Digital Technology Adoption for Modern Slavery Risk Mitigation in Supply Chains: An Institutional Perspective

Abstract

Tens of millions of people worldwide – at a minimum – are victims of modern slavery (MS), including various forms of human trafficking, forced labor, and child labor. In the current digitization era, digital technology may be used to recruit or control MS victims, but it also has the potential to mitigate MS risks in supply chains. However, although scholars have increasingly focused on this social issue, the critical role of digital technology in MS risk mitigation remains unclear. This research aims to identify which digital technologies have been adopted by focal firms to mitigate MS risks and how they do so, and to explore how institutional changes affect digital technology adoption. We conduct a secondary data analysis by performing content analysis on MS statements for financial years from 2017 to 2021 issued by the top 50 firms selected from the Fortune Global 500 list. According to our coding results, we identify seven types of digital technologies adopted by focal firms, and explain how these digital technologies mitigate potential MS risks in supply chains by considering two dimensions of risk management – risk detection and risk prevention. Based on the socio-technical perspective and institutional theory, we develop a conceptual model to reveal the role of technology complexity, collaboration orientation, and risk management stage in digital technology adoption. This paper is the first to explore digital technology adoption as a way of mitigating MS risks and to identify the relevant actors that form an MS risk mitigation ecosystem. The proposed conceptual model and associated propositions reveal how institutional rules affect firms' digital technology adoption and provide directions for future research.

Keywords: digital technology, modern slavery, supply chain risk management, risk detection, risk prevention

1. Introduction

Modern slavery (MS) is a broad concept describing a set of disparate but related offences involving slavery, servitude, forced labor, and human trafficking (Haynes, 2016). In the management literature, MS is generally described as perpetrators forcing victims to work, controlling them through threats, violence, and financial exploitation, restricting their movements, and treating them as a commodity (Crane, 2013). Scandals involving multinational corporations sourcing products made with the use of forced labor have featured frequently and prominently in the popular press. For example, in 2014, news emerged that high-profile companies, such as Walmart and Tesco, had purchased prawns from a Thai company that relied on fishing boats manned by slaves for its fishmeal supply (Hodal et al., 2014). As a result, MS has become a pressing social issue, attracting increasing attention from policy makers, civil society, the public, and even business leaders (Caruana et al., 2021).

The adoption of the Modern Slavery Act 2015 (hereinafter referred to as the MSA) by the UK Government in April 2015 represents a milestone, as it was the first national legislation against MS in Europe (UK Government, 2015). Part 6, Section 54 of the MSA requires all business organizations operating in the UK with a turnover in excess of or equal to £36 million to issue an annual slavery and human trafficking statement (hereinafter referred to as the MS statement). In fact, MS scholars regard the emergence of the MSA as a key institutional change (Christ et al., 2019; Crane, 2013; Flynn, 2020; Flynn & Walker, 2020). According to Flynn and Walker (2020), the MSA and its accompanying expectations of social sustainability represent institutional rather than market pressure on firms, in the form of legislation, non-governmental organization (NGO) activities, professional standards, stakeholder initiatives, media coverage, and consumer activism. Therefore, focal firms face regulatory, normative, and cultural cognitive pressures in respect to MS risk detection and prevention in their global supply chain networks (Flynn, 2020). Based on the institutional perspective, several scholars have explored firms' responses to such institutional change. Stevenson and Cole (2018) were the first to discuss MS statements issued by companies, and how they detect and remedy MS issues in

their supply chains. Flynn (2020) then identified focal firms' actions to comply with the MSA and explored the antecedents influencing those actions. As a result, the actions taken by companies to counter MS risk are seen as responses to institutional change to gain social legitimacy.

A number of measures against MS have been discussed in the literature and industry, including digital technology adoption (Tickler et al., 2018). In the current era of constant change, digital technology is advancing in leaps and bounds, subverting traditional business operations (Chen et al., 2022; Choi et al., 2022; Llopis-Albert et al., 2021). Digital technologies, including enterprise systems, machine learning, big data, blockchain, and virtual and augmented reality applications, have received unprecedented investment, and are being applied to all aspects of business activities (Chen et al., 2021; Costa Climent & Haftor, 2021). In particular, perpetrators of MS are increasingly using digital technology to exploit victims, such as recruiting victims through social media and controlling them through webcam surveillance (Wilton Park, 2017). However, digital technology also offers an potential solution to MS. Numerous organizations, coalitions, and initiatives have called for the use of digital technology to combat MS. For example, a coalition of leading global technology companies, civil society organizations, and the United Nations has launched the Technology Against Trafficking initiative, which aims to develop technological tools to combat human trafficking (Tech Against Trafficking, 2018). For Urmila Bhoola, UN Special Rapporteur on Contemporary Forms of Slavery, "It (technology) definitely presents both a threat and an opportunity. But the opportunities for using tech as a tool to identify people who are in MS and to assist them are far greater and they outweigh the threat" (Elks, 2019).

However, despite the enthusiasm in academia and industry, scant literature discusses the role of digital technology in tackling MS risks in supply chains. Exceptions include Boersma and Nolan (2020) and Christ and Helliar (2021), who explored the potential of blockchain technology to mitigate MS risks, yet only focused on a single technology instead of a comprehensive list of digital technologies adopted by focal firms. Moreover, while McGrath

et al. (2021) explored the role that technology plays in creating and fostering transparency in global supply chains, they failed to take account of the effect of increased supply chain transparency on MS. As a result, little is known about the digital technologies adopted by firms to combat MS, which represents a critical research gap. In addition, the adoption of digital technologies involves not only the core characteristics of the technology itself, but also non-technical or social factors, such as institutional context. According to Flynn and Walker (2020), the lack of theoretical framing of MS limits the ability to understand why and how firms respond to government and social expectations to combat MS. Therefore, to address the afore-mentioned research gaps and deepen our understanding of digital technology adoption for MS mitigation, this research aims to identify different types of digital technologies and their roles in MS risk mitigation. Since the emergence of MSA is considered an institutional change that forces firms to improve their supply chain practices to prevent potential MS, we also explore the effects of institutional pressers on digital technology adoption at a supply chain level. Thus, we propose the following three research questions to guide our research:

1. What are the digital technologies adopted by focal firms to mitigate MS risks in their supply chains?
2. What are the effects of institutional change on digital technology adoption to mitigate MS risks in focal firms' supply chains?
3. How does digital technology adoption affect MS risk mitigation?

Using content analysis, we analyze MS statements issued by 50 firms on the Fortune 500 lists for the financial years 2017–2020, capturing the digital technologies adopted by those business giants, and identify actors involved in digital technology adoption to build an MS risk mitigation ecosystem. Based on the socio-technical perspective and institutional theory, we analyze and propose a conceptual model for the heterogeneity in companies' adoption of digital technology. Institutional theory was chosen because it emphasizes the influence of systems in shaping social and organizational behavior (Scott, 1995). The existing CSR and social sustainability literature has adopted institutional theory as the primary theoretical lens via

which to explain corporate information disclosure behavior (e.g., Luo et al., 2017; Russo-Spena et al., 2018; Sun et al., 2018). This is also the case for the MS literature, and therefore, here, a firm's digital technology adoption to mitigate against MS risks is considered a response to institutional change and pressures, enabling us to develop a conceptual framework to explain the relationships among the factors driving digital technology adoption for MS risk mitigation.

Our content analysis is the first to examine firms' digital technology adoption to tackle MS risks, providing a basis for future MS research. In particular, we identify seven technologies adopted at a supply chain level in the MS context, and how institutional change in the form of regulative, normative, and cognitive rules promotes different types of digital technology adoption. We also explore the role of technology complexity and collaboration orientation to deepen our understanding of digital technology adoption for MS risk mitigation. The rest of the article is structured as follows. Section 2 provides a literature review, introducing the background on MS, MSA-related research, digital technology adoption in the supply chain, and the theoretical lens of the socio-technical perspective and institutional theory. Section 3 introduces the research design, including sample selection, data collection, and the content analysis approach. The results are presented in Section 4, followed by a discussion including the proposed conceptual model and propositions in Section 5. Finally, Section 6 provides a summary of the research and notes future research directions.

2. Literature review

Despite emerging almost a century ago, MS has received less attention in the operations management literature than other aspects of firm-level social sustainability (e.g., employee benefits). This section reviews the origin of MS and the emergence of the MSA, followed by how digital technology adoption relates to MS and current research gaps in this area. Finally, we review the application of the socio-technology perspective and institutional theory and the relationship between institutional factors and MS issues.

2.1 Modern slavery in supply chains

Slavery has existed for thousands of years and in various forms (Crane, 2013). However, with the continuous progress of human civilization, it has gradually transformed from a lawful behavior approved by the ruling elite class to a serious crime despised by society. MS in supply chains have been the subject of much recent concern; examples include the Thai seafood industry (Hodal et al., 2014) and the Malaysian electronics sector (Verité, 2014). Estimates of the scale of the problem vary, but there is a consensus that it represents a significant ethical and reputational challenge. For example, after the Thai supplier Charoen Pokphand Foods was accused of using fish meal from fishing boats operated by slaves in 2014, several large supermarkets in Europe and the US (including Carrefour, Tesco, and Wal-Mart) removed these products from their shelves (Hodal et al., 2014). NGOs have also blamed firms for not trying hard enough to detect and remediate potential MS risks in their supply chains (Wolf, 2014).

