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Emerging Research and Future Pathways in Digital Supply Chain Governance

Guest Editorial

Paolo Barbieri, Lisa Ellram, Marco Formentini, Jörg M. Ries

1. INTRODUCTION¹

Over the past 20 years, the management of supply chain relationships, and particularly related governance theories, instruments, and mechanisms have received increasing attention in operations management research (cf. Pilbeam et al., 2012, Bonatto et al., 2020). The emergence of fragmented and globally dispersed supply chains has laid the foundation for various forms of interorganisational governance (Gereffi et al., 2005) that utilise contractual and relational mechanisms to balance interdependencies and individual interests in a way that allows effective collaboration and control for improved performance (Pilbeam et al., 2012).

As information and communication technologies (ICT) support information and process integration across the supply chain, it is not surprising that the recent emergence of new, ICT-based technologies in the context of “Digital Transformation” – a phenomenon also labelled as “Fourth Industrial Revolution” or “Industry 4.0” – is attracting enormous interest both in practice and research communities. Yet the large majority of research on Digital Transformation conducted in the supply chain context to date has been focused on describing the features of this new phenomenon, its diffusion, or its technological implications (Buyukozkan and Gocer, 2018; Seyedghorban et al., 2020). Nevertheless, the impact of these new digital technologies on the mechanisms of buyer-supplier interaction and, more generally, on supply chain governance is acknowledged by the nascent Digital Supply Chain (or, “Supply Chain 4.0”) literature. These technologies have the potential to act in modifying either the factors that influence the coordination and control mechanisms of the interorganisational relationships (e.g., visibility and verifiability of information and behaviours; richness and timeliness of information that influence the individual or joint actions), or the mechanisms themselves (e.g., automated processes and decision-making). In addition to the potential impact on the forms of safeguards and degree of collaboration, digital technologies could also lead to a change in the very object of governance, e.g., by extending its scope from the buyer-supplier dyad to a broader, multi-player, multi-tier ecosystem (Mahapatra et al., 2019).

Despite the apparent impact of new, digital technologies, theoretical and empirical studies on governance in the digital supply chain remain scarce. Scholarly literature has typically explored the relation between digitalization and supply chain governance with respect to a single and specific technology (e.g., blockchain, IoT, big data analytics, etc.). The prevailing approach of these studies is to analyse the impact of the considered technology on the prevailing governance mechanisms – although few studies consider the moderating role of the technology on the relationship between governance and some performance dimension(s) (e.g., Bryan-Jean et al., 2020; Del Giudice et al., 2021). A more holistic consideration of the effect of the various emerging digital technologies in the context supply chain governance is still required. The practitioner literature, in contrast, has proposed several models of a digital supply chain which are based on the simultaneous adoption of several technologies (McKinsey & Company, 2016; PwC Strategy&, 2016). It also discussed their diffusion and expected benefits and some possible implications for governance, such

¹ The Guest Editors of this Special Issue are grateful to the numerous people who generously supported its realization. Our gratitude goes, first of all, to IJOPM’s Editors-in-Chief, Constantin Blome, Cristina Gimenez and Tobias Schoenherr, who kindly accepted our proposal and led us with professionalism and patience in the overall management of the process. A special thanks to Martin Schleper (IJOPM Editorial Assistant) and Manmeet Nirmal (Emerald Editorial Office) for their constant editorial support along the process. Also, the Special Issue would have not been possible without the precious contribution of the great team of reviewers and their invaluable feedback on the papers submitted. All the Guest Editors contributed equally to this Editorial and to the management of the Special Issue.

as new opportunities for integration and collaboration, and the possible need for digital trust (Ernst&Young, 2016).

In the light of increasing importance of digital technologies for supply chains, this special issue aims to offer one of the first collective contributions to how the ongoing Digital Transformation is impacting the structure, practices, and performance of interorganisational governance in supply chains. In this Editorial, the Guest Editors first briefly review the extant supply chain governance literature to shed light on common themes and the consideration of digitalization and related topics. This is followed by a discussion of the main topics covered by past studies on Supply Chain Digitalization. Finally, the accepted papers are briefly presented and analysed, in order to derive a summary of the key messages, cutting-edge implications for practice, and suggestions for future research.

2. SUPPLY CHAIN GOVERNANCE AND DIGITALISATION

This section briefly reviews the extant supply chain governance literature in operations and supply chain management research to shed light on common themes and future research opportunities in the context of supply chain governance and digitalisation. Relevant articles have been identified by means of a systematic literature review approach based on a set of search and selection criteria that allow for a reproducible sample (Denyer and Tranfield, 2009). To keep this section focused, we include only articles that explicitly refer to governance in a supply chain context. In addition, we focussed on a list of well-known Operations Management (OM) journals (Chartered Association of Business Schools, 2021) and searched via Business Source Complete for articles that contain “supply chain” and “governance” in either title, keywords or abstract. Building on this systematic review approach, we initially identified 145 articles published in OM journals as of 2020. Each article identified during the initial search was evaluated for possible relevance. After excluding papers that either lacked a supply chain perspective or were not concerned with interorganisational governance, we obtained a final sample of 128 articles published between 1999 and 2020 that address different forms of governance instruments and mechanisms, potential barriers, and trade-offs as well as performance implications. Figure 1 illustrates the number of articles published per year. As can be seen, following early works of Schmitz Whipple et al. (1999) or Giannoccaro and Pontrandolfo (2003), there has been a steep increase in the number of articles published, especially in the past decade. In fact, 50% of the identified articles have been published within the past four years.

