspects that are connected to the supply chain and legislation. A review of recent studies on supply networks and their mapping will be covered.

Understanding and exploiting the sub-consciousness knowledge is important and an interview is the best tool to perform it (Denzin and Lincoln, 2000). Interviews with the different internal stakeholders are conducted to gain a deeper understanding of the opinions, information, and ongoing risks in the supply chain about Environmental, Social and Governance (ESG) aspects of human rights and sustainability. The interview questions will be formed based on the literature review on supply chain mapping (Chopra and Meindl, 2021; Christopher and Peck, 2012). Additionally, fundamental research to better understand the different legislations and its implications, and their roles in the supply chain will be performed. To continue, the best sustainability practices regarding forced and child labor, and environmental issues that are coupled with regulations will be reviewed. The study will be established in a supply chain mapping literature review (Hugos, 2018; Simchi-Levi et al., 2019).

The data gathered from the literature study, and interviews will be used to analyze in a qualitative approach as described by Hannes et al (2012) to build a thorough mapping of the supply chain. To continue, the challenges and improvements will be addressed in the supply chain mapping once the present situation of ABB Robotics supply chain is known (Andry et, al 2022). Further, the case study related to forced labor and child labor, exploitation of human rights, and environmental aspects will be analyzed in relation to supply chain mapping.

3 Frame of reference

In the current business landscape, where organizations operate across sophisticated supply chains, a profound comprehension of the regulatory, environmental, and ethical dimensions within the supply network is necessary. Here, we focus more on the legislation, environmental concerns, and supply chain accountability in terms of literature and theoretical framework. This sets a stage to explore more and to analyze the supply chain dynamics, exposing the challenges and obligations that guide organizations in their pursuit of sustainable and responsible practices concerning the Environmental, Social and Governance (ESG) aspects.

3.1 Legislation

The existing and upcoming legislations such as the Uyghur Forced Labor Prevention Act (UFLPA), the German Supply Chain Due Diligence Act (GSCDDA), European Union (EU) Directive on Corporate Sustainability Due Diligence Act (CSDDA), and other similar legislations signaling a paradigm shift in governance. These regulations not just demand organizations to have visibility on their Tier-1 suppliers but further upstream to Tier-n, which emphasis the organizations responsibility to eradicate the forces and child labor across supply chain (U.S. Customs and Border Protection, 2022).

The UFLPA Act states that the materials or products sourced or produced from the region of Xinjiang are made with forced labor (U.S. Customs and Border Protection, 2022). Hereafter, the companies should prove before entering the US market that these goods are not with forced labor or not connected to Xinjiang Uyghur Autonomous Region (XUAR) at the US borders to avoid the seizure of goods (U.S. Customs and Border Protection, 2022). The enforcement of UFLPA from June 2022 has already led to a compliance issue for the organizations (David et al., 2022). For instance, the focus on cotton, tomato, and poly-silicon-based products that are exported from XUAR are of main concern for the moment (U.S. Customs and Border Protection, 2022). (Sandler, Travis & Rosenberg, P.A. 2023) claim that CBP has added potentially high-risk materials such as polyvinyl chloride and aluminum to the list of UFLPA enforcement. Similarly, the GSCDD and EU Directive on CSDD Act resemble EU companies to identify and investigate their supply chain while addressing the risks involved in human rights (forced and child labor) and the environments of their manufactured products (European Commission, 2022). Additionally, the EUCSDD act imposes duties on companies to establish a business model and strategy that is compliant with the Paris Agreement (European Commission, 2022). These regulations and legislations depict an impact on industries and organizations that link their materials, sub-assemblies, or other manufacturing processes to this base and may face potential disruptions in the supply chain and a reputational damage, therefore.

3.2 Environmental Concerns

Paulina. G (2014) describes companies have been working hard in recent years to minimize their internal environmental consequences. As businesses tends to source parts globally for their manufacturing processes, a threat to the environment seems to be large. To preserve the environment for future generations, businesses should strive for sustainable development and

the minimization of their negative environmental effects in all their operations. This leads to the conclusion that the environment affects every element, including the expansion of avoiding environmental hazards and other industrial enterprises (Paulina. G, 2014). In the past 20 years, companies and academics have become more concerned about the environment in relation to supply chains. Meanwhile, finding creative methods to manage the goods' production, quality, and quantity as well as their flexibility in collaborating with suppliers, dealers, and consumers to optimize supply chains and lessen their negative effects on the environment is of prime concern (Paulina. G & Carlos. A. R, 2012). This is due in part to the governments of many different countries around the world implementing new environmental protection laws, as well as the academic community including the new restrictions in their better analyses of the new situation.

3.3 Accountability Framework Initiative

The Accountability Framework initiative (2019) covers twelve fundamental principles connected to the human rights and environmental hazards. But here we would be concentrating only on the principles that fall within our area of expertise because many of them do not pertain to the issues of this thesis. The Accountability Framework initiative (AFi) is a new project that relies on the assistance of companies and other suppliers to make the crucial changes necessary to reduce environmental consequences. The AFi offers practical roadmaps to help companies set goals, act, improve the supply chain, and support environmental and human rights concerns as depicted in figure 2. The expansion of this framework to produce commodities is supported by a coalition for human rights and the environment, which brings new partners to AFi. The use of AFi is meant to help companies react to the rising expectations for corporate responsibility, human rights, environmental protection, and other related concerns.

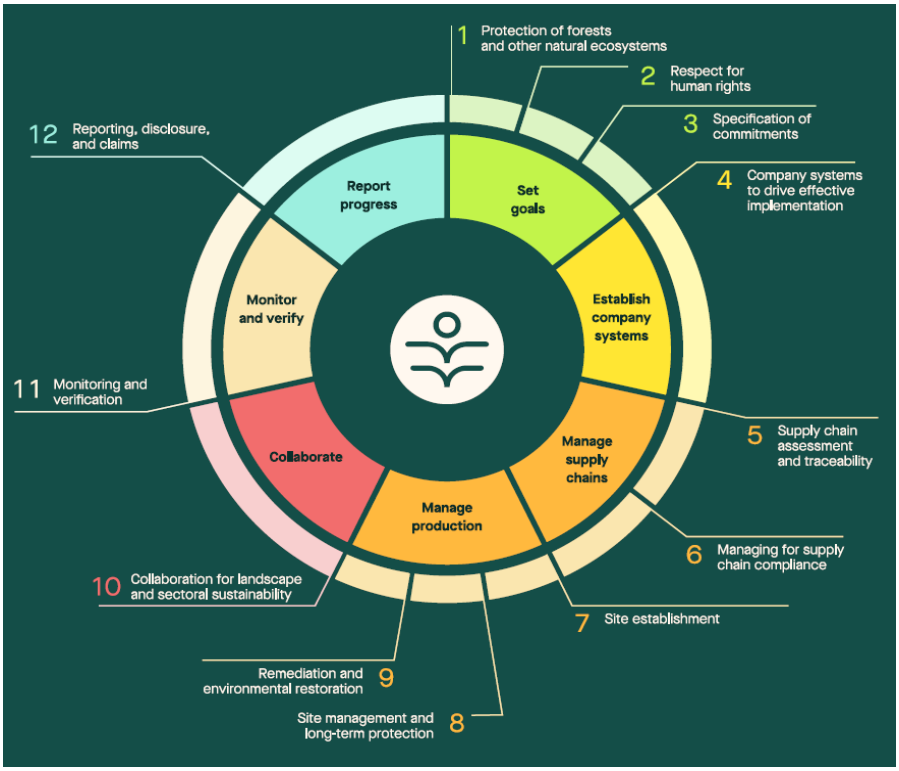


Figure 2: Accountability Framework Initiative (AFi) (Source: Accountability Framework Initiative, 2019)

Companies engaged in supply chain moderation may run into situations where it is neither practical nor required to keep an eye on certain industrial facilities (Accountability Framework Initiative, 2019). In this scenario, companies can expand the region where the production facilities are situated. Companies can choose a risk-based strategy in these situations, which is one of the ways available, along with a conservative one (Accountability Framework Initiative, 2019). In a conservative approach, the companies could opt to assume that if the supply sources come from a region identified as having certain high-risk materials, then the rest of the companies fall into the same categories (Accountability Framework Initiative, 2019). Using a resource-based approach, organizations may monitor regions at the regional level and assess risk based on actual sourcing data from high-risk areas. However, if the area level monitoring reports indicate a significant risk of non-compliance across the geographic region, a risk-based view would be required to have an accurate monitoring. Imagine that the exact monitoring is not necessary if the company's area-level monitoring determines that there is a little risk.

3.4 Hierarchy of Supply Systems Mapping

The hierarchy of supply systems mapping proposed by MacCarthy et al (2022), emerges as a salient conceptual framework. This structured approach navigates the sophisticated supply chain network with an overview of micro-level to macro-level supply chain. As shown in figure 3, it enables the organizations to understand the complex interdependencies that span their supply networks (B.L. MacCarthy et al., 2022). This can offer a better view for ABB Robotics to adopt the relevant level in mapping and a structured way to look at the diversity level of its supply chain.

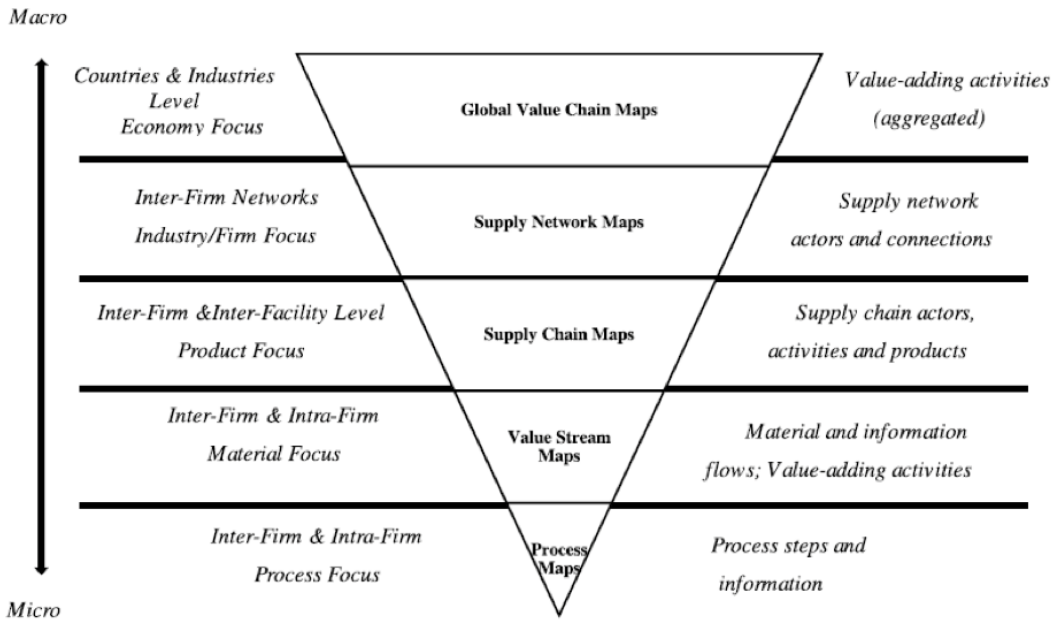


Figure 3: Hierarchy for Supply Systems Mapping (Source: B.L. MacCarthy et al., 2022)

The hierarchy of maps is illustrated as below from micro-level to macro-level.

Process Maps: To begin at the micro-level of the hierarchy, process maps develop as the foundational layer. These maps outline specific processes within an organization, describing the sequence of activities, interactions, and information flow that is close to the creation of a

product (B.L. MacCarthy et al., 2022). Process maps facilitate a microscopic understanding of operational complexities, allowing organizations to identify inefficiencies, redundancies, and potential enhancements within discrete processes (B.L. MacCarthy et al., 2022).

Value Stream Maps: This level is slightly broader in scope; value stream maps encompass the entirety of processes involved in delivering value to customers. These maps pass through departmental boundaries, capturing not only internal activities but also external interactions with suppliers and customers (B.L. MacCarthy et al., 2022). Value stream mapping facilitates organizations to uncover end-to-end process bottlenecks, streamline value, and foster a holistic perspective on operational efficiency (B.L. MacCarthy et al., 2022).

Supply Chain Maps: In the ascending level of hierarchy, the supply chain maps capture the interactions and relationships that spans across an organization, from suppliers to customers (B.L. MacCarthy et al., 2022). These maps extend a 360-degree view of the chain's activities, highlighting the flow of materials, information, and resources. Such kind of supply chain mapping facilitates the identification of potential vulnerabilities, disruptions, and opportunities for optimization within the network.

Supply Network Maps: With the further extension of the level, supply network maps develop the perspective to include multiple supply chains that interconnect due to shared suppliers or customers (B.L. MacCarthy et al., 2022). These maps capture the dynamic interdependencies across the diversified supply chains, offering insights into the cascading effects of disruptions and fostering strategies for enhanced resilience and collaboration.

Global Value Chain Maps: At the macro-level of the hierarchy, global value chain maps characterize the interconnectedness of today's business landscape. These maps go beyond organizational and geographical boundaries, involving multiple supply networks that spread across international borders (B.L. MacCarthy et al., 2022). Global value chain mapping exposes the sophisticated complexities of sourcing, manufacturing, distribution, and customer engagement on a global scale. It also facilitates the identification of strategic partners, risk mitigation strategies, and opportunities for value creation across diverse markets (B.L. MacCarthy et al., 2022).

