



Managing Labor Sustainability in Digitalized Supply Chains: A Systematic Literature Review

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Abstract: With increasing concerns of labor issue risks within supply chains, both academia and practitioners are paying increasingly great attention to how to design and implement effective management approaches to enhance labor sustainability in supply chains. Furthermore, digitalization facilitates and brings both opportunities and challenges to this area. Using the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), we conducted a systematic literature review based on 50 selected papers from the Web of Science database. Starting from the supply chain level, this study identifies digital technology (DT)-enabled labor sustainability management practices, barriers to the adoption of DT in labor management practices, and the performance outcomes of such practices. In addition, we put forward solutions to eliminate those identified barriers to facilitate DT adoption in firms' labor sustainability management. Last, future directions and research opportunities for both supply chain management and labor sustainability are summarized.

Keywords: labor sustainability; human resource management; supply chain management; digitalization; review



The sustainability of supply chains (SCs) has become increasingly prominent in today's business environment [1]. Among the three pillars of sustainability (economy, environment, and society), how to promote human resources related practices in the social pillar is of great importance [2]. Social issues in sustainability include labor conditions, child labor, human rights, health and safety, minority development, the inclusion of disabled/marginalized people, and gender [2]. These aforementioned issues have been widely discussed in the literature of supply chain management (SCM) [2]. Still in development, the extant literature has evaluated the importance of talent management and focused on employee-related approaches in achieving social sustainability in SCs [3]. Furthermore, SCM should rely on certain labor practices or people management approaches to achieve sustainability because economic or environmental sustainability can be better achieved through talent with related knowledge and skills. Hence, we contend that the core issue in achieving social sustainability of SCM relies on both strategies and practices of labor sustainability practices.

In a time full of volatility and uncertainty, technological innovation brings both challenges and opportunities for SCM [4]. For example, at the current stage of the COVID-19 pandemic, an increasing number of organizations are shifting from offline to online working [5]. On the one hand, online working brings more convenience for employees in terms of allowing them to balance their work and family roles; on the other hand, it also makes it hard for employees to provide either their work or family life with their full attention. To cope with this ambiguous and changeable environment, scholars argue that management of labor issues should be incorporated with digitalization tools to increase the efficiency of diverse employees [6]. Despite the use of digitalization tools making traditional human resource management (HRM) more efficient, it also brings new technology-related concerns,



Citation: Chen, C.; Feng, Y.; Shen, B. Managing Labor Sustainability in Digitalized Supply Chains: A Systematic Literature Review. *Sustainability* **2022**, *14*, 3895. https://doi.org/10.3390/su14073895

Academic Editor: Sara Perotti

Received: 2 March 2022 Accepted: 24 March 2022 Published: 25 March 2022

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Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). such as data privacy and security. All these changes in HRM also exist in all SC members and generate new opportunities and challenges in sustainable SCM [7]. Unfortunately, current literature on how digitalization influences the sustainability of labor practices in SCs is piecemeal. A systematic literature review is needed to help researchers understand what the typical labor practices in SCs are within the context of digitalization, how digitalization promotes traditional labor practices in SCs, and whether firms are willing to embrace digitalization in labor practices in SCM.

In this paper, utilizing the Web of Science database, we carry out a literature review under the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and identify the current state of the literature on labor practices in SCs within the context of digitalization. First, we identify digital technology (DT)-enabled labor sustainability management in SCs, after which we discuss the barriers against the adoption of DT in labor practices in SCs; next, we summarize the effectiveness of DT-enabled labor practices in SCM. In addition, we put forward solutions for eliminating the barriers to and improving performance outcomes in DT-enabled labor sustainability management in SCs. Our manuscript contains two contributions to the literature: First, we identify the main research trends in labor sustainability management in SCs in the era of digitalization. Second, we point out future directions based on the results of the literature review. As a final point in this paper, we discuss managerial implications.

2. Research Methodology

In this study, we adapted the PRISMA guidelines to analyze the literature [8,9]. PRISMA provides a checklist to guide the reporting of a systematic review. We followed suggestions from PRISMA in developing the search strategy, article selection criteria, and data extraction procedures. We also employed CiteSpace [10] to identify pivotal points in the literature.

2.1. Search Strategies and Data Sources

As we focus on the management of labor issues in SCs in the context of digitalization, we first define the concept of DT-enabled labor sustainability management in SCs as management approaches concerning employees in SCs with the application of digital technologies. Therefore, during the literature searching process, we focused on three areas: management of labor practices, SCM, and digitalization. Management of labor practices can also be classified into HRM strategies and HRM practices. The former indicates the organizational design for labor management on the strategic level, such as sustainability strategies and corporate social responsibility (CSR), while the latter indicates specific practices in implementation [11]. Therefore, we chose labor issues, corporate social responsibility, and human/labor management as the search terms. As the concept of digitalization is quite broad, we focus on seven representative types of DT, including big data, artificial intelligence, digital, virtual reality, Industry 4.0, and blockchain, all of which are commonly utilized DTs in the business context [6]. We also added the term "digitalization" in case of any omission. Overall, we used search combinations of terms related to labor sustainability practices ("labor issue(s)" OR "corporate social responsibility" OR "human resource/labor management"), digitalization ("big data" OR "artificial intelligence (AI)" OR "digital" OR "virtual reality" OR "industry 4.0" OR "blockchain" OR "digitalization"), and the term "supply chain management". The searched terms were checked in the subject of articles in the Web of Science database. Only research articles or review papers were kept. The first screening step resulted in 383 research articles.