To address MS risks hidden in global supply chains, section 54 of the MSA, entitled "Transparency in Supply Chains" (TISC), requires firms to issue an annual statement to describe the actions taken to combat MS issues. The UK Government's stated intent for the TISC clause is "to make it absolutely transparent what action a business is or is not taking and will allow investors, consumers and the general public to decide who they should and should not do business with" (UK Home Office, 2015a, p. 6). Since its inception, the MSA has been highly controversial, with some parties hailing it "a unique opportunity to make Britain once again a world leader in the fight against slavery" (Butler-Sloss et al., 2015, p. 8), and others calling it a "vanity project … rushed through Parliament without proper consultation" that would "offer almost no help to the victims of the crime" (Dugan, 2012). Islam and Van Staden (2021) explored the limitations of the disclosure and transparency requirements of the MSA and, more specifically, how anti-slavery activists experience and interpret the new regulations and regulators' implementation of such. They found limited confidence among anti-slavery activists regarding the act's call for transparency in relation to the elimination of slavery from global supply chains. However, it is undeniably an important process in the fight against MS,

because it not only heightens awareness of MS risk management, but provides an opportunity for the public to observe the measures taken by firms. Other countries have since introduced MS-related legislation to improve transparency regarding an organization's supply chain; for example, the Australian Government (2018) introduced the Modern Slavery Act 2018 in October 2018.

2.2 Digital technology adoption to mitigate modern slavery risks

Recently, there has been an explosion of MS research within the SCM literature. In particular, several scholars have focused on company MS statements to provide insights or comprehensive summaries regarding firms' response to the MSA. For example, Stevenson and Cole (2018) analyzed MS statements issued by 101 firms in the apparel and textile industry. They found that most firms use the same practices to detect and remediate MS problems as for other social issues, and called for more targeted or innovative actions. Flynn (2020) adopted institutional theory to investigate the drivers of FTSE 350 firms' compliance with the MSA. Schaper and Pollach (2021) identified trends in firms' MS statement changes, revealing extremely heterogeneous reporting practices. However, although such studies shed light on how firms address MS risks in their supply chains, the literature is silent on how digital technologies may help to address MS risks.

This is despite the fact that organizations and institutions have called for the use of technology to combat MS issues. Landmark conferences such as the Wilton Park conference in London in June 2017 have focused on the role of digital technology in tackling MS, making direct connections between technology and anti-MS practices (Rende & Shih, 2019). Blockchain, for example, has been recognized as a potential technical solution for MS in recent reports (e.g., ILO et al., 2019) and studies (e.g., Christ & Helliar, 2021; Rogerson & Parry, 2020). Blockchain technology's embracing of decentralization and tamper-proofing, combined with its smart contract (Saberi et al., 2019) and tokenization (Narayan & Tidström, 2020) capabilities, can improve the transparency and traceability of supply chains, and as such has been adopted by focal firms for product information disclosure (Choi et al., 2020). Firms such

as Ford, for example, have adopted blockchain to monitor potential MS risks in their supply chains (Wolfson, 2019). While McGrath et al. (2021) conducted qualitative research to explore the role of technology in creating and promoting transparency in supply chains, to the best of our knowledge, there is no research that systematically summarizes digital technologies adopted by focal firms to combat MS issue.

2.3 The socio-technical perspective and institutional theory

The emergence of advanced technical systems may lead to social change – a complex and interactive long-term process that affects actors, technologies, and institutions (Fuenfschilling & Truffer, 2014). In light of this, the management literature has suggested that, when exploring the role of technology in a particular field, it is short-sighted to focus only on the technological core of the emerging technologies, as technological artefacts are greatly influenced by technological, political, social, and economic factors (Lin et al., 2016). In this context, the socio-technical perspective highlights the interactions between consumers, industry, and government related to the technology, and provides a theoretical perspective on digital technology adoption in the social context. Past studies have adopted this perspective to explore the interdependence and coevolution of technological systems and social structures (such as policies, institutions, users, and markets), enabling specific socio-technological transformations (e.g., Morgan-Thomas et al., 2021). This perspective is therefore particularly suitable for exploring the adoption of digital technology for MS issues.

Institutional theory has become the mainstream approach to explore the measures taken by firms to combat MS issues, since firms' efforts are seen as responses to institutional pressures to obtain social legitimacy (Flynn et al., 2020). Institutional theory holds that the structures, policies, and practices within a firm are determined by institutional changes (Meyer & Rowan, 1977). As a result, any firm's business reflects not only the technical requirements of a specific activity, but also the expectations of its institutional stakeholders and the rules and norms of the institutional environment (DiMaggio & Powell, 1983; Meyer & Rowan, 1977; Scott, 2008). Such expectations, rules and norms then generate institutional pressures, forcing firms to adopt

advanced practices. As Dowling and Pfeffer (1975, p. 122) noted, "organizations seek to establish congruence between the social values associated with or implied by their activities and the norms of acceptable behaviour in the larger social system." Institutional theory further explains the sources of institutional pressure and the mechanism underlying their influence. For example, regulatory agencies and civil society groups can force firms to behave in a certain way, professional groups exert normative influence on firms, and peer interaction leads to mutual imitation (DiMaggio & Powell, 1983).

In the context of MS, firms tend to present a positive social image by showing that they are strengthening their policies and practices to prevent MS in their supply chains. Firms judged negligent in this regard can lose the support of political and economic stakeholders and the social legitimacy of their operation business (Dowling & Pfeffer, 1975). The UK Government assumes the same responsibilities for MS, reminding firms that "a failure to comply with the provision or a statement that an organisation has taken no steps, may damage the reputation of the business" (UK Home Office, 2015b, p. 6). However, concern has arisen about the effectiveness of the MSA, and reports have pointed out that the content of firms' statements lack disclosure of specific actions taken (UK Home Office, 2019). In light of this, digital technology adoption may serve as a concrete measure to help firms cope with growing institutional pressure to achieve social legitimacy.

In fact, institutional pressure on firms over MS did not begin with the MSA. Rather, it follows lengthy efforts by organizations such as NGOs to uncover MS issues in supply chains. For example, the International Labour Rights Forum (IRIF) and Green America accused Hershey, an American food company, of hiding information about its supply chain, which is riddled with risks of MS including child labor, human trafficking, and forced labor (IRIF, 2010). Similarly, the call for digital technology to combat MS comes from NGOs. The Mekong Club, for example, established a member-based business association in 2015 to collaborate with private companies, academia, and NGOs to explore and develop technology projects (Mekong Club, 2021). Founded in 2018, Tech Against Trafficking aims to collaborate with global technology

companies and civilian organizations to develop digital technologies to combat human trafficking (Tech Against Trafficking, 2018). In summary, more and more firms have begun to adopt digital technology to combat MS, and this phenomenon is worthy of further exploration. The next section explains our methodology.

3. Methodology

To address the research questions, we performed a thorough review of the news relating to digital technology adoption for MS mitigation and the MS statements issued by our focal companies. Based on content analysis of secondary data (i.e., MS statements and relevant news), this research is not only qualitative and exploratory in nature, but also quantifies the trends in the identified themes (i.e., different types of technologies) as a form of longitudinal analysis of MS statements. This section provides background on content analysis and an overview of our data collection and analysis.

3.1 Content analysis approach

Content analysis is frequently applied in operations management, including MS research, to evaluate the extent of disclosure of various types of information (Schaper & Pollach, 2021; Stevenson & Cole, 2018). Content analysis is used to determine the presence of certain words, themes, or concepts within given qualitative data (Weber, 1985). By adopting a coding approach, content analysis researchers can condense texts into content categories and analyze the presence, meanings, and relationships of such words, themes, and concepts. The content analysis approach can be applied in qualitative, quantitative, or mixed modes of research, and employed with a wide range of analytical techniques to generate and put into context findings (White & Marsh, 2006). Specifically, quantitative analysis deals with duration and frequency of forms, while qualitative analysis focuses on substantively valid concepts (Gong & Ribiere, 2021). In this paper, we adopt a combination of qualitative and quantitative analyses to better explore digital technology adoption in supply chains for MS risk mitigation. Moreover, content analysis is useful given the aims of this investigation, as it allows for the examination of

connections between elements (Tesch, 1990). Stevenson and Cole (2018) argued that content analysis based on secondary data is suitable for the nascent state of theory development surrounding MS. Moreover, it is appropriate because documents such as MS statements issued by firms provide evidence on how digital technologies are adopted to combat MS issues.

