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# Human-Centered System Design for Global Supply Chain

Sheng-Hung Lee<sup>a, b, d</sup>, Olivier L. de Weck<sup>c</sup> and Joseph F. Coughlin<sup>d</sup>

<sup>a</sup> MIT Integrated Design & Management (IDM); <sup>b</sup> MIT Department of Mechanical Engineering;

<sup>c</sup> MIT Department of Aeronautics and Astronautics; <sup>d</sup> MIT AgeLab

*The study discusses the global supply chain from the perspective of “people” including labor, workers, staff, leaders, and the company’s structure, culture, and codes around them. The objective is to analyze global supply chains through a human-centered system framework considering the desirability of people, feasibility of business, and viability of technology to achieve “true” sustainability in the dimension of individuals, communities, and companies. The study uses literature reviews, expert interviews, and case studies to illustrate the importance of workers’ human rights, working conditions, and environment and explore how to create value for people while bringing profits for companies.*

*The topic of the supply chain is a large complex system-level social challenge consisting of many diverse components including product materials, logistics, transportation, people, government, community, regulations, and many other factors. Apple says: “The complex and global network of businesses that provide goods, labor, and services to Apple comprise our supply chain. We define our supply chain broadly, including everything from the places where our suppliers’ source raw materials; the design, engineering, manufacturing, and recycling of our products; logistics, sales, and support functions; and suppliers that support Apple services”; whereas Nike defines supply chain as responsible sourcing, focusing on foundational expectations; gender equity; health & safety; worker engagement and wellbeing; and environmental responsibility.*

*Academia has also started to emphasize the people’s human rights, education, welfare, and quality of life, and ethical issues in the supply chain. Sustainable supply chains not only consider the savings and profits of companies. When we discuss sustainable supply chains, we need to think about their impact on the community. How does the supply chain impact people’s human rights, welfare, cost, and quality of life? There are many topics and perspectives to look at in the global supply chain industry. In the study, we focus not only on the company level but also on the scale of society. We’ve hypothesized that there is no perfect global supply chain d. It depends on how we define what is the perfect sustainable global supply chain system.*

*We might simplify the challenges of the global supply chain for research, especially when we emphasize the scope of people and human rights. Labor is not portable and they are not a substitute, whereas capital is portable. Therefore, we need to acquire a much more comprehensive understanding of the tensions between cost and resilience. People working in the supply chain industries should be protected by the law or company code because they have the right to work in a safe, healthy environment to contribute their expertise and be treated with respect and dignity regardless of their positions, titles, and nationalities. Companies should establish provisions for staff to protect their rights and keep them safe and healthy physically and psychologically. The human side of technology is as critical as the technology itself. To build a sustainable global supply chain to spark resilience, recovery, and growth, we need to first consider people, profit, and our planet holistically to create a positive social impact on our communities.*

**Keywords:** Global Supply Chain; Sustainability; Community; Human-Centered System Design; System Architecture

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\*Corresponding author: **Sheng-Hung Lee** | e-mail: [shdesign@mit.edu](mailto:shdesign@mit.edu)

# 1. INTRODUCTION

The topic of the supply chain is a large complex system-level social challenge consisting of lots of diverse components including product materials, logistics, transportation, people, government, community, regulations, and many other factors. Apple defined its supply chain as follows: “The complex and global network of businesses that provide goods, labor, and services to Apple comprises our supply chain. We define our supply chain broadly, including everything from the places where our suppliers source raw materials; the design, engineering, manufacturing, and recycling of our products; logistics, sales, and support functions; and suppliers that support Apple services” (Apple, 2021), whereas Nike defines supply chain as a responsible sourcing, focusing on foundational expectations; gender equity; health & safety; worker engagement and wellbeing; and environmental responsibility (Nike, 2021).

In academics, universities and institutes have also started to reflect and emphasize the people in terms of their human rights, education, welfare, quality of life, and ethical issues in the supply chain system (Bateman et al., 2021; Bateman, 2020). "Sustainable supply chains do not mean to only consider saving and the profits of the companies. They will figure it out. We need to think about its impact on the community when we discuss the topic of sustainable supply chain. How does the supply chain impact people: human rights, welfare, cost, and quality of their lives? Capital is portable, but people are not portable," said Professor Timothy Gutowski, Department of Mechanical Engineering at Massachusetts Institute of Technology (MIT Course: 2.S985 Exploring Sustainability at Different Scales).