2.2. Article Selection Criteria

The selection of the articles to review was conducted in two rounds. First, we reduced the initial list of 383 articles by examining the relevance of the research areas and deleted articles from areas that were not related to the field of management, such as engineering, computer science, environmental sciences, ecology, etc. We retained 155 papers after this step. Second, the full texts of the selected 155 articles were read, and we further excluded those not truly in the cross-fields of digital technology, labor management, and SCM. After this step, we identified 50 relevant research articles. These 50 articles were all included in the following analysis. Figure 1 shows the review process.



Figure 1. Literature review process (adapted the PRISMA statement).

2.3. Data Extraction Procedures

First, we employed CiteSpace to generate pivotal points in the literature. This approach helped us to identify key terms from the visualized literature network. Then, we deeply analyzed the content of the research articles, highlighted the key questions, and summarized the main conclusions. Three authors separately sorted the key results and conclusions into several themes. Then, the authors discussed these themes and classifications, further refined the conclusions, summarized the papers, and finally generated the literature review results.

3. General Overview of the Selected Articles

Before discussing the research conclusions, we would first like to analyze the general information of the selected 50 articles. Specifically, we focused on the date of publication, the journals, the affiliations of the authors, the research designs, and the research contexts.

3.1. The Distribution of the Research Articles across Time Periods

Figure 2 shows the distribution of the research articles across the period between 2006 and 2021 and indicates that the number of studies on DT-enabled labor sustainability management in SCs keeps increasing, with a dramatic increase after the year 2019.

The implication of Figure 2 is that this topic is of increasingly great importance. Studies on DT-enabled labor sustainability management in SCs had been boosted after the year 2019. In addition to the historical trend, the whole business context has been changed since the outbreak of COVID-19, accelerating the adoption of digital technology in industrial management; thus, more and more scholars are engaging in this area.



Figure 2. Distribution of the research articles across time.

3.2. The Distribution of the Research Articles by Journal

We summarized the information on the journals and found that the selected articles were from 32 journals. Figure 3 summarizes that nine journals have publicized more than two articles. The largest source of the selected articles is the *Journal of Cleaner Production* (six articles), followed by the *Journal of Business Ethics* (three articles), the *Journal of Business Logistics* (three articles), *Resources Conservation and Recycling* (three articles), *Sustainability* (three articles), the *International Journal of Logistics-Research and Applications* (two articles), the *International Journal of Production Economics* (two articles), the *Journal of Business and Industrial Marketing* (two articles), the *Journal of Enterprise Information Management* (two articles), and *Supply Chain Management: An International Journal* (two articles). Overall, our analysis shows that the topic of DT-enabled labor sustainability management in SCs has been accepted by multidisciplinary journals.



Figure 3. Distribution of the research articles by journals.

3.3. The Distribution of the Research Articles by Countries

Figure 4 shows that the 50 articles were written by authors from 29 countries. We calculated the number of publications for each country based on the affiliation information of each article. For example, if one paper contained three authors from Serbia, France, and



Austria, we added one publication under the categories of Serbia, France, and Austria. If one selected paper contained two authors, both from China, we added one publication under the category of China. This statistic has been widely used in the calculation of publications from a geographic perspective in systematic reviews [9].

Figure 4. Distribution of the research articles by country.

As shown in Figure 4, China (including mainland China, Hong Kong, and Taiwan) and the United States contributed the greatest number of relevant articles, followed by France, the United Kingdom, Brazil, India, Italy, Australia, and the United Arab Emirates. It is delightful to see that scholars worldwide have paid attention to this topic; more than half of the articles were written by international research teams.

3.4. The Distribution of the Research Articles by Research Designs

We then analyzed the methods used in the selected papers. The empirical methods included survey approaches, case studies, the Delphi method, and interview designs. There were also several papers using a theoretical framework and review approaches. Figure 5 shows the distribution of the research methods.



Figure 5. Distribution of the research articles by research designs.

From Figure 5, we can clearly find that empirical studies dominate the literature. Among them, twenty-five articles used survey approaches, three articles used case-study methods, three articles used the Delphi method, and one article used an interview design. There were also nine papers describing management phenomena and developing theoretical frameworks to guide future studies. Furthermore, there were two articles that used mathematical models to highlight the importance of human factors in SCM.

