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Abstract

Customers now do their research and buy products across multiple channels and increasingly demand product personalization. They expect not only transparency around order status and delivery, but near instant order fulfilment. And they're increasingly concerned about product origin and quality, as well as product and supply chain sustainability. In most cases, these heightened expectations apply to customers in consumer-facing industries and B2B customers. Supply chains are also increasingly facing major disruptions such as changing and extreme weather conditions, global health crises and supply shortages. For example, many supply chains are being affected by the 2019–20 COVID-19 (coronavirus) outbreak either through unexpected increases or drop-offs in demand as well as supply shortages. Without high levels of visibility into suppliers and sub-suppliers, companies increase their exposure to supply chain risks and become less resilient. And while more than three-quarters of respondents recognize the importance of visibility into the sustainability practices of their organization and suppliers, few have full visibility into either. A new Bloomberg Business Week Research Services survey and report makes it clear that innovative supply chain tools are widely acknowledged to be crucial to meeting corporate goals now and in the future as supply chains grow more complex, customers become more demanding and globalization accelerates. Where there is a risk of disruption to supply chains, public bodies may wish to consider whether to require multiple sources for the same 'at risk' product and/or components involved in the supply of that product as a security-of-supply measure. This would then be reflected in the tender evaluation stage of the procurement where the body can award marks based on how bidders respond to this element of the requirement. The public body may want to reassure itself that the bidder will be able to ensure continuity of supply at all times during the contract even if scenarios such as those experienced in the early days of Covid-19 were to apply. The public sector in Scotland is well resourced with access to huge amounts of spend and contract data at a local, sectoral and national level. As well as forming the basis for decisions on how to

optimize opportunities for collaboration by putting in place local, sector or national contracts and frameworks, this data can be used to identify opportunities for market development and to gain a sense of the influence the Scottish public sector has on the market. The national sustainable procurement tools provide a starting point for assessing supply chain vulnerabilities. Investing in real-time supply chain analytics can help businesses gain key inventory and forecasting metrics to combat volatility of markets.

Keywords: *Real, Time, Supply, Chain, Ecosystem, Balanced, Scotland*

1.1 Introduction

Customer behaviours and expectations are changing dramatically, challenging the established supply chain and operations setups of leading industrial companies. Customers now do their research and buy products across multiple channels and increasingly demand product personalization (Helo & Shamsuzzoha, 2020). They expect not only transparency around order status and delivery, but near instant order fulfilment and they're increasingly concerned about product origin and quality, as well as product and supply chain sustainability. In most cases, these heightened expectations apply to customers in consumer-facing industries and B2B customers (Lejarza & Baldea, 2020). Supply chains are also increasingly facing major disruptions such as changing and extreme weather conditions, global health crises and supply shortages. For example, many supply chains are being affected by the 2019–20 COVID-19 (coronavirus) outbreak either through unexpected increases or drop-offs in demand as well as supply shortages. These changes are taking place against the backdrop of the Fourth Industrial Revolution (4IR), with digital technologies impacting every aspect of how companies run their businesses from creating digitally connected products and services to automating data-driven supply chains (Savić, 2020). Also known as Industry 4.0, this era of digital transformation ushers in new real-time data gathering across the supply chain, smart analysis, and algorithms to better simulate and predict different supply chain scenarios and foster data- based decision-making. To succeed in this quickly evolving and increasingly digital marketplace, companies need to transform their supply chains. Supply chains are becoming more integrated with multiple value chain partners. They're also becoming not just automated but autonomous able to act with limited human intervention and ultimately self-orchestrating (Tella, 2020).

Supply chain transparency sets the stage and is a key catalyst for greater sustainability in Scotland (Generowicz, Kulczycka, Partyka & Saługa, 2021). Although the majority of companies see supply chain transparency as a priority, Digital Champions are significantly further along the road to achieving end-to-end transparency. They report much greater levels of visibility over product content, supply chain financials on a transaction level and logistics flows in near-real-time. Indeed, nearly half (47%) of Digital Champions implementing transparency are already able to use a digital twin of their supply chain (Generowicz et al., 2021). That enhances transparency and dynamic optimization of the total cost of ownership. These high levels of transparency are also helping companies respond to increased sustainability requirements across their supply chains, for example by making it possible to track a product's full chain of custody (Tella, 2020).