3.2 Data collection

Our sample consists of MS statements issued by the top 50 firms of the Fortune 500. Past MS research has generally focused on listed firms on a single stock exchange. For example, Flynn (2020) focused on Financial Times Stock Exchange (FTSE) firms, while Christ et al. (2019) focused on Australian Stock Exchange (ASX) firms. However, our research aims to provide a comprehensive description of digital technology adoption to address MS risks. Therefore, we selected the top 50 firms of the 2021 Fortune Global 500 list (Fortune, 2020) because they represent the 50 largest and the most economically successful firms in the world. Specifically, we excluded firms based on the two criteria. First, we removed firms in the insurance and financial sectors, because most of these lack physical supply chain networks, and are thus exempt from the MSA. Second, we removed firms whose headquarters are based in developing countries, as these may not carry out their main business in the UK, and are thus also exempt from the MSA. After adopting the two exclusion criteria, we identified the remaining top 50 firms from the 2021 Fortune Global 500 list as our sample firms, as listed in Appendix A.

We obtained the data from multiple sources. First, we directly obtained most MS statements issued by our sample firms from the Modern Slavery Registry, a database maintained by the Business & Human Rights Resource Centre. This database includes MS statements issued by firms from 2016–2020, and is the main data source in existing MS research (e.g., Schaper & Pollach, 2021; Voss et al., 2019). We also searched the sample firms' website and other data sources (e.g., MS statement registry operated by the UK Government) if a statement was not found in the Modern Slavery Registry. Our final sample contains 203 statements from the 50 sample firms for the financial years 2017–2021. The statements provided information on what

digital technologies have been adopted by the focal firms and how the adopted technologies mitigate MS risks in their supply chains.

We also searched digital-technology-related terminologies and MS keywords in the Factiva database to obtain relevant news from 2016–2021 as additional data. The news search provided a baseline for coding different types of technologies and background information (e.g., the actors involved and their roles) in digital technology adoption. Factiva is a business information and research tool owned by Dow Jones that aggregates nearly global news sources (Ding et al., 2018). Much operations management research adopts this database to search for news, announcements, or scandals related to a research topic (e.g., Cousins et al., 2020). The search terms (see Appendix B) were selected based on relevant literature (e.g., Ageron et al., 2020) and reports and consultations with an external expert panel. Using a combination of the search terms, 231 news items were found. Both co-authors read each of these individually to exclude news irrelevant to digital technology adoption to combat MS; inclusion and exclusion criteria are presented in Table 1. The full interrater agreement among the two co-authors was 86.7% (65 papers). Consequently, 10 items were subject to joint further analysis, with the co-authors comparing notes and discussing until agreement was reached. In the end, we obtained 69 news items from 2016–2021. The entire data collection process is presented in Figure 1.

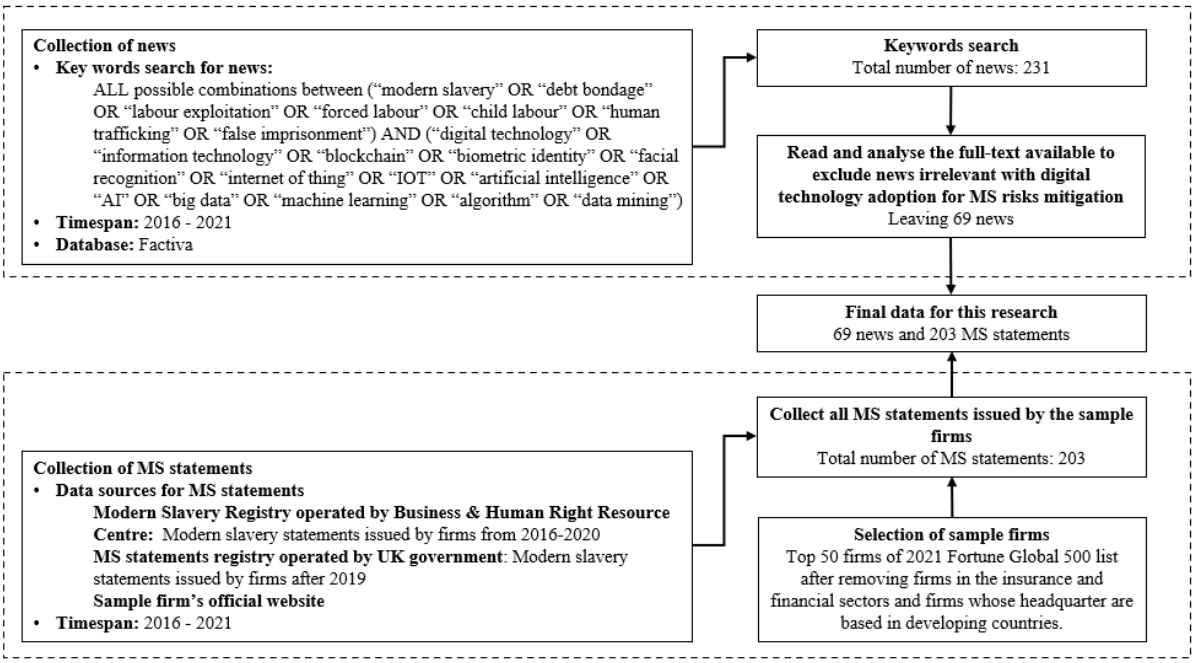

Figure 1. Data collection process

Inclusion criteria	Focuses on certain technology applied for MS mitigation Focuses on various technologies applied for MS mitigation
Exclusion criteria	Only focuses on MS issues in supply chains Contains the terms "technology" and "modern slavery," but does not explain how certain technology can be applied to counter MS issues

Table 1. Inclusion and exclusion criteria for sample news selection

3.3 Data analysis

Following Schaper and Pollach (2021), we adopted manual content analysis to code the digital technology mentioned in MS statements for each firm over time. To develop the coding scheme, we first read literature and news related to digital technology adoption for MS issues to identify the categories of technologies that may appear in the statements. Both co-authors then read all the statements to extract critical data and record these in a spreadsheet for later coding. Based on the description of the digital technology in the statements and the purpose of

using the technology, the co-authors developed a coding instrument containing seven codes across two risk management dimensions – risk detection and risk mitigation – indicating all the types of digital technologies that have been adopted to improve focal firms' management of MS issues in their supply chains (see Table 2).

Subjectivity and deviations in the understanding of a concept by co-authors may result in inconsistent coding of a certain concept. Therefore, both co-authors of this paper discussed coding until agreement was reached in the case of a disagreement.

Since we are concerned with not only the categories of technologies applied, but also the frequency of different categories and how they change over time, we conducted a descriptive analysis for different types of coded technologies. The frequency of each code per year was calculated by the number of statements, with the specific code divided by the total number of statements in the same year.

4. Results

Based on our content analysis, we identified seven digital technologies from the secondary data – digital whistleblowing, working hour monitoring system, blockchain, internet monitoring system, digital supplier assessment toolkit, responsible recruitment toolkit, and digital training. Based on the role of those technologies in MS risk mitigation for our focal firms, we further grouped the above seven technologies into two categories. We grouped digital whistleblowing, working hour monitoring system, blockchain, internet monitoring system, and supplier assessment toolkit into the category of MS risk detection technology, and responsible recruitment toolkit and digital training into the category of MS risk prevention technology.

Table 2 provides an overview of the seven technologies under the two categories, which we introduce in Sections 4.1 and 4.2, respectively. In Section 4.3, we provide the frequencies of the coding categories and their trends over time from 2017–2020, and in Section 4.4, we present an MS risk mitigation ecosystem containing the actors involved in digital technology adoption.

Risk management role	Digital technology	Description	Exemplar firms
Risk detection	Digital whistleblowing	Anonymous and multilingual whistleblowing mechanism via hotline, firm website or smartphone app	ASDA, Amazon, Apple
	Work hour tracker	Remote monitoring systems for detecting working hours of employees in a firm or a supplier's factory	Dell, Samsung, Intel
	Blockchain	Distributed ledger technology that improves traceability and transparency of supply chains to identify MS risks	Apple, Ford, IBM
	Internet monitoring	Automated detection systems that identify MS risks exposed to social media or other internet resources through cloud computing, big data, or artificial intelligence	Volkswagen, IBM, Microsoft
	Digital supplier evaluation	Online assessment mechanisms to detect and evaluate potential MS risks faced by suppliers through online toolkit or digital accounting spreadsheets	Alphabet, Samsung, Tesco
Risk prevention	Responsible recruitment toolkit	Online support toolkit that provides standardized process for supplier responsible recruitment	ASDA, Apple, Tesco
	Digital training	Training system that offers online courses and tests on MS risks through website and smartphone App	Tesco, Nestle, Intel