3.5. The Distribution of the Research Articles by Research Contexts

Empirical studies and some theoretical papers mentioned the contexts of their studies. Overall, these studies were conducted in more than 38 country contexts. Figure 6 shows the distribution of the majority of contexts mentioned in the articles.



Figure 6. Distribution of the research articles by research contexts.

More than seven studies used multiple-country research contexts. For example, the survey study of Ali et al. [12] utilized a mixed sample containing participants from Singapore, Malaysia, Indonesia, the Philippines, Vietnam, and Thailand. In addition, the survey study of Longoni et al. [13] utilized a mixed sample from Spain, France, and Italy. In terms of single-context designs, four studies came from a Chinese context, and four studies were conducted in an Indian context. The contexts of Italy and the US each contributed three studies, and the contexts of Brazil, Iran, and South Africa each contributed two studies. In addition, there were also studies from the contexts of Ghana, Korea, Poland, Portugal, Serbia, and the UK.

3.6. The Trend of Research Topics

Additionally, we employed CiteSpace to identify pivotal points with keywords of the literature. As shown in Figure 7, we can see that the concept of human resource management, SC management, performance, sustainability, and big data emerged among clusters. Furthermore, we employed CiteSpace to generate pivotal points in the periods of 2006–2015 (seven papers), 2016–2020 (thirty-two papers), and 2021 (eleven papers), as shown in Figure 8. We chose the years 2016 and 2020 as cutoff points as there were two obvious rises in the number of articles at these years. It could be clearly seen that, before 2015, the pivotal points of human resource management, sustainability, and strategy were extracted from the literature. From 2016 to 2020, more pivotal points, such as big data and performance, were extracted from the literature. We inferred that after 2015 a growing

number of empirical studies examining the relations between HRM and SCM, in addition to digital technology terms, such as big data, gradually appeared in the literature. In addition, HRM occupied a central place in the literature of 2016 to 2020. In the articles from 2021, we found that the pivotal point of big data developed quickly and emergingly took a central role in connecting HRM and SCM. Hence, we conclude that DT-enabled labor sustainability management is of increasing importance to social sustainability in SCM.



Figure 7. Pivotal points in the literature (2006–2021).



(a) Pivotal points in the literature (2006–2015)



(**b**) Pivotal points in the literature (2016–2020)

Figure 8. Cont.



(c) Pivotal points in the literature (2021)

Figure 8. Pivotal points in the literature (2006–2015, 2016–2020, and 2021).

In the next step, we review the articles in a more detailed way. Based on the result of pivotal points from CiteSpace, we argue that current literature has discussed labor sustainability management, especially human resource practices in SCs under digitalization, and has examined whether DT-enabled practices bring advantages to firms. In addition, the literature has also identified barriers to adopting DT in labor management in SCs and solutions to eliminate barriers as well as to improve the performance outcomes in DT-enabled labor sustainability management in SCs.

4. Stages of DT-Enabled Labor Sustainability Management in SCM

As digitalization makes information-sharing more efficient and faster than before, scholars have contended that organizations should incorporate digital technologies into traditional management approaches to facilitate SCM performance. In this regard, the existing studies have discussed the mutual benefits of human resources and digitalization technology practices in affecting SCM performance. Furthermore, some theoretical frameworks for the joint effect of labor sustainability management and digitalization on supporting SCM were also raised in the literature.

4.1. DT-Enabled Labor Sustainability Management in SCs

Current literature has identified ways in which digitalization can help enhance the efficiency of practices of labor management and further extends the traditional function that HRM takes with the help of digitalized technologies. With this line of research, we propose that firms can rely on advanced HRM to implement DT-enabled labor sustainability management.

4.1.1. How Digitalization Benefits Labor Sustainability Management

In this research area, many studies have discussed how digitalization empowers traditional HRM practices with more tools to manage talent for SCs in organizations. For example, blockchain technology can be used to reduce deceptive recruitment and unethical recruitment in the migrant workforce [6]. Blockchain and big data analytics can be used to trace working conditions, working hours, living wages, social welfare, and equity, as well as to promote workplace health and safety [14]. Blockchain can also integrate government agencies, third-party inspection agencies, and industry associations in the monitoring system so that sustainable development in SCM can be guaranteed. In addition, AI can also help HRM activities such as scanning candidate resumes, classifying job categories, preparing documents, and managing employee data. AI can also utilize data on employee satisfaction and evaluation to provide assessments, predict employee turnover [15], and even make HRM decisions [16]. Industry 4.0 technology and smart tools also help organizations reduce communication gaps among different levels in the organizational hierarchy [17].