AI is accelerating supply chain improvements and will become the new norm (Toorajipour, et al., 2021). AI can be an enormously powerful accelerator of key supply chain capabilities, with the potential to drive efficient decision-making and build systems that can autonomously adapt to changing conditions. By applying sophisticated AI methods, such as machine learning and natural

language processing, to supply chain capabilities, companies can increase transparency, improve planning and enhance logistics flows (Toorajipour, et al., 2021). Digital Champions are well ahead of the rest of the sample in this area; they're making more extensive use of data and are more likely to be applying AI to turbocharge key supply chain decisions, but leveraging AI isn't always easy. Companies need to master the challenges posed by ensuring relevant data is being generated throughout the supply chain (Li, 2020). Intelligently combining structured and unstructured data provides the foundation for data analytics. Data points flow from diverse sources and may be generated internally, externally orfrom publicly available data sources, so establishing a data network that is able to read, clean and analyses all of these diverse sources is key. It's also important to employ AI responsibly and with sufficient governance in place, for example by considering the interpretability and explainability of algorithms and taking possible biases into account (Bennett & McWhorter, 2021).

While no supply chain can ever be fully prepared for and protected from global shocks of the magnitude created by the novel coronavirus, good visibility into all aspects of the supply chain, including suppliers and sub-suppliers, can build resilience and agility to lessen the impact of risk events (Golan, Jernegan & Linkov, 2020). The report stated that 49% of Supply Chain Leaders (the top 12 % of respondents) can capture real-time data insights and act on them immediately, while 51% use AI and predictive analytics to capture insights. This allows Supply Chain Leaders to react in real time to changing conditions from widescale disruptions to individual customer complaints. In a multi-tiered global supply chain, end-to-end visibility is tough enough to achieve in the best of times. But the spread of the coronavirus has laid bare supply chain vulnerabilities and their impact on the world economy. As a result, the importance of supply chain visibility and resiliency has never been clearer. When the spread of the virus across China, forced the shut downs of 1000's of factories, and with it a large proposition of the words supply, we needed real time visibility of which materials, products, and customers were going to be affected, and what alternate source of supply were available (Toorajipour, et al., 2021). As production has starts up, we need visibility into the logistics capacity available to move goods across the globe, and to the actual demand of products as we struggle to keep vital commodities stocked and have almost zero demand for luxury items (Golan et al., 2020).

2.1 Real-Time Supply Chains

Real-time data is also essential to maintain visibility across the supply chain (Helo & Shamsuzzoha, 2020). While the report shows that supply chain leaders generally report greater visibility than others, this is an area where all companies need to improve, especially as they look further down their multi-tiered supply chain. Without high levels of visibility into suppliers and sub-suppliers, companies increase their exposure to supply chain risks and become less resilient. And while more than three-quarters of respondents recognize the importance of visibility into the sustainability practices of their organization and suppliers, few have full visibility into either (Xu, Guo & Rodgers, 2020). A new Bloomberg Business Week Research Services survey and report makes it clear that innovative supply chain tools are widely acknowledged to be crucial to meeting corporate goals now and in the future as supply chains grow more complex, customers become more demanding and globalization accelerates (Ishfaq, Davis-Sramek & Gibson, 2021). In this context, supply chain innovation is becoming more important as companies that have invested in traditional tools are now determined to operate real-time supply chains. Although more than three-quarters of survey respondents noted that demand and supply forecasting and planning tools are already very important, and a majority already has these tools in place, adopting newer

supply chain tools that support the creation of real-time supply chains is recognized as highly important (Inoue & Todo, 2020).