Table 2. Digital technologies identified in the sample data

4.1 Digital technologies for MS risk detection

4.1.1 Digital whistleblowing

Whistleblowing refers to a practice or behavior whereby an individual reports inappropriate, unethical, or illegal behavior within an organization to an authority that is capable of correcting that behavior (Bell, 2011). Traditionally, employees can report suspected violations or seek advice from their managers or the human resources or compliance departments. However, fear of identity exposure and retaliation is a major deterrent. Hopefully, this may be addressed in the current digital era, as many firms have adopted a digital whistleblowing mechanism in their risk management. We define the term digital whistleblowing as employees or other stakeholders reporting potential MS risks to their firm's ethics department or external authorities via hotlines, websites, or smartphone applications. We noted that most firms have emphasized protection for whistleblowers. For example, Volkswagen (2021) stated:

> The reports can be made anonymously on all channels, if desired. Strict confidentiality and secrecy are maintained throughout the entire process. The Whistleblower System guarantees the highest possible protection for whistleblowers and affected persons. Discrimination against whistleblowers is a serious regulatory violation and will not be tolerated. (p. 6)

In addition, several firms collaborate with a third party to provide a hotline with 24/7 access and multilingual support. For example, PepsiCo provides employees in its supply chains and other stakeholders with a 24/7, anonymous hotline called Speak Up, operated by an independent third party. Speak Up is accessible anywhere in the world with dedicated toll-free phone lines in over 60 countries and multiple languages and by web in 23 languages. According to data published by PepsiCo (2021), approximately 34% of the reported cases were substantiated or partially substantiated, which resulted in various forms of remediation practices. As a result, digital whistleblowing encourages employees and other stakeholders to report suspicious behavior anytime and anywhere, helping companies detect potential MS risks in their supply chains.

4.1.2 Digital supplier evaluation

Our coding results indicate that several firms have adopted a remote auditing mechanism, such as online questionnaires or digital toolkits, to assess whether their suppliers are compliant with respect to MS issues. We collectively refer to these remote supplier audit methods as digital supplier evaluations. Compared with conventional in-person audits or assessments, which rely on an auditor physically traveling to a factory or site, digital supplier evaluations provide flexibility, especially relevant given the COVID-19 pandemic. Tesco (2021), for example, have adopted a digital supplier evaluation tool called Stronger Together Progress Reporting to monitor their supplies:

> We also mandated the completion of the Stronger Together Progress Reporting tool for all UK based suppliers. Using this online self-assessment, companies can track the progress they have made in addressing modern slavery risks and identify the next steps for their businesses and supply chains, to ensure their approach continues to evolve. (p. 20)

While some scholars argue that this type of audit cannot replace traditional on-site auditing, further developments in technology are expected to improve digital supplier evaluations (Zinser et al., 2020). In summary, digital supplier evaluations help firms monitor their suppliers remotely and flexibly to detect potential MS risks.

4.1.3 Work hour tracker

Work hour trackers aim to monitor employees' working hours. In the past, such trackers were generally used to monitor whether an employee was late or left early, as part of evaluating their performance. However, with the improvement in firms' MS risk awareness, work hour trackers can also be used to detect whether employees are putting in overly long working hours. In addition, our coding results indicate that firms have adopted work hour trackers at the supplier level to monitor whether workers are working overtime in factories. For example, Dell (2021) have acknowledged that:

> We share tools we have developed with factories, often to help automate monitoring areas of concern where the local team may not have the resources. Examples include our weekly working hour monitoring tool, which captures data from factories where employees are at-risk of working more hours than the 60-hours-per-week standard. (p. 6)

In 2020, Dell monitored 203,211 employees at 126 supplier factories and found that 11% worked more than 60 hours per week. To address non-compliant suppliers, Dell partnered with 23 suppliers to better understand the root causes and help address the additional complexities related to weekly working hours compliance due to COVID-19. Therefore, work hour trackers can help firms monitor the working hours of employees in their suppliers' factories, helping them detect potential risks of employee excessive overtime.

4.1.4 Internet monitoring

The final risk detection technology we identified is internet monitoring, a concept that covers all intelligent systems that use artificial intelligence or cloud computing to analyze the vast internet resources to identify potential MS risks in a firm's supply chain. For example, Volkswagen (2021) stated that:

> Another approach that has been pursued since 2020 is the use of a service provider which comprehensively audits suppliers using artificial intelligence. Constant monitoring of freely available internet sources including social media allows information on possible violations by suppliers to be reported in real time. (p. 12)

Although firms did not explain the technical details of these smart systems in their MS statements, it is not difficult to speculate that this system integrates natural language processing and machine leaning to analyze accessible resources on the internet, which is consistent with news coverage of such technologies. For example, technology company Staqu has released an open-source intelligence platform called PINE that leverages natural language processing to extract MS-related information from open-source data (Express Computer, 2019). As a result,

users can use the platform to perform a variety of proactive analytics on people, organizations, or regions, enhancing firms' capability to detect MS risks around their business.

4.1.5 Blockchain

Blockchain technology has emerged as a means to mitigate MS risks in supply chains in recent literature (Christ & Helliar, 2021; Boersma, 2020). Blockchain, also known as distributed ledger technology, features digital information recorded in blocks that are linked together and distributed across multiple nodes (computers) as blockchain records. Each block of information is verified in real time, creating a transparent transaction history (Kemp, 2015). Therefore, blockchain can create a record of transactions for anything of value, and trace the supply chain journey from source to end user, increasing supply chain transparency for various kinds of products (Dubey et al., 2020). For example, the World Wildlife Fund collaborated with a Fijian fishing firm and a blockchain technology provider to adopt this technology in Australia, Fiji, and New Zealand to track when and where tuna was caught (Visser & Hanich, 2018). By adopting blockchain, they can verify whether the tuna sold by the fishing firms is sustainably caught and free of MS. Our coding results indicated that our sample firms are mainly applying blockchain technology to identify if the metal minerals in their products are categorized as conflict minerals; that is, minerals from mines in areas of conflict controlled by non-government military groups or factions in the Democratic Republic of the Congo. For example, Ford is using blockchain technology provided by IBM to track supplies of cobalt, a key ingredient for electric car batteries, to combat labor exploitation (Wolfson, 2019).

4.2 Digital technologies for MS risk prevention

4.2.1 Digital training

Digital training is a method of training based on the use of new digital tools that enable users to learn specific knowledge in different ways. Thanks to the availability of the internet and the advent of smartphones, employees can access content from anywhere, at any time, to obtain information related to MS risk mitigation. According to our coding results, most firms have

already offered digital training courses and tests to employees and suppliers' workers through online websites or smartphone applications. The training materials include knowledge and skills to identify and remediate possible MS risks; for example, Amazon (2021, p. 9) stated that "The training will support suppliers in identifying, assessing, and mitigating specific risks to migrant workers, including worker-paid recruitment fees."

In addition, NGOs and other organizations may be involved in the digital training process. Alphabet (2021), the parent company of BMW, stated:

> The BMW Group offers a wide range of sustainability training courses for purchasers, internal process partners and suppliers to make them more aware of the topic. This includes classroom courses in association with the University of Ulm to become a 'Certified Sustainability Officer' as well as web-based training course in association with econsense, which includes case studies on sustainability in the supplier network. (p. 7)

In summary, digital training, a risk prevention technology that requires long-term adoption, can increase managers' and employees' awareness of MS risks, and provide them with the necessary knowledge to remediate identified risks.

4.2.2 Responsible recruitment toolkit

Several sample firms have also adopted the responsible recruitment toolkit – an online tool that provides a comprehensive guide for suppliers and labor agencies to conduct responsible recruitment – to avoid illegal recruitment in their supply chains. The toolkit contains self-assessment checklists, worker training records, and remedial tracking records that are easy for suppliers to adopt. Our coding results indicate that focal firms have promoted the use of the responsible recruitment toolkit in their supply chains. For example, according to ASDA (2021), by 2020, 59 of its suppliers had adopted this online toolkit to better conduct responsible recruitment. Moreover, Apple (2021) stated that "Nearly 150 suppliers across 20 countries were trained on the Responsible Recruitment Toolkit in 2020" (p. 17).

Therefore, applying the toolkit at the supplier level helps to prevent MS risks by enabling responsible recruitment processes in the supply chain.

4.3 Distribution and trends in digital technology adoption

Table 3 indicates the relative frequencies of the coded technologies in the firms' statement for each year. Taking the frequency of the 2020 financial year as an example, 84.37% and 81.25% of sample firms, respectively, reported the adoption of digital training and whistleblowers in their MS statements or other social sustainability reports, indicating the most widely used risk prevention and risk detection technologies. Two risk detection technologies, digital supplier evaluation and the work time tracker, were used to a moderate extent, with a frequency of 71.88% and 62.50%, respectively. The frequency of responsible recruitment toolkit reached 69.75% in 2020, indicating moderate adoption of this technology. Internet monitoring and blockchain were the least used risk detection technologies, with only 34.37% and 28.13%, respectively, of firms mentioning these in 2020.

