Guest editorial: Supply chain transparency: opportunities, challenges and risks

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1. Introduction

With increasing pressure from consumers, regulatory bodies and capital markets, firms are being compelled to disclose more information about their products and supply chains (SCs) (Menon and Jain, 2024; Wang *et al.*, 2024; Zheng *et al.*, 2024). Moreover, it has become a hot topic to investigate the impact of social and environmental performance on the long-term development of firms (Chen *et al.*, 2021; Gualandris and Kalchschmidt, 2016; Xu *et al.*, 2023). Supply chain transparency (SCT), a critical aspect of sustainable practices, is receiving increasing attention from the academic community (Carter and Rogers, 2008; Morgan *et al.*, 2023). Moreover, a number of companies have already initiated practices for SCT. For example, Nike, a leading global manufacturer of sports shoes and apparel, launched a project called Manufacturing Map, which allows consumers to view the manufacturing locations of Nike products, as well as information on labor standards and environmental impact (Nike, 2024). The renowned Spanish fashion brand Mango has made its list of third-tier manufacturers available online, offering consumers a transparent view of the brand's efforts towards sustainability (Mango, 2022).

It is crucial for firms to improve SCT. Specifically, SCT can convey positive signals to stakeholders, facilitating financing behavior (Shi *et al.*, 2024), deepening partnerships (Baharmand *et al.*, 2021; Besiou and Van Wassenhove, 2020) and enhancing overall performance (Jia *et al.*, 2023). Furthermore, SCT enhances an organization's capacity for risk identification and management (Dubey *et al.*, 2019). For example, by enhancing the visibility of the upstream operations within the SC, firms can gain a clearer understanding of the entire SC's functioning (Sadeghi *et al.*, 2023). This, in turn, enables them to devise proactive strategies aimed at reducing the likelihood of disruptions and mitigating the adverse impact of such disruptions on business operations (Tang, 2006). Moreover, SCT contributes to advancing sustainable firm practices (Dahlmann *et al.*, 2023; Kalkanci and Plambeck, 2020) and mitigating information asymmetry (Lamming *et al.*, 2001; Sadeghi *et al.*, 2022).

Transparency is generally considered a valuable trait; however, in SCs and upstream operations, maintaining confidentiality is equally critical. According to Bai and Sarkis (2020), implementing SCT requires firms to disclose their complex, multi-layered SC information, including raw material procurement, production processes, SC operations, partnerships and environmental protection measures. Therefore, pursuing SCT may lead to negative consequences, such as increased competition, reputation damage and legal and regulatory risks (Liu *et al.*, 2024; Sodhi and Tang, 2019).

The purpose of this editorial is to summarize key themes in current SCT research. Then, we synthesize these key themes into a structured framework, which will offer meaningful reference for the subsequent research. Finally, we provide a few unique insights into the gaps and directions for future research.

2. A research framework for SCT

To pinpoint the critical issues in SCT research, identify new contributions and determine future directions in the field, we have classified the existing literature on SCT. Subsequently, we design a comprehensive research framework that addresses four key questions, as illustrated in

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Figure 1. The framework consists of antecedents, practices, outcomes and challenges. Therefore, the following questions guide the logic:

(1) What are the main factors affecting SCT?

(2) What are the main aspects of SCT practices?

(3) What challenges impede firms while improving SCT?

(4) What are the outcomes of SCT for firms?

(5) What risks do firms encounter when improving SCT?

2.1 Influencing factors

The demand for SCT has been driven by the concerns of stakeholders (Sodhi and Tang, 2019; Wang *et al.*, 2024) and the normative pressures of regulations (Budler *et al.*, 2024). Firms' disclosure is a crucial component of SCT, yet the extent of such disclosure is a highly subjective decision (Gardner *et al.*, 2019). In the existing literature, various factors affecting SCT have been identified.