4.1.2. How Labor Sustainability Management Facilitates Digitalization

Some studies have also identified advanced HRM as an important factor accelerating organizations' digitalization and innovation processes in SCM. Using survey data from engineering and manufacturer supplier firms, Bag et al. [18] argued that a series of human resource management practices are relevant to the adoption of Industry 4.0 tools such as big data analytics for SCM, such as training and capacity building, the empowerment of employees, readiness for organizational change, using cross-functional teamwork, and promoting a learning climate. By investigating firms from employees in KSA, UAE, Egypt, and Lebanon, Singh and El-Kassar [19] found that green innovation practices, resulting from green SCM practices, should produce more significant effects on economic and environmental performance when firms implement advanced green HR training.

4.1.3. Building DT-Enabled Labor Sustainability Management

In addition to utilizing digitalization tools in managing labor issues, scholars have further proposed that DT should be incorporated into HRM systems to facilitate SC's performance. For example, Dao et al. [20] stated the necessity of the integration of HRM and IT systems to strengthen organizational sustainability. This argument also receives empirical support from Mandal [21] who found the positive interaction of human capital and various IT capabilities on healthcare SC performance and healthcare agility. In addition, some studies have developed new HRM frameworks that facilitate an SCM digitalization context. For example, Liboni et al. [22] argued that HRM tasks in an Industry 4.0 context should consider the association of human, technology, and organizational factors. To facilitate SCM in Industry 4.0, HRM should focus on the enhancement of qualifications and education, collaboration and integration, and data and information integration at the SC level.

4.2. Outcomes of DT-Enabled Labor Sustainability Management in SCs

The existing literature has provided many empirical results on the role of advanced HRM in the context of digitalization in promoting organizations' SCM performance; however, the concept of DT-enabled labor sustainability management is still in its infant stage. Current studies have analyzed how digitalization capability or context facilitates labor sustainability management in promoting SCM, and many studies largely focus on the effectiveness of green HRM.

4.2.1. Positive Role of DT-Enabled Labor Sustainability Management

Digitalization can enhance the social capital of an organization; it leads to increased SC performance by providing more human capital resources and competitive advantages [23]. Scholars are interested in the performance outcomes of DT-enabled labor sustainability management in SCs. According to the resource-based theory, corporate management approaches bring competitive advantages for organizations. For example, advanced HRM can attract, develop, and retain talent for an organization. In the context of digitalization, it is also predicted and supported by many empirical studies that HRM contributes to SCM [24]. In the context of digitalization, HRM should be further incorporated with technological or sustainable features [25–27]. In addition to theoretical explanations, some scholars have tried to justify the importance of labor sustainability management to SCM from other methodological perspectives. For example, Yassine et al. [28] established mathematical models, and their results demonstrated that SC managers need to incorporate environmental and human factors together in their supplier selection decisions to attain the sustainability of SCs.

4.2.2. Boundary Conditions for DT-Enabled Labor Sustainability Management

Though theoretically proved as effective, DT-enabled labor sustainability management does not always accelerate SCM performance from an empirical perspective. For example, using survey data from 682 SMEs in Italy's service sector, Scuotto et al. [26] failed to establish significant relationships between ICT (information and communication technologies)-specialized human resources and the use of ICTs within SCM. Jabbour et al. [29] found that it is the technological aspect rather than the human/organizational aspects of environmental management that has a positive relationship with the adoption of green product development practices in a Brazilian context. These non-significant results stimulate scholars to pay particular attention to certain boundary conditions in which DT may either amplify or hinder the effectiveness of labor sustainability management. For example, with empirical evidence from 378 Italian firms, Del Giudice et al. [25] found that big data acts as a positive moderator between the relationship of circular economy HRM and firm performance for circular economy SCs in such a way that their positive relationship should be more significant in the context with a higher level of big data adoption. On the other hand, Nejati et al. [30] found that resistance to change negatively moderates the positive relationship between green HRM practices, such as recruitment, selection, and green SCM performance. In conclusion, big data capabilities or organizational cultures that favor change or innovation can boost the role of advanced HRM in promoting SCM for organizations.

4.2.3. Suppressing Effect of Labor Sustainability Management

In addition to potential moderators, the literature has also documented an interesting phenomenon in labor sustainability management. Using survey data from 139 manufacturing firms in Ghana, Agyabeng-Mensah et al. [31] found that the adoption of internal green SC practices could negatively affect the market and financial performance of firms, while the implementation of green HRM and SC cooperation could catalyze internal green SC practices to improve firm performance. We explain this conclusion as a suppressing effect of green HRM and SC cooperation, indicating that, on the one hand, internal green SC practices may occupy investment and harm firms' financial performance. On the other hand, it also reinforces a sustainable culture that turns green HRM implementations into reality. Additionally, green HRM helps firms to effectively carry out green practices and further gain competitive advantages; thus, it increases sales and improves profitability as a mediator in the relationship between internal green HRM, as a subdimension of overall sustainable practices, further coordinates with other SC management practices in affecting overall performance.