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To uncover the key themes within the literature sample, we performed topic modelling on the abstracts of the sample articles. This was done by the help of a Latent Dirichlet Allocation (LDA) model, a widely used topic modelling approach in management research. LDA is a probabilistic computational linguistic technique that identifies the latent topics in a corpus of documents by modelling each document as a mixture of latent topics and each topic as multinomial distribution over a vocabulary of words (cf. Newman et al., 2009). Figure 2 illustrates the outcome of the LDA model with 5 topics in the form of word clouds of the ten top-ranked

words in each topic (note that the font size indicates the words' specificity for the topic). It is not surprising that governance instruments, specifically contractual and relational instruments (cf. Poppo and Zenger, 2002; Lumineau and Henderson, 2012), which enable control and collaboration in the supply chain appear as two distinct topics. While contractual governance, based on transaction cost economics (TCE), highlights the importance of formal systems, structures, and processes (cf. Pilbeam et al., 2012), relational governance emphasises the role of long-term relationships based on shared norms and values for improving collaboration and performance (Bonatto et al., 2020). Another topic builds on the Global Value Chain (GVC) typology that posits five supply chain governance structures based on the three dimensions: transaction complexity, ability to codify, and supply network capabilities (Gereffi et al., 2005). While low complexity transactions with high codifiability and highly capable suppliers can be governed through contractual arrangement, complex transactions with low codifiability and highly capable suppliers demand for a more relational form of governance. Complex transactions with low codifiability and low supplier capability create reluctance to outsource and demand for more hierarchical governance structure (Gereffi et al., 2005; Ashenbaum, 2018). A fourth topic emerges around supply chain governance mechanisms and outcomes affected by the variety of instruments enabling effective coordination and control (Pilbeam et al., 2012). Lastly, safeguarding sustainable business practices within the supply chain in order to improve environmental and social sustainability appears as an increasingly relevant topic in the context of supply chain governance. In the light of increasing stakeholder awareness (Ni and Sun, 2018) and the role of lower tiers for supply chain sustainability (Meinlschmidt et al., 2018), effective governance within the supply chain is crucial to attain sustainable performance objectives.

While we could not find a distinct topic related to governance in digital supply chains due to the scarcity of studies and their limited focus, we identified some articles enquiring the relation between specific digital technologies and supply chain governance. To broaden the discussion, we therefore also included the wider (non-OM-focussed) literature in the following. Given the novelty of the theme, not surprisingly some Delphi studies with experts have been conducted (Kache and Seuring, 2017; Kurpjuweit et al., 2021), which investigated the opportunities, challenges, and barriers of these new technologies. Undoubtedly, digitalization owns a general, cross-industry disruptive potential and it can impact several different performance dimensions. Yet some studies chose to focus only on a particular type of context or performance aspect. Specifically, Kurpjuweit et al. (2021), remarkably one of the few studies that consider the interplay between two digital technologies (Additive Manufacturing and blockchain) focussed on the Additive Manufacturing context; Boehmer et al. (2020) followed a similar approach for servitization; while e-commerce was chosen by Mola et al. (2017), who investigated the impact of this technology on the governance modes in fashion industry. Finally, Del Giudice et al. (2021) studied the effect of digitalization and governance on the specific performance aspect of sustainability.

Regarding specific digital technologies, the interest in blockchain and its effect on governance is mainly driven by its promise to allow traceability – an aspect of supply chain visibility that enables the firm to ascertain provenance (Schmidt and Wagner, 2019; Ghode et al., 2020; Hastig and Sodhi, 2020) – and ensure the authenticity of the shared information. This permits a more effective management of the ownership of the data, and it reduces the risk of information asymmetry and opportunistic conduct in the supply chain due to improved transparency (Kurpjuweit et al., 2021; Kramer et al., 2021). On the one hand, transparency and immutability to existing database functionalities provided by the blockchain technology can alter transactional exchange relationships by lowering uncertainty and opportunism which enables more market-oriented governance structures (Schmidt and Wagner, 2019). On the other hand, the increased usability of valid, high-quality data could also augment cooperation among parties. Blockchain can be of particular interest in a context of distributed manufacturing network that relies on the exchange of digital, proprietary information, such as the additive manufacturing domain (Kurpjuweit et al., 2021). Yet, the development of an appropriate interorganisational governance structure emerges in Kurpjuweit et al. (2021) as the main relational barrier in the management of blockchain project. This result confirms a previous finding on the

adoption of Big Data Analytics in the supply chain (Kache and Seuring, 2017) despite the acknowledgement that Big Data Analytics has a high potential in facilitating a shared and more effective decision-making approach, as well as higher visibility and transparency in the supply chain (Kache and Seuring, 2017). However, real-time data gathering coupled with advanced analytics capabilities improves information availability and accessibility and can enable formal governance instruments (Tachizawa et al., 2015). Lastly, Internet of Things (IoT) technology enhances data generation, storage and sharing capacity. As such, it can foster the stronger coordination and incentive alignment among exchange partners, and the reduction of the transaction costs (Boehmer et al., 2020). Interestingly, in Boehmer et al.'s (2020) study on IoT-enabled servitization, for some (more advanced) business models it was found that IoT increases the level of trust in the relationship, a result that deserves attention. This is significant given the claim that digital technologies, which support the transition to a more objective and formal exchange, will decrease the importance of the relational governance mechanisms in the digital supply chain (e.g., Tachizawa et al., 2015; Schmidt and Wagner, 2019).