The most critical step is enabling insightful supply chain management. Supply chain business decisions need to be made in a business context, not in a silo. Companies leveraging the wealth of performance data about their supply chains can enable that real-time analysis, gain insight into fragmented business processes and achieve deeper visibility through alerts based on key performance indicators (KPIs) (Ishfaq, et al., 2021). The result is a transition from management by exception to management by information. The second step is transitioning from traditional S&OP to sales and operations business planning. Companies cannot afford to disconnect their sales and operations business planning from tactical planning. Business priorities and operational decisions must be balanced against a clear understanding of their financial impact. Using solutions that combine operations and financial data, the business can collaboratively create scenarios and simulate the effects of decisions in real time to increase supply chain profitability (Nunes, Causer & Ciolkosz, 2020).

Another key driver is embracing the concept of a demand-driven supply chain; the most prevalent supply chain challenge is lack of clarity into what customers want and when they want it (Tiedemann, 2020). In a demand-driven model, companies use POS, social media and market research data to sense customer demand signals immediately and to respond in real time to build that demand into the planning processes. This accelerates supply chain processes and reduces planning cycle times, working capital (inventory) and lead times. It also provides the opportunity to increase revenue by avoiding stock outs, increasing promotion effectiveness and optimizing new product launches. With complex global networks, ensuring efficient execution in the areas of logistics and order fulfillment is more critical than ever. With increased supply chain complexity, it becomes more difficult to deliver the perfect order (Santos, 2020). At the same time, transportation costs are rising across more complicated supply chains. Optimizing execution requires real-time visibility into shipping processes and track-and-trace capabilities, along with automated warehouse and distribution processes and advanced transportation planning (Cheshmberah & Beheshtikia, 2020).

To transition to a real-time supply chain, these five areas need to be tightly integrated and coordinated, besides advanced solutions, companies need advanced analytics that can support real-time decision making (Attaran, 2020). Recent advancements in the area of in-memory computing are already allowing companies to respond quickly to market dynamics with real-time visibility into customer demand. Mobile solutions, with their user-friendly interfaces, can deliver real-time optimization to all stages of the supply chain. The road to a real-time supply chain is getting shorter, and those who have arrived say it is well worth the journey. Those not there yet need to engage partners who will enable them to adopt and integrate these technologies in a non-disruptive way, through side-by-side deployment options and turn-key deployment projects (Agrawal & Narain, 2021). Software considerations might include: Yammer, Cloud Systems: Collaboration, Enterprise Social Networking, jive software: social intranet recourse kits and asana: for task designation.

Globalization has led to an explosion of manufacturers, dealers, suppliers and distribution areas. While this amplifies business growth, it also demands unfaltering management of a complex network of the regional supply chain (Lim, Lee, Foo, Ooi & Tan, 2021). Thus, organizations are looking for ways to improve visibility into their operations, across departments and beyond boundaries of locations. Real-time analytics brings to the table detailed reporting the very basic

requisite of visibility (Cheshmberah & Beheshtikia, 2020). Real-time monitoring of demand, critical events, KPI and transactions, not only improves control and cost efficiency but renders the business more agile by enhancing responsiveness to situations and ultimately minimizing customer impact. Increasing operational costs inevitably affect budgets, working capital, cost of end-product and cash flow. Systematic and timely analysis of critical data can help to achieve cost optimization in areas including material sourcing, load planning, fleet sizing, route and freight costing. Detailed analysis of finances, capability constraints and potential supplier risk can minimize monetary loss in the later stages of supply chain management (Cheshmberah & Beheshtikia, 2020).