4.2.4. Main Effects of Green HRM

Our literature review identifies green HRM as an important factor in promoting SCM performance in the digitalization era [32]. Green HRM contains certain practices that reflect efforts in preventing pollution and promoting environmental management through typical HRM activities such as green recruitment and selection, green training, green performance management, green pay and reward, and green involvement [33]. Jabbour [34] regarded the idea of green HRM as consisting of two dimensions, namely green HRM systems and green HRM organizational enablers. Green HRM systems refer to environmental recruitment and selection, eco-focused training, and eco-aware performance assessment and rewards, while green HRM organizational enablers include ecological organizational cultures, green teams, and eco-focused employee empowerment [34]. The implementation of green HRM requires the facilitation of digital techniques, such as online recruiting and digitalized training; thus, it requires the overall awareness of the sustainability of a company [33]. Green HRM can facilitate the successful implementation of environmental management by hiring employees who commit to environmental issues, improving employees' capabilities for environmental management, and appraising as well as rewarding employees' environmental contributions; hence, green HRM can promote firms' performance, especially regarding sustainability in SCM. For example, Jabbour et al. [35] proposed a synergistic and integrative framework for the green HRM-green SCM relationship. Longoni et al. [13] furthermore examined that green SCM plays a mediating role in the relationship between green HRM and environmental performance. Nejati et al. [30] divided green HRM into subdimensions of recruitment and selection, development and training, employee empowerment, pay and reward, and performance management and appraisal. Their empirical results show that among these dimensions of green HRM, development, and training, employee empowerment, and pay and rewards have the most positive influences on green SCM.

5. Barriers to Adopting Digitalization for Labor Sustainability Management in SCM

Though studies confirm positive outcomes for adopting digitalization in labor management in SCM, firms still face barriers to adopting digitalized management approaches in practices. Digitalization is featured as a mixed nature; therefore, in addition, the successful implementation of DT in SCs requires talent and organizational support for a backup. Digitalization not only brings organizations sophisticated technologies and skills for production and services but also changes the manner in which employees can be developed in the SC sector and maintain good relations with outside stakeholders. Hence, as a double-edged sword, the context of digitalization brings organizations efficiency as well as shocks that are inevitable for organizations to meet to promote organizational transformation. Through the literature review process, we conclude that there are both internal and external barriers that organizations face in adopting digital technology for managing labor issues in SCM.

5.1. A Lack of Relevant Talent for Digitalization

Digitalization brings organizations competitive advantages, not only in technology infrastructure but also in human resources [36]; however, from an internal perspective, a lack of talent is the main barrier against organizations' adoption of digitalization transformation in SCs. The literature has identified several underlying reasons why acquiring SCM talent is quite difficult for firms. First, as job demands change rapidly, there is a lack of employees sophisticated in both SCM and digitalization-related knowledge, such as big data analytical skills [36,37]. A lack of talent with necessary skills or competencies is viewed as an obstacle to the implementation of Industry 4.0 [38]. Another critical reason is that talent training programs in education systems are highly behind what is required. The required skills, knowledge, and abilities for SCM in the context of digitalization are not commonly taught in universities [36]. van Hoek et al. [39] contended that universities should engage managers in scientific research and provide more company-engaged and customization programs hosted by faculty with more industry experience.

5.2. A Lack of Stakeholder Alignment for Digitalization

As an organization's SCM performance is highly relevant to strategic alignment among stakeholders, an organization's digitalization process in SCM requires not only internal human resources but also outside stakeholders' support, i.e., the government, suppliers, customers, and third-party organizations. Studies have found that a lack of alignment on digitalization awareness among stakeholders threatens the adoption of digitalization processes in SCM. For example, Yadav et al. [40] utilized a decision-making trial and evaluation laboratory approach to identify critical obstacles to adopting blockchain in agriculture SCs in India. The major barriers included a lack of government regulation and a lack of awareness among agro-stakeholders. Other obstacles include concerns of security, privacy, and interoperability, resulting from sophisticated blockchain system designs, as well as agro-stakeholders' resistance to using blockchain systems.

In conclusion, when implementing DT-enabled labor sustainability management in SCs, organizations face obstacles from both inside and outside [2]. On the one hand, organizations should possess enough talent to facilitate digitalization transformation. On the other hand, organizations also need to align with stakeholders to develop DT-enabled practices in a synergistic manner.

6. Tactics for Building DT-Enabled Labor Sustainability Management in SCM from an Organization's Perspective

As we have identified in the previous section, the barriers against an organization's digitalization process in SCM are lacking strategic alignment with stakeholders and lacking qualified talent. An appropriate organizational strategy is an attempt to overcome the shortcoming of lacking strategic alignment. Thereby, there are several studies trying to analyze how strategic level factors, such as the role of executives, organizational capital, and sustainability practices, facilitate SCM in the digitalization era. In addition, a critical step in supplying required human resources is identifying the competency of SCM talent within the digitalization era and developing them under an appropriate organizational culture.