In this paper, we studied the concept of the supply chain through the lens of “people,” which covers labor, workers, staff, leaders, and the organization/company’s structure, culture, and codes around them. Our objective is to envision and analyze global supply chains through a people-based framework considering the desirability of people, the feasibility of business, and the viability of technology to achieve “true” sustainability in the dimension of individuals, communities, and companies.

Figure 1. presents the global supply chain system evolution and how we envision it to be in this study through establishing a standard to protect people and codes of conduct to refine labor rights. Ultimately, we think not only that dedicated staff or positions to monitor supplier’s actions should be in place, but also companies or organizations can and must cultivate a people-centered framework towards outsourced labor management and labor-related issues.

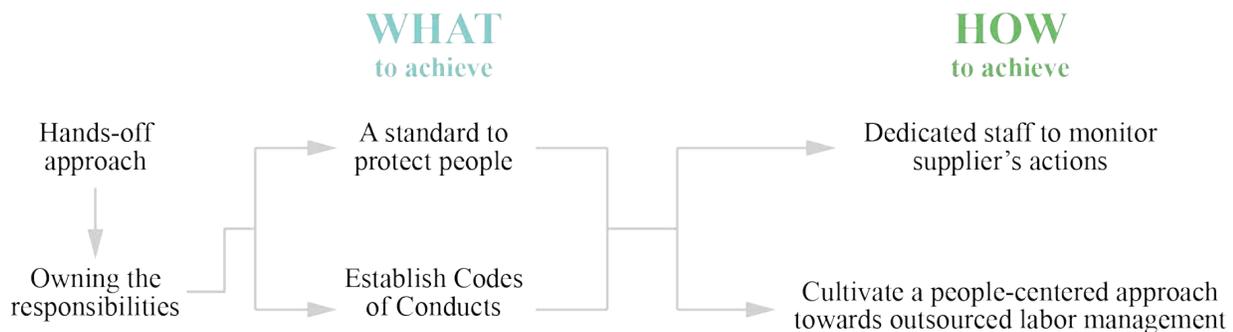


Figure 1. The evolution of the global supply chain system (designed by Sheng-Hung Lee and Nayeli Arellano).

# 2. LITERATURE REVIEW AND INTERVIEW

## 2.1. Global Supply Chain

According to the MIT State of Supply Chain Sustainability 2021 report, companies and organizations have raised significant interest not only in environmental issues, but also in social problems: human rights protection, worker welfare, labor, and safety. Since the pandemic in 2020, companies and corporate goals have been reprioritized (Bateman et al., 2021). Dr. Alexis Bateman, Director of MIT Sustainable Supply Chains Initiative, mentioned in her State of Supply Chain Sustainability presentation that companies have very different levels of commitment and investment in the current Sustainability Issues (Figure 2). Historically, environmental issues are more emphasized than social issues, though lately this has changed and more focus has been placed on the social aspect of the topic. Said social aspect among others goals is ranked highest, above even than the eradication of child labor and forced or slave labor. In response to solve the above mentioned issues, from the survey and research, Figure 3 indicates

that organizations across industries usually initiate standards or establish supplier codes of conduct (Bateman, 2020).