3. ARTICLES INCLUDED IN THE SPECIAL ISSUE

In light of the increasing importance of digital technologies for supply chain governance, we now examine the papers included in our special issue in order to highlight their primary novel contributions, and we summarize the key messages that arise from this overview.

Hohn and Durach (2021) investigate the impact of Additive Manufacturing (AM) on supply chain governance and social sustainability, by adopting an exploratory research design based on two consecutive Delphi studies in the context of the global mass apparel industry. The article sheds light on potential social sustainability issues that may be amplified as the results of AM adoption; moreover, implementing AM may also reinforce existing supply chain governance structures, currently dominated by powerful apparel retailers.

Keller et al. (2021) explore the role of informal governance mechanisms to coordinate actors of digitalized supply chains, using case studies of ten German firms. Digitalized supply chain may reduce the need for interpersonal contacts, which in turn may decrease the ability to coordinate with informal governance mechanisms; however, the need for personal contacts remains paramount in the context of specific phases of a digitalized business relationship; in other words, interpersonal contacts are not completely replaceable by digital technology.

Yang et al. (2021) investigate in their model how supply-side digitalization affects supplier opportunism through supplier IT integration and supply visibility, and the role of relational ties. They test their hypotheses using data from Chinese manufacturing companies. The study highlights both challenges and opportunities brought by digitalization to SC governance, and the increased complexity in safeguarding SC relationships.

Paolucci et al. (2021) study the effect of specific subsets of digital technologies and governance mechanisms (relational and contractual) on efficiency of automotive SCs. Using data from a sample of Italian automotive suppliers, it emerges that Transaction Cost Economics assumptions on governance mechanisms are appropriate to enhance cost performance. However, different patterns are shaped by specific types of digital technologies (network technologies vs. digital-physical interface technologies).

Aben et al. (2021) analyse how governance mechanisms address information asymmetry (uncertainty and equivocality) arising in capturing, sharing and interpreting information generated by digital technologies. In this case smart sensors are used to collect data about the health of Dutch infrastructure networks. In terms of originality, this study focuses on public-private relationships. The authors highlight that addressing information uncertainty generated by digital technologies requires invoking contractual control and coordination, and relational governance.

Faruquee et al. (2021) investigate the role that communication, trust, and digital transformation can play in the relationship between joint problem solving and supply chain resilience. Using data from the UK and US manufacturing sectors, the main focus of this study is on buyer-supplier relationships. The study underlines that digital technologies may not completely replace relational trust, but they may facilitate it; in addition, the actual impact of digital transformation is far more complicated than the initial benefits that it appears to bring within a supply chain.

Son et al. (2021) focus on the effectiveness of the governance mechanisms (i.e., legal contracts and relational contracts) in suppressing buyer opportunism in the context of more digitally capable buyers. The study adopts the perspective of SMEs suppliers in the Korean industry. It emerges that in a context of digital capability asymmetry, suppliers may become more dependent on buyers; only relational governance offers effective protection to SME suppliers.

A summary of the research questions, theories and methods applied in the papers of the special issue is illustrated in table 1.

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4. MAIN THEMES ACROSS THE ARTICLES

We compared the accepted articles to identify the emerging key themes, as an opportunity to derive future research opportunities.

First, the majority of articles published in this special issue focus on buyer-supplier relationships, rather than an extended, multi-tier analysis of the supply network ecosystem. The later appears to be still under development. Only Hohn and Durach (2021) provide a broader perspective at different supply chain levels (i.e., producer level, upstream supply chain, downstream supply chain) in investigating the governance implications of adopting AM in the global mass apparel industry.

However, the special issue provides a valuable understanding of both buyer and supplier perspective in the dyadic unit of analysis. Adopting the buyer's perspective, Yang et al. (2021) underline the potential risk of increasing supplier opportunism when implementing supply-side digitalization through supplier IT integration. On the other hand, it is possible that increasing supply visibility in favour of the buyer would also reduce supplier opportunism. These results clearly highlight for buying companies the complexity of implementing digital transformation initiatives, and the need to adopt appropriate governance mechanisms.

When considering the supplier's perspective which is less investigated in this literature as compared to the buyer's perspective), Paolucci et al. (2021) provide the point of view of automotive suppliers (i.e., tier 1 and tier 2 suppliers) and the specific challenges they face when implementing digital technologies, in light of increasing performance improvement expectations – and pressure - by their customers. The study provides insights on the development of new governance mechanisms (relational vs. contractual) in the buyer-supplier relationship, and the impact on suppliers' cost performance, moderated by the adoption of different types of digital technologies. Son et al. (2021) focus on the perspective of Korean SME suppliers, characterized by lower digital competencies in comparison to their buyers, and in turn more exposed to buyer opportunism. This represents an interesting result, which highlights the potential increasing divide produced by digital transformation at the supply chain level.