The structure of the SC network is pivotal in either promoting or constraining SCT (Dubey *et al.*, 2020). Gualandris *et al.* (2021) examine the relationship between SCT and SC structure characterized by interconnectivity and heterogeneity. Their research reveals a positive

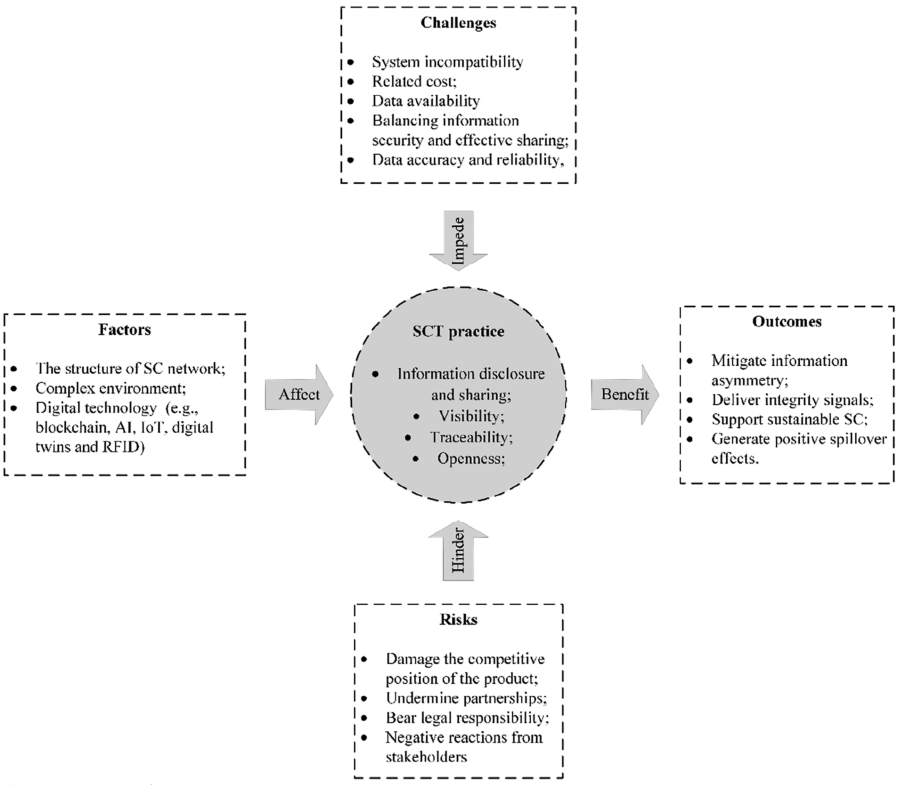

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Figure 1. Research framework to classify literature about SCT

correlation between SC density and transparency, as well as between geographical heterogeneity and transparency. At the node level of the SC network, relational embeddedness fosters information sharing among SC members, thereby enhancing SCT. Feng *et al.* (2024) discover that supplier concentration positively impacts SCT. In addition, the relative position of firms in different SCs also affects their transparency performance, especially the "hub firms" that play key roles in multiple SCs. These hub firms often need to maintain a high level of transparency in different business relationships to facilitate the management and coordination of complex transaction networks.

Given today's volatility, uncertainty, complexity and ambiguity of the business environment (what is labeled as VUCA), it can be challenging for firms to achieve the required level of SCT for optimal business performance. Specifically, according to the dynamic capability theory, a firm's external environment has a decisive impact on its SC strategy, thereby affecting the extent of its information disclosure, and is moderated by internal and external environmental factors such as online media reports, government environmental subsidies and industrial competition intensity (Qrunfleh and Tarafdar, 2014; Wang *et al.*, 2024). Moreover, various stakeholders have diverse demands for a firm's SCT. For instance, carbon transparency in greenhouse gas emissions from the SC is a result of complex interactions among normative, mimetic and coercive pressures (Tuladhar *et al.*, 2024). Similarly, while firms need to disclose their information openly, they also need to maintain their legitimacy by achieving their sustainable development goals. Therefore, firms must balance and carefully manage the tension between these two aspects (Dahlmann *et al.*, 2023).

Another essential factor contributing to the current widespread attention on SCT is the emergence of necessary technologies to support transparency (Bai and Sarkis, 2020). Digital technologies have sparked a revolutionary transformation in the field of SC management. Digital technologies can assist organizations in capturing, representing and analyzing complex SC operations (Budler *et al.*, 2024; Xu *et al.*, 2023). Specifically, through digital technologies such as Internet of Things (IoT) (Feng *et al.*, 2020), digital twins (e.g. cloud computing and big data analytics) (Freese and Ludwig, 2024), Radio Frequency Identification (RFID) (Heese, 2007) and 5G wireless (Morgan *et al.*, 2023), firms may better reach real-time data collection, intelligent analysis and simulation capabilities. Consequently, the deployment of these technologies assists firms in overcoming multi-level information barriers within the SC (Bai and Sarkis, 2020; Keller *et al.*, 2021) and ensuring the accuracy and credibility of full-chain information sharing (Feng *et al.*, 2024). For instance, techniques such as data mining and network analysis can assist researchers in extracting valuable information from vast amounts of data, revealing potential connections within the SC network (Feng *et al.*, 2024). Finally, AI and machine learning technologies can augment firm operations through automation, thereby enhancing efficiency and transparency (Zheng *et al.*, 2024).