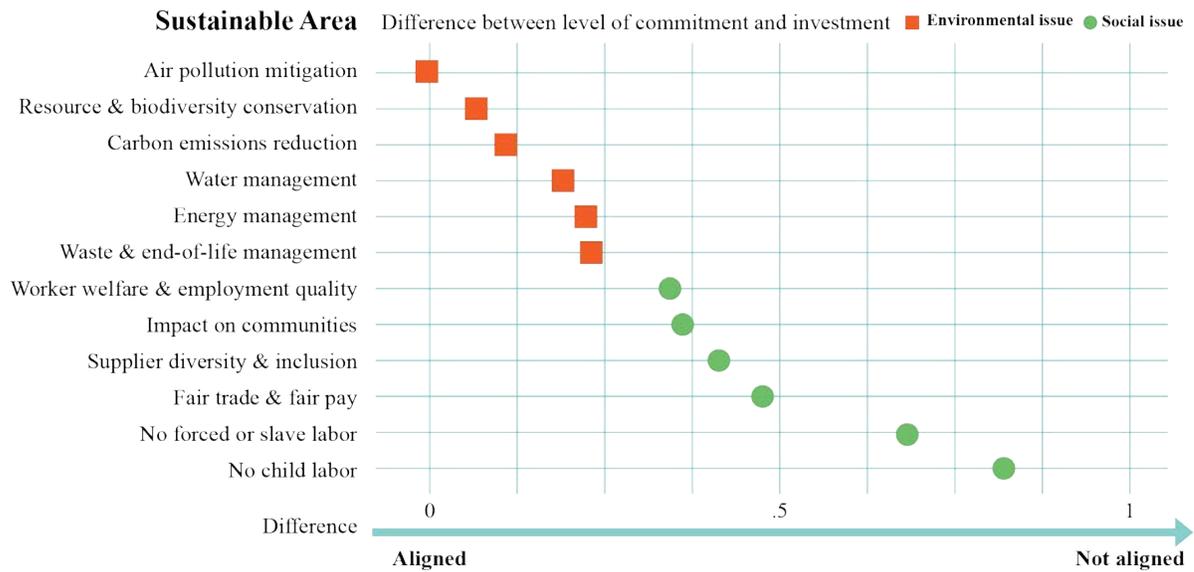


Figure 2. Companies' goals and investments diagram from Dr. Alexis Bateman's research (Bateman, 2020) (Re-illustrated by Sheng-Hung Lee)

Apple's 2021 progress report—People and Environment in Our Supply Chain—echoes the importance of human/labor rights, including: working hours, wages, benefits, and contracts, anti-discrimination, grievance mechanism, anti-harassment and abuse, prevention of involuntary labor, prevention of underage labor, protected class, freedom of association and collective bargaining (Apple, 2021, p. 29), which aligns Apple's vision, mission, and what Tim Cook, CEO of Apple said, "Apple is a technology company, but we never forget that the devices we make are imagined by human minds, built by human hands, and are meant to improve human lives."

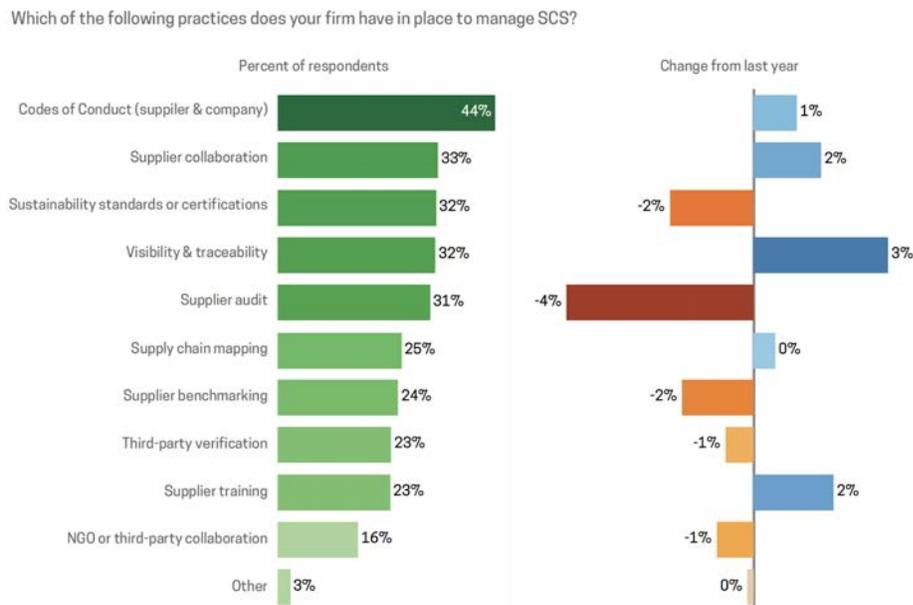


Figure 3. Practices in 2020 and year-over-year change from 2019 to 2020. N = 616 (2019) & 1,561 (2020) (Bateman et al., 2021).

In academia, Greg Distelhorst and Richard M. Locke used the data and information of companies (e.g., retailers and manufacturers) to analyze how firm-level trade influences the social standards around the globe (Distelhorst & Locke, 2018). Richard M. Locke pointed out that protecting workers and their human rights needs the support of a combination from the firm-level contribution, government effort, and solid and long-lasting supply-chain connections. He validated this assumption by collecting factory-level audit data and comprehensive interviews from country to country to find the sophisticated relationships, high-level pain points, and potential opportunity areas of interest to explore the key factors affecting workers rights and to demonstrate under what scenarios we can make improvements and achieve social impact (Brady, 2014; Locke, 2013).