The potential of this hierarchy lies in its recognition that each mapping technique contributes a unique dimension to the understanding of supply chain dynamics (B.L. MacCarthy et al., 2022). B.L. MacCarthy et al., (2022) also describes that, with the integration of these techniques, organizations can enforce a multi-faceted view that empowers them to strategically align their supply chain operations with overarching business goals. Therefore, the adoption of this hierarchical approach can enable organizations to orchestrate with a more harmonized approach in the upstream supply chain and can also integrate sustainability, risk mitigation, and operational efficiency in a seamless way possible.

3.5 Supply Chain Network Structure

The Supply Network Structure, a foundational framework conceptualized by Lambert et al. (1998), serves as an essential cornerstone in understanding the complex interplay of entities within the global supply chain ecosystem. Illustrated in Figure 4, this framework offers a 360-

degree view of the dynamic relationships with details winding through suppliers, manufacturers, distributors, retailers, and customers, surpassing the conventional supply chain paradigms (Lambert et al., 1998).

The conventional or earlier supply chain management models and ideas that were widely used before to Lambert et al.'s release of the Supply Network Structure framework in 1998. These traditional paradigms frequently took a more linear or one-dimensional perspective on the supply chain, emphasizing the movement of commodities from suppliers to manufacturers, then to distributors, retailers, and lastly to customers. They frequently fell short of the Supply Network Structure framework in terms of capturing the complex and constantly changing interactions between different components of the supply chain ecosystem. The paragraph highlights that the Supply Network Structure framework goes beyond these traditional models by providing a more complete and 360-degree view of all the organizations participating in the global supply chain.

The fundamental premise of the Supply Network Structure lies in its recognition that a supply chain extends beyond tier-1 up until tier-n (figure 4) (Lambert et al., 1998). Furthermore, it also represents a complex and interconnected network wherein the actions of any participant resonate across the entire network. This conceptualization embraces the multifaceted exchange of materials, information, and value, binding together entities across various tiers and domains (Lambert et al., 1998).

The significance of this network structure is that it offers an insight into the complexities of extended supply chain tiers. As organizations navigate scenarios involving tier-n levels or beyond tier-3 in the upstream supply chain, the Supply Network Structure attains heightened relevance. By unveiling the web of relationships encompassing raw material suppliers, sub-assemblers, sub-contractors, and other intermediaries, this framework facilitates an enhanced understanding of the complex interactions shaping the final product (Lambert et al., 1998).

Incorporating the Supply Network Structure into this study supplements the understanding of multi-tiered supply chain dynamics. As ABB Robotics endeavors to explore tier-n levels and beyond tier-3 in its upstream supply chain, this framework will serve as a guiding compass. It enables a thorough understanding of the broader relationships impacting supply chain operations, allowing the identification of potential risks, inefficiencies, and strategic opportunities.

This framework's enduring pertinence is underscored by its adaptability to modern complexities, incorporating global value chains, digital transformations, and regulatory obligations. In a landscape where supply chains go beyond geographical boundaries and organizational confines, the Supply Network Structure remains a timeless tool for organizations to navigate the sophisticated connections. It empowers them to foster resilience, innovation, and strategic decision-making within their supply network systems (Lambert et al., 1998).

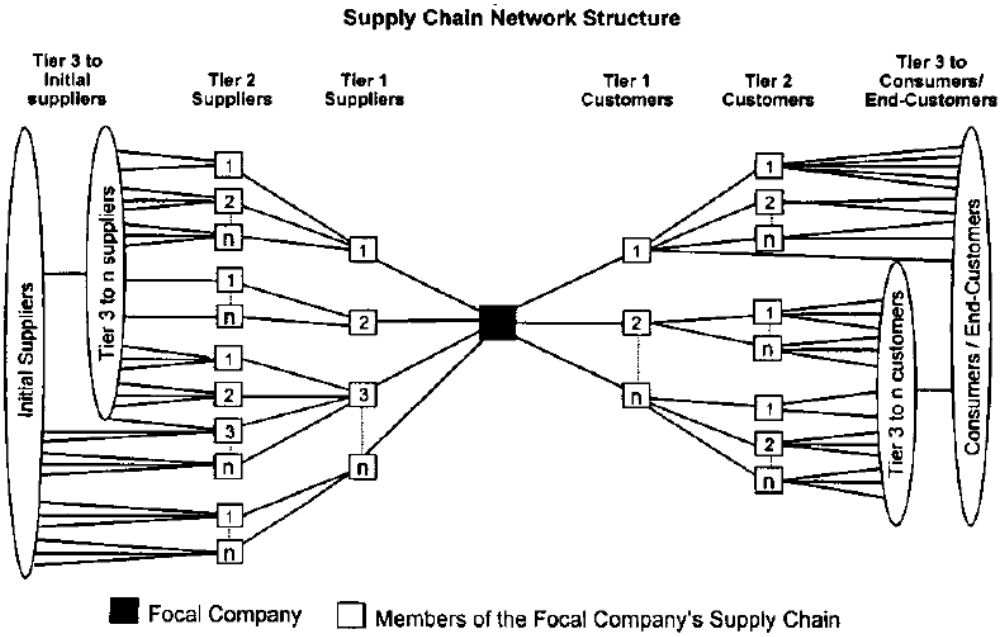


Figure 4: Supply chain network structure (Source: Lambert et. al. 1998)

4 Findings & Analysis

4.1 RQ1: Why to map: What legalizations, in terms of human rights and environmental issues, require ABB Robotics to have upstream supply chain visibility?

The process of supply chain mapping is the first step in building an effective strategic supply chain management approach. Moreover, customers nowadays are more interested in the origins of items, their history, the people engaged in their development, and the manufacturing processes. Gardner and Cooper recommended using supply chain mapping to enhance supply chain performance and reorganize networks, improving the alignment of a company's strategy first and then with its supply chain strategy (MacCarthy et al., 2022). To improve industrial operations, the flow of materials from suppliers must be planned, controlled, and monitored, which calls for the ability to recognize and follow changes in the global economy. As a result, supply chain mapping is required for several contemporary supply chain concerns (MacCarthy et al 2022). A variety of approaches have been put into place over the last ten years to deliver end-to-end traceability in supply chain mapping by merging data sources and extra private and public data information systems. Several providers offer solutions and consulting services to solve these issues for supply chain visibility, traceability, resilience, and sustainability.

Supply chain mapping, to put it simply, is the process of gathering supplier data from a company's upstream supply chain, allowing for the origin of raw materials to the end of finished goods and delivering to the customers (Anna Cantwell, 2022). For instance, the production process of the smartphone manufacturer Fairphone can be tracked all the way down to the basic ingredients, including minerals, which were used in the production (Anna Cantwell, 2022). Due to their inevitably complicated supply network architecture made up of several geographically dispersed organizations, firms find it extremely challenging to retain supply chain visibility over their supply chain network (Mubarik et al, 2021). For companies, the upstream supply

chain's invisibility is a significant barrier and may limit their capacity to react to any unexpected stoppage, which might result in issues with the environment and forced labor (Mubarik et al, 2021). Scaling the map is crucial to verify the relationship between the supply chain mapping and other factors like performance and visibility (Mubarik et al, 2021). Supply chain mapping is important because it improves visibility, detects hazards, increases efficiency, strengthens connections, meets customer requests, provides resilience, and enables performance assessment. These elements work together to improve supply chain performance, which is critical for organizations success and competitiveness. The development of the supply chain mapping's components can serve as its building blocks, promoting further study of the subject among businesses. Having a solid foundation for supply chain mapping aids companies in helping to increase the supply chain's resilience (Mubarik et al, 2021). To have a comprehensive picture of the upstream supply chain within the organization, supply chain mapping must be completed.

The focal firms explore their inbound/outbound supply networks for raw materials, completed goods, and crucial components using supply chain mapping (Anna Cantwell, 2022). Supply network maps primarily offer structural visibility into complex and interconnected actor networks. The first step in addressing many current supply chain challenges, which have resulted in increasing government monitoring, is the requirement to map the supply chain. For any organization, government, and consumer, the supply chain is the top problem. Increased awareness of the need for businesses to respect human rights, such as those related to child labor and forced labor, and environmental concerns in their supply chains has emerged during the past years. Governments and multinational corporations have created legal frameworks and regulations that ensure business compliance with these goals by requiring supply chain transparency and due diligence (Anna Cantwell, 2022).

Owing to the introduction of laws, the US is now keeping an eye on regulations regarding the origin of the products and modern slavery in supply chains. Keener in how these new regulations are built up to regulate contemporary slavery and environmental concerns. Due to these laws, businesses must ensure that every aspect of their services, including the relationships with upstream suppliers, complies with the law (Kai Leisering, 2022). The whole supply chain of their upstream suppliers is likewise subject to these requirements in addition to the organizations themselves (Kai Leisering, 2022).

4.1.1 UFLPA - Uyghur Forced Labor Prevention Act

A various law to address human rights and environmental aspects in the upstream supply chain have recently been proposed and implemented by the US, EU, and Germany, etc. Notably, the US has passed the Uyghur Forced Labor Prevention Act (UFLPA), which prohibits the importation of products made in China's Xinjiang Uyghur Autonomous Region (XUAR) or by organizations connected to XUAR unless there is convincing evidence that they were not produced or made using forced labor. This law, known as the Withhold Release Orders (WRO) process has been implemented under Section 307 of the Tariff Act, and has already been in place for ten years. Instead of outlawing XUAR altogether, it explicitly prohibits the importation of items/commodities from XUAR produced wholly or partly with a link to forced or child labor (White & Case, 2023).

The UFLPA's section 307, which goes beyond the ban, establishes a "rebuttable presumption" under which products manufactured in XUAR or identified as having been produced using child or forced labor are forbidden from entering the country (Michael. et al, 2022). Another restriction is that the UFLPA does not include any de minimis exemption, which means that every product related to XUAR, regardless of its place of origin or the nation from which it is imported, is subject to a rebuttable presumption (White & Case, 2023). The CBP may restrict or seize imported products in connection with XUAR, as well as the enforcement of UFLPA and the imposition of penalties. The US government has previously designated items like polysilicon, textiles, and tomatoes as having high-risk materials, therefore this danger is severe for such products. Aluminum and polyvinyl chloride were recently added to CBP's list of high-risk materials, and as a result, CBP will now pay particularly close attention to these key minerals and the goods that are made with them with conformity to UFLPA (White & Case, 2023). The CBP recommends businesses to be more cautious about claims of forced labor in the sector and keep an eye on their relationships with suppliers and the working conditions of people in their supply chains. Also, businesses must do risk assessments in accordance with due diligence procedures and be honest about their supplier networks. Importers must proactively monitor every link in their supply chain to lower the likelihood of forced labor (White & Case, 2023). Supply chains differ across various nations, businesses, and sectors. Giving an example, a solar panel company that imports components from other nations reviews the product and provides all the necessary documentation, such as financial, transportation, packing lists, certificates of country of origin, invoices for purchases, contracts, inventories of inputs and outputs, bills of lading, and payments (USCBP, no year). The procedure for each shipment will be the same because the production of solar panels necessitates the importation of supplies from several nations. CBP reviews the information provided after receiving it from the solar panel manufacturer to ascertain if the supply chain contains components from the XUAR or a company on the UFLPA list (APPENDIX A). The shipping is free in US markets if CBP determines that the items are not covered by UFLPA and other regulations (USCBP, n.d. 2023).

4.1.2 EU CSDDA - European Union Corporate Sustainability Due Diligence Act

The EU introduced the CSDDD law in February 2022 to protect human rights and the environment by forcing businesses to verify that they are operating both inside and outside the EU in accordance with the law (White & Case, 2023). The Corporate Sustainability Due Diligence Directive has been the goal of Responsible Business Conduct for the whole European Union (EU). The proposed CSDDD alters the responsibilities of the organizations governed by the legislation to include corporate due diligence criteria for human rights and environmental issues. Whether the commodities specified above are offered for sale in the EU or not, the same due diligence would apply to worldwide supply chains. Regardless of the type of business they operate in, both EU and non-EU companies are obligated to comply with due diligence requirements (White & Case, 2023). Companies with high-risk areas are also required to minimize any restrictions and work collaboratively with their subsidiaries throughout their entire supply chain to act on any subsidiaries that are subject to regulation. Companies ought to utilize care to address the implications of human and environmental factors that fall within the purview of due diligence. Organizations that adhere to the CSDDD should be required to

take safeguards to prevent abuses of human rights and environmental laws, especially in their manufacturing processes and supply chain operations (White & Case, 2023).

4.1.3 GSCDDA - German Supply Chain Due Diligence Act (LkSG)

Supply chain German due diligence act implemented on 1st of January 2023 imposing legal compliance on the companies to carry out due diligence procedures with respect to human rights such as forced/child labor and environmental aspects. This applies to countries outside Germany once when the company falls under the due diligence act registration requirements. Companies in Germany also fall under EU regulations. LkSG is now applied to companies with more than 3000 employees and will be reduced to 1000 in the upcoming year, however, it will not consider workers who have been sent abroad. It includes multinational corporations and has a branch office in Germany. Organizations should be equipped with the required processes for producing and delivering items to clients domestically and abroad. As part of LkSG, businesses must establish appropriate and effective risk management in their systems for both their direct suppliers and their operations, but indirect suppliers also require risk assessment with respect to human rights and environmental aspects which ABB Robotics are already performing. The LkSG's due diligence aims to clarify the precise restrictions under international rules, such as the prohibition of child labor, forced labor, and slavery (White & Case, 2023). These objectives were defined to increase worker safety, workplace health, and worker protection. In addition to these restrictions, companies are legally bound by the Basel Convention on Control of Transboundary Movements of Hazardous Wastes and their Disposal, the Stockholm Convention on Persistent Organic Pollutants, and the Minamata Convention on Mercury (White & Case, 2023).