Blockchain refers to a shared distributed ledger where transactions are digitally recorded and linked in a chain containing the entire history or provenance of an asset (Baharmand *et al.*, 2021). It promotes SCT and traceability through its key attributes of traceability, immutability, auditability and provenance (Menon and Jain, 2024; Saurabh and Dey, 2021; Tuladhar *et al.*, 2024). Smart contracts, one of the most notable innovations in blockchain technology, facilitate the automation of business processes and include member information within the upstream and downstream SC (Ahmed *et al.*, 2022). Through this information flow, firms can achieve product traceability, goods location tracking, storage condition monitoring and compliance verification (Menon and Jain, 2024). Moreover, blockchain applications encompass interoperability with various Industry 4.0 technologies (Dolgui and Ivanov, 2022; Li *et al.*, 2023).

2.2 SCT practices

Within the existing literature, terms such as disclosure, visibility, traceability and openness are often used synonymously with SCT, leading to ambiguity in key concepts. This ambiguity may

lead to a lack of clear direction and objectives when implementing SCT practices (Keller *et al.*, 2021). Furthermore, this inconsistency poses challenges in comparing and integrating research findings on SCT (Morgan *et al.*, 2023). To avoid confusion and promote a consistent understanding of SCT, we clarify these terms based on previous literature (Table 1).

Attributes such as visibility, traceability, openness and disclosure are intertwined, collectively forming the fundamental concept of SCT and guiding its practical implementation (Gualandris *et al.*, 2021; Montecchi *et al.*, 2021). First, SCT practices are manifested in the proactive disclosure of relevant information and information sharing (Sodhi and Tang, 2019). For instance, Sadeghi *et al.* (2022) find that supplier disclosures through buyer's monitoring of business continuity and operations performance can lead to improved performance by the buyer. Such disclosures facilitate real-time information flow, encompassing order status, inventory levels, production progress and SC risk information, which is essential for achieving SCT (Dubey *et al.*, 2020).

Second, it is crucial to ensure that each link in the SC has adequate visibility and traceability, thereby enabling the entire operational process of the SC to be tracked and recorded (Ahmed *et al.*, 2022; Keller *et al.*, 2021; Tuladhar *et al.*, 2024). Regarding visibility, it actually involves multiple levels, determined by the quantity and quality of information shared within the SC (Barratt and Oke, 2007). Therefore, to enhance SC visibility, the key lies in widely sharing useful and meaningful information. This enables firms to gain a deeper understanding of the state of the SC, thereby enhancing its resilience and efficiency. Traceability encompasses two distinct aspects: tracking and tracing. Tracking refers to identifying the source and characteristics of a specific product, including supplier names, methods of material procurement and place of origin (Cousins *et al.*, 2019; Garcia-Torres *et al.*, 2019). On the other hand, tracing necessitates the compilation of a historical record of the product's movement within the SC. However, some firms only disclose how they ensure product sourcing without revealing supplier names or other specific details. Patagonia faced criticism for its inhumane treatment of geese, which violates the responsible down standard (DesMarais, 2014). Subsequently, the company developed a "traceable" initiative to ensure tracing its upstream sources back to the farm (Sodhi and Tang, 2019). The Patagonia example

Table 1. Terms related to SCT

Terms	Definition	References
SCT	SCT is defined as the extent to which a company or organization voluntarily and clearly discloses information about various aspects of its SC operations to its stakeholders. This information covers the entire SC process, including but not limited to raw material procurement, production processes, logistics and distribution, sales, etc.	Bai and Sarkis (2020), Montecchi *et al.* (2021), Sodhi and Tang (2019)
SC visibility	Participants within the SC have access to or share key information related to SC operations, thereby meeting the needs of stakeholders	Agrawal *et al.* (2024), Barratt and Oke (2007), Kalaiarasan *et al.* (2022)
SC traceability	The ability of a firm to track and trace products from raw material procurement to final product delivery to consumers	Cousins *et al.* (2019), Kamble *et al.* (2020)
SC openness	It refers to the degree and scope of information sharing among various participants in the SC	Cadden *et al.* (2013), Montecchi *et al.* (2021)
Disclosure	The process of firms openly sharing information with internal and external stakeholders involves disclosure in various areas, such as quality, environment impact, social responsibility and sustainability	Chen *et al.* (2022), Li *et al.* (2018), Marquis *et al.* (2016)