Locke and Monica Romis proposed a new model for improving labor standards (Figure 4) and their research highlights how the fragmentation of the supply chain (and the short-term nature of relationships between retailers and their suppliers) has put downward pressure on workplace standards. Corporate brands' labor codes of conduct have proven insufficient, and governments must play a more substantive role in oversight (Locke & Romis, 2006).



Figure 4. Model of Code of Conducts Comparison (Locke & Romis, 2006)

(Re-illustrated by Sheng-Hung Lee)

When we discuss a people-based framework for the global supply chain, we also view this topic through the lens of consumers. The concept of an open supply chain, OpenSC, is a great example. The OpenSC makes items and processes traceable and transparent by three steps: verify, trace, and share (Open Supply Chain, 2019). “Verify claims about responsible production at source; trace products throughout the supply chain; share that information with consumers to promote responsible purchasing,” said Markus Mutz, CEO, and Co-Founder of OpenSC (Mutz, 2020). They aim to provide detailed information with consumers and use AI/machine learning to help customers make purchasing decisions that people think are decent and responsible, which ties to OpenSC’s vision: “Our transparency solution drives responsible consumption.” The vision and approach of OpenSC can be applied and extended to the other six categories: origin, environment, social impact, animal welfare, health, and safety.

## 2.2. Expert Interview

We conducted an hour-long in-depth expert interview with Dr. David Correll. He is a lecturer and a research scientist at the MIT Center for Transportation and Logistics (CTL), where he also serves as Co-Director of the MIT FreightLab and as a Course Lead in the MITx MicroMaster’s in Supply Chain Management program. We recorded the interview session for the purpose of research and summarized the discussion into the below shown key takeaways:

- Interviewee: Dr. David Correll, MIT Center for Transportation and Logistics (CTL)
- Interview Moderator and Note Taker: Sheng-Hung Lee and Nayeli Arellano
- Interview Time and Date: 15:00~16:00, November 24, 2021
- Interview Key Takeaways:
  - We need to consider the concept of visibility upstream, because the further we go down the supply chain, the harder it is for us to track impact, environmentally and socially. Knowing who are the major

players upstream in the supply chain could also help us figure out who would be responsible for what part of the process and its consequences.

- We should think more about the importance of data traceability of the items/products we use every day e.g., source map.
- The diamond shape of the supply chain. What if we reverse the service delivery process from the result to the origin? What happens to our suppliers in between?
- Motivation: Some firms recognize that their power/impact can greatly influence the supply chain e.g., IKEA, Unilever. Therefore, they treat their people and culture well with social responsibility.
- People are now more aware of how things are made. They are starting to consider their product's sustainable issues and their carbon emission-related issues as well. The consumers are starting to look at who they buy their products from and what are the other available options while purchasing.
- We can think about the justice of access in the context of the supply chain. How do we reveal the value of justice in the supply chain system?
- As we evolve, we see things more holistically. We grow more conscious of us as a community, and our connection and consequential effect in the natural world.
- In regards of labor, clearly the supply chain has had an impact on our society. How can we find a quantifiable way to measure said impact? This has proven to be a tough question to answer. Companies need to consider the unmeasurable social components, especially those surrounding labor. "You cannot measure what you protected yourself from." Until companies are fully transparent with their practices, this will most likely continue to be an unquantifiable topic.
- How should companies communicate their Sustainability practices to their consumers in a clear and digestible way? What is the to-the-point information of products/things that the consumers need to know?
- We should try not to be too descriptive when we discuss the word "sustainability". It should be left open. There are many different situations and factors to consider. It is an industry-driven/industry-based and context-driven word. We cannot over simplify the word "sustainability."

### 2.3. System Architecture

In this study, we applied a selected system architecture framework adapted by Professor Wood's research (Wood, 2012) to help analyze the data and material in the literature reviews (Figure 5.). The system architecture, system engineering, and system thinking approaches and frameworks help us view the whole global supply chain as a complicated system and make us study this topic as a large complex systemic socio-technological challenge, which enables us to think mindfully and to define the relationship of each element and sub-system within the system (Wood, 2012). We can use the "ilities (De Weck et al., 2013)" to measure the complexity of the supply chain system and to use the concept of "emergence (Crawley et al., 2016)" to evaluate the uncertainty and conditions' unpredictability of the systems to have better clarity to study the subjects and to identify the key system stakeholders and their objective (Ovienmhada et al., 2021) to realize the root cause of the challenges (Table 1).