	Codes	**2017**	**2018**	**2019**	**2020**	**2021**
Detection	1-Digital whistleblowing	65.62%	71.88%	78.13%	81.25%	77.14%
	2-Digital supplier evaluation	62.50%	65.62%	65.62%	71.88%	62.86%
	3-Work hours tracker	40.62%	46.88%	53.13%	62.50%	51.43%
	4-Internet monitoring	25.00%	25.00%	28.13%	34.37%	31.43%
	5-Blockchain	21.87%	25.00%	25.00%	28.13%	17.14%
Prevention	2-Digital training	68.75%	78.12%	81.25%	84.37%	85.71%
	1-Responsible recruitment toolkit	59.39%	59.38%	62.50%	68.75%	62.86%

Table 3. The frequency of digital technology adoption over time

Our coding results also present the evolution of each technology adoption over time. As shown in Figure 2, adoption rates for all digital technologies rose between 2017 and 2020, confirming that more and more companies are adopting technologies to detect and counter MS risks in

their supply chains. Although rates declined from 2020 to 2021, this may be because only 35 of the 50 sample companies had released their reports for the 2021 financial year at the time of writing. Work time trackers saw the biggest adoption rate increase between 2017 and 2020 (21.88 percentage points), followed by digital whistleblowing (15.63 percentage points) and digital training (15.62 percentage points). Internet monitoring, digital supplier evaluation, and responsible recruitment toolkits experienced relatively small increases (9.37 percentage points, 9.38 percentage points, and 9.36 percentage points, respectively). The technology with the smallest increase in adoption was blockchain (6.26 percentage points).

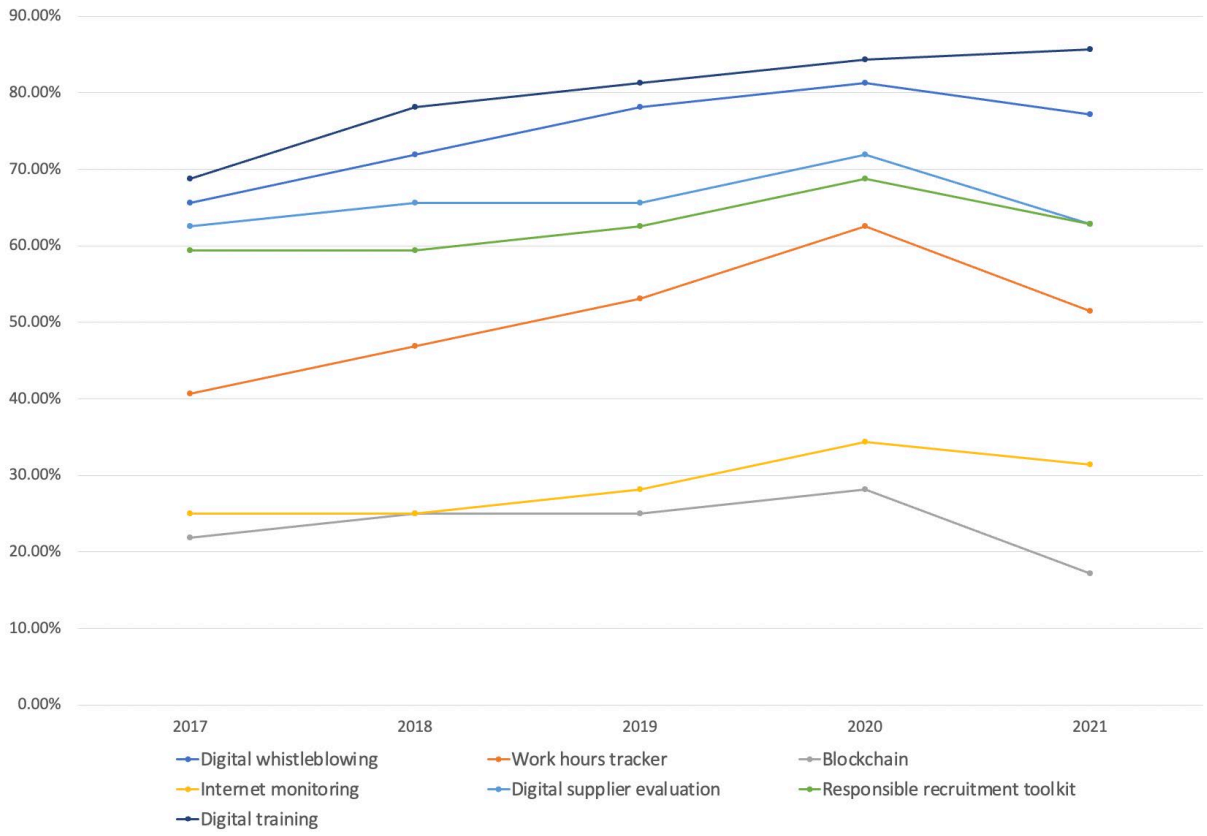

Figure 2. Trends in digital technology adoption from 2017 to 2021

4.4 Toward an MS risk mitigation ecosystem

Achieving sustainability at the supply chain level requires the cooperation of supply chain partners (Jia et al., 2020; Zheng et al., 2021). Similarly, the use of digital technology relies not only on the efforts of the focus company, but also those of external participants. Based on our

sample data (i.e., MS statements and news), we have identified the actors involved in digital technology adoption and the collaboration mechanism among them. As shown in Figure 3, in addition to focal firms and their suppliers, we have identified three other participants – NGOs, governments, and technology providers. First, NGOs have a long history of fighting MS, including identifying and monitoring MS risks hidden in supply chains. For example, China Labor Watch once issued a report accusing Foxconn, Apple's supplier in China, of requiring employees to work long hours of overtime and failing to adequately insure them (Yee, 2012). Firms cannot afford to ignore MS risks in their supply chains, as exposure of a supply chain scandal to the media would decimate the firm's reputation. Such revelations of MS in supply chains also provides intelligence for governments, leading them to closely monitor firms and enforce information disclosure about their supply chains. Therefore, institutional pressures from NGOs and the government to mitigate MS in the supply chain has driven focal firms to adopt a variety of measures to combat MS, including digital technology adoption.

Second, many traditional retailers or manufacturers may lack the ability to develop digital technology on their own, and may therefore collaborate with third-party technology providers to develop or purchase digital technology. As mentioned in the last section, Ford has adopted blockchain technology provided by IBM to track and verify ethical mineral sources to ensure a reliable source of industrial mined cobalt. Moreover, NGOs have also been involved in the development of technology. The International Organization for Migration (IOM, 2018), for example, has collaborated with companies such as Microsoft and British Telecom to develop cloud-based risk identification systems. As a result, technology providers develop specific technologies for firms to audit their suppliers, as described in the previous two sections. Finally, technology providers may also provide technology directly to focal firms' suppliers; for example, ASDA's suppliers have adopted the responsible recruitment toolkit provided by a company called RRT. In summary, these actors form an MS risk mitigation ecosystem that adopts the above digital technologies to combat MS in the supply chain.

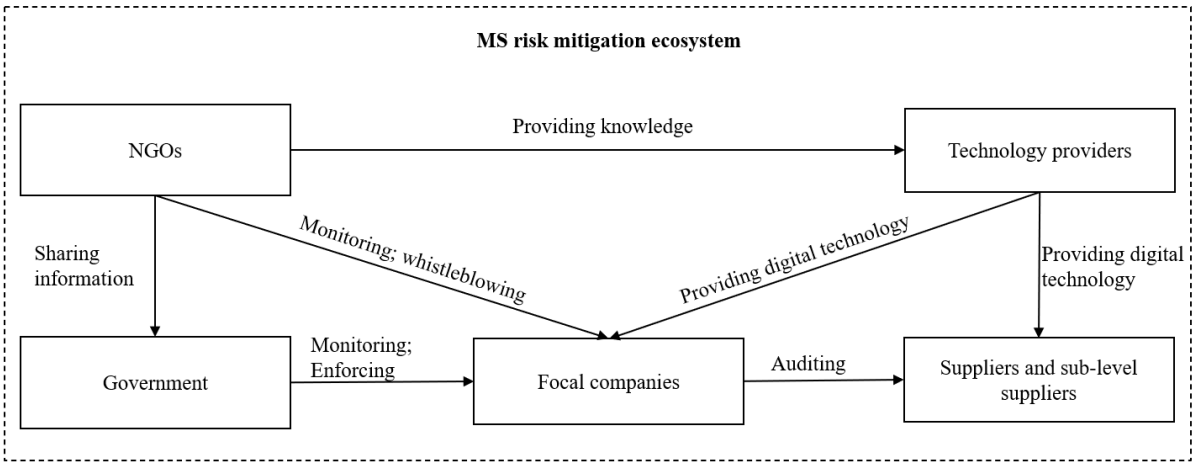

Figure 3. The actors involved in the MS risk mitigation ecosystem.