Source(s): Authors

highlights how firms may need to respond to social and consumer concerns through SCT practices when confronted with ethical and environmental responsibilities.

Third, to ensure the availability, integration and sharing of SC data, it is crucial to establish a unified data standard and platform (Dolgui and Ivanov, 2022). Such a unified platform and standard help to eliminate information silos and facilitate effective communication among participants. Furthermore, it promotes collaborative work throughout the SC, thereby improving operational efficiency. As a result, with greater transparency and accessibility of information, new participants can more easily join the SC and collaborate with existing participants. This helps to attract more innovation and resources into the SC, further enhancing its openness.

In summary, SCT practices involve a series of measures adopted by firms in SC management, such as disclosing, sharing and tracking relevant information and data within the SC. These practices aim to enhance the visibility and openness of the SC (Budler *et al.*, 2024). Within this framework, firms not only comply with regulatory requirements through information disclosure, but also build a transparency ecosystem to foster trust and collaboration among stakeholders (Montecchi *et al.*, 2021).

2.3 Challenges

While digital technologies offer opportunities for SCT, they still face challenges in their implementation and utilization in facilitating SCT (Morgan *et al.*, 2023). Specifically, many firms utilize disparate systems and software in SC management. These systems may not be compatible or difficult to integrate, resulting in data silos and information gaps (Kalaiarasan *et al.*, 2022). Consequently, integrating data from these diverse IT solutions and ensuring they are correctly mapped to corresponding data fields becomes a critical challenge (Agrawal *et al.*, 2024). Moreover, SCT practices require certain fixed costs, such as those associated with technology infrastructure and data processing. The deployment of advanced digital technologies demands substantial initial investments (Feng *et al.*, 2020). For small and medium-sized firms, these financial commitments can be difficult to afford, particularly when resources are limited.

The implementation of SCT practices by firms is limited by data availability (Cousins *et al.*, 2019; Xu and Jackson, 2019). There is a lack of information about SC operations beyond first-tier suppliers, especially for indirect suppliers and downstream links in the SC (Dou *et al.*, 2018; Tokkozhina *et al.*, 2023). The reasons primarily lie in the vast number of suppliers, their global distribution and their reluctance to share information, as well as issues with the quality of information (Sodhi and Tang, 2019).

Parties involved in the SC often need to share sensitive information to achieve transparency (Chen *et al.*, 2022; Lamming *et al.*, 2005). However, balancing information security and effective sharing remains a major hurdle. This is not to undermine the issues of trust. Information sharing with other parties across the SC requires trust in the fact that the information is not used to diminish one's competitive advantage (i.e. will my supplier use my information to become my competitor?), security concern (i.e. will my buyer be able to protect my information so it does not fall in the hands of bad actors?) and power issues (i.e. will my buyer leverage my information against me in future contracts?).

The SC involves multiple stages, including production, procurement, logistics and sales to achieve transparency in the SC, it is imperative to collect and integrate data from these various stages. Given the multitude of data sources and varying formats, ensuring data accuracy and reliability poses a significant challenge (Dahlmann *et al.*, 2023; Dou *et al.*, 2018; Gardner *et al.*, 2019). In the era of misinformation, transparency may no longer serve as a robust mechanism supporting the sustainable development of SCs, but rather becomes a required strategy (Mol, 2015). Specifically, the phenomena of information overload and distortion lead to key information often being overshadowed, the spread of false information and a weakening of the practical utility of transparency (Sodhi and Tang, 2019). Concurrently, the proliferation

of information also gives rise to issues of data pollution and information distortion, further impeding the effective implementation of transparency. Most fundamentally, the absence of legitimate information verification agencies makes it challenging to ensure the authenticity and authority of information, thereby significantly diminishing the role of transparency in driving the development of SCs (Agrawal *et al.*, 2024; Kalaiarasan *et al.*, 2022).