4.1.4 Dutch Human Rights Due Diligence Act

The Dutch government introduced a new law in the middle of 2022 called Responsible Business Conduct, which encompasses both human rights and environmental protection in their due diligence act (Worldfavour, 2023). In their due diligence, Dutch companies as well as international firms operating in the Netherlands are required to consider factors like human rights and the environment. This is known as responsible business conduct. A firm must have a minimum balance of 20 million euros, minimum annual revenues of 40 million euros, or 250 or more employees in order to comply with the minimum standards of this Responsible Business Conduct (Worldfavour, 2023).

The Dutch Human Rights and Environmental Due Diligence (HREDD) Act requires companies to regularly assess the risks and actual negative consequences of their activities, as well as those of their business partners, regarding human rights and environmental issues outside of the Netherlands. Companies may use this to address their impacts and improve decision-making and risk management systems to comply with the principles and standards of the OECD Guidelines on multinational firms by taking human rights and environmental concerns into account (Worldfavour, 2023). The Dutch due diligence will be based on the UNGPs and OECD guidelines which basically are based on the human rights and environmental due diligence rules. Implementing this HREDD helps millions of people is lives and makes better conditions for them which is a crucial step towards guaranteeing sustainable corporate practices and global supply chains (Worldfavour, 2023). As part of the due diligence process, companies are

required to follow all firm policies and operational guidelines, including those relating to assessing the current and potential effects of the investigation, developing and putting into practice risk management strategies, establishing company priorities, gauging the success of the investigation, and disclosing the results of their annual due diligence procedures (Worldfavour, 2023).

In November 2022, the Dutch political parties introduced a revised version of the Responsible and Sustainable International Business Act to the Dutch House of Representatives (Herbert Smith Freehills, 2023). This legislation, passed by the Dutch government, mandates that both domestic and foreign companies operating within the country must take responsible measures to safeguard human rights and the environment. Companies falling under this law are required to ensure that their commercial transactions and production activities do not have adverse effects on environmental or human rights matters, both within and outside the Netherlands. To qualify for coverage under the Netherlands Responsible and Sustainable International Business Act, companies must meet at least two of the following three criteria: total assets of 20 million euros, net revenue of 40 million euros, and an average of 250 employees annually. Notably, these criteria are less stringent than those in place in several other EU nations, such as LkSG, which requires 3000 employees and plans to reduce this threshold to 1000 employees by 2024 (Herbert Smith Freehills, 2023).

Under this law, companies are obligated to minimize any adverse impacts resulting from their activities to the greatest extent possible, and they must make necessary reparations if such impacts occur. Furthermore, if they are unable to mitigate the risks, companies are required to terminate their business relationships with suppliers, even if doing so might indirectly harm those suppliers (Herbert Smith Freehills, 2023). The legislation specifies a series of actions that companies must take to mitigate the risks associated with human rights and environmental concerns. Companies are expected to take swift action in addressing issues such as forced labor, child labor, climate change, environmental damage, unsafe working conditions, slavery, unfair discrimination, and exploitation (Herbert Smith Freehills, 2023).

Due diligence has a number of requirements, and these are the standards that companies must meet to be qualified. Qualified organizations must first familiarize themselves with the defined requirements for due diligence. The due diligence standards are then developed using these criteria, and they are discussed in more detail below. The policies must state the undertaking's commitment to safeguarding environmental risks and human rights in compliance with OECD Guidelines for International Businesses (Herbert Smith Freehills, 2023). Next, companies must control the risk assessment responsibilities, which include yearly completion of the analysis and risk prioritization processes. Following the completion of the risk analysis, companies must address the adverse consequences by developing new strategies, risk management plans, and climate action plans. From that point on, companies must evaluate the application and execution of their due diligence procedures every year. The last stage is to put the mechanisms that are needed for this due diligence into place (Herbert Smith Freehills, 2023).

4.1.5 Norwegian Transparency Act

The Norwegian Transparency Act went into effect in July 2022, requiring businesses to investigate any violations of labor laws and human rights in their supply chains and suppliers. These investigations must be followed up on, and violations must then be reported to the public.

According to the Norwegian Transparency Act, companies must have an average of 50 full-time employees, a minimum revenue of 70 million NOK, and a minimum balance of 35 million NOK. As a result, rules apply to both Norwegian and overseas companies. Companies must adhere to their organizational norms, identify, and prioritize risks, and minimize repercussions while implementing the Norwegian Transparency Act. Customers can ask businesses to give them precise details about their items.

On July 1, 2022, the Norwegian Transparency Act came into effect (Worldfavour, 2023). This legislation requires large businesses to uphold fundamental human rights and ensure that fair working conditions are maintained throughout their supply chains. The Norwegian Act aligns with the principles of corporate sustainability due diligence in addressing human rights and environmental implications within global supply chains, following similar steps taken by the UK and the European Commission (Solfrid and Sarah, 2022). The Norwegian Transparency Act incorporates elements of the OECD Guidelines for Multinational Enterprises and the UN Guiding Principles on Business and Human Rights. The primary obligations of companies under this Act include conducting due diligence to identify and assess the specific adverse effects on human rights and working conditions within their supply chains (Solfrid and Sarah, 2022). Companies must adhere to their organizational norms, identify, and prioritize risks, and minimize repercussions while implementing the Norwegian Transparency Act (Worldfavour, 2023). Customers can ask businesses to give them precise details about their items. Additionally, companies must take the necessary steps and assume responsibility for producing an annual report that details the procedure and findings of their due diligence while also responding to stakeholder questions and requests within a two- or three-week time frame. Larger businesses that operate in Norway are liable to taxation under Norwegian law since they are covered by legislation that considers major multinational businesses (Solfrid and Sarah, 2022). Companies that meet the requirements of this legislation must have annual revenues of at least NOK 70 million, total assets of NOK 35 million, and an average of 50 full-time employees. If both parent firms and subsidiaries meet these criteria collectively, the business is regarded as big. 8,800 businesses are expected to conduct analyses and provide their findings to substantiate the existence of adequate working conditions and fundamental human rights (Solfrid and Sarah, 2022).

4.1.6 United Kingdom Modern Slavery Act

In 2015, the United Kingdom became the pioneer in enacting the Modern Slavery Act, which sets the standards for combating modern slavery. This legislation mandates that any company with a global revenue exceeding 35 million GBP must adhere to the UK Modern Slavery Act. These businesses are obligated to publish an annual statement on slavery and human trafficking for each financial year. This statement should encompass information about the actions taken by the company to prevent slavery and human trafficking within their supply networks, along with an evaluation of their effectiveness and impact.

Despite this milestone, the UK's Modern Slavery Act faced criticism as other countries globally intensified their efforts to combat modern slavery, impacting forty million people. The UK faced scrutiny for its low prosecution and conviction rates in cases related to slavery (Ruth Green, no year). Section 54 of the Act, which requires companies operating in the UK and internationally with annual revenues exceeding thirty-six million pounds to disclose an annual statement on slavery and human trafficking, received significant attention. While most

companies complied by submitting their reports in 2017, there were still some that had not done so. Clare Connellan (White & Case, 2023) pointed out that there are hundreds of companies that have yet to report on issues related to human trafficking and enslavement. She also emphasized that the modern slavery registers reveal the limited progress made by thousands of businesses. These registers indicated that, by March 31, 2019, approximately 17,000 firms could face public naming and shaming if they failed to provide the required statement. Connellan further noted that this initiative could encourage other companies to be more transparent, leading to changes in their practices. However, it is worth mentioning that many companies were unaware of the research and were not eager to be included on the list of identified and publicly criticized entities (Ruth Green, no year). Under the Contemporary UK Slavery Act, companies headquartered in the UK are obligated to publicly disclose the report detailing the measures taken to adhere to the Modern Slavery Act within their supplier chain (Ruth Green, no year).

The significance of the Modern Slavery Act is its broad applicability, encompassing all companies operating in any part of the UK, regardless of their origin or initial establishment, provided they meet the annual criteria (Simmons & Simmons LLP, assessed 2023). Companies, including those from other countries, must thoroughly scrutinize their involvement in the supply chain considering this legislation. Even if they do not precisely meet the requirements, some businesses view such actions as socially responsible. In response to the COVID-19 outbreak, the government issued a statement on April 20, 2020, emphasizing the importance of continued reporting on modern slavery issues (Simmons & Simmons LLP, assessed 2023). The statement underscores the need for companies to remain vigilant in identifying and mitigating modern slavery risks within their supply chain throughout the pandemic. Firms are urged to assess how the outbreak may have altered their demand and supply chains, potentially increasing the risk of labor exploitation and jeopardizing employee health and safety. If a company fails to pay its employees during an epidemic, it is required to disclose this in its statement.

Companies must provide a statement on slavery and human trafficking, explicitly confirming that these crimes have not occurred within their supply chains or operations (Simmons & Simmons LLP, assessed 2023). Furthermore, businesses are obligated to state that they have taken no actions associated with modern slavery or human trafficking alongside their statement. While the legislation does not specifically use the term "supply chain," it encourages companies to be flexible in how they describe their supply networks, although the supply chain should be comprehensively covered. Although the Modern Slavery Act mandates only the issuance of a statement, the guidance emphasizes the government's encouragement for every company to establish a robust and effective response (Simmons & Simmons LLP, assessed 2023).

4.1.7 Canadian Transparency Act

The Canadian Minister of Slavery introduced a rule in 2021 to encourage Canadian companies ' transparency into global supply chains to detect and reduce child slavery and forced labor. The Senate adopted this piece of legislation in late 2021, and it is anticipated to take effect in January 2024 (Worldfavour, 2023). For private as well as public companies that produce and import items into Canada, a minimum of two conditions must be met for the business to be subject to the law. A minimum of twenty million Canadian dollars in assets, 40 million Canadian dollars in sales, and an average of at least 250 employees are required of the firms (Worldfavour, 2023).

Companies that are subject to this Act must submit an annual report detailing their operations and accomplishments. The second requirement is that the reports must provide details on the due diligence methods, train the workers, and assess the protocols in place to guarantee that child labor and forced labor are not used in the company's supply chain. If the report is created in compliance with the Canada Business Corporations Act, firms must distribute it to their stakeholders as well as publish it on their organization's website (Worldfavour, 2023).

The Canadian Transparency Act primarily aims to mitigate or eliminate the risks associated with forced labor and child labor within the supply chains of companies (Jessica et al., 2023). A private member's bill, known as S-211 or the "Fighting Against Forced Labour and Child Labour in Supply Chains Act and Customs Tariff Amendment," has been repeatedly proposed in Parliament and would have a direct impact on both Canadian and foreign businesses (Jessica et al., 2023). S-211 intends to establish a reporting regime that would be made public, with the objective of preventing and reducing the utilization of child labor and forced labor at any stage of production, whether in Canadian enterprises or foreign companies whose products are imported into Canada (Jessica et al., 2023). Under this system, numerous public and private organizations are required to produce an annual report outlining the measures they have taken during the previous fiscal year to combat the use of forced labor and child labor in their supply chains (Jessica et al., 2023). Private companies must submit these reports to the Minister of Public Safety and Emergency Preparedness, with a deadline for publication on or before May 31 each year. The reports due in May 2024 must include the actions taken to mitigate the risks of child labor and forced labor (Jessica et al., 2023).

Non-compliance with the requirements of the Fighting Against Forced Labour and Child Labour in Supply Chains Act, including the submission of false or misleading statements or information to the Minister, may result in individuals or entities being liable to summary conviction and facing fines of up to $250,000 (Jessica et al., 2023). This provision serves as a deterrent and reinforces the importance of adhering to the obligations outlined in the Act. It emphasizes the seriousness of ensuring accurate reporting and preventing any attempts to misrepresent or provide misleading information. By implementing this penalty, the Act aims to strengthen accountability and encourage full compliance with the regulations, thereby promoting transparency and combating forced labor and child labor in supply chains (Jessica et al., 2023).

4.1.8 Australian Modern Slavery Act

Australia's Modern Slavery Act, enacted in 2019, mandates that larger Australian companies must report on their efforts to mitigate the risks of modern slavery within their supply chains and operations (Hon, M. P, 2022). Businesses with an annual total turnover exceeding 100 million AUD are required to submit an annual report outlining the measures they are taking to combat modern slavery in their supply chains and operations. Australia is committed to addressing modern slavery in all its forms, both domestically and internationally, as there are approximately twenty-five million modern slavery victims worldwide (Hon, M. P, 2022).

The 1930 ILO Forced Labour Convention aimed to eradicate forced labor and prevent modern slavery by addressing its root causes. Australia has a responsibility to prevent and eliminate forced labor, provide access to remedies for its victims, impose penalties on non-compliant

companies, and refrain from leniency (Hon, M. P, 2022). The Australian government is also committed to advancing global gender equality and supporting robust economic growth.

In alignment with its foreign policy, Australia, along with Bali, co-chairs initiatives on human trafficking, smuggling, and related crimes, with a strong focus on reducing forced labor and other modern slavery forms (Hon, M. P, 2022). Under Australia's Modern Slavery Act, companies with substantial revenues are obliged to annually disclose their efforts to address modern slavery, a law that came into effect in 2018 (Aljazeera, 2022). However, there has been criticism, especially from smaller companies, regarding the Act's limited scope, which applies only to firms with annual revenues exceeding one hundred million dollars and lacks financial penalties (Aljazeera, 2022).