We believe that having the opportunity to evaluate both buyer and supplier perspectives when approaching governance in the context of digital transformation initiatives, and facing the related challenges, is one of the key contributions of this special issue.

The accepted articles focus on different types of operational performance objectives. Paolucci et al. (2021) analyse in detail the impact on supplier's cost efficiency. Yang et al. (2021) discusses both positive and negative impacts of digitalization: enhancing integration with the major supplier through digitalization at the technology level by promoting supplier IT integration, it is possible to achieve compatibility, interconnectivity, and interoperability with the major supplier. Alternatively, the buyer could be exposed to supplier opportunism. The authors also accentuate the role of supply visibility as an opportunity to counterbalance supplier opportunism. It emerges that supply chain governance plays a key role in the context of the dynamic relationships generated by the digital transformation phenomenon.

When analysing the accepted papers, the theme of sustainability in the context of digitalized supply chains and related governance issues seems to be still under development, despite the important role played by sustainability in the supply chain governance literature as previously underlined in our review. Hohn and Durach (2021) analyse the role of AM and the impact on social sustainability in the global mass apparel industry. This is the only accepted study focusing explicitly on sustainability. It appears that the research on digital transformation is still mainly focusing on operational impacts, and the theme of governance should be extended to embrace sustainability dimensions following a triple bottom line perspective (Formentini and Taticchi, 2016).

From a technological point of view, the articles accepted in this special issue focus on a variety of enabling technologies, shedding light on their impact on several supply chain processes. Aben et al. (2021) investigate the role of sensors used to collect data in the context of road infrastructure maintenance. The study highlights the information uncertainty generated by the large amount of data, and in turn the need to develop specific governance mechanisms related to contractual control and coordination, especially in a complex context such as private-public relationships. Hohn and Durach (2021) focus in detail on additive manufacturing, and the potential impact on global apparel supply chains. The other studies consider more general digital technologies and their interplay. For instance, Keller et al. (2021) investigate ten German digitalized supply chains, to investigate the role of digitalization in terms of data analytics and transparency; Yang et al. (2021) focus on supply-side digitalization, i.e., the buyer's adoption of digital supply chain systems to perform transaction with its suppliers; technologies such as IoT, cloud computing, big data analytics, 5G, and blockchain to digitalize the supply-side processes (e.g., purchasing, replenishment, and invoicing). The technologies investigated in Paolucci et al. (2021) are classified in two subsets; i.e., network technologies (focusing on synchronisation and accessibility) and physical-digital interface technologies (focusing on virtualisation and traceability). Faruquee et al. (2021) includes in the construct "Digital Transformation" defined as the level of adoption at the supply chain of several technologies, such as AI, blockchain, ERP, cloud-based ERP, e-Procurement, cloud-based e-Procurement. Son et al. (2021) also include a variety of technologies (such as robotics, 3D printing, smart sensors, etc.) when evaluating their construct "Extent of Supplier's Digital Technology Adoption".

Interestingly, the special issue is also characterized by the adoption of a variety of research methods, i.e., Delphi (Hohn and Durach, 2021), multiple case study (Keller et al., 2021; Aben et al., 2021) and survey (Yang et al., 2021; Paolucci et al., 2021; Faruquee et al. 2021; Son et al., 2021). This variety of methods highlights that research on governance in the context of digitalized supply chains is not exclusively at an exploratory stage; it seems research is advancing towards the development and testing of complex models to grasp the dynamics and implication of Digital Transformation in the context of buyer-supplier relationships. As already highlighted, additional understanding is required from a more extended supply chain perspective.

Further, this evolution of research seems to be developed and structured around relevant theoretical lenses. Transaction Cost Economics (TCE) is a relevant lens, adopted in Yang et al. (2021) in conjunction with Social Exchange Theory (SET) as appropriate integrated theoretical perspectives to investigate supplier opportunism and relational ties; TCE is also adopted in Paolucci et al. (2021) due to the primary focus on cost efficiency. Resource Dependence Theory (RDT) plays an important role in investigating the dependence of SME suppliers (Son et al., 2021) and potential consequences of AM in global apparel supply chains (integrated with Stakeholder Theory in Hohn and Durach, 2021). The Relational View used in Faruquee et al. (2021) provides the basis to understand collaborative approaches in the relationships between communication, trust, joint problem solving, digital transformation and supply chain resilience. Information Processing theory (IPT) is adopted in Aben et al. (2021) to investigate the need to address information asymmetry through specific governance mechanisms.

5. KEY MESSAGES EMERGING FROM THE STUDIES

We believe several important shared messages are emerging from the majority of the accepted studies. These messages represent a relevant contribution both to research and practice:

- 1) Relational/informal governance is not replaceable, as it represents an important instrument to protect supply chain actors, especially in the case of opportunism emerging from the dependence created by information or digital capability asymmetries in the buyer-supplier relationship.
- 2) There is the need for differentiated approaches in identifying and implementing digital technologies from a supply chain perspective: in other words, there is not a “one-size-fits-all” approach in implementing digital technologies, and in turn developing appropriate governance mechanisms.
- 3) It is not the case that “the more digital technologies the better”; digital technologies should be implemented with careful understanding of the specific supply chain context they are adopted, and the benefits sought.