When we take a look at how a leading jewelry manufacturer leveraged a business intelligence solution, enabled with automated KPI notifications, to gain complete visibility into stock levels and accordingly streamline their processes (Konovalenko Ludwig & Leopold, 2021). Inaccurate forecasting is plaguing businesses everywhere especially the ones in industries like healthcare, consumer goods, retail, automotive, and logistics. The instability in demand is driving businesses to adopt tools to gain real-time forecast ability, to respond to highly volatile markets that have no tolerance for bottlenecks (Konovalenko et al., 2021). For example while healthcare businesses cannot afford to be understocked, overstocking can lead to costly wastage for those that deal with consumer goods. Investing in real-time supply chain analytics can help businesses gain key inventory and forecasting metrics to combat volatility of markets. Over the last thirty years, logistics has undergone a tremendous change: from a purely operational function that reported to sales or manufacturing and focused on ensuring the supply of production lines and the delivery to customers, to an independent supply chain management function that in some companies is already being led by a CSO - the Chief Supply Chain Officer (Finkenstadt & Handfield, 2021). The focus of the supply chain management function has shifted to advanced planning processes, such as analytical demand planning or integrated S&OP, which have become established business processes in many companies, while operational logistics has often been outsourced to third-party LSPs. The supply chain function ensures integrated operations from customers to suppliers (Finkenstadt & Handfield, 2021).

Industry 4.0 creates a disruption and requires companies to rethink the way they design their supply chain. Several technologies have emerged that are altering traditional ways of working. On top of this, mega trends and customer expectations change the game, besides the need to adapt, supply chains also have the opportunity to reach the next horizon of operational effectiveness, to leverage emerging digital supply chain business models, and to transform the company into a digital supply chain (Belhadi, Kamble, Gunasekaran & Mani, 2021). Several mega trends have a heavy influence on supply chain management: there is a continuing growth of the rural areas worldwide, with wealth shifting into regions that have not been served before. Pressure to reduce carbon emissions as well as regulations of traffic for socioeconomic reasons add to the challenges that logistics are facing. But changing demographics also lead to reduced labor availability as well as increasing ergonomic requirements that arise as the workforce age increases, at the same time customer expectations are growing: the online trend of the last years has led to increasing service expectations combined with a much stronger granularization of orders (Belhadi, et al., 2021). There is also a very definite trend towards further individualization and customization that drives the strong growth of and constant changes in the SKU portfolio. The online-enabled transparency and easy access to a multitude of options regarding where to shop and what to buy drives the competition of supply chains (Belhadi, et al., 2021).

New approaches of product distribution reduce the delivery time of high runners to few hours. The basis for these services is built by advanced forecasting approaches, e.g., predictive analytics of internal (e.g., demand) and external (e.g., market trends, weather, school vacation, construction indices) data as well as machine status data for spare-parts demand, and provides a much more precise forecast of customer demand (Mancini & Gansterer, 2021). Forecasts are not carried out on a monthly basis, but weekly, and for the very fast-moving products even every day. In the future we will see "predictive shipping," for which Amazon holds a patent - products are shipped before the customer places an order. The customer order is later on matched with a shipment that is already in the logistics network (being transported towards the customer region) and the shipment is rerouted to the exact customer destination (Mancini & Gansterer, 2021).

Ad hoc and real-time planning allows a flexible reaction to changing demand or supply situations. Planning cycles and frozen periods are minimized and planning becomes a continuous process that is able to react dynamically to changing requirements or constraints (e.g., real-time production capacity feedback from machines) (Ajaykumar, Mao, Brown & Huang, 2021). Once the products are sent, increased flexibility in the delivery processes allows customers to reroute shipments to the most convenient destination. New business models, such as Supply Chain as a Service for supply chain planning functions or transport management, increase the flexibility in the supply chain organization. Supply chain can be bought as a service and paid for on a by-usage basis instead of having the resources and capabilities in-house. The specialization and focus of service providers allow them to create economies of scale as well as economies of scope and also attractive outsourcing opportunities (Ajaykumar et al., 2021).