## 3. DISCUSSION

### 3.1. Critical Questions

The study explores how we envision a people-based framework for the global supply chain considering the desirability of people, the feasibility of the business, and the viability of technology to achieve "true" sustainability in the dimension of individuals, communities, and companies. Since a sustainable global supply chain consists of a series of large complex and systemic socio-technological challenges, there are many aspects that we need to take into serious and comprehensive consideration, especially when we focus on the element/sub-systems of people in the global supply chain systems in this study. Hence, we suggest considering the following critical questions and observations to give us more holistic perspectives:

This is a big problem with global implications. An incremental change is needed since change happens a little at a time. Is outsourcing labor in developing nations fair for workers in developed countries? How do we ensure we are not just creating a new problem? How can we make sure companies create long-lasting solutions? Can we secure long-term employment in developing nations?

Though we cannot answer all the questions, we found papers stating that when outsourcing labor, companies should aim for a mutually reinforcing cycle in which more efficient plants invest in their workers, who, in turn,

promote improvement throughout the factory, rendering these facilities yet more efficient and thus capable of producing high-quality goods on time and at cost while also respecting corporate codes of conduct.

Firms should be able of preventing any violation to their workers integrity by providing the skills, technology, and organizational support to their suppliers. In return, this would enable factories to enforce labor standards on their own. If brands provide their suppliers with the technical know-how and management systems required to run more efficient businesses and allow them to invest in higher wages and better working conditions, these factories would be able to deliver high-performance operations.

What is a universal standard of a people-centered supply chain? Can we standardize and still leave room for variation? What should the basis of this standard be? How do you measure it? Should we have tolerances based on region-specific requirements? How do you maintain a minimum level of transparency in a people-centered supply chain model? There does not seem to be a universal standard in place, and given the previously mentioned “unquantifiable” aspect of this topic, it will take time, work and full cooperation from firms to develop it.

In the past, most brands relied on manufacturers and suppliers that were located within their home countries or were vertically integrated multinational corporations that owned their subsidiaries in foreign markets. Today, lead firms are coordinating the production of thousands of independent suppliers located for the most part in developing countries. In many cases, the governments of these nations hosting these new factories lack the institutional capacity to regulate labor, health, safety, and environmental standards. Moreover, they often intentionally overlook their own laws for fear of driving up costs and thereby repelling foreign investment, jobs, and tax revenues.

Without a doubt, communities in developing countries are negatively impacted by the lack of global labor regulations. Nowadays, improving global labor standards is still a challenge that begins with the complexity of today’s supply chains. The key seems to be in data. Being able to trace and record valuable information across the entire supply chain will bring us closer to smart, efficient, safe, and healthy labor conditions worldwide.

### 3.2. Analyze Literature Material and Data through System Architecture

When we look at the research topic—People-based Framework for Global Supply Chain, we define it as a large complex systemic challenge. A supply chain consists of lots of subsystems and elements such as product, material, manufacturing, transportation, labor, regulation, government, cost, and people. People are the one subsystem we want to emphasize in the context of the global supply chain system, to explore its influence on social aspects and impacts (Lee, 2021). Therefore, we applied the system architecture framework adapted by Professor Wood’s research (Table 1) to discover its external context, system boundary, constraints or opportunities, emergent properties (unexpected things in the system), system stakeholders and their objectives, system forms, and system functions (Ovienmhada et al., 2021).

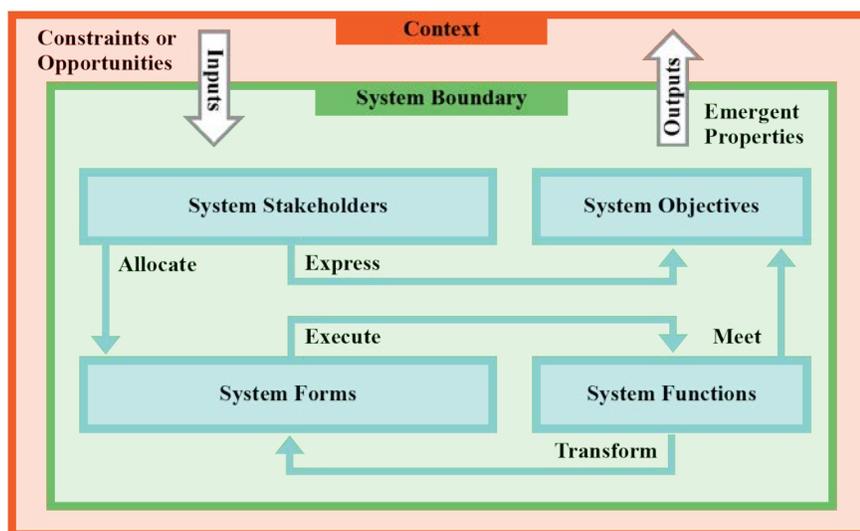


Figure 5. System architecture framework (Re-illustrated by Sheng-Hung Lee)