5. Discussion

Based on the findings, we have proposed a three-dimensional typology diagram that captures the characteristics of each digital technology adopted (see Figure 4). First, collaboration orientation refers to the intention of focal firms to collaborate with suppliers when adopting the digital technology. Only internal monitoring does not involve working with suppliers; the remaining six technologies involve collaboration (i.e., directly auditing suppliers). Second, technology complexity refers to whether adoption of a particular technology involves a complex infrastructure or requires a high level of information technology in the company. We grouped internet monitoring and blockchain into high-complexity technology, because these technologies involve AI, cloud computing, or other advanced digital technologies, which are highly complex for firms to adopt. In contrast, digital whistleblowing, digital supplier evaluation, work hour tracker, responsible recruitment toolkit, and digital training were grouped as low-complexity technology, as they are generally the digitization of existing procedures. The final variable is risk management (risk detection and risk prevention), consistent with the classification in Sections 4.1 and 4.2. Risk detection focuses on detecting hidden hazards in current activities and practices, while risk prevention seeks to avoid activities that may bring potential risks. In summary, the seven technologies are categorised into four types based on the three variables.

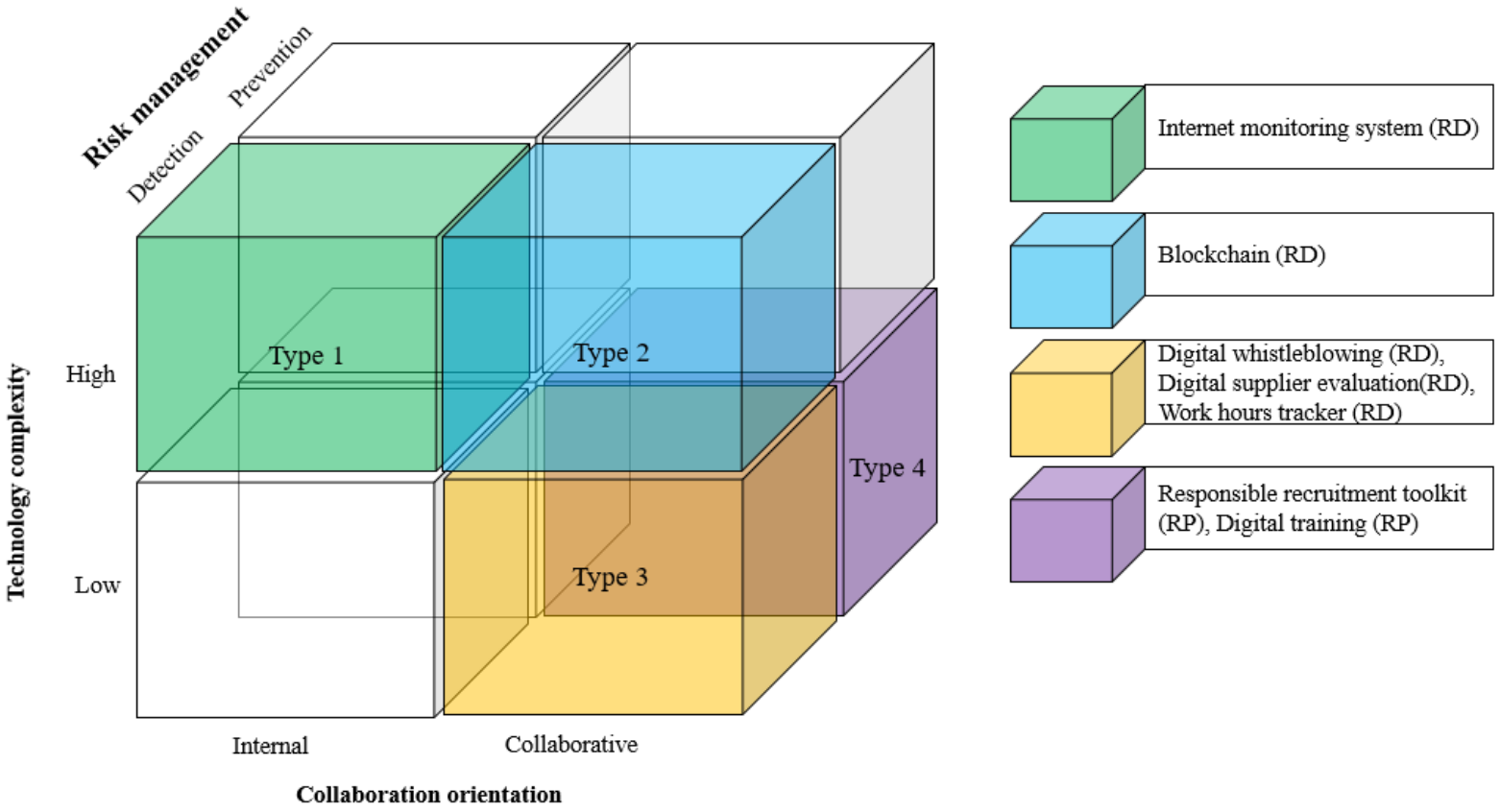

Figure 4. Three-dimension topology

Adopting the social-technical perspective and institutional theory, and based on the findings, we developed a conceptual model, as shown in Figure 5. We developed a number of propositions that capture the characteristics of each digital technology and explore the relationship between each factor related to digital technology adoption for MS risk mitigation.

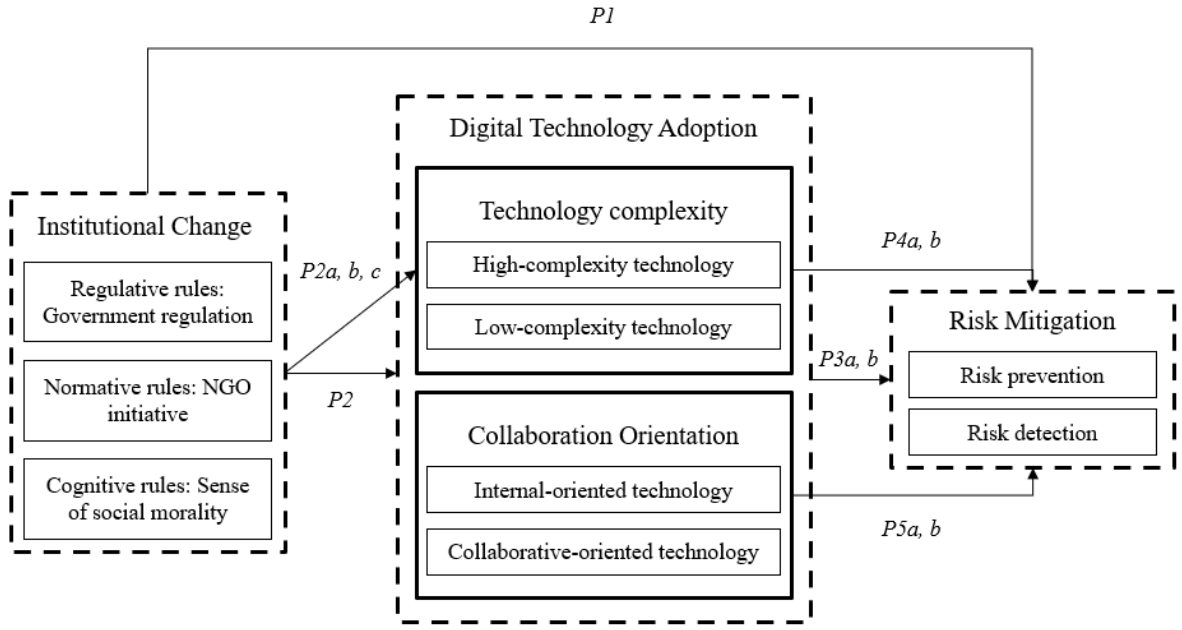

Figure 5. Proposed conceptual model

5.1 Institutional change and MS risk mitigation

According to Crane (2013), the existence of MS can be understood as economically rational in certain niche environments, despite the broader institutional belief that it is irrational. Furthermore, the same authors stated that MS is more likely to persist in illegitimate industries where organizations already exercise oversight over regulatory and other formal institutional forces, and where standards are determined by the institutional norms of fellow renegades. Thus, Crane (2013) emphasized the role of external institutional changes in curbing MS; that is, forcing organizations to adopt a "zero-tolerance" attitude toward MS to achieve social legitimacy.

According to Russo-Spena et al. (2018) and Luo et al. (2017), organizations' engagement with CSR activities mainly derive from institutional factors; namely, requirements from central or

local governments. Institutional change is, in fact, not only reflected in specific legal provisions (e.g., MSA), but also in the transformation of the overall institutional environment, which includes regulators, professional groups, NGOs, the media, and consumers. For example, regulators can force firms to behave in certain ways; professional groups exert a normative influence on firms, and peer interactions lead firms to copy each other (DiMaggio & Powell, 1983). Therefore, scholars have argued that exposing companies to public and media scrutiny through MSA will force them to take an active stance on MS (Voss et al., 2019), and this has been accepted in most current MS research. For example, Flynn and Walker (2020) found that following the MSA, some companies have made changes, such as carrying out employee training or updating the contract terms of suppliers, which can be considered organizational adjustments to adapt to the institutional change.