6.1. Strategies Related to Labor Sustainability Management in Supporting SCM in the Digitalization Era

6.1.1. Sharing Leadership with Technology

Some scholars have discussed how executive-level managers and technology in the digitalization era share responsibilities of traditional leadership roles. Studies have started to consider technology-driven aspects as meaningful elements in leadership philosophies for SCM. For example, Akhtar et al. [41] proposed and tested that data-driven and adaptive leadership is a key determinant for SCs' financial and sustainability performances. Furthermore, we infer from the literature that a new leadership style that combines both human qualities and digital technology advantages is necessary to build an effective SCM against the context of volatile digitalization. Our inference is supported by Wehrle et al. [42] who utilized a Delphi study design with clustering analysis and found that the context of digitalization should lead to a strong integration of SCM executives and digital technologies in sharing traditional leadership roles. They predicted that SCM executives will dominate in the roles of human caregivers, human aspects, and psychologists as well as show intense learning adaptability and retaining, while digital technologies will dominate in technical aspect roles. More importantly, SCM executives and digital technologies should jointly assume the role of digital influencers, i.e., AI in recruiting, digital onboarding, digital network management, performance monitoring, digital employer platforms, and recovering roles.

6.1.2. Organizational Digitalization Capability

Some studies have also discussed how digitalization-related organizational capital influences SCM performance. Among these studies, technological capacity is one of the most relevant concepts. Using survey data from 520 mining companies in South Africa, Bag et al. [43] found that big data analytic management capability is positively associated with innovative green product development, which further influences innovation and learning performance as well as sustainable SC performance. In addition, SC innovativeness moderates the relationships between innovative green product development and innovation as well as learning performances in such a way that the positive relationship would be further enlarged under a higher SC innovativeness situation.

Furthermore, some scholars argued that organizations' digitalization capacities should fit with external requirements to improve overall performance. Using a single case-study analysis approach, Wang et al. [44] analyzed how a cross-border E-commerce enterprise achieves resilient SCs in an unexpected environment, such as COVID-19. On the basis of information processing theory, they proposed that the environmental uncertainties of logistics environments would increase a company's information processing requirements. Once the information processing requirements fit with a firm's information processing capabilities, the organization would obtain a highly ambidextrous ability to build a resilient SC. In their framework, the advantage of exploitation and exploration ambidexterity should lead to the agility, redundancy, and flexibility of SC resilience, while the morality ambidexterity should lead to a culture for risk management of SC resilience. Additionally, more importantly, a firm should acquire information processing capabilities from adopting information technology, establishing a highly connected organizational structure, and developing coordination and control mechanisms.

6.1.3. Sustainability in Promoting SCM in the Digitalization Era

Finally, as sustainability represents the overall strategy that organizations hold toward sustainable development [45,46], engagement in sustainable practices is salient for organizations to achieve socially sustainable outcomes. Studies have shown that corporations taking more sustainable practices will achieve better performance in SCM. For example, using survey data from 244 US and German corporations, Ehrgott et al. [47] found that customer social pressure and social middle management pressure are associated with socially sustainable supplier selection, which should be further associated with suppliers' strategic capabilities, firm reputation, and extent of organizational learning in supplier management.

In addition, the effectiveness of sustainability on SCM performance is contingent on some factors. For example, Fontoura and Coelho [48] surveyed 425 SC partners for Portugal's biggest energy supplier, and the results showed that the SC partners' sustainability positively impacts their shared value, competitive advantages, and performance. Furthermore, the positive relationship between sustainability and value sharing or performance is more salient for highly SC leadership-dependent companies, while the relationship between sustainability and competitive advantages is more salient for companies with low SC leadership dependency. Some other studies have also identified the fact that the effectiveness of sustainability is contingent on organizational digitalization capability. For example, using three-wave survey data from 260 Chinese managers, Wang et al. [49] found that the positive relation between external sustainability and green SCM is more positive for companies with high big data analytics capability, indicating that digitalization-related capacity would further amplify the positive effect of management strategies on SCM performance.

6.2. Identifying Key Competencies of SCM Talent in the Digitalization Era

Current literature has discussed staff competencies related to SCM in the digitalization era from top management team members to middle managers and finally front-line SCM staff. Though we find that competencies such as lifelong learning and emotional intelligence may produce important effects on SCM, most studies in this area have discussed competencies in a descriptive way, rather than empirically testing the relationship between competencies and performance in terms of individual SC tasks or overall SCM performance.

6.2.1. Competency of Top Management Team Members

Some studies have focused on the competency of top management team members in facilitating SCM performance in the context of digitalization. For example, Akhtar et al. [50] identified top management team members' tangible competencies, including educationbased, experience-based, and analytical-based competencies, as key determinants for building relationship-based business networks which should be critical for organizations to achieve sustainable performance. In addition, other studies have also found that top management support promotes green SCM performance by enhancing teamwork and work culture [51,52] as well as facilitating HRM to use big data analytics to improve their competitive advantages [53].