External Context	System Boundary	Constraints or Opportunities (Input)
The topic of the supply chain is a large complex system-level social challenge consisting of lots of diverse subsystems/components from product materials, logistics, transportation, people, government, community, regulations, and many other factors.	The study focuses on people in the global supply chain system. We view people as one of the subsystems in the global supply chain including human rights, labor-related issues, welfare, tax, healthcare insurance, quality of life, and how these elements impact our society from the global supply chain.	<ul style="list-style-type: none"> <li>• What is a universal standard of a people-centered supply chain? Can we standardize and still leave room for variation? What should the basis of this standard be? How do you measure the standard? Should we have tolerances based on region-specific requirements?</li> <li>• How do you maintain a minimum level of transparency in a people-centered supply chain model?</li> </ul>
Emergent Properties		System Stakeholders
<ul style="list-style-type: none"> <li>• Is outsourcing labor in developing nations fair for workers in developed countries? How do we ensure we are not just creating a new problem?</li> <li>• How can we make sure companies create long-lasting solutions? Can we secure long-term employment in developing nations?</li> <li>• How can we use technology for smart, efficient, safe, and healthy labor conditions?</li> </ul>		<p>Who are the “clients” of the sustainable supply chains?</p> <ul style="list-style-type: none"> <li>• Investors (product strategy, business plan, marketing)</li> <li>• Community (people, job opportunity)</li> <li>• Government (regulation, countries)</li> <li>• Employees (human rights, welfare, healthcare insurance)</li> <li>• Company (tax, labor, manufacturing, relocation, job opportunities, organization structure, outsourcing)</li> </ul>
System Objectives	System Forms	System Functions
How might we envision a people-based framework for the global supply chain considering the desirability of people, the feasibility of the business, and the viability of technology to achieve “true” sustainability in the dimension of individuals, communities, and companies?	The system can consist either in a physical form or informational form (Crawley et al., 2016). People, labor, staff are physical system forms, whereas their human rights, labor-related issues, welfare, tax, healthcare insurance, and quality of life are informational.	System functions are defined by their forms. Each physical system form and informational system form has different functions. The majority function of people-based framework for the global supply chain to deliver robust sustainability solutions in the dimension of individuals, communities, and companies to achieve the desirability of people, the feasibility of the business, and the viability of technology.

Table 1. Summary of applying system architecture framework to analyze a people-based framework for the global supply chain.

## 4. SUMMARY

There are lots of topics and perspectives to look at in the supply chain industry. In the study, we focus not only on companies and organizations’ level but also on the scale of society. We organized the information and prioritized it focusing on people and human rights in the context of the global supply chain. The intention of the research is beyond discussing how to make companies successful in terms of their business and profit. The aim is to raise people’s awareness on caring about human rights, people, and labor problems in the global supply chain, to make our society better through referencing a people-based framework as a first step.

We’ve made a hypothesis that there is no perfect global supply chain in the world. It depends on how we define what is the perfect sustainable global supply chain system. We might easily simplify the situation and challenges of the global supply chain for the research analysis, especially, when we emphasize the scope of people and human rights. Labor is not portable and they are not a substitute, whereas capital is portable (Banerjee & Duflo, 2019). Therefore, we need to acquire much more comprehensive and deep understanding to study this topic in the tensions between cost and resilience. People who work in the supply chain industries should be protected by the law or company code because they have the right to work in a safe and healthy environment to contribute their expertise and be treated with respect and dignity regardless of their positions, titles, and nationalities. The

companies should establish provisions for their staff not only to protect their rights but also to make them safe and healthy physically and psychologically.

The human side of technology (Brach, 2012) is as critical as the technology itself. When we want to build a sustainable global supply chain to spark resilience, recovery, and growth, we need to first consider people, profit, and our planet holistically to create a positive social impact on our communities.

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