Although Christ et al. (2019) found that some companies take negative or evasive measures in the face of such change, the MS literature has generally emphasized that it results in companies improving their supply chain practices to eliminate potential risks as much as possible. For example, Stevenson and Cole (2018) discussed the convergence of MS statements and summarized the supply chain practices disclosed by companies, including MS risk detection, remediation, and prevention. Therefore, although institutional change centered on the MSA cannot eradicate MS phenomena hidden in the supply chain completely, it does see companies strive to eliminate MS risks in their supply chain to gain social legitimacy and avoid possible reputational damage and punishment from regulatory authorities. Therefore, we propose that:

> P1. The institutional change marked by the MSA coerces firms to take steps to mitigate MS risks in their supply chains.

5.2 Institutional change and digital technology adoption

The socio-technical perspective holds that technological development is not only determined by thee technical core, but also by non-technical factors, including political, social, and

economic factors (Lin et al., 2016). We argue that digital technology adoption to counter MS is also influenced by non-social factors, particularly the pressure due to institutional change.

Geels (2004) pointed out that different actors bring different institutional rules to the technology system. Scott (1995) distinguished three dimensions of institutional rules: regulative, normative, and cognitive. First, the regulative dimension refers to formal rules that constrain behavior and regulate interactions, such as the MSA, which provides coercive pressures for focal firms to comply with TISC. Under institutional theory, when new rules and regulations are introduced, and enforced, coercive pressures can stimulate organizational change either directly or indirectly through institutional dependencies. Therefore, to ease such pressure as well as enhance their legitimacy, firms tend to reconsider and reshape their business practices along with these rules. Second, the normative dimension refers to values, norms, role expectations, duties, rights, and responsibilities, which are internalized through social processes (Geels, 2004). In the MS context, NGOs have been attempting to uncover MS in the supply chain of focal firms, which is seen as a regulatory pressure for companies to improve their current practices to gain social legitimacy. Finally, cognitive rules constitute the nature of reality and the frames through which meaning or sense is made (Geels, 2004). Symbols have an effect by shaping the meaning attached to objects and activities. Examples includes words, concepts, myths, signs, and gestures (Scott, 1995). According to our sample data, Microsoft and Amazon have voluntarily joined the Tech Against Trafficking coalition, while other firms such as Apple and ASDA have indicated a desire to be ethical leaders in their industry, and are always cautious regarding issues of human rights. As a result, cognitive rules push them to be pioneers in adopting advanced practice (i.e., digital technology adoption) to counter MS risks. Based on the above discussion, we propose:

> P2. Institutional changes in the form of regulative, normative, and cognitive rules promote digital technology adoption for MS risk mitigation in supply chains.

Overall, based on the data analysis and findings, we noticed that firms have positively responded to the institution rules via adopting various technologies to avoid slavery and human

trafficking. However, it is interesting that firms' responses to regulative rules and normative rules present remarkable differences in terms of technologies adopted.

The first difference refers to the complexity of technology adopted. On the one hand, NGOs mainly encourage practitioners to adopt specific emerging technologies to advance the monitoring and mitigation of MS risks. For example, Code 8.7 engages with practitioners to combine AI with novel data streams to promote MS detection (Delta 8.7, 2019). Especially in the Industry 4.0 era, these emerging technologies (e.g., AI, blockchain, and big data analysis) are widely applied and demonstrate great potential for acquiring information, mitigating risks, and addressing social issues. As a result of NGO initiatives, firms are inspired to deploy new technologies with high complexity as an MS mitigation strategy. Specifically, in the five years from 2015 to 2020, we identified two major high-complexity technologies – blockchain and internet monitoring system – which have been adopted as MS mitigation strategies. This is because NGOs tend to be advocates and pioneers, taking action to combat unfair treatment of labor (Flynn & Walker, 2020); they constantly push firms to take action against MS, including the adoption of complex technologies such as AI and blockchain.

On the other hand, government regulations regarding MS (i.e., the MSA) primarily focus on coercing enterprises to release MS statements and reach relevant MS goals. However, the MSA provides only a vague framework for company disclosures and does not further stipulate detailed practices that companies must adopt (Islam & Van Staden, 2021). Essentially, governments set a low bar for firms in terms of tackling MS and complying with requirements; as long as all mandates are met, firms can employ whatever means (i.e., technology) they want. Against this backdrop, in the face of government regulations and codes, firms tend to pick low-hanging fruit and adopt symbolic technologies that are accessible, cheap and easy to implement, such as a whistleblowing system, work hour monitoring, and e-training. For example, a work hour monitoring system is effective as a performance indicator, ensuring that slavery and human trafficking is not occurring in supply chains, while e-training is a convenient

and cost-effective way to promote staff's knowledge regarding slavery and human trafficking, and consistent with the training objective in many MS regulations.

Based on this, we propose that:

> P2a. Normative rules formulated by NGOs tend to promote adoption of high-complexity technology to counter MS risks in supply chains.

> P2b. Regulative rules from governments tend to tolerate adoption of low-complexity technology to counter MS risks in supply chains.

Further, we observed another difference, related to firms' attitude toward government regulations and NGO initiatives. In general, enterprises show more a positive attitude toward government regulations than NGO initiatives. For example, from 2017 to 2020, the three technologies that saw the biggest percentage point change in use – work hour monitoring (21.88%), whistleblowing system (15.63%), and e-training (15.62%) – are low-complexity technologies that either have been used by companies in the past to combat general social problems (i.e., work hour trackers and digital whistleblowing) or directly respond to the requirements of the MSA (digital training). Meanwhile, the adoption rate for high-complexity technologies – blockchain and internet monitoring – only increased by 6.26 and 9.37 percentage points, respectively, from 2017 to 2020. Indeed, relative to governments, NGOs lack of power to enforce firms to change or reshape their behaviors. Thus, firms are more likely to perceive less institutional pressure from NGOs, leading to less striving for legitimacy. On the contrary, governments promoting MS countermeasures tend to require firms to comply with the MSA by showing evidence of meeting the six MS mandates, even if in a superficial way. Thus, we propose that:

> P2c. Firms respond to government regulations more positively than to NGO initiatives.

5.3 Digital technology adoption for MS risk mitigation

This research argues that digital technology adoption is critical to countering MS, with associated risk mitigation mainly falling into two types: risk prevention and risk detection.

Risk prevention, also known as risk avoidance, implies an active avoidance of any activity in any form that may carry potential risk (Stevenson & Cole, 2018). For our firms, MS risk prevention has been achieved through various technologies, such as digital training and education and the responsible recruitment toolkit. By focusing on MS risk prevention, these firms minimize their supply chain vulnerabilities. For example, the responsible recruitment toolkit contains critical guidance for hiring processes; suppliers can modify their recruitment accordingly, avoiding slavery and human trafficking issues in future. In addition, digital training can make all participants, from employees to managers, aware of the forms and harms of MS, helping to avoid MS risks at both the individual and organizational levels.

While risk prevention works to prevent potential future risks, risk detection, the other critical component of risk mitigation, focuses on identifying risks hidden in current business activities and supply chain practices (Gold et al., 2015; Stevenson & Cole, 2018). Understanding how to best detect and anticipate MS risks allows firms to pre-emptively prepare prior to a threat occurring, and recover from it more quickly. Advanced digital technologies, including blockchain, internet monitoring systems, and supplier assessment toolkits, have demonstrated great potential for actively detecting MS risks. For example, unlike the responsible recruitment toolkit, which focuses on the future, a supplier assessment toolkit essentially provides firms with a checklist for MS activities, and helps them to monitor and evaluate the ongoing practices of their suppliers, eventually contributing to MS risk detection. For example, Dell identified that 11% of its supplier factories failed to comply with weekly work hours by adopting work hour trackers, providing a chance to understand the causes and help address relevant issues. Based on the above discussion, digital technology adoption mitigates MS risks by improving risk detection and prevention procedures. Therefore, we argue that digital technology adoption is a mediator in the institutional change – MS risk mitigation relationship, and propose that:

P3a. Digital technology adoption mitigates MS risks in focal firms' supply chains leading to MS risk prevention and detection.

P3b. Digital technology adoption mediates the relationship between institutional change and MS risk mitigation.

5.4 The role of technology complexity and supply chain collaboration in risk mitigation

This research also finds that the degree of technology complexity and supply chain collaboration orientation may affect an MS risk mitigation strategy. In other words, digital technologies with different degrees of complexity and collaboration orientation are expected to play different roles in forming an MS risk mitigation strategy.

First, we found that higher-complexity technology usually contributes to MS risk detection (see Types 1 and 2 in Figure 3). For example, in line with its tamper-proof nature, blockchain can enhance the traceability and visibility of a supply chain. As a result, high-complexity technology makes it difficult for suppliers to fake the original source of their products to evade detection by blockchain-based traceability systems. Similarly, employing internet monitoring can reduce information asymmetry between focal firms and suppliers via intelligent systems backed by AI, cloud computing, or other data analysis techniques. Therefore, firms are able to grasp and analyze MS-related information hidden in current supply chains, leading to better performance of MS risk detection. In contrast, low-complexity technology tends to involve digitalization of traditional practices, such as digital whistleblowing and digital training. Digital whistleblowing, for example, provides potential victims with a channel to report suspicious behaviors, while digital training raises MS awareness of managers, employees, and suppliers' workers, preventing MS risks at both the firm and supplier levels.