6.2.2. Competency of SCM Staff

In addition to top management team members' competencies, recent attention has been moved to other front-line managers and staff. For example, Bag et al. [43] found that big data analytic talent capability is positively associated with employee development, which is further associated with sustainable SC performance. Saniuk et al. [54] argued that logisticians are of high demand in industrial enterprises that have implemented Industry 4.0. Their work required critical skills for either managerial staff or industrial staff. For industrial staff, required competencies should include technical skills, an ability to solve problems, an ability to use IT systems, analytic capacity, communications, and lifelong learning. Critical competencies for managerial staff should include lifelong learning, social media service, skills to connect technology and management, the ability to work in a team, and openness to changes. Contradicting intuition, managerial staff need to update their managerial skills to lead technological innovation rather than taking a technology expert role. Furthermore, a close comparison indicates that the competency of lifelong learning is important for both industrial staff and managerial staff [54]. In a similar vein, van Hoek et al.'s [39] study also supported the critical competency of lifelong learning and appealed that university education models and research models should be changed to support this quality.

Another talent quality that is critical in organizations' SCM performance in the digital era is managers' emotional intelligence. By investigating 155 manager-level supervisors in the US, Keller et al. [55] found that managers possessing higher levels of emotional intelligence can help their subordinates manage emotions and build more positive working conditions for them, thereby resulting in increased employee retention and more positive service outcomes for external customers in the SCM process. van Hoek et al. [39] supported this perspective and further argued that within the post COVID-19 period, the importance of the emotional intelligence of SC managers should be highlighted. An emotionally intelligent manager can enhance employee resilience as well as support them in stressful and changeable periods.

6.3. Establishing a Culture of Learning and Innovation in Supporting SCM in the Digitalization Era

Another important factor that needs to be considered in facilitating DT-enabled labor sustainability management in SCs is developing appropriate organizational shared values and norms (i.e., organizational culture or climate) catering to the context of digitalization. Research has identified that a culture of learning and innovation is of great importance. For example, Shamim et al. [56] argued that to facilitate the technology acceptance of Industry 4.0 for SC efficiency in the service sector, organizations should develop learning, knowledge management, and innovation capability focused management practices. Organizations can leverage their organizational structure, leadership style, HRM practices, and innovation climate to shape the value of learning orientation and innovation among employees in the organization.

In conclusion, previous literature has discussed strategic-level factors such as the role of executives, organizational digitalization capability, and sustainability practices in affecting SCM in the digitalization era, as well as individual competencies and organizational culture facilitating SCM in the context of digitalization. We conclude that, under the umbrella of DT-enabled labor sustainability management, organizations should implement both digitalized HRM practices and digitized governance, as well as develop digitalization capability to achieve sustainable development objectives.

7. Discussion

7.1. Main Findings

This study focused on labor management in SCs, the social side of sustainability, and analyzed articles on DT-enabled labor sustainability management in SCs. We summarized our research findings in Figure 9. Through processes of systematic review, we analyzed 50 articles and found that the research field appeared in 2006 and received dramatically increasing attention after 2019. Current studies have heavily relied on survey methods to examine theoretical models in different cultural contexts. Based on the analysis from 50 articles, we identified several topics that cover the field of DT-enabled labor sustainability management in SCs. First, the current literature is in the stage of identifying the advantages and performance of labor sustainability management in SCs under digital transformation. Extant studies have discussed the mutual benefits of labor management

practices and digitalization technology in affecting SCM performance. A rudimentary concept of DT-enabled labor sustainability management is developing, and some empirical results support the role of advanced HRM, such as green HRM, in the context of digitalization in promoting organizations' SCM performance. Scholars have further identified some boundary conditions, such as digitalization capability and innovation resistance.



Figure 9. Summary of literature review.

In addition, the literature has recognized existing barriers against the adoption of DT in labor sustainability management in SCs, including a lack of strategic alignment with stakeholders and a shortage of talent for digitalized SCM. Furthermore, studies have raised tactics for building DT-enabled labor sustainability management in SCM from the perspective of organizations. A firm can leverage the role of executives, organizational capital, and sustainable practices to facilitate SCM in the digitalization era. It can also improve key competencies for SCM talent and establish a culture of learning and innovation to facilitate the performance of SCs within the context of digitalization.