4.1.9 Swiss Transparency Act

The Swiss Code of Obligations went into effect on January 1 of 2022 and included a one-year transition period (Michael. et al, 2022). The first final Ordinance of the Swiss Code of Obligations detailing the rules for due diligence and reporting regarding conflict minerals and child labor was released by the Swiss Federal Council in December. There are extra obligations imposed by the Swiss Federal Council on many US-based corporations and other companies doing business in Switzerland that are a part of their supply chains and are subject to Swiss Federal Council rules and laws (Michael. et al, 2022). Both child labor and conflict materials are subject to restrictions. However, they are less stringent than similar corporate human rights due diligence laws that have recently been established in Germany and Norway, which include a larger variety of laws and rights. Companies must meet certain criteria to be covered by the Swiss Code of Obligations, including having 250 full-time employees on average annually, twenty million Swiss Francs in total assets, 40 million Swiss Francs in sales, and is classified as an SME for two consecutive financial years (Michael. et al, 2022).

Switzerland has recently heightened its commitment to safeguarding human rights on a global scale by introducing non-financial reporting requirements and due diligence obligations. Within the Swiss Code of Obligations, recent regulations from the Swiss Federal Council have banned the trade of minerals and metal ores like tin, tantalum, tungsten, and gold from high-risk regions to the EU. This move aligns with the Conflict Minerals Regulation enforced by the EU, which aims to restrict access to natural resources, as these minerals are sometimes associated with forced labor, given their high market value. Consequently, businesses are now subject to the new Swiss supply chain due diligence requirements when dealing with high-risk minerals and metals for Switzerland or supplying them to the Swiss market, provided their primary place of business or registered office is located there. Although the new laws do not cover the import and processing of recycled materials, companies falling under the Swiss Code of Responsibilities must rigorously adhere to the due diligence responsibilities (Eike and Fiona, 2022).

Essential components of compliance include implementing an appropriate management system that encompasses the company's supply chain policy, risk management, and supply chain traceability. This information must be made accessible to the public and suppliers through various means, such as company websites and other approved channels (Eike and Fiona, 2022). Companies obligated to provide reports on their due diligence efforts must ensure that these reports are publicly available for at least a decade. Failure to fulfill these duties, such as

knowingly providing false information in reports or neglecting to submit reports as required, can result in penalties of up to 100,000 Swiss francs. In cases of unintentional errors, rather than negligence, businesses may face fines of up to 50,000 Swiss francs (Eike and Fiona, 2022).

The study has been condensed in Table 2 to give a summary of the numerous laws pertaining to human rights and environmental concerns. A fast grasp of the legislative goals regarding human rights, environmental issues, and the necessity of adhering to due diligence and transparency standards is made possible by the table's presentation of essential elements including due diligence, transparency, human rights, and environmental factors. These laws explicitly attempt to address and control concerns relating to the environment, protecting human rights, and guaranteeing responsible practices via due diligence, as shown in the table below.

Table 2: Legislation Analysis

Legislations	**Due Diligence**	**Transparency**	**Human Rights**	**Environmental Aspects**
US UFLPA	No mention of due diligence guidelines followed.	Transparency is not necessary.	Yes! emphasizes forced and child labor	No environmental aspects covered
EU CSDDD	Address and identify both human right and environmental issues according to due diligence standards of OECD guidelines.	Annual reports must be made available on their website so that people may learn about the relevant due diligence steps completed in prior years.	Includes minorities who practice different religions or languages, child labor, forced work, etc.	Waste management and the use of chemicals

De LkSG	With relation to environmental and human rights concerns, periodically identify risks and undertake risk assessments based on the due diligence standards of UNGP's guidelines.	Recording a company's adherence to due diligence, keeping records of it, and archiving them for at least seven years.	Prohibition of forced labor, forced sexual orientation, forced religion, etc.,	The Stockholm Convention on Persistent Organic Pollutants, the Minamata Convention on Mercury, and the Basel Convention on Control of Transboundary Movements of Hazardous Wastes and their Disposal all impose legal obligations on companies.
Dutch HREDD	Companies must conduct diligence and identify threats to human rights and the environment in accordance with OECD and UNGP standards.	Requires companies to disclose their yearly reports on value chain developments, hazards, and monitoring findings.	Includes forced labor, exploitation of people, slavery, and hazardous working conditions.	Annually compile reports on harmful working conditions and climate change
Norwegian Transparency Act	Companies must put the OECD standards into practice and do their due diligence.	Each year, make the due diligence report available online.	Put a focus on worker rights and fair working conditions.	Environmental issues are not addressed.
UK Modern Slavery Act	Follows the guidelines of ILO standards.	Companies are required to publish an annual report on modern slavery, including measures to prevent and reduce it.	Focuses on the supply networks' usage in modern slavery and human trafficking.	No mention of environmental issues.

Canadian Transparency Act	Following the guidelines of OECD in identifying the high-risk areas.	No specific transparency in Canada.	Companies should concentrate on preventing child and forced labor. putting into practice S-216.	Avoiding damaging environmental practices was mentioned, but not in any detail.
Australian Modern Slavery Act	Identifying and reducing human hazards requires human rights due diligence in accordance with OECD and UNGP recommendation	No specific transparency in Australia.	Focuses on human rights, human trafficking, women rights, rights to equality for men.	No mention of environmental issues.
Swiss Transparency Act	OECD and UNGP principles for human rights due diligence to prevent consequences on people and the environment.	Companies must provide yearly reports that meet strict requirements, such as those related to pollution, human rights, and risk management.	Risk and impact analysis for human rights to prevent adverse effects on people.	No specific mention on environmental issues.

4.2 RQ2: What to map: What are the high-risk supply chains for ABB Robotics in terms of human rights and environmental issues?

This delves into the exploration of high-risk supply chains concerning human rights and environmental issues within the context of ABB Robotics. Developing upon the theoretical bases established in the preceding chapters, this section attempts to identify and analyze sectors that pose elevated risks, contributing to the organization's commitment to responsible sourcing and sustainability.

The detailed exploration of industries that present elevated human rights and environmental risks within ABB Robotics' supply chain network is presented below. The identified sectors are elaborated based on the findings from desktop research, considering their distinct characteristics, supply chain complexities, and historical patterns of risk occurrence to the organizations. Generally recognized high-risk industries such as raw material sourcing, electronics components, textiles and apparel, agriculture, and mining and minerals are examined within the context of ABB Robotics operations.

According to the Trafficking Victims Protection Act (TVPRA) of 2022, a list of goods (Figure 5) indicates that goods from China, produced with forced labor, significantly impact human rights violations. The U.S. Department of Labor's (DOL) List of Goods Produced by Child or Forced Labor (APPENDIX C) reveals that 18 goods on the list are produced with forced labor in China, with 10 of them having a connection to the Xinjiang region for forced labor, and four new downstream goods produced in China linked to forced labor. The Global Slavery Index (2018) highlights the electronics category as one of the major high-risk items imported to the USA with both human rights and environmental impacts (see Figure 6). In addition, the goods that are in the list with reported forced labor in Xinjiang region are as follows - Cotton, Electronics, Polysilicon, Footwear, Garment, Gloves, Hair products, Textiles, Thread/Yarn, Tomato products. And the electrical and electronic components (APPENDIX D) should be of prime concern to ABB Robotics considering its global supply base.

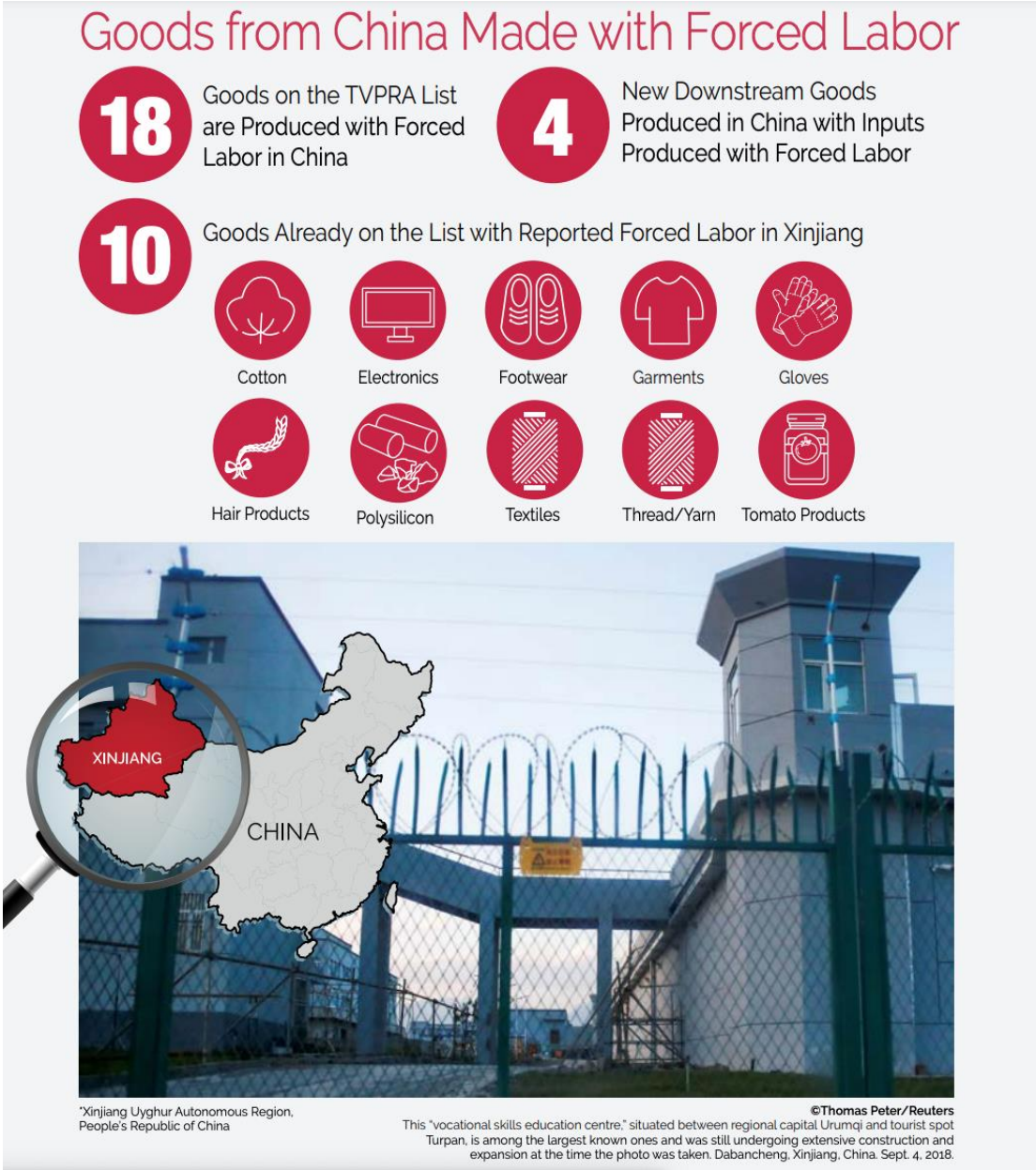


Figure 5: Goods from China made with forced labor (Source: TVPRA List of goods, 2022)

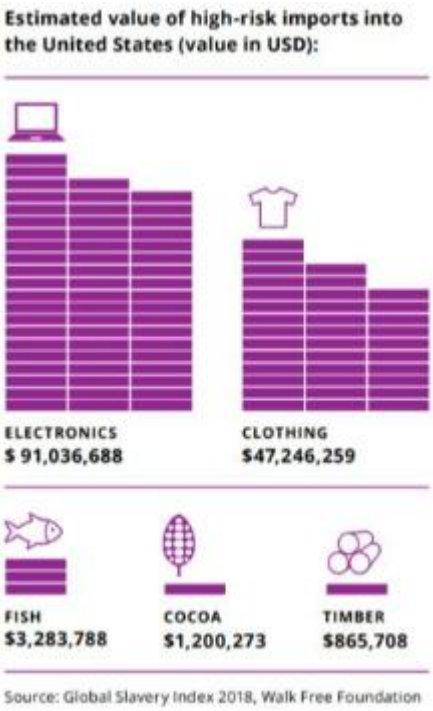


Figure 6: High-risk products imported to US (Source: Global Slavery Index 2018, Walk Free Foundation)

It is also noticed that US government authorities have identified four high risk sectors that has a potential adverse impact with human rights and environmental concerns. They are Apparel, Cotton and Cotton products, Silica-based products (including aluminum alloys, silicones, and polysilicon), Tomatoes and downstream products are the main identification. The UFLPA identifies Polysilicon as a high-priority sector and its process is described as shown in figure 7 are applicable to a violation of human rights. Similarly, Aluminum and PVC (Polyvinyl chloride) will be a new addition to the list and are also the main high-risk categories for ABB Robotics in its supply chain.

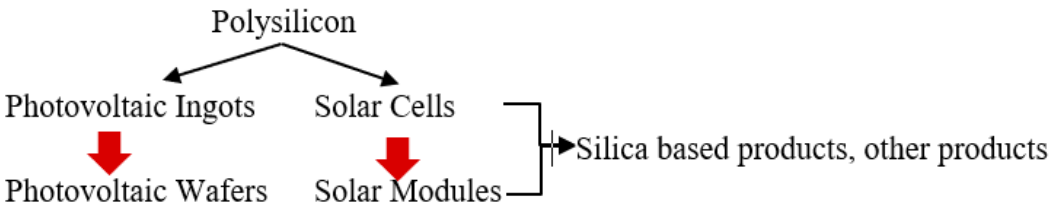


Figure 7: Polysilicon process

Silica-based products can be as mentioned below but are not limited (UFLPA - CBP)

- Component materials – Silicon, including metallurgical grade silicon, silicon oxide and certain silicones in primary forms.
- Intermediate goods – additives for aluminum alloys and concrete, integrated circuits, and semiconductor device.
- FG – adhesives, electronic, lubricants, photovoltaic cells, solar generators, solar panels, and parts thereof.