Overall, our special issue highlights not only positive implications of Digital Transformation in the context of supply chain governance. It also brings forth many challenges and potential areas for future research. This includes:

- Potential negative social sustainability implications from adopting emerging digital technologies, e.g., additive manufacturing (Hohn and Durach, 2021);
- Governance challenges posed by equivocality and uncertainty of information generated by digital technologies (Aben et al., 2021);
- Potential negative impacts on cost efficiency and coordination of transactions between supply chain actors (Paolucci et al., 2021);
- The “dark side” of buyer/supplier opportunism: the special issue approaches both supplier and buyer perspectives to address this important theme (Yang et al., 2021; Son et al., 2021);
- The paradoxical interplay between digital transformation and trust (Faruquee et al., 2021): simple technologies may be a key driver of relational trust while heavy investment in technology may harm relational trust.

6. CUTTING EDGE PRACTICE

The research in this special issue provides implications for both theory and for practice. Yet there is much more to be done in expanding knowledge and theory related to the implications of digitization on governance. In practice, there are examples of organizations and networks that are testing the limits of digital technology and governance transformation. The term ecosystem has been increasingly, but inconsistently used in business research. In this context, we consider a business ecosystem broadly to include, “...multiple actors linked to operate around a focal firm or a platform, forming a network of interconnected actors” (Järvi

and Kortelainen 2017, p 216). The idea of ecosystems often embraces the concepts of collaboration, interdependence, and networks. While the research included in this special issue does not specifically look at network level digital governance mechanisms, we see it manifest all around us in various ways.

For example, the CDP's Supply Chain group is an excellent example of how digitization is facilitating the management and governance of Scope 3 emissions. The CDP serves as the clearing house, organizer and disseminator of information about supplier environmental sustainability performance. It asks its over 200 members to invite their key suppliers to complete the CDP sustainability survey. If a company is invited by multiple customers, it need only complete the survey once. The CDP then compiles all the data from suppliers to match the Supply Chain member companies and provides the Supply Chain member company with a snapshot of how its suppliers are doing overall, as well as individual data for each contributing supplier (CDP, 2021). While there is heavy digitization, there is no new technology at play here, just a creative application of existing digital technology to provide both member companies and their suppliers a convenient and standardized way to share data. Access to this data is an essential part of governing the supply base regarding sustainable practices. Yet the data can be used in many ways—simply as information, to gain understanding, or to get goals. Thus, while the digitization provides the platform, it does not create the governance structure.

One of the editorial team is currently involved in research that explores a major retailer's global supplier relationships and interrelationships, and how it effective the retailer is in working with its suppliers to achieve its goals around order fulfilment. Digital transformation has always been a significant part of this retailer's strategy domestically and globally. It has experienced many challenges in rolling new digital technologies out to its suppliers, especially in global markets. It was difficult for suppliers in other countries to understand the benefits of implementing new digital technologies (related to ordering, inventory visibility, transportation, and so on), let alone to implement them properly. They were many technologies that simply did not get properly implemented outside of the retailer's domestic market, even when the retailer was a very important, long-term customer. The retailer started a supplier forum where it meets with its top suppliers on a regular basis to share its growth plans, plans for new digital technologies, benefits of these digital technologies, and get feedback on supplier concerns, what is working and what is not working. This is an important governance forum for the retailer. Yet it was still having challenges. It recently rolled out a mirror image of this forum with its suppliers at the country level in its key markets. It opens more direct communication on digitization technologies, goals and implementation at the country level. Initial results appear to be good. This series of country-level networks within a larger network is an exciting form of emerging ecosystem that will be worth watching and studying in terms of its impact on governance, digitization, and buyer-supplier relationships. The possibilities for the interplay between digitalization and governance are limited only by organizations' willingness and ability to try new things. In the next section, we provide suggestions for future research.

7. RESEARCH AGENDA AND CONCLUSIONS

We invite future studies to develop a more extended understanding of the impact of DT on SC governance, considering multiple tiers of the supply chain as well as upstream and downstream implications. More specifically:

- What are the negative and positive sustainability implications emerging from supply chain digitalization regarding the social, environmental and financial impacts? It seems that research on (supply chain) digitalization is still lacking of a sustainability perspective, in terms of how digital technologies would play a role in improving supply chain sustainability. It is also our opinion that the focus is too narrowly defined on dyadic buyer-supplier relationships. In line with the recommendations in the sustainable supply chain management literature (Seuring and Müller, 2008), there is the need to consider both, a wider range of issues and a more extended part of the supply chain in understanding the impact of digital technologies on supply chain governance.