2.4 Outcomes

Researchers have explored the positive effects of SCT. Firstly, information asymmetry can lead to SC instability, impacting the overall performance of firm (Bai and Sarkis, 2020; Besiou and Van Wassenhove, 2020). SCT contributes to mitigating information asymmetry within the SC. For instance, when organizations share information typically reserved internally with SC partners (e.g. detailed product costs or procurement information), it improves SC efficiency and establishes a relationship of mutual trust (Azadegan *et al.*, 2020a; Lamming *et al.*, 2001; Sadeghi *et al.*, 2022). Consequently, SC managers can enhance SCT by promoting information sharing, visibility, traceability and transmission verification (Song *et al.*, 2023).

Based on signaling theory, SCT serves as a positive integrity signal, providing investors and other external stakeholders with a more comprehensive view of the firm (Jia *et al.*, 2023). SCT can expand market potential (Guan *et al.*, 2020), hedge against operational failure risks (Mollenkopf *et al.*, 2022) and improve a firm's negative image (Awaysheh and Klassen, 2010; Azadegan *et al.*, 2020b). Specifically, to enhance consumer awareness and trust in product value (Montecchi *et al.*, 2021), it is necessary to disclose information on the origin and quality of raw materials (Saberi *et al.*, 2019), the firm's sustainable activities (Dubey *et al.*, 2020; Shi *et al.*, 2024) and its commitment to corporate social responsibility (Awaysheh and Klassen, 2010). This public disclosure of information facilitates consumers' deeper understanding of products, thereby influencing their purchasing decisions. This is not to undermine the organizational learning that occurs as a result of SCT. Indeed, expectations of transparency require firms to dive deeper into their operations and practices and unfold activities and practices that they may not have had a clear understanding of. Following organizational learning and information processing theory, expectations of transparency are bound to enhance firm knowledge (Azadegan *et al.*, 2019, 2020a).

SCT is considered one of the main supports for sustainable SC management (Carter and Rogers, 2008). It enables firms to understand the overall impact of their SC activities and facilitates environmental, social and governance (ESG) sustainable initiatives (Kalkanci and Plambeck, 2020). Dahlmann *et al.* (2023) note that as firms accumulate experience and refine practices in SCT management, scope 3 emissions are expected to decrease relatively. Jia *et al.* (2023) emphasize the importance of information transparency in promoting collaboration and sustainability performance. Similarly, Cousins *et al.* (2019) argue that a high level of SC traceability can significantly promote green SC management practices, thereby improving the sustainability of the SC.

Finally, the disclosure of SC information CCS positive spillover effects throughout the entire SC. Specifically, the disclosure of customer information, combined with the customer's accounting information, aids in uncovering potential earnings fraud by suppliers (Li *et al.*, 2023). Additionally, ESG disclosures from upstream suppliers and sub-suppliers have a positive impact on the transparency of the entire extended network. This indicates that every link in the SC contributes to the overall network's transparency (Feng *et al.*, 2024).

2.5 Risks

Although building consumer trust is a key motivation for transparency, the associated costs and risks of providing relevant and accurate information should not be overlooked (Marquis *et al.*, 2016; Sodhi and Tang, 2019). Proprietary costs refer to the expenses associated with improper disclosure, including reputation loss fees, legal litigation and regulatory compliance

costs (Li *et al.*, 2018). Research suggests that suppliers are more likely to conceal mandatory disclosure information when major clients require protection of proprietary information Chen *et al.* (2022).

A potential constraint on full disclosure is that certain disclosures may harm a firm's competitive position in its product market (Li *et al.*, 2018). Even if a firm is willing to disclose information, it still needs to protect its commercial interests (Gardner *et al.*, 2019). Specifically, in a highly competitive business environment, firms often possess unique products, technologies or business strategies that form the basis of their competitive advantage (Budler *et al.*, 2024). Excessive disclosure of details may provide competitors with critical information, enabling them to imitate or surpass the firm's products or services (Lamming *et al.*, 2005).

Moreover, if a firm discloses sensitive information related to its SC, technology partners, or customers, it may have a negative impact on its business relationships, potentially leading to the loss or change of partners. This is because partners may fear that their proprietary information, trade secrets and even personal data could be disclosed to unrelated third parties (Lamming *et al.*, 2005). Such disclosures diminish partner trust and customer loyalty toward the firm, thereby undermining the continuity and stability of business development and partnerships (Chen *et al.*, 2022).