Second, we found that internal-oriented technologies only contribute to risk detection, as shown in Figure 3. Moreover, although collaborative-oriented technologies contribute to both MS risk detection and prevention, they contribute more to MS risk detection (see Types 2 and 3 in Figure 3). Essentially, higher demand for supply chain collaboration indicates higher

involvement of various supply chain members. Since MS risks are generally hidden in focal firms' global supply chains, it is necessary to collaborate with suppliers to detect potential risks. In light of this, these technologies could enhance firms' risk detection capability and help them monitor a wider range of participant behavior within their supply chain. For instance, a work hours monitoring system, as a collaboration-oriented technology, involves the engagement of upstream suppliers, allowing focal firms to monitor multiple suppliers and check for slavery or human trafficking. Based on this, we formulate our final hypotheses:

P4a. High-complexity technologies only contribute to MS risk detection.

P4b. Low-complexity technologies contribute to both MS risk detection and risk prevention.

P5a. Internal-oriented technologies only contribute to MS risk detection.

P5b. Collaborative-oriented technologies contribute more to MS risk detection than risk prevention.

6 Conclusion

In this study, we conducted a content analysis based on MS statements issued by 50 firms from Fortune Global 500 lists to explore the state of art of digital technology adoption to combat various forms of MS. We identified two groups of technologies adopted for MS risk mitigation – those focused on risk detection and those focused on risk prevention. MS risk detection technologies include digital whistleblowing, work hour monitoring system, blockchain, internet monitoring system, and digital supplier assessment toolkit, while MS risk prevention technologies include responsible recruitment toolkit and digital training. Our results indicate that the adoption rates for all technologies increased from 2017 to 2020, confirming that more and more companies are adopting technologies to counter potential MS risks in their supply chains. Moreover, we identified key actors involved in digital technology adoption in the MS context, and how they interrelate with each other to form an MS risk mitigation ecosystem. Finally, based on the socio-technical perspective and institutional theory, we analyzed the

relationship between the institution system and the technology system, shedding light on how institutional change promotes digital technology adoption in the MS context, and leading to the development of our conceptual model and related propositions.

6.1 Contributions

This study makes three theoretical contributions to the supply chain literature on MS risk mitigation. First, this paper is the first to explore digital technology adoption as a way of mitigating MS risks and identify relevant actors that form an MS risk mitigation ecosystem. Previous studies focus on actions combating MS disclosed by focal firms, yet ignore the role of digital technology adoption (e.g., Schaper & Pollach, 2021). Adopting a content analysis approach, this study identified seven technologies adopted at a supply chain level in the MS context, providing a baseline for future research. Therefore, our research fills this gap and contributes to the supply chain literature on MS risk mitigation.

Second, adopting the socio-technical perspective and institutional theory, we discussed focal firms' digital technology adoption as a response to legislation such as the MSA, NGO initiatives, and a sense of social morality. Although existing MS literature draws on institutional theory (Flynn & Walker, 2020), no study has employed it to explore digital technology adoption to mitigate MS risks. We further summarized characteristics for each technology adopted by focal firms in a three-dimensional typology diagram, and linked the institutional rules arising from different actors to different types of technologies. Our findings indicate that institutional change in the form of regulative, normative, and cognitive rules promote digital technology adoption for MS risk mitigation in supply chains. Interestingly, we found that normative rules formulated by NGOs tend to promote high-complexity technology, whereas regulative rules by governments tend to tolerate low-complexity technology. In this context, firms respond to government regulations more positively than to NGO initiatives.

Third, we explored the role of technology complexity and collaboration orientation as two aspects of digital technology adoption in MS risk mitigation. We found that both higher-

complexity and collaboration-oriented technologies contribute more to MS risk detection than risk prevention, deepening our understanding of the role of different technologies in MS risk mitigation. We are the first to identify these two characteristics of such technology, and the link between them and risk mitigation.

Our paper has important practical implications. It may help managers and researchers understand the strategic importance of digital technology adoption in MS risk mitigation. By presenting different types of digital technologies adopted by sample firms and how the adoption rate increased over 2017–2020, this research confirmed the growing trend toward digital technology adoption in the MS context. For managers, our results present the state of art of such adoption, providing insights into the selection of existing technologies to mitigate MS risks based on three dimensions – technical complexity, collaboration orientation, and risk management stage. Meanwhile, our results suggest that businesses respond more positively to government regulations than NGO initiatives for digital technology adoption. Therefore, governments should further encourage firms to develop and adopt technologies to combat MS issues through legislation, while NGOs should intensify their calls for digital technology adoption and work more closely with governments to secure regulation support.

6.2 Limitations and future research directions

Despite the contributions discussed above, this study has several limitations. First, our sample contains 50 firms from Fortune Global 500 lists. Although our sample firms represent industry leaders, we may not capture the digital technologies adopted by smaller firms. Therefore, future research may obtain a larger sample. Second, this study only focused on technologies adopted by focal firms. Biometrics recognition, satellite imagery and other digital technologies used by government, human rights departments, or NGOs also have the potential to combat MS issues. Future research could explore how these technologies mitigate MS risks and form part of the MS risk mitigation ecosystem. Third, this study did not quantify the relationship between institutional rules and digital technology adoption, nor did we explore how firm-level factors influence digital technology adoption. Kamble et al. (2021) argued that the adoption of digital

technology can be conceptualized as a dynamic capability. Exploring the factors affecting digital technology adoption at the firm level could help decision-makers evaluate their strategy for adopting digital technology. Therefore, future research could quantify the effects of the relationship among the constructs related to digital technology adoption to deepen our understanding of how to promote digital technology adoption in the MS context. Finally, other variables may affect the relationships among institutional change, digital technology adoption, and MS risks mitigation. Future research may explore how these factors, such as firm size, industry type, and firm age, affect the above relationships.

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Appendix A – The 50 sample firms selected from the Fortune Global 500 list

	MS statements collected (years)				
Firms	2017	2018	2019	2020	2021
1. Walmart*	√	√	√	√	√
2. Amazon	√	√	×	√	×
3. Apple	√	√	×	√	√
4. Toyota	√	√	√	√	√
5. Volkswagen	×	√	×	√	√
6. Samsung	√	√	√	√	×
7. AmerisourceBergen	×	×	√	√	√
8. BP	√	√	√	√	×
9. Royal Dutch Shell	√	√	×	√	√
10. Alphabet	√	√	√	√	×
11. ExxonMobil	√	√	√	√	×
12. Costco	√	√	√	√	√
13. Cardinal Health	√	√	√	√	√
14. Microsoft	√	√	√	√	√
15. Glencore	√	√	√	√	×
16. Ford	√	√	√	√	√
17. Honda	√	√	√	√	√
18. General Motors	×	×	×	√	×
19. Mitsubishi	√	√	√	√	√
20. TotalEnergies	√	√	×	√	×
21. NTT	√	√	√	√	√
22. Comcast	×	√	√	√	√
23. Chevron	√	√	√	√	√
24. Dell	√	√	√	×	×
25. Target	×	×	√	√	×
26. Nestle	√	√	√	×	×
27. Lowe’s	×	×	√	√	√

28. Hyundai Motor	×	×	×	√	√
29. Facebook	√	√	×	√	√
30. Sony	√	√	√	√	√
31. UPS	×	×	√	√	√
32. Johnson & Johnson	√	√	√	√	√
33. Hitachi	√	√	√	√	√
34. Bosch	×	×	×	√	√
35. Tesco	√	√	√	√	√
36. General Electric	×	√	√	√	√
37. Intel	√	√	√	√	√
38. DHL	×	√	√	√	√
39. Mitsui	√	√	√	√	√
40. Nissan Motor	√	×	√	√	√
41. IBM	√	√	√	√	×
42. Procter & Gamble	√	×	√	×	√
43. E. ON	√	√	√	√	×
44. PepsiCo	√	√	√	√	√
45. BASF	√	×	√	√	√
46. FedEx	√	√	√	√	√
47. Walt Disney	√	√	×	√	×
48. ADM	√	√	√	√	√
49. Roche	×	√	×	√	×
50. Siemens	√	×	√	√	√

Note: * We collected MS statements issued by ASDA, the subsidiary of Walmart in the UK.

Appendix B – Keywords for the news search of the Factiva database

AND	
A. MS related	B. Digital technology related
Modern slavery	Digital technology
Debt bondage	Information technology
Labor exploitation	Blockchain
Forced labor	Biometric identity
Child labor	Facial recognition
Human trafficking	Internet of Things
False imprisonment	IoT
	Artificial intelligence
	AI
	Big data
	Machine learning
	Algorithm
	Data mining