The suppliers operating in less stringent areas can be assessed with a risk-based approach where the goods and products are banned to be produced due to Forced or Child labor (DOI gov). And areas where less labor laws and environmental laws are associated with its supply chain can also be assessed. The materials such as Aluminum, Polyvinyl Chloride, Polysilicon: Silica-based products are of primary concern to ABB Robotics regardless of the location of materials and final goods that are produced which are linked to human rights exploitation and environment risk areas that should be assessed.

The high-risk categories could also be a strategic importance to ABB Robotics. Further, the organization must fulfill the corporate due diligence obligations in the supply chain regarding human rights and environmental issues. Hence, the identification of high-risk categories or sectors where there is a potential risk for both human rights and environmental issues is of prime importance in mapping the supply chain. This can be attempted through the risk-based approach. The risk-based approach assists ABB Robotics to determine on which area it should focus on while mapping its supply chain. By doing so it is possible to identify the high-risk categories/sectors in its supply chain and it enables to conduct more detailed mapping.

The Environmental hazards and modern slavery might potentially exist in any form in the company's supply chain. ILO estimates 27,6 million people in forced labor across the world. This can be due to the nature of the business, employment, and infrastructure, which can also enable suppliers to face risks. However, it is essential for companies to use moderation in their risk-assessment process and avoid giving all other businesses the same amount of risk exposure (Ehi. E. E, 2020). Therefore, as we focus on high-risk categories and places in this thesis, it would be preferable for ABB Robotics to use a risk-based strategy to monitor high-risk regions (Accountability Framework Initiative, 2019).

A factor to be considered while using a risk-based strategy in moderation (Ehi. E. E, 2020) is as below.
Country risks: - Risks may be increased in a company's global supply chain with threats to human rights, such as when persons from other countries are hired by a company using their official documents and identifications or when hiring is regularly conducted through agents.

Industry risks: Considering that people are trained for their specific duties, switching industries might be risky for them. For instance, the risks that might result in instances when employees are subject to forced labor, such as when they are required to work in the manufacturing sector's but pushed to work in mineral extraction companies.

Transaction risks: - Risks associated with transactions include money laundering, by which banks and other organizations assist in financing modern slavery and forced labor in a company's supply chain.

Company partnership risk: As we are aware, there are dangers involved in collaborating with different suppliers and in partnerships between companies since the first party will have better knowledge of the latter's operations and principles.

For instance, if enough due diligence is executed, the partnership firms' risks will be similarly low (Ehi. E. E, 2020). Therefore, there are certain tools and guidance for supply chain mapping

and due diligence frameworks that have been identified in this thesis (APPENDIX B) and to address forced labor abuses in global supply chain (APPENDIX C)

The identification of risks increases the resilience to act and address the future disruptions that occur in the supply chain. The risks in the supply chain helps to streamline the process and speed up the investigation process for the cause, strengthens and builds the stronger supplier relationship. Therefore, the identified risks lead to the prioritization of human rights and environmental issues that cause an adverse impact on ESG (Environmental, Social and Governance). Whereas it can be deeply prioritized to prevent and mitigate its impact in the supply chain. Hence, identifying the risky potential suppliers in the lower tier with the supply chain mapping helps ABB Robotics to prevent and mitigate the exploitation of forced and child labor. However, we have made a generic template (Table 3) that describes a basic element to conduct a risk assessment. In addition, working with tier-1 suppliers to deploy the risk mitigation program with lower tier suppliers can adhere to the environmental, social and governance requirements while tailoring the risk mitigation program.

Risk Assessment: The assessment of risk conducted can be based on the below questionnaires.

- Type of materials that are prone to Human rights and environmental issues.
- Regions or countries that are home to Human rights and environmental issues.
- Type of workers that are at utmost risk.

Table 3: Risk Assessment

Spend Category	Evaluation Criteria	Key stakeholders
BU Level	● Relative magnitude of impact/risk ● Leverage to improve. ● Nature of business relationship	● Supply Chain (SC) ● Procurement ● Production ● NGO ● Sales & HR ● Trade Unions and Workers

4.3 RQ3: How to map: What standards and methods are required for accurate and up-to-date mapping of ABB Robotics 'high-risk supply chain in terms of human rights and environmental issues?

This section focuses on the mapping standards and methodologies essential for ensuring transparency and compliance within ABB Robotics' supply chain.

4.3.1 Regulatory Framework and Compliance Implications

The legislations such as UFLPA, GSCDD (LkSG), CSDDD, Norwegian and others as mentioned above impose companies such as ABB Robotics and others to identify, prevent and mitigate the adverse impacts on Human rights violation and sustainability via their supply chain. These regulations and legislations address organizations to comply and act diligently while having transparency in their supply chain.

4.3.2 Global Traceability Standards and Accountability Framework Initiative for Due Diligence

Global Traceability Standard (2017) describes which data and traceability conditions are required for true transparency with legitimate visibility and access to accurate information across supply chains. However, the ESG (Environment, Social and Governance) lies with the Tier - 2, 3 & 4 suppliers and are also vulnerable to risks. This drives ABB Robotics to have visibility, traceability, and transparency in its supply chain by mapping down to its tier-n suppliers while embedding the due diligence. Furthermore, the due diligence initiative guided by the Accountability Framework Initiative (AFi) underlines the importance of supplier information management.

As we understand that mapping the supply chain is crucial and important, the CIPS (CIPS.org, 2013) proposes the steps on how to map the supply chain while mitigating the supplier risk and ensuring the business resilience. The first step is to recognize the risks posed by lower-tier suppliers. For instance, a lower-tier supplier's failure to supply due to unforeseen circumstances could have a rise and fall effect on the entire supply chain. Additionally, the unethical practices or activities by lower-tier suppliers, such as using forced or child labor, could negatively impact a brand's reputation.

To create visibility across all tiers of the supply chain, building a coordinated global supplier database and creating an accurate supply chain map detailing every supplier at every level is essential (CIPS.org, 2013). This requires a standardized approach to the management of supplier information, and automation is key to ensuring that all relevant information is linked to lower tier suppliers.

Incentivizing suppliers to engage in the mapping process involves effective communication that articulates the advantages, which include the capacity to assess risks within their supply chains and enhance their overall business resilience. Moreover, it is crucial to provide reassurance to suppliers that they have control over who can access their data and can uphold the confidentiality of their commercial information.

Finally, mapping a supply chain can be a complex and time-consuming exercise, and it is often more efficient and effective to work collaboratively within a community of shared suppliers. This makes it simple for independent companies to "cascade invitations" down the supply chain, and suppliers can determine what information to make visible to whom.

4.3.3 Multi-Tier Mapping: Navigating complexities

The mapping should be initiated based on a risk-based approach and is also stated in one of the legislations imposed by UFLPA and other legislations. The most vulnerable issues in the supply chain frequently are thrown by second tier suppliers or beyond in the upstream chain (Tachizawa & Wong, 2014). Therefore, ABB Robotics should have a remedy and action to address these regulations and legislations while complying with its due diligence initiative/actions. And to leverage its liability in the upstream supply chain through the practices like risk assessment with its due diligence compliance. If not, the implications of not fulfilling

or not complying with due diligence could lead to a reputational and brand impact along with the legal cost (XXX). Hence, with the less supply chain visibility or traceability the incident of violations with the exploitation of human rights and environmental impacts are hard to be recognized. This could be due to lack of information of the lower-tier suppliers (Kim and Davis, 2016), and it is hard to be governed without mapping the supply chain. Therefore, the supply chain mapping characteristics should be based on the number of tiers, length of the supply chain, list of products and geospatial representation.

4.3.3.1 Integrate Supply Systems Mapping & Supply Chain Network Structure

The hierarchical approach to supply systems mapping, as proposed by MacCarthy et al. (2022), offers a structured method to solve the complexities of ABB Robotics' high-risk supply chains. By employing the Supply Network Maps and Supply Chain Maps as a hierarchy and intertwining it with a Supply Chain Network structure proposed by Lambert et al (1998), ABB Robotics can delve into multi-tier levels within the supply chain.

Supply Network Maps provide a macroscopic view of industry connections, while Supply Chain Maps offer detailed insights into product flows and relationships. But in the relationship between Supply Network and Supply Chain an innovative way of integration lies i.e., Supply Chain Network structure. This approach can offer a comprehensive visualization of interplay between industries, firms, and product-specific flows. Supply Chain Network structure emphasizes the connections between suppliers, sub-suppliers, i.e., beyond tier-2 and the elaborated trails that lead to ABB Robotics final products. The incorporation of this holistic perspective can enable ABB Robotics to gain a distinctive view that spans from industry-level influences on the detailed complexities of product-specific flows.

4.3.3.2 Leverage Multi-Tier Mapping for Informed Decision-Making

Supply chain mapping plays a vital role in the verification and comprehension of suppliers across multiple levels or tiers within an organization's supply chain. While the structure of supply chains may differ among businesses, Tier-1 typically enjoys the highest level of transparency. This tier comprises direct suppliers and distributors, often accounting for a significant portion of expenses while contributing a relatively small percentage of revenue. On the other hand, Tier-2 includes sub-suppliers and usually exhibits lower visibility for most businesses. The tiers with the lowest visibility are typically Tier-3 and beyond, where supply chain risks tend to originate. Despite their lower spending, suppliers in these tiers frequently provide raw materials or critical components, making disruptions in these tiers potentially harmful to an organization's operations (Monczka et al., 2015).

Furthermore, even though Tier-3 suppliers have a smaller expenditure, their presence in the supply chain can potentially impact issues related to human rights exploitation and environmental concerns. Mapping the supply chain from the end-product down to its raw materials, with visibility and traceability extending to at least tier-3 suppliers is essential and is achieved in at least 85% of the supply chain (Gaur & Gaiha, 2020). Multi-tier mapping takes it a step further by incorporating supplier-validated data, offering a more precise representation of the supply chain (Tachizawa & Wong, 2014). This approach tackles the challenge of decreasing visibility as we delve deeper into the supply chain. Given that a significant number of disruptions originate from the indirect supply chain (Tier 2+), where visibility is often

limited, it is imperative to map the supply chain at least to tier-3 suppliers (Gupta et al., 2018).

The adoption of multi-tier mapping can equip ABB Robotics with a robust foundation for informed decision-making. The integration of Supply Systems Mapping (Supply Network Maps, Supply Chain Maps) and Supply Chain Network Structure mutually encourages ABB Robotics to identify critical nodes, potential vulnerabilities in its supply for the high-risk categories or to comply with the legislation requirements. This thorough understanding can channel strategic choices, risk mitigation efforts, and ethical sourcing decisions parallelly. By incorporating this approach multi-tier mapping becomes essential as it unveils dependencies, vulnerabilities, and risks embedded in lower-tier suppliers, contributing to a holistic understanding of the supply chain structure. Meanwhile, the embracement of multi-tier mapping enables ABB Robotics to navigate the complexity of its high-risk supply chain with intelligence and agility.

4.3.3.3 Advantages and Disadvantages of Multi-Tier Mapping

Multi-tier supply chain mapping offers several benefits while also presenting certain challenges. The advantages include the validation of suppliers by incorporating their input, which enhances accuracy and visibility (Gupta et al., 2018). Moreover, multi-tier mapping is crucial for meeting Environmental, Social, and Governance (ESG) compliance requirements (Tachizawa & Wong, 2014). However, this approach requires time to verify suppliers and can involve significant expenses. Nevertheless, it is important to emphasize that visibility is fundamental to achieving supply chain resilience, even though obtaining such visibility can be a time-consuming process (Monczka et al., 2015).

Multi-tier supply chain mapping, which integrates supplier-validated data, offers a more precise and comprehensive comprehension of the supply chain (Tachizawa & Wong, 2014). Extending the mapping process to lower tiers allows organizations to enhance visibility and mitigate supply chain risks (Monczka et al., 2015). Although this approach demands time and investment, the advantages it brings, including increased accuracy, ESG compliance, and improved supply chain resilience, justify the effort. The information collected for supply chain mapping should encompass data sources for materials, supplier details, shipping information such as the Bill of Lading (BOL), invoicing records, country of origin, mining records, transportation, and more. ABB Robotics can achieve complete transparency within its supply chain by automating data collection and analysis from suppliers and their sub-suppliers. Employing a multi-tier approach for supply chain mapping empowers ABB Robotics to attain traceability, transparency, and visibility within its supply chain. Furthermore, it facilitates compliance with regulatory requirements, enhances supply chain efficiency, and aids in recognizing the key players within its upstream supply chain, ensuring the verification of the supply chain flow.

The below steps could be followed as a method to map the upstream supply chain leading to visibility, traceability, and transparency.

- Identify stakeholder, Teir-1,2,3…..n
- Collect proof or verify linkages.
- Supplier discovery mapping, Transaction, High Risk region
- Raw Material (RM) - Automotive, Electronics, Renewables
- Link to Xinjiang – geographically in supply chain to comply with UFLPA legislation.

- Link to entity listed under UFLPA (APPENDIX A) (Source CBP) – if yes, then make a note in supply chain
- Look at the BOM and map out the supply chain process.
- Map down the current known database and look for unknown databases while mapping the supply chain via entities with information such as the Contracts, BOL (Bill of Lading), COO (Country of Origin), etc.

4.3.4 How ABB Robotics can obligate and comply with due diligence

To meet the social and environmental impact in the supply chain while complying to the legislation, the understanding of material origin in the network for sourced material is required while managing the supply chain with legal obligations. Hence the traceability and assessment of supply base in upstream supply chain is essential and to manage the compliance Accountability Framework initiative can be referred (Figure 2). The attributes such as location of supplier, certificates, audit results and so on can be beneficial to map the supply chain while knowing such information about suppliers to assess the risk and compliance (AFi). Whereas the traceability with the volume of product can help to include these attributes to the product volume (AFi).