Publicly disclosed SC information may involve contract fulfillment and confidentiality obligations. Consequently, this could potentially lead to contractual disputes and liability for breach of contract. Furthermore, if the disclosed information involves personal data or privacy issues, the firm may violate data protection regulations, facing the risk of substantial fines and legal action. Additionally, SC disclosure may trigger legal responsibilities, particularly in issues involving the environment, labor rights and human rights (Sodhi and Tang, 2019). If a firm engages in illegal activities or breaches ethical standards, it may face reputational damage and penalties from regulatory authorities (Chen *et al.*, 2019).

Finally, SCT practices can lead to negative consumer reactions toward unethical firms (Birkey *et al.*, 2018; Sodhi and Tang, 2019). Moreover, through the information disclosed by firms, both government and non-governmental organizations can pinpoint instances where corporate entities have violated social and environmental standards (Chen *et al.*, 2019). For example, fashion retailer H&M published a SCT report in 2022, listing the origins of various materials used in clothing manufacturing (H&M, 2020). However, some consumers and environmental groups discovered that some of H&M's suppliers did not comply with international labor standards. This negative news led to a decline in consumer trust towards H&M, even sparking a boycott movement. Therefore, it is particularly important to meticulously address complex issues within the SC, ensuring that the disclosure of information does not tarnish the brand image of the firm or erode consumer trust.

3. Future research directions

Through a review of past and current research, we have identified several research directions worthy of further attention. The theme of how to promote SCT practices through internal and external factors – such as SC structure, digital technology and distinct concept – still has many answers to be found and even more questions to be posed. These all constitute the future research agenda in the field of SCT.

3.1 Examining the impact of SC design on SCT

We encourage more research to explore the impact of SC design on SCT. There is notable discord among studies on how firm positioning affects transparency. Gualandris *et al.* (2021) find that "hub firms" occupying key positions in multiple SCs exhibit higher transparency. Others suggest that higher-tier suppliers in the SC typically have greater control and influence, thus being more adept at promoting transparency (Bush *et al.*, 2013; Villena and Gioia, 2018).

Some findings suggest that lower-tier supplier firms may encounter more challenges in transparency due to constraints from upper entities (Mol, 2015). We believe this is an important matter to explore. Future studies should investigate how a firm's position within and between SCs affects SCT.

In addition, there is a need for the examination of the relationship between SC design and transparency in different economic, social and cultural contexts. For example, does this relationship vary across industries? Does it differ based on geographical regions? It is necessary to analyze the reasons for these differences and explore how to develop effective SCT management strategies for firms in different contexts.

3.2 Achieving SCT in multi-tier networks

Given the constrained access to information by firms concerning their suppliers and customers, achieving SCT in a comprehensive and expansive SC network presents a significant challenge (Khan *et al.*, 2021). Nevertheless, it is crucial to understand the flow of information and key participants within each link of the SC (Tokkozhina *et al.*, 2023). It facilitates firms to effectively identify potential risks and opportunities in SCs. Consequently, future research could delve into exploring and appraising the SCT in complex multi-tiered supplier and customer networks (Feng and Zhu, 2024). It may be insightful to explore the role of intermediaries or third-party auditors in promoting cross-tier SCT, as well as the potential of standardization or certification processes to simplify information sharing.

Relevant methodologies, such as quantitative surveys, qualitative analysis, or case studies, can be employed by researchers to investigate the topic (Agrawal *et al.*, 2024). In quantitative surveys, researchers can explore transparency within the complex structure of the SC through the utilization of questionnaires, statistical analysis and model development. Moreover, case studies involve in-depth field observations and interviews, allowing researchers to understand the structure and relationships within multi-level SC networks, thereby providing a more comprehensive evaluation of transparency levels. Future research can investigate how information and communication technology tools can further enhance the depth of transparency research within complex SC networks.