3.1 Real-Time Supply Chains in Scotland

Supply chain activities underpin the operation of every manufacturing business and are crucial to its success. They typically involve cross-functional processes and can grow to be complicated and problematic, adding cost, friction and stress and disrupting customer service (Ahmed, 2021). Often businesses are very focused on their product and how it is made, without giving adequate consideration to supply chain questions such as these: How can you balance supply and demand? How do you decide what quantity and when to make or buy? Are you making to order or to stock? How much stock should you hold? The COVID-19 pandemic has placed a spotlight on the risks of the continuity of, and disruption to, supplies caused by supply chain vulnerabilities and surges in demand. It has also underlined the potential risk of poor product quality, human rights abuse, and fraud in public contracts. Conversely, we have seen some really innovative activity with Scottish businesses re-purposing their production to support the needs of the Scottish public sector in protecting citizens during this crisis (Ahmed, 2021). This SPPN offers practical advice on steps public bodies can take to encourage supply chains and address vulnerabilities to supplies in line with Scottish procurement legislation. It also includes information on a range of procurement initiatives and a range of business support activity underway across Scotland to support supplier development (Ahmed, 2021).

The public sector in Scotland is well resourced with access to huge amounts of spend and contract data at a local, sectoral and national level (Thompson, Hendry & Mead, 2021). As well as forming the basis for decisions on how to optimize opportunities for collaboration by putting in place local, sector or national contracts and frameworks, this data can be used to identify opportunities for market development and to gain a sense of the influence the Scottish public sector has on the market (Thompson, et al., 2021). The national sustainable procurement tools provide a starting point for assessing supply chain vulnerabilities. The tools have been designed to help public bodies

optimize the economic, social and environmental outcomes of their procurement activity. A series of supporting guides are also available to help public bodies embed sustainability into their procurement processes. For example, the Materials Security guide is concerned with the procurement of products or services from sources that are potentially vulnerable to supply disruption (Bruce et al., 2021).

Life Cycle Impact Mapping requires you to consider where in the procurement cycle risks and opportunities apply (raw materials, manufacturing and logistics, use and disposal or end of life management), and subsequently how they might be addressed (Kordi et al., 2021). Specifically, security of supply risks may become apparent when considering raw materials, and manufacturing and logistics stages. When considering impacts during the use of the product/service delivery, it may be important to ensure that maintenance and repair services are readily available indicating a need for accessible, skilled labour (Kordi et al., 2021). Market engagement may help public bodies to better understand the supply chain and where in the procurement cycle potential risks and opportunities apply. For example, pre-market engagement and meet the buyer events can help buyers to engage market providers, understand and influence evolving market capacity and capability, supporting the development of sourcing strategies and future-proofed specifications (Kordi et al., 2021).

Mapping the supply chains of goods being sourced is key to understanding if they are potentially vulnerable to supply chain problems (LeBaron, 2021). Identifying those supply chains known to be located in high-risk or not easily accessible locations will enable the public body to prioritise goods, and plan for challenging scenarios, perhaps by identifying sources of supply that do not present the same risks and/or alternative supply chains that will help mitigate risk because, for example, they are shorter/less complex. Demand management and good forecasting, collaboratively where relevant, can assist or support good planning and management of limited products and services (LeBaron, 2021). In any event, public bodies should consider whether existing collaborative Framework Agreements offer a quick and sustainable route to market. Framework managers are often a rich source of information in terms of commodity supply chains, availability and routes to market (LeBaron, 2021).

Where there is a risk of disruption to supply chains, public bodies may wish to consider whether to require multiple sources for the same ‘at risk’ product and/or components involved in the supply of that product as a security-of-supply measure (Modgil, Gupta, Stekelorum & Laguir, 2021). This would then be reflected in the tender evaluation stage of the procurement where the body can award marks based on how bidders respond to this element of the requirement. The public body may want to reassure itself that the bidder will be able to ensure continuity of supply at all times during the contract even if scenarios such as those experienced in the early days of Covid-19 were to apply (Modgil, et al., 2021). In terms of how the bidder would address this, it may mean looking to ensure supply chains from a variety of geographic locations. In either event, the public body may wish to consider any cost implications associated with adding these requirements and/or whether their inclusion may inadvertently create a barrier to the diversity of the supply chain.