7.2. Opportunities for Future Studies

7.2.1. Revealing the Mechanism Underlying DT-Enabled Labor Sustainability Management

As a component of sustainability management, labor sustainability management in SCs is a research area that has been paid much less attention than green SCM. Different from environmental management issues in SCs that are pressured by regulations, customers, or other stakeholders, labor practices in SCM are less observed by outside stakeholders, hence their importance has been underestimated in the past. With the capability of digital technologies, labor sustainability management in SCs could be observed and measured in more transparent ways, according to the literature [40]. The field of DT-enabled labor sustainability management in SCs and green SCM might not be suitable for analyzing the drivers or barriers in DT-enabled labor sustainability management in SCs. There is a lack of research in the area, and future research should uncover its full

driving mechanism. In addition, current studies seldom discuss how external factors such as consumer pressure, social networks, or social media advertising [57–59] affect DT-enabled management. Lastly, future studies can also benefit from discussing how DT-enabled labor sustainability management improves organizational resilience. Resilience demonstrates the levels of organizations' capabilities in tolerating and coping with adversity and uncertainty [60]. DTs enhance information exchange accuracy and efficiency and provide opportunities to improve supply chain transparency in labor sustainability management, i.e., more accurate predictions on labor supply and developing appropriate training programs to equip employees with more knowledge, abilities, and skills to cope with uncertainty from the outside. Hence, we infer that DT-enabled labor sustainability management should improve organizational resilience, which will be further positively associated with organization sustainable development. Empirical studies should be launched to further examine these relationships.

7.2.2. Discussing the Sustainability of SCs from a Global Perspective

Articles in the field discussing the implementation of DT-enabled practices in SCs occur in the context of developing countries, such as India and China, while the majority of the researchers came from developed regions where socially responsible consciousness is more advanced. Such results indicate that, in a global context, consumers from developed regions have strongly motivated firms to trace upstream suppliers' labor issue management practices in developing regions. As the development of the labor management of suppliers is in developing regions, there is a need for scholars to conduct research on how DT-enabled practices can help these suppliers proactively integrate or cooperate with their customers in developed regions or in different cultural contexts [61] to achieve SC-level performance maximization. In addition, leveraging the literature on sustainable HRM, which contends that firms can utilize HR systems to support their sustainable strategies [62], we suggest that future research empirically test the role of sustainable HRM in SCM within the context of digitalization.

7.2.3. Exploring Labor Sustainability Management within the Context of the Gig Economy

Research on talent in digitalization and SCM should be better connected with new employment arrangements. Keller and Cappelli [63] have proposed a new model of talent management that focuses on the match of talent supply and demand for organizations. They raised four strategies, including inventory, just in time, internal capacity, and outsourcing, in response to the challenges of reliability and responsiveness in talent management. In addition, the context of digitalization makes the talent supply more flexible than ever; according to Cappelli and Keller's [64] classification, there is a variety of employment arrangements in the workplace. Our review shows that current labor issues in SCM are largely related to an internal capacity, such as formal employees and managerial staff, while there is a lack of studies focusing on how gig workers or labor outsourcing from agency organizations facilitate a firm's SCM performance. Few studies empirically discuss how DT-enabled labor sustainability management helps firms trace the working conditions and wellbeing of outsourcing labor in suppliers. Hence, future research can shift the labor issues from the inside to the outside to enrich the literature.

7.2.4. Polishing Research Designs for DT-Enabled Labor Sustainability Management

From the perspective of research methods, this field still needs more empirical and modeling investigations to advance to a more sophisticated level. Currently, management practices are usually measured through surveys in empirical research; however, the research designs in the selected studies contain many concerns. First, current survey designs usually invite a single employee from a firm to evaluate certain management practices and SCM performance, leaving the concerns of common method bias. Future studies can utilize multisource data in analyses. For example, performance data can be measured via objective data, while management approaches can be measured via top-level executives or functional employees. Second, current studies are of cross-sectional designs, from which it is hard to draw causal conclusions. Future studies should apply longitudinal designs to further confirm their conclusions. Third, as employees at different levels perceive management practices or firm-level strategies differently, it would be better to investigate top management team members and HRM directors rather than distributing surveys to general supervisors or employees in the SC sector. Apart from empirical investigations, mechanisms in the optimization of firms' decisions on DT investment to advance HRM in SCs should be further explored. In this case, modeling research is lacking and needed in future research.

8. Limitations and Future Directions

This study provides implications for the digital transformation of labor sustainability management in SCs through a thorough review of the field. However, there exist some limitations. First, we relied on the Web of Science database. Although Web of Science includes a wide range of publications and has been used in plenty of review articles, other databases, such as Scopus, might cover the full research field as well. Second, we incorporated research articles while ignoring practical journals which might be a news source for practitioners. Finally, a comprehensive review of economics-based, environmental-based, and social-based sustainable SCM practices in the digital era should be fully conducted and analyzed to understand the full picture of DT-enabled labor sustainability management in SCs.

Author Contributions: Conceptualization, C.C., Y.F. and B.S.; methodology, C.C. and Y.F.; writing original draft preparation, C.C. and Y.F.; writing—review and editing, B.S.; supervision, Y.F. and B.S.; project administration, Y.F.; funding acquisition, C.C. and Y.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Natural Science Foundation of China (72102036, 71902023), the Shanghai Sailing Program (21YF1401000), and the Fundamental Research Funds for the Central Universities (2232021E-11, 2232018H-09).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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