- In line with the emerging circular supply chain literature (Farooque et al., 2019) how will digitalization facilitate the growth of the circular economy, and what are the implications in terms of governance? Farooque and colleagues (2019) underline that the literature focusing on technologies under the umbrella of Industry 4.0 and their contribution towards the circular economy is still at the infancy stage. In addition, they highlight in their research agenda that many opportunities lie in investigating collaboration and coordination mechanisms towards circular supply chains. We emphasize the opportunity to combine these two research directions, inspired by the aim of our special issue.
- Behavioural theory has been recently used (e.g., Aversa et al., 2021; Banerjee et al., 2021) in the context of operations management research to investigate novel implications of Digital Transformation. In line with these recent studies, what are the opportunities to develop a better behavioural understanding of governance in the context of buyer-supplier relationships, and supply chains in a more extended perspective?
- Transparency is an important benefit of digitalization explored in the literature. But what are the implications of increased transparency available for digitalization of product and financial flows in the supply chain? Will the more powerful players in the supply chain utilize their information about the flows of other supply chain members to their own advantage, or to the advantage of the supply chain? Dependence seems to be one of the key factors to consider in the studies included in this special issue: we invite scholars to investigate more in-depth the role of power (Reimann and Ketchen Jr, 2017) in the context of digitalized supply chains.
- How can we protect our supply chains from increased cyber-crimes in the age of greater digitalization, transparency, and sharing of information? The theme of interorganizational cybersecurity seems rather scarce (Ghadge et al., 2019). Due to the increasing reliance on digital technologies, supply chain scholars should develop research collaborations with other experts in the cybersecurity domain in order to develop meaningful interdisciplinary investigations to advance knowledge in the context of supply chain-wide cybersecurity.
- Can digitalization be instigated by different tiers in the supply chain? Who are the “sources” of digitalization throughout the supply chain, and how is digitalization spread to other supply chain counterparts? The themes related to the diffusion of digital capabilities, and the adoption of specific incentives to motivate supply chain actors in implementing specific digital technologies (especially in the context of partnerships or strategic relationships) deserve more attention.
- Will various types of digitalization diffuse across industries at different rates? What will influence the level of DT adoption? Our special issue focused mainly on manufacturing companies; an intriguing research avenue is characterized by understanding the contextual factors related to different industries, and their impact on different digital transformation developments and dynamics – for instance, the agri-food industry, characterized by the growing relevance of smart agriculture technologies, represents an important area for investigation.
- Our special issue highlighted the role of established theoretical lenses, such as TCE, RDT, IPT, etc. Is there an opportunity to build new theory around supply chain digitization and governance?
- Is social network analysis a good method to understand digital governance implications across the extended supply chain? What are other methodological approaches relevant to investigate the implications in the context of complex networks?

The Guest Editors of this special issue believe that there are significant additional research opportunities linking governance and digital technologies. There are many positives and potential negatives that can arise out of digitalization. If we do not plan in advance for the implications of greater digitalization, data transparency and new technologies, we will not be able to fully embrace their advantages, or pre-empt their potential problems.

REFERENCES

- Aben, T.A.E., van der Walk, W., Roehrich, J.K. and Selviaridis, K. (2021), "Managing information asymmetry in public-private relationships undergoing a digital transformation: the role of contractual and relational governance", <https://doi.org/10.1108/IJOPM-09-2020-0675>
- Ashenbaum, B. (2018), "From market to hierarchy: An empirical assessment of a supply chain governance typology", *Journal of Purchasing and Supply Management*, Vol. 24, No. 1, pp. 59-67.
- Aversa, P., Formentini, M., Iubatti, D. and Lorenzoni, G. (2021), "Digital machines, space, and time: Towards a behavioral perspective of flexible manufacturing", *Journal of Product Innovation Management*, Vol. 38, No. 1, pp. 114-141.
- Banerjee, A., Lücker, F. and Ries, J.M. (2021). "An empirical analysis of suppliers' trade-off behaviour in adopting digital supply chain financing solutions", *International Journal of Operations & Production Management*, Vol. 41, No. 4, pp. 313–335.
- Boehmer, J.H., Shukla, M., Kapletia, D. and Tiwari, M.K. (2020), "The impact of Internet of Things (IoT) on servitization: an exploration of changing supply relationships", *Production Planning & Control*, Vol. 31, No. 2-3, pp. 203-219.
- Bonato, F., de Resende, L.M.M. and Pontes, J. (2020), "Relational governance in supply chain: a systematic literature review", *Benchmarking: An International Journal*, Vol. 27, No. 6, pp. 1711-1741.
- Bryan Jean, R.-J., Kim, D., Lien, Y.-C. and Ro, S. (2020), "The moderating effect of virtual integration on intergenerational governance and relationship performance in international customer–supplier relationships", *International Marketing Review*, Vol. 37, No. 3, pp. 579-592.
- Buyukozkan, G. and Gocer, F. (2018), "Digital Supply Chain: Literature review and a proposed framework for future research", *Computers in Industry*, Vol. 97, pp. 157-177.
- CDP (2021). Supply Chain Membership. Accessed July 10, 2021 at <https://www.cdp.net/en/supply-chain>.
- Chartered Association of Business Schools (2021), Academic Journal Guide 2021, available at: <https://charteredabs.org/academic-journal-guide-2021/>.
- Del Giudice, M., Chierici, R., Mazzucchelli, A., Fiano, F. (2021), "Supply chain management in the era of circular economy: the moderating effect of big data", *International Journal of Logistics Management*, Vol. 32, No. 2, pp. 337-356.
- Denyer, D. and Tranfield, D. (2009), Producing a systematic review. In: Buchanan, D., Bryman, A., (Eds). *The Sage Handbook of Organizational Research Methods*, Sage Publications Ltd, London, pp. 671-689.
- Ernst&Young (2016), "Digital supply chain: It's all about that data".
- Farooque, M., Zhang, A., Thürer, M., Qu, T. and Huisingh, D. (2019) "Circular supply chain management: A definition and structured literature review", *Journal of Cleaner Production*, Vol. 228, pp. 882-900.
- Faruquee, M., Paulraj, A. and Irawan, C.A. (2021), "Strategic supplier relationships and supply chain resilience: Is digital transformation that precludes trust beneficial?", <https://doi.org/10.1108/IJOPM-09-2020-0702>
- Formentini, M. and Taticchi, P. (2016), "Corporate sustainability approaches and governance mechanisms in sustainable supply chain management", *Journal of Cleaner Production*, Vol. 112, pp. 1920-1933.