4.3.4.1 Approaches to SC traceability, assessment, and due diligence

The supply chain tracing is a decisive stage to confront the due diligence and to know about the suppliers in the various levels of the upstream supply chain. Whereas, mapping the entire supply chain is an initial part of tracing activity which includes tier-1 suppliers and further down to the lower tier suppliers or raw material suppliers. The mapping of ABB Robotics supply chain should be that the more comprehensive it goes in its supply chain, the more accurately it can capture the risks of forced & child labor along with environmental issues from its upstream supply chain. In addition, refer to the APPENDIX B for the identified tools and guidance for supply chain mapping and due diligence framework.

- Identify and engage stakeholders such as non-governmental organizations (NGO's), company management and regulators.
- Understanding supplier relationships – Seek tier-1 suppliers to join the mapping suppliers and invite the tier-2 suppliers.
- Better understanding of potential risks and the bottlenecks
- Acknowledge the risks that are associated with each entity, including legal, political, economic, and environmental threats.
- Track the data using the digital technologies and is good when you have the information.

ABB Robotics currently follows the GRI (Global Reporting Initiative – Global standards for sustainability impact) reporting standards to portray its sustainability assessments. However, ABB Robotics can evaluate its tier-1 suppliers using the sustainability performance indicators that could capture the requirements or information of its lower tier suppliers. Followed by supplier surveys based on the environmental, health, safety, and labor practices along with the procurement practices used. In addition, DOL's Comply Chain system can enable ABB Robotics the way to act diligently with an effective due diligence system that includes the following features. For further information refer APPENDIX B.

- Engage stakeholders and partners.

- Assess risks and impacts.
- Develop a code of conduct.
- Communicate and train across supply chain.
- Monitor compliance.
- Independent review
- Report performance and engagement

In addition, ABB Robotics can emphasize to demonstrate the compliance with the utilization of Forced Labor Enforcement Task Force (FLETF) strategy that offers comprehensive direction regarding the due diligence process, supply chain tracing (and chain of custody), and measures for supply chain management that can be adopted while adhering to the human rights and environmental obligations. If ABB Robotics can meet the requirements of US-CBP (US Customs Border and Protection) and the ambitious standards that are established with UFLPA along with EU CSDDA, then it would be easy enough to comply with the other EU regulations in future such as EU proposal on the ban on products made with forced labor, etc.

4.3.5 Data for mapping

The supply network level shall avail the various data sources and information in the process like Geographical Information Systems (GIS), Harmonized System (HS) - products categorized, International Standard Industrial Classification (ISIC) (Frederick, 2019). In addition, several international trade datasets like UN Comtrade (monthly), EuroStar (regional level) could also be utilized for a network level (MacCarthy et al., 2022). Though these databases would not provide a connection on a product or BOM level where the ingoing item is not mapped or traced. MacCarthy et al., (2022) describes the other sources to keep a look on trade data could be OECD Inter-Country Input-Output and World Input-Output, as these feed on an industry level with inter-firms. Since, all this data feeds to map a supply chain on a network level while allowing it to further map down to different tiers of the chain along with the location (geographical). The supply network map would not showcase the structure of a specific firm with their connections in the chain which is a constraint to map on buyer-supplier or a product or BOM level. Hence, to map the supply chain on a product or BOM level it should collect the data or source on a buyer-supplier level (dyadic) and buyer-supplier-supplier level (triadic).

The Natural Language Processing technique can be used to pull and analyze the public text data to export the buyer-supplier relationships (Wichmann et al., 2020). However, the probability of accuracy level is still unknown (Wichmann et al., 2020) and the buyer-supplier data is quite critical and valuable but challenging to accumulate.

The databases curated to map the industry level network with connections between firms operating in a selected industry or in a group of related industries can be collected from the sources - Mergent Online Supply Chain, Compustat Supply Chain,Suite, Factset Revere Supply Chain, and Bloomberg SLPC MacCarthy et al., (2022). In addition, the Securities and Exchange Commission data is beneficial in locating the suppliers of publicly traded US companies. However, these are helpful for supply network mapping but not for supply chain mapping (MacCarthy et al., 2022).

The complexity of supply chain is quite high and once the mapping is performed it can become outdated at some level. Mapping a supply chain is not a one-time exercise – it is an ongoing activity that must be taken care on a regular basis, as the supply base and the supply chain can change rapidly. Therefore, to be more resilient and agile, the mapping of supply chain should be carried out on a regular basis and consistently. Besides all, the utilization or implementation of digital technologies such as blockchain, digital twins, artificial intelligence, etc, can become helpful to keep it up to date. MacCarthy et al (2022) suggests an alternative approach to map the supply chain with the use of digital technologies like Big Data. Also, adds that the start-ups like Everstream Analytics (DHL Resilience 360), Altana AI enables the organization to map the supply chain on a network level with multi-tier mapping. The data such as trade, product shipments, bills of lading, facility locations. A few to mention are Makersite, OpenSC, VersedAI. These digitalization tools can have an impact on the supply chain and to oversee its complexity much upstream.

The software or solution providers such as Sourcemap, Supplyshift, Resilinc, Sustainabil, Sedex, Prewave, Versed AI, IntegrityNext, etc could be a good try to make an impact with the utilization of digital technologies in an effective way. ABB Robotics can set up its risk mitigation according to local business levels or requirements while collecting the data through blockchain technology to know who is in the supply chain and where they come from. In addition, ABB Robotics can have a contractual clause or standardize the current code of conduct while seeking the suppliers to oblige with it by sharing or passing the same to its tier - 1 suppliers.

5 Recommendations

Due to globalization, supply chains with several tiers of suppliers have become increasingly complex, making it difficult to maintain openness and visibility along the whole supply chain. When compared, supply chain transparency broadens the definition of visibility to include sharing information with customers and other stakeholders (Dietrich et al., 2022). Transparency entails giving customers access to product information without including them in supply chain system design. The benefits of tracing and monitoring technology include not just making supply chains for businesses transparent and observable, but also giving companies advantages like high product quality, positive supplier relationships, and reduced supplier risks. Information sharing across ABB Robotics businesses, suppliers, and clients improves the sturdiness and robustness of globally operating value chains while also assisting external planning processes. As a result, ABB Robotics must manage increasing pressure from sources including customers, suppliers, and governments to maintain openness and visibility. Furthermore, to differentiate its brand from that of its rivals, ABB Robotics should concentrate on social and environmental sustainability problems.

Technology-wise, the supply chain structural layer is supported by distributed/decentralized systems (Dietrich et al., 2022). Companies who are required to disclose needs might use the distributed/decentralized database to map their supply chains. Individual suppliers must participate in multiple types of supply chains from various kinds of manufacturing organizations. As a result, suppliers are working with more groups. ABB Robotics could use technologies like blockchain technology as an alternative to the distributed database to serve as a single technical standard for their whole supply chain (Dietrich et al., 2022). According to

recent research, collaboration on the blockchain and increased supply chain visibility would be beneficial for the firms in their supply chain and may allow them to compete with their rival companies.

ABB Robotics may also add a layer for supply chain mapping incidents that could affect assets and their supply chains. Supply chain events mapping layer may make ABB Robotics supply chain structure more visible, allowing for the tracking of each significant supply chain event independently. The GS1 Event Product Code Information Services (EPCIS) standards are included in this layer of the supply chain event mapping, which helps to define the scope of the supply chain events. Different applications can produce and exchange event data that is visible to other applications as well as to companies. According to EPCIS, an event's "what," "when," "where," and "why" components include the event's subject, its time and date, its location, and its business context. Supply chain networks may cooperate and integrate their resources and commodities with virtual identities in the cloud to increase the flexibility and efficiency of ABB Robotics production operations. Applications like blockchain technology make it possible to track and map every step of the supply chain.

To cut down the resource intensive approach, utilization of digital technologies like blockchain, AI mapping can provide a quick solution for mapping the primary supply chain. It is also essential to integrate validation techniques to obtain a comprehensive understanding of the actual supplier network. Combining digital technologies with multi-tier mapping in a hybrid approach enables organizations to achieve both speed and coverage in their supply chain mapping efforts, thereby further strengthening their resilience in the face of disruptions. Furthermore, to assess the risk-relevant categories/sectors with raw materials, further down in the chain, the automated multi-tier mapping assists to establish transparency across all the levels. As this integration leads to leverage the advantages and mitigate the disadvantages, leading to the development of a more resilient supply chain (Gupta et al., 2018; Tachizawa & Wong, 2014). Therefore, we recommend adopting a hybrid approach that combines digital technologies with multi-tier mapping to optimize speed and coverage.

6 Conclusion

In conclusion, this thorough investigation shows how crucial it is for ABB Robotics to maintain human rights and guarantee environmental compliance diligently in its upstream supply chain. The difficulties identified in this study provide a reminder of the complex and varied nature of these important objectives. We understand how challenging it is for ABB Robotics to fulfill its ethical and sustainability goals without incorporating supply chain mapping and due diligence into its supply chain. The challenges found in this extensive investigation demonstrate just how many complex elements are at play in this incredible initiative.

6.1 Challenges

After the thorough analysis, we would also like to address certain challenges that has to be acknowledged and noted, while supply chain mapping and due diligence is essential for ABB Robotics to comply with human rights and environmental regulations.

6.1.1 Data Accuracy and Reliability

We would like to mention that despite mapping the supply chain as accurately as possible, there are still certain challenges and implications that arise in the mapping process. Accurate and reliable data collection from lower-tier suppliers can be challenging, as some suppliers may lack sophisticated systems or transparency. Meanwhile, the suppliers may tend not to share the information for mapping as they consider it as a proprietary data, or it might put a relationship at risk. Overcoming this challenge requires a collaborative effort between ABB Robotics and its suppliers to establish data-sharing protocols and ensure the integrity of information.

6.1.2 Resource Allocation

Supply Chain mapping is resource intensive and difficult to gather all the necessary information from the upstream supply chain, as suppliers change at any level in the upstream. The process of multi-tier supply chain mapping and continuous due diligence demands significant resources, both in terms of time and financial investment. Hence, ABB Robotics may need to allocate adequate resources to sustain these efforts and strike a balance between cost-effectiveness and comprehensive risk management. For instance, mapping the supply chain at product or BOM level linkage is time intense.

6.1.3 Regulatory Variations

ABB Robotics operates in a global marketplace with diverse norms and regulatory environments. The legal regulations also impose the continuous vigilance and adaptability to rapidly respond to the different regulations that evolves in different regions. Therefore, adapting supply chain practices to align with different regions requirements while maintaining a consistent ethical framework can pose a challenge and necessitates a thorough research and localized strategies to build a robust compliance mechanism.

The mutual benefit of transparency must be clearly communicated with the supplier, which should be of prime importance to achieve the trust and to break the barrier of supplier participation. Though the mapping is conducted effectively it is less assured to detect the supply correlations in an efficient way due to lack of information about the product flow. It is hard to witness which product is supplied to which customer on the supply chain map level and accurate level of data collection is costly. To sum it up with all these challenges, the mapping should not be just to gain the visibility in the upstream tier but also to assess the risk in the network that must be an iterative process and not a one-time process.

6.2 Further Investigation

Based on the insights from this study, we have pointed several opportunities for further investigation to be focused on and are as below.

Exploring innovative methods to engage stakeholders, particularly those in lower-tier supplier roles or beyond tier-2, can offer strategies to promote transparency, accountability, and cooperation. This can be followed by identifying effective communication channels and incentive systems that motivate lower-tier suppliers to actively participate and commit to

sustainable practices. Furthermore, investigating mechanisms to support suppliers in improving their ethical and environmental standards can contribute to a more sustainable supply chain. This may involve examining capacity-building programs and collaborative initiatives that empower suppliers to meet higher standards, thereby generating positive social and environmental impacts.

Moreover, further research can focus on the integration of environmental impact assessments into supply chain mapping and risk analysis. This approach can provide a more comprehensive understanding of the potential environmental risks associated with various suppliers, materials, and processes in the upstream supply chain.

We had a demo session to learn more about the process and methods used by one of the emerging solution providers i.e., Prewave is one among the other solution providers who offer to understand the supply chain mapping along with the utilization of digital technology. Prewave offers this solution to automotive companies like BMW, Audi, VW, Siemens, Porsche, etc.

Prewave uses the AI based tool, lists the suppliers accordingly and has an accessibility to open-source data, local news, and media for analysis. In addition, it addresses how organizations can comply with due diligence acts along with the better resiliency in its supply chain. The tier-n level of mapping is conducted down till the raw material level based on four sources of data i.e., private data, shared data, public information (annual report, various trade report, etc), predictive capability with the algorithm base and the likelihood. However, the level of accuracy depends on the correctness of supplier information.

The analysis and assessment of risk are based on the risk-based approach, commencing at the scanning level of supplier, industry, and country risk (geo-spatial). This assessment is conducted alongside other data such as spend and certification, converging to provide a comprehensive 360-degree view. However, during the session, a constraint became evident due to time limitations, particularly in the effective and accurate mapping of the supply chain at a specific-product or BOM linkage level. Similarly, we have certainly identified few more of them such as SourceMap, IntegrityNext, Sustainabil, Resilinc, Versed AI, World favor, etc. But due to time constraint we could not analyze them thoroughly. Therefore, we advise ABB robotics to further investigate the similar solution providers to find the right accuracy level of mapping their supply chain with the utilization of digital tools, to act and comply with different legislations and regulations with due diligences.