3.3 Exploring the contribution of SCT to firm value

It is important to understand the contribution of SCT to firm value. Recently, Mollenkopf *et al.* (2022) discuss how the positive signals of SCT can protect firms from the negative effects of product recall signals. However, the positive impact of SCT is not unconditional. Mol (2015) points out that its effectiveness depends on specific factors, such as accessibility of information and recipients' comprehension. Further research could investigate under what circumstances SCT can yield positive outcomes and quantitatively analyze the extent to which SCT adds value to firms. For example, how can management costs, stakeholder pressures and the quality of information disclosure be balanced to achieve an optimal level of SCT? Additionally, how do the interests of various parties interact and influence a firm's decisions regarding SCT? Addressing these questions can help us gain a deeper understanding of the contribution of SCT to firm value.

3.4 Assessing the negative aspects of SCT

The current research primarily focuses on the positive effects of SCT practices (Guan *et al.*, 2020; Jia *et al.*, 2023; Kalkanci and Plambeck, 2020; Song *et al.*, 2023). However, attention should also be given to the risks and negative consequences that SCT may bring to firms (Budler *et al.*, 2024; Montecchi *et al.*, 2021). Disclosing complex and multi-layered SC information can lead to various challenges, such as leaking of sensitive information (Li *et al.*, 2018), damaging partnerships (Lamming *et al.*, 2005), facing legal and regulatory constraints (Sodhi and Tang, 2019) and attracting more regulatory and public scrutiny (Liu *et al.*, 2024;

Mol, 2015). Therefore, future research could focus on empirical studies to identify the risks and negative impacts of SCT practices, thereby developing effective SCT management strategies.

3.5 Promoting SCT with digital technologies

With regard to the research on improving SCT with digital technology, the majority of efforts focus on theoretical exploration and conceptual validation (Menon and Jain, 2024). To provide deeper insights into the underlying mechanisms and practical applications of this specific practice, it is imperative to conduct empirical research (Tokkozhina *et al.*, 2023). Specifically, researchers could conduct field experiments or interviews to track the specific applications of blockchain technology in SCT practices and assess its advantages in terms of traceability, immutability, auditability and provenance (Feng *et al.*, 2020). It is noteworthy that many digital technologies are still in their nascent stages (Menon and Jain, 2024; Saurabh and Dey, 2021). The initial investments required for adopting new technologies could potentially lead to costs exceeding their value to businesses (Chen *et al.*, 2023; Li *et al.*, 2023). Therefore, the cost associated with implementing digital technology is a concern. Future research should explore how to achieve economies of scale and scope, enabling digital technologies to gain sustainable competitive advantages in managing SCT.

3.6 Exploring the integration of digital technologies

Considering the rapid development of digital technologies, future research could explore how to integrate digital technologies, such as blockchain, Internet of Things (IoT) and AI, to further improve SCT (Dolgui and Ivanov, 2022). In addition, the combination of such technologies can have complementary positive of potentially diminishing returns. For instance, whether the combination of blockchain technology, the IoT and AI can significantly improve the traceability of SCs can be a viable area of inquiry (Bumblauskas *et al.*, 2020). How does RFID complement 5G wireless technology? More importantly, given the recent attention given to AI, research in this arena is of utmost importance. SC's leverage AI to enhance efficiencies and transparency. For instance, research can further explore how machine learning and supervised/unsupervised learning can assist in fraud detection.

3.7 Conceptualizing SCT

The terms related to SCT, such as traceability, visibility and disclosure, are often used interchangeably (Budler *et al.*, 2024; Sodhi and Tang, 2019). It is crucial to clearly define these terms and their application scenarios. Therefore, future research could employ an exploratory approach, such as case studies, to delve into the practices of SCT in diverse industries and contexts. Through detailed analysis of specific cases, researchers can reveal the multi-dimensional characteristics of SCT and construct a more precise and comprehensive conceptual framework (Agrawal *et al.*, 2024). Such a framework would facilitate the clarification of the connotation and extension of SCT, thereby establishing a robust foundation for subsequent theoretical research and practical applications (Montecchi *et al.*, 2021).

4. Conclusion

By synthesizing past and recent literature, we have outlined some key themes of SCT to date. Subsequently, we propose a comprehensive conceptual framework that delineates the key elements of SCT, including the influencing factors, concepts, practices, challenges, outcomes and risks of SCT. As illustrated by the papers in this editorial, the importance of SCT, coupled with advancements in technology, presents numerous research opportunities. Consequently, we have identified unresolved issues in current research and potential future research directions. This editorial aims to enhance our understanding of SCT and establish a foundation

for future research in this field. Moreover, it is intended to motivate scholars and researchers to create new research opportunities and contribute more to the practice of SCT.

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