- Gereffi, G., Humphrey, J. and Sturgeon, T.J. (2005), "The governance of global value chains", *Review of International Political Economy*, Vol. 12, No. 1, pp. 78–104.
- Ghadge, A., Weiß, M., Caldwell, N. D., Wilding, R. (2018), "Managing cyber risk in supply chains: a review and research agenda", *Supply Chain Management: An International Journal*, Vol. 25, No. 2, pp. 223-240.
- Ghode, D., Yadav, V., Jain, R., Soni, G. (2020), "Adoption of blockchain in supply chain: an analysis of influencing factors", *Journal of Enterprise Information Management*, Vol. 33, No. 3, pp. 437-456.
- Giannoccaro, I. and Pontrandolfo, P. (2003), "The organizational perspective in supply chain management: an empirical analysis in Southern Italy", *International Journal of Logistics Research and Applications*, Vol. 6, No. 3, pp. 107-123.
- Hastig, G.M. and Sodhi, M.S. (2020), "Blockchain for Supply Chain Traceability: Business Requirements and Critical Success Factors", *Production and Operations Management*, Vol. 29, No. 4, pp. 935-954.
- Hohn, M.M. and Durach, C.F. (2021), "Additive Manufacturing in the apparel supply chain — impact on supply chain governance and social sustainability", *International Journal of Operations & Production Management*, Vol. ahead-of-print, No. ahead-of-print. <https://doi.org/10.1108/IJOPM-09-2020-0654>
- Järvi, K. and Kortelainen, S. (2017), "Taking stock of empirical research on business ecosystems: a literature review", *International Journal of Business and Systems Research*, Vol. 11, No. 3, pp. 215-228.
- Kache, F. and Seuring, S. (2017), "Challenges and opportunities of digital information at the intersection of Big Data Analytics and supply chain management", *International Journal of Operations & Production Management*, Vol. 35, No. 1, pp. 10-36.
- Keller, J., Burkhardt, P. and Lasch, R. (2021), "Informal governance in the digital transformation", *International Journal of Operations & Production Management*, Vol. ahead-of-print, No. ahead-of-print. <https://doi.org/10.1108/IJOPM-09-2020-0660>
- Kramer, M.P., Bitsch, L. and Hanf, J. (2021), "Blockchain and its Impact on Agri-food Supply Chain Network Management", *Sustainability*, Vol. 13, No. 4, pp. 1-22.
- Kurpjuweit, S., Schmidt, C.G., Klockner, M. and Wagner, S. (2021), "Blockchain in Additive Manufacturing and its impact of Supply Chains", *Journal of Business Logistics*, Vol. 42, No. 1, pp. 46-70.
- Lumineau, F. and Henderson, J.E. (2012), "The influence of relational experience and contractual governance on the negotiation strategy in buyer–supplier disputes", *Journal of Operations Management*, Vol. 30, No. 5, pp. 382-395.
- Mahapatra, S.K., Narasimhan, R., and Barbieri, P. (2019), "A contingent assessment of the structural and governance characteristics of interconnected dyads in multitier supply chains", *International Journal of Operations & Production Management*, Vol. 39, No. 5, pp. 714-738.
- McKinsey & Company (2016), "Supply Chain 4.0 – the next generation digital supply chain".
- Meinlschmidt, J., Schleper, M.C. and Foerstl, K. (2018), "Tackling the sustainability iceberg: A transaction cost economics approach to lower tier sustainability management", *International Journal of Operations & Production Management*, Vol. 38, No. 10, pp. 1888-1914.
- Mola L., Russo, I., Giangreco, A. and Rossignoli, C. (2017), "Who knows what? Reconfiguring the governance and the capabilities of the supply chain between physical and digital processes in the fashion industry", *Production Planning & Control*, Vol. 28, No. 16, pp. 1284-1297.