References:-

ABB. (2023). https://new.abb.com/products/robotics

Accountability Framework initiative, (2019). Operational Guidance on monitor verification. https://accountability-framework.org/fileadmin/uploads/afi/Documents/Operational_Guidance/OG_Monitoring_Verification-2020-5.pdf.

Alexis, B. and Leonardo, B. (2019). https://hbr.org/2019/08/what-supply-chain-transparency-really-means

Aljazeera. (2022, Nov 17). Australia's modern slavery law not working, report says. https://www.aljazeera.com/economy/2022/11/17/australias-modern-slavery-law-not-working-report-says

Andry, J, F., Nurprihatin. F., and Liliana, L (2022); "Supply Chain Mapping to Prepare Golden Generation 2045 for Future Technology Infrastructure" E3S Web Conferences 359. https://doi.org/10.1051/e3sconf/202235905004

Anna, C. (2022, December). The what, why, and how of supply chain mapping. Action sustainability. https://www.actionsustainability.com/what-why-how-supply-chain-mapping/.

Ansari, Z, N., and Qureshi, M. N (2015)., "Sustainability in Supply Chain Management: An Overview". https://web.s.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=0&sid=2b77a77a-91ac-4a39-be58-3e3e1edc0342%40redis

Bryman, A. (2008). Social Research Methods (3rd ed.). Oxford University Press

Bryman, A. (2016). Social Research Methods (5th ed.). Oxford University Press

B. L. MacCarthy, Wafaa A.H. Ahmed, and Guven. D (2022), "Mapping the supply chain: Why, what and how"? International Journal of Production Economics.

Bell, E. Bryman, A. & Harley, B. (2019). Business Research Methods (5th ed.) Oxford University Press.

Busse, C. Schleper, M.C. Weilenmann, J. Wagner, S. M. "Extending the supply chain visibility boundary Utilizing stakeholders for identifying supply chain sustainability risks," International Journal of Physical Distribution & Logistics Management Vol. 47 No. 1, 2017pp. 18-40.

Creswell, J.W. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage Publications.

Chopra, S. and Meindl, P. (2021). Supply Chain Management: Strategy, Planning, and Operation. Pearson Education.

Christopher, M. and Peck, H. (2012). Building the Resilient Supply Chain. International Journal of Logistics Management, 23(1), pp.3-4.

David E. Bond., Dean A. Barclay., Allison. K., and Matt.S (2022). Uyghur Forced Labor Prevention Act: Commercial Implications, Compliance Challenges and Responses. https://www.whitecase.com/insight-alert/uyghur-forced-labor-prevention-act-commercial-implications-compliance-challenges-and

David, E. et al. (2023). Supply Chain Compliance with Human Rights and Environmental Obligations.

Denzin, N., and Lincoln, Y., (2000), "The Landscape of Qualitative Research: Theories and Issues", SAGE publications Inc., Thousand Oaks, CA, USA.

Dr. Eike, W, G., and Fiona, C., (2022, February 04). Swiss usher in corporate reporting and due diligence mandates. Pinsent Mason https://www.pinsentmasons.com/out-law/news/swiss-usher-in-corporate-reporting-and-due-diligence-mandates (Assessed Apr 2023)

Dubois, A., & Gadde, L. E. (2002). Systematic combining: An abductive approach to case research. Journal of Business Research, 55(7), 553-560

Ehi, E. E. (2020), Using the risk-based approach to curb modern slavery in the supply chain, Journal of Financial Crime Vol. 27 No. 2, 2020 pp. 313-322. https://www.emerald.com/insight/content/doi/10.1108/JFC-05-2019-0056/full/pdf?title=using-the-risk-based-approach-to-curb-modern-slavery-in-the-supply-chain-the-anglo-american-and-marks-and-spencer-example.

European Court of Human Rights, Council of Europe. Accessed Mar 06, 2023. https://www.echr.coe.int/documents/convention_eng.pdf

Elaine. W., Brad. D., Emily. B., Dave. C., Madhuri., P (2022). Risk in the Supply Chain: Proposed Laws Seek Unprecedented Transparency https://businesslawtoday.org/2022/07/risk-supply-chain-proposed-laws-seek-unprecedented-transparency-fashion-sustainability-act/

Fabian Dietrich, et al., (2022). Towards a model for holistic mapping of supply chains by means of tracking and tracing technologies. 28th CIRP Design Conference, May 2018, Nantes, France.

Frederick, S., 2019. Global value chain mapping. In: Handbook on Global Value Chains. Edward Elgar Publishing, Cheltenham, UK, pp. 29–53.

Felicia. S. (2021). Biden signs Uyghur Forced Labor Prevention Act into law. https://www.washingtonpost.com/politics/biden-uyghur-labor-law/2021/12/23/99e8d048-6412-11ec-a7e8-3a8455b71fad_story.html

Gaur, V., & Gaiha, A. (2020). Building a Transparent Supply Chain. Operations and Supply Management. Harvard Business Review.

Giunipero, L.C. and Aly Eltantawy, R. (2004), "Securing the upstream supply chain: a risk management approach", International Journal of Physical Distribution & Logistics Management, Vol. 34 No. 9, pp. 698-713. https://doi.org/10.1108/09600030410567478

Hannes, K., Lockwood, C., & Pearson, A. (2012). A comparative analysis of three online appraisal instruments' ability to assess validity in qualitative research. Qualitative Health Research, 22(10), 1429-1436

Herbert, S. F. (2023), Dutch Legislators Propose Human Rights and Environmental Due Diligence Law, Herbert Smith Freehills. https://www.herbertsmithfreehills.com/latest-thinking/dutch-legislators-propose-human-rights-and-environmental-due-diligence-law (Assessed Mar 2023)

Hon, M. P. (2022, April 05). Australia ratifies International Forced Labour Protocol, Minister Of Foregin Affairs Mister For Women. https://www.foreignminister.gov.au/minister/marise-payne/media-release/australia-ratifies-international-forced-labour-protoco

Hugos, M., (2018). Essentials of Supply Chain Management. John Wiley & Sons.

ILO, Forced Labour, Modern Slavery and Human Trafficking, https://www.ilo.org/global/topics/forced-labour/lang--en/index.html (accessed 14 Mar 2023)

Jessica, B, H., Sabrina, A, B., Sharon, G, K, S., Laurie, c, W., Ethan, M,G. (2023, February 06). What Canada's New Forced Labour Reporting Law (Bill S-211) Means for Businesses. Bennett, Jones. https://www.bennettjones.com/Blogs-Section/What-Canadas-New-Forced-Labour-Reporting-Law-Bill-S-211-Means-for-Businesses

John, T. Gardner. and Martha C. Cooper (2011), "Strategic Supply Chain Mapping Approaches", Journal of Business Logistics, Vol. 24, Issue 2. https://doi.org/10.1002/j.2158-1592.2003.tb00045.x

Kai, L. (2022, December 12). EU Supply Chain Law Obliges Companies to Operate in a Fair and Sustainable Manner. EQS Group. https://www.eqs.com/compliance-blog/eu-supply-chain-law/

Kalaiarasan. R., (2022). "Supply chain visibility in the manufacturing industry: conditions and realisation". Licential Thesis in Production Engineering. https://www.diva-portal.org/smash/get/diva2:1694536/FULLTEXT01.pdf

Kim, Y.H., & Davis, G.F. (2016). Challenges for Global Supply Chain Sustainability: Evidence from Conflict Minerals Reports. Academy of Management Journal, Vol.59, No.6. Special Forum Research https://doi.org/10.5465/amj.2015.0770

Kovacs, G., & Spens, K. M. (2005). Abductive reasoning in logistics research. International Journal of Physical Distribution & Logistics Management, 35(2), 132-144.

Lambert, D, M., Martha, C, C., and Janus, D, P. (1998), "Supply Chain Management: Implementation Issues and Research Opportunities," The International Journal of Logistics Management, Vol. 9, No. 2, pp. 1-19

Caridi, M., Perego, A., and Tumino, A (2011), "Measuring supply chain visibility in the apparel industry". https://www.emerald.com/insight/content/doi/10.1108/14635771311299470/full/pdf?title=measuring-supply-chain-visibility-in-the-apparel-industry

Miller, G. T., and Spoolman, S. E. (2019). Living in the Environment. 20th ed. Boston, MA: Cengage Learning.

Monczka, R. M., Handfield, R. B., Giunipero, L. C., & Patterson, J. L. (2015). Purchasing process models: Inspiration for teaching purchasing and supply management. Journal of Purchasing and supply chain management. http://dx.doi.org/10.1016/j.pursup.2019.100577

Mubarik, M., Kusi-Sarpong, S., Govindan, K., Khan, S., A., & Oyedijo, A (2021), "Supply chain mapping: a proposed construct," International Journal of Production Research, https://doi.org/10.1080/00207543.2021.1944390

Michael, R. L, et al. (2022). Ropes & Gray. Complying with the Uyghur Forced Labor Prevention Act – a Detailed Compliance Roadmap. https://www.ropesgray.com/en/newsroom/alerts/2022/06/complying-with-the-uyghur-forced-labor-prevention-act-a-detailed-compliance-roadmap.

Patten, M.L. (2018). Understanding Research Methods: An Overview of the Essentials. Routledge.

Paulina, G. (2014). Environmental Issues in Logistics and Manufacturing, Environmental Issues in Automotive Industry. https://link.springer.com/content/pdf/10.1007/978-3-642-23837-6.pdf

Paulina, G. and Carlos, A. R. (2012). Environmental Issues in Logistics and Manufacturing. Environmental Issues in Supply Chain Management, https://link.springer.com/content/pdf/10.1007/978-3-642-23562-7.pdf

Proposal for a Directive of the European Parliament and of the council on Corporate Sustainability Due Diligence and amending Directive (EU) 2019/19377, COM(2022) 71 final, 23.2.2022. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022PC0071

Proposal for a Regulation of the European Parliament and of the council on prohibiting products made with forced labor on the Union market 2022/0269, COM(2022) 453 final, 14.9.2022. https://single-market-economy.ec.europa.eu/system/files/2022-09/COM-2022-453_en.pdf

Ruth, G. UK Modern Slavery Act failings point to need for global action on slavery, International Bar Association the global voice of the legal profession. https://www.ibanet.org/article/57FC8A75-2A33-422C-9274-E98E53056472

Somapa. S., Cools. M., Dullaert. W (2017). "Characterizing supply chain visibility – a literature review". https://www.emerald.com/insight/content/doi/10.1108/IJLM-06-2016-0150/full/pdf?title=characterizing-supply-chain-visibility-a-literature-review

Sandler, Travis & Rosenberg, P.A. (2023). Forced Labor Enforcement Efforts Expanded to PVC Products. WorldTrade Interactive, Inc. https://www.strtrade.com/trade-news-resources/str-trade-report/trade-report/february/forced-labor-enforcement-efforts-expanded-to-pvc-products

Shahbaz, M. S., RM Rasi, R. Z., Bin. M, F., Rehman, Z (2017). "What is Supply Chain Risk Management? A Review."

https://www.researchgate.net/publication/320762415_What_is_Supply_Chain_Risk_Management_A_Review

Simchi-Levi, D., Kaminsky, P., and Simchi-Levi, E. (2019). Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies. McGraw-Hill Education.

Simmons & Simmons LLP (2020, September 25). The Modern Slavery Act 2015. https://www.simmons-simmons.com/en/publications/ck9k5zaml7bx70900rg16tcqc/the-modern-slavery-act-2015 (Assessed Apr 2023)

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. Journal of Business Research, 104, 333-339. Doi: https://doi.org/10.1016/j.jbusres.2019.07.039

Solfrid, H, B., and Sarah, H, A. (2022, June 23). New Norwegian Transparency Act on social sustainability becomes effective as of 1 July 2022. Baker Mckenzie https://www.globalcompliancenews.com/2022/06/23/norway-new-norwegian-transparency-act-on-social-sustainability-becomes-effective-as-of-1-july-2022

Tara, N, and Cliodhnagh, C (2019), Supply Chain Visibility: Traceability, Transparency, and Mapping Explained https://www.bsr.org/en/blog/supply-chain-visibility-traceability-transparency-and-mapping

Tachizawa, E.M., & Wong. C.Y. (2014). Towards a theory of multi-tier sustainable supply chains: A systematic literature review. Journal of Supply Chain Management. http://dx.doi.org/10.1108/SCM-02-2014-0070

Thomas Y. Choi., Dale. R, and Bindiya. V (2020), "Coronavirus is a Wake-up call for Supply Chain Management" https://hbr.org/2020/03/coronavirus-is-a-wake-up-call-for-supply-chain-management

Thornhill, A., Saunders, M., & Lewis, P. (2009). Research methods for business students. London: Prentice Hall

U.S. Customs and Border Protection Operational Guidance for Importers., June 13, 2022 https://www.cbp.gov/sites/default/files/assets/documents/2022-Jun/CBP_Guidance_for_Importers_for_UFLPA_13_June_2022.pdf

U.S Customs and Border Protection (2023 April). The ultimate guide to Human Rights Due Diligence laws – who is affected and how to comply.

Worldfavour (2023) https://blog.worldfavor.com/the-complete-list-of-national-human-rights-due-diligence-laws-whos-affected-and-how-to-comply. (Assessed Mar 2023)

USCBP,(n.d. 2023) https://www.cbp.gov/sites/default/files/assets/documents/2023-Feb/Best%20Practices%20for%20Applicability%20Reviews_Importer%20Responsibilities_0.pdf

United Nations. (1945). Charter of the United Nations. Article 1, Section 3

United Nations General Assembly. (1948). Universal Declaration of Human Rights. Resolution 217(III) A. https://www.un.org/en/about-us/universal-declaration-of-human-rights

United Nations Global Compact. (2017). Guidance on responsible business in conflict-affected and high-risk areas: A resource for companies and investors. https://www.unglobalcompact.org/library/4851

Pereseina, V. L., Jensen, M., Hertz, S. "Challenges and Conflicts in Sustainable Supply Chain Management," Evidence from the heavy-vehicle industry. https://www.diva-portal.org/smash/get/diva2:690851/FULLTEXT01.pdf

White & Case, 2023 https://www.whitecase.com/insight-alert/supply-chain-compliance-human-rights-and-environmental-obligations

Wichmann, P., Brintrup, A., Baker, S., Woodall, P., McFarlane, D., 2020. Extracting supply chain maps from news articles using deep neural networks. Int. J. Prod. Res. 58, 5320–5336. https://doi.org/10.1080/00207543.2020.1720925

APPENDIX A - UFLPA Entity List

UFLPA Entity List are as below

A list of entities in Xinjiang that mine, produce, or manufacture wholly or in part any goods, wares, articles, and merchandise with forced labor Section 2(d)(2)(B)(i)
Baoding LYSZD Trade and Business Co., Ltd.
Changji Esquel Textile Co. Ltd. (and one alias : Changji Yida Textile)
Hetian Haolin Hair Accessories Co. Ltd. (and two aliases: Hotan Haolin Hair Accessories; and Hollin Hair Accessories)
Hetian Taida Apparel Co., Ltd (and one alias: Hetian TEDA Garment)
Hoshine Silicon Industry (Shanshan) Co., Ltd (including one alias: Hesheng Silicon Industry (Shanshan) Co.) and subsidiaries
Xinjiang Daqo New Energy, Co. Ltd (including three aliases: Xinjiang Great New Energy Co., Ltd.; Xinjiang Daxin Energy Co., Ltd.; and Xinjiang Daqin Energy Co., Ltd.)
Xinjiang East Hope Nonferrous Metals Co. Ltd. (including one alias: Xinjiang Nonferrous)
Xinjiang GCL New Energy Material Technology, Co. Ltd (including one alias: Xinjiang GCL New Energy Materials Technology Co.)
Xinjiang Junggar Cotton and Linen Co., Ltd.
Xinjiang Production and Construction Corps (including three aliases: XPCC; Xinjiang Corps; and Bingtuan) and its subordinate and affiliated entities

A list of entities working with the government of Xinjiang to recruit, transport, transfer, harbor or receive forced labor or Uyghurs, Kazakhs, Kyrgyz, or members of other persecuted groups out of Xinjiang Section 2(d)(2)(B)(ii)
Aksu Huafu Textiles Co. (including two aliases: Akesu Huafu and Aksu Huafu Dyed Melange Yarn)
Hefei Bitland Information Technology Co., Ltd. (including three aliases: Anhui Hefei Baolongda Information Technology; Hefei Baolongda Information Technology Co., Ltd.; and Hefei Bitland Optoelectronic Technology Co., Ltd.)
Hefei Meiling Co. Ltd. (including one alias: Hefei Meiling Group Holdings Limited)
KTK Group (including three aliases: Jiangsu Jinchuang Group; Jiangsu Jinchuang Holding Group; and KTK Holding)

Lop County Hair Product Industrial Park
Lop County Meixin Hair Products Co., Ltd.
Nanjing Synergy Textiles Co., Ltd. (including two aliases: Nanjing Xinyi Cotton Textile Printing and Dyeing; and Nanjing Xinyi Cotton Textile)
No. 4 Vocation Skills Education Training Center (VSETC)
Tanyuan Technology Co. Ltd. (including five aliases: Carbon Yuan Technology; Changzhou Carbon Yuan Technology Development; Carbon Element Technology; Jiangsu Carbon Element Technology; and Tanyuan Technology Development)
Xinjiang Production and Construction Corps (XPCC) and its subordinate and affiliated entities

A list of facilities and entities, including the Xinjiang Production and Construction Corps, that source material from Xinjiang or from persons working with the government of Xinjiang or the Xinjiang Production and Construction Corps for purposes of the ‘‘poverty alleviation’’ program or the ‘‘pairing-assistance’’ program or any other government-labor scheme that uses forced labor Section 2(d)(2)(B)(v)
Baoding LYSZD Trade and Business Co., Ltd.
Hefei Bitland Information Technology Co. Ltd.
Hetian Haolin Hair Accessories Co. Ltd.
Hetian Taida Apparel Co., Ltd.
Hoshine Silicon Industry (Shanshan) Co., Ltd., and Subsidiaries
Xinjiang Junggar Cotton and Linen Co., Ltd.
Lop County Hair Product Industrial Park
Lop County Meixin Hair Products Co., Ltd.
No. 4 Vocation Skills Education Training Center (VSETC)
Xinjiang Production and Construction Corps (XPCC) and its subordinate and affiliated entities
Yili Zhuowan Garment Manufacturing Co., Ltd.

APPENDIX B - Tools and Guidance for Supply Chain mapping and Due Diligence Frameworks

- Better Trade Tool - Integrate the supply chain transparency efforts and to report the social compliance. Also helps to understand the forced and child labor exploitation risks in the global supply chain with specific goods imported to US (www.dol.gov/agencies/ilab/better-trade-tool)
- Comply Chain - Steps to comply with the forced and child labor with due diligence for all the legislations. Business Tools for Labor Compliance in Global Supply Chains (www.dol.gov/ilab/complychain)
- Danish institute for Human Rights impact assessment guidance and toolbox - Offers a systematice guide and tools for execution, authorization, and evaluation of human rights impact assessments (https://www.humanrights.dk/business/tools/human-rights-impact-assessment-guidance-and-toolbox)
- Ethical Trade Initiative Due Diligence - Guide on human rights due diligence while recommending companies to prevent and manage the risks with a due diligence framework (https://www.ethicaltrade.org/resources/human-rights-due-diligence-framework)
- Know the Chain - Uses the benchmarking as a tool to identify and share the best practices while driving the industries/companies to adopt it to protect the welfare of labor. (www.knowthechain.org)
- Responsible Sourcing Tool - Visualize and understand the risks of human trafficking in supply chains (www.responsiblesourcingtool.org)
- STREAM (Supply Chain Tracing and Engagement Methodologies) with a collaboration of Verite - Supply Chain Traceability, Mapping and Due Diligence (www.dol.gov/agencies/ilab/streams-supply-chain-tracing-and-engagement-methodologies); (www.dol.gov/agencies/ilab/global-trace-protocol-project)

APPENDIX C – Resources to address forced labor abuses in global supply chains

The following list provides resources to help importers and others address forced labor abuses in global supply chains.
International Standards:

- The United Nations Guiding Principles on Business and Human Rights
- The Organisation for Economic Co-operation and Development (OECD) Guidelines for Multinational Enterprises (including sector-specific guidance)
- The ILO Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy
- The ILO publication, Combating Forced Labour: A Handbook for Employers and Business
- ILO Guidelines Concerning the Measurement of Forced Labor
- ILO General Principles and Operational Guidelines for Fair Recruitment
- International Organization for Migration's ethical recruitment standards

- The Office of the High Commissioner for Human Rights guide on The Corporate Responsibility to Respect Human Rights (OHCHR guide).
- The U.S. Department of Labor's Findings on the Worst Forms of Child Labor
- The U.S. Department of Labor's List of Goods Produced by Child Labor or Forced Labor
- The U.S. Department of Labor's List of Products Produced by Forced or Indentured Child Labor
- Federal Acquisition Regulations
- National Action Plan on Responsible Business Conduct
- The updated Xinjiang Supply Chains Business Advisory (July 2021)
- The U.S. Customs and Border Protection's Reasonable Care: An Informed Compliance Publication and other relevant publications
- The U.S. Customs and Border Protection's Forced Labor website resources
- The U.S. Customs and Border Protection's Withhold Release Orders and Findings, including those involving China and Xinjiang, and related FAQs that may aid importers in identifying additional merchandise, regions, and producers whose imports into the United States may be subject to exclusion and/or seizure.

Other:

- Group of Seven (G7) Trade Ministers 'Statement on Forced Labor
- The Human Trafficking Legal Center's guide, Importing Freedom: Using the U.S. Tariff Act to Combat Forced Labor in Supply Chains.

Combating Forced Labour: A Handbook for Employers and Business, International Labour Organization, (June 25, 2015) https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---declaration/documents/publication/wcms_101171.pdf.

Comply Chain, U.S. Department of Labor, https://www.dol.gov/ilab/complychain/ (last visited Apr 20, 2023).

Findings on the Worst Forms of Child Labor, U.S. Department of Labor, https://www.dol.gov/agencies/ilab/resources/reports/child-labor/findings (last visited Apr 08, 2023)

General Principles and Operational Guidelines for Fair Recruitment, International Labour Organization (2019), https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---migrant/documents/publication/wcms_536755.pdf

Guidelines Concerning the Measurement of Forced Labor, International Labour Organization (2018), https://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/meetingdocument/wcms_648619.pdf.

Guidelines for Multinational Enterprises, Organisation for Economic Co-operation, and Development, https://www.oecd.org/corporate/mne/ (last visited Apr 19, 2023)

G7 Trade Ministers 'Statement on Forced Labor, GOV.UK (Oct. 22, 2021), https://www.gov.uk/government/news/g7-trade-ministers-statement-on-forced-labour-annex-a

Importing Freedom: Using the U.S. Tariff Act to Combat Forced Labor in Supply Chains, The Human Trafficking Legal Center (June 2020),

https://htlegalcenter.org/?smd_process_download=1&download_id=4935
National Action Plan on Responsible Business Conduct, U.S. Department of State (June 22, 2021), https://www.state.gov/responsible-business-conduct-national-action-plan/

Reasonable Care: An Informed Compliance Publication, U.S. Customs and Border Protection (Oct. 25, 2017), https://www.cbp.gov/sites/default/files/assets/documents/2020-Feb/icprescare2017revision.pdf (last visited Mar 25, 2023).

Strategy to Prevent the Importation of Good Mined, Produced, or Manufactured with Forced Labor in the People's Republic of China (dhs.gov)

See Forced Labor, U.S. Customs and Border Protection, https://www.cbp.gov/trade/forced-labor/ (last visited Mar 25, 2023)

The IRIS Standard Report Version 1.2, International Organization for Migration: IRIS Ethical Recruitment, (2019) https://iris.iom.int/sites/g/files/tmzbdl201/files/documents/IRIS%20Standard%20Report%20.pdf.

The Corporate Responsibility to Respect Human Rights, UN Human Rights Office of the High Commissioner (June 1, 2012), https://www.ohchr.org/sites/default/files/Documents/Publications/HR.PUB.12.2_En.pdf.

Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy, International Labour Organization, https://www.ilo.org/empent/areas/mne-declaration/lang--en/index.htm (last visited Apr 19, 2023)

UN Guiding Principles on Business and Human Rights, Business & Human Rights Resource Centre, https://www.business-humanrights.org/en/big-issues/un-guiding-principles-on-business-human-rights/ (last visited Apr 19, 2023)

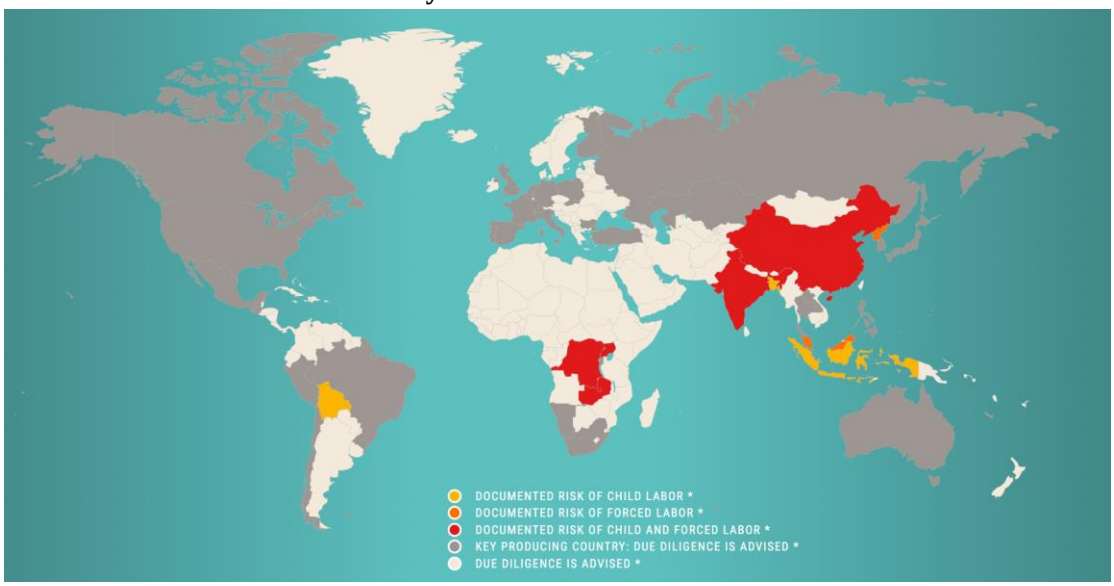
Uyghur Forced Labor Prevention Act, U.S. Customs and Border Protection, https://www.cbp.gov/trade/forcedlabor/UFLPA (last visited May 19, 2022)

Xinjiang Supply Chain Business Advisory.

2020 List of Goods Produced by Child Labor or Forced Labor & List of Products Produced by Forced or Indentured Child Labor

APPENDIX D - Electrical & Electronics Industry Risk

Electrical and Electronics industry Risk – Forced & Child Labor



Source: - Responsible sourcing tool.

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SERVICE MANAGEMENT AND LOGISTICS
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se

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