- Newman, D., Asuncion, A., Smyth, P. and Welling, M. (2009), "Distributed Algorithms for Topic Models", *Journal of Machine Learning Research*, Vol. 10, pp. 1801-1828.
- Ni, W. and Sun, H. (2018), "A contingent perspective on the synergistic effect of governance mechanisms on sustainable supply chain", *Supply Chain Management*, Vol. 23, No. 3, pp. 153-170.
- Paolucci, E., Pessot, E. and Ricci, R. (2021), "The interplay between digital transformation and governance mechanisms in supply chains: evidence from the Italian automotive industry", <https://doi.org/10.1108/IJOPM-09-2020-0672>
- Pilbeam, C., Alvarez, G. and Wilson, H. (2012), "The governance of supply networks: a systematic literature review", *Supply Chain Management*, Vol. 17, No. 4, pp. 358-376.
- Poppo, L. and Zenger, T. (2002), "Do formal contracts and relational governance function as substitutes or complements?", *Strategic Management Journal*, Vol. 23, No. 8, pp. 707-725.
- PwC Strategy& (2016), "Industry 4.0 – How digitization makes the supply chain more efficient, agile, and customer-focused".
- Reimann, F. and Ketchen Jr, D.J. (2017), "Power in supply chain management", *Journal of Supply Chain Management*, Vol. 53, No. 2, pp. 3-9.
- Schmidt, C.G. and Wagner, S.M. (2019), "Blockchain and supply chain relations: A transaction cost theory perspective", *Journal of Purchasing and Supply Management*, Vol. 25, No. 4, <https://doi.org/10.1016/j.pursup.2019.100552>.
- Schmitz Whipple, J., Frankel, R. and Anselmi, K. (1999), "The effect of governance structure on performance: A case study of efficient consumer response", *Journal of Business Logistics*, Vol. 20, No. 2, pp. 43-62.
- Seuring, S. and Müller, M. (2008), "From a literature review to a conceptual framework for sustainable supply chain management", *Journal of Cleaner Production*, Vol. 16, No. 15, pp. 1699-1710.
- Seyedghorban, Z., Tahernejad, H., Meriton, R. and Graham, G. (2020), "Supply chain digitalization: past, present and future", *Production Planning & Control*, Vol. 31, No. 2-3, pp. 96-114.
- Son, B.-K., Kim, H., Hur, D. and Subramanian, N. (2021), "The dark side of supply chain digitalisation: supplier-perceived digital capability asymmetry, buyer opportunism and governance", <https://doi.org/10.1108/IJOPM-09-2020-0711>
- Tachizawa, E.M., Alvarez-Gil, M.J. and Montes-Sancho, M.J. (2015), "How "smart cities" will change supply chain management", *Supply Chain Management*, Vol. 20, No. 3, pp. 237-248.
- Yang, L., Huo, B., Tian, M. and Han, Z. (2021), "The impact of digitalization and inter-organizational technological activities on supplier opportunism: the moderating role of relational ties", <https://doi.org/10.1108/IJOPM-09-2020-0664>

Authors	Title	Keywords	Research question	Theory	Method
Hohn and Durach	Additive Manufacturing in the Apparel Supply Chain — Impact on Supply Chain Governance and Social Sustainability	Additive manufacturing, 3D printing, apparel industry, supply chain governance, socially sustainable supply chain management, social sustainability	What is the impact of additive manufacturing on supply chain governance and social sustainability in global mass apparel supply chains?	RDT & Stakeholder theory	Delphi study
Keller et al.	Informal governance in the digital transformation	Multiple case study, informal governance mechanism, digitalization, transparency, data analytics	How are informal governance mechanisms used for coordinating actors of digitalized supply chains?	No theory	Multiple case study
Yang et al.	The impact of digitalization and inter-organizational technological activities on supplier opportunism: the moderating role of relational tie	Digitalization, IT integration, Visibility, Relational ties, Supply chain governance	What is the impact of digitalization and interorganizational technological activities on supplier opportunism?	TCE & SET	OLS regression
Paolucci et al.	The interplay between Digital Transformation and governance mechanisms in supply chains: evidence from the Italian automotive industry	Contractual governance, Relational governance, Physical-digital interface technologies, Network technologies, Survey	How does the adoption of digital technologies affect the governance mechanisms of the buyer-supplier relationship in the automotive industry? and How does the interplay between the adoption of digital technologies and governance mechanisms of the buyer-supplier relationship affect the cost performance of automotive suppliers?	TCE	Multi-respondent survey
Aben et al.	Managing information asymmetry in public-private relationships undergoing a digital transformation: The role of contractual and relational governance	Digital transformation, information asymmetry, contractual governance, relational governance, public-private relationships, Information Processing Theory	How do governance mechanisms address information asymmetry (uncertainty and equivocality) arising in capturing, sharing and interpreting information generated by digital technologies?	IPT	Multiple case study
Faruquee et al.	Strategic supplier relationships and supply chain resilience: Is	Resilience, Digital transformation, Trust, Joint problem solving	What is the role that communication, trust, and digital transformation can play in the relationship between joint	Relational view	Survey, multiple linear regressions

	digital transformation that precludes trust beneficial?		problem solving and supply chain resilience?		
Son et al.	The dark side of supply chain digitalisation: Supplier-perceived digital capability asymmetry, buyer opportunism and governance	Digitalisation, Buyer–supplier relationship, Opportunism, Governance, SMEs, Resource dependence theory	What is the effectiveness of governance mechanisms (legal contracts and relational contracts) in suppressing buyer opportunism?	RDT	Hierarchical regression

TABLE 1