In Scotland, within the context of supply chain interruptions and vulnerabilities, the contractor will be expected to demonstrate that it has a comprehensive, on-going and systematic approach to identifying and managing risks relating to employment standards, working conditions and use of child labour in the supply chains relevant to the contract/framework agreement (Modgil et al., 2021). This should include policy, roles and responsibilities, objectives, targets and programmes, training and awareness, communications (including whistle blowing), documentation and

procedures, supply chain management, emergency response, monitoring and reporting (including identification of all suppliers, changes made and audits undertaken in accordance with appropriate standards for example ETI Base Code, SEDEX, or equivalent), corrective action and review (Modgil et al., 2021).

4.1 Balanced Ecosystems

Companies, business models and management techniques have had to evolve to both ref act and take advantage of these changes which, most critically, have made possible the enormous increase in world trade and global prosperity (Yermolenko et al., 2021). Greater use of collaborative partnerships, outsourcing and off-shoring has created elongated networks of organizations that require more sophisticated management and controls than ever before. Consequently, modern supply chains have become complex, multilayered, interconnected distribution systems that enable companies and countries to trade more effectively and efficiently (Yermolenko et al., 2021). Developed by innovative, competitive and ambitious stakeholders and users, they have been the essential enablers of international cargo fows around the world, bringing economic and social benefits, and leading to a steady improvement in the standard of living for millions.

Confirming how these networks enable business in an increasingly connected world, the Financial Times' (FT) lexicon describes how 'businesses operate in a broader network of related businesses offering particular products or services this is known as a business ecosystem (Ivanov, D., & Dolgui, 2021). They further define the business ecosystem as 'a network of interlinked companies, such as suppliers and distributors, who interact with each other, primarily complementing or supplying key components of the value propositions within their products or services'. From the supply chain perspective, Cranfeld School of Management's Dr Martin Christopher adopts an end-to-end perspective of the flows of product and accompanying information from the source of raw materials to delivery to the end customer and sometimes beyond – to develop a definition of supply chain as: 'The network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer'.

Leading companies are increasingly considering their supply chains as strategic as a business enabler, as a revenue driver and as a differentiator (Ivanov & Dolgui, 2021). In many sectors, companies compete on the basis of their supply chains, as much as on their actual products. For many businesses – particularly those in high-tech and consumer electronics time to market and effective distribution channels are critical success factors, and therefore supply chain management capabilities become a source of competitive advantage (Singh & Agrawal, 2021). Historically there have been many misunderstandings about what exactly is supply chain, with many business managers thinking that it's all about trucks and warehouses which are in fact components of logistics, which in turn is a part of supply chain management. As a commercial entity, each principal forms their own distinctive supply chain ecosystem, adopting a different composition of similar functional participants, or in several cases, particularly within industry sectors, many of the same actual participants, all contributing in many different supply chain ecosystems for different principals (Singh & Agrawal, 2021). And so it goes on, such that today's supply chains encompass complex webs of interdependencies, frequently spanning the globe, designed and deployed to optimize critical attributes such as speed, agility and resilience – that drive competitive advantage.

As modern supply chains in Scotland increasingly resemble ecosystems rather than linear chains, the suppliers, manufacturers and service providers that work together to service one client's supply chain could well be fiercely competing against each other to win business to provide services for a different client's supply chain (Cantner, Cunningham, Lehmann & Menter, 2021). Indeed, whilst each company has their own supply chain ecosystem over which they have control that same company will most likely be a participant in several other supply chain ecosystems, for example for its customers or suppliers. This combination of complexity and connectedness result in scenarios where a company may find that one single external organization may actually be a supplier, and/or a customer and/or a competitor depending in whose supply chain ecosystem configuration they are operating! High-tech sector examples would include Apple and Samsung, or Microsoft and IBM. In this context, organizations must therefore develop the capabilities to effectively work with not just multiple different partners in their own ecosystem, but also the same partners playing multiple different roles across other ecosystems (Cantner et al., 2021).

5.1 Conclusion

Supply chain transparency sets the stage and is a key catalyst for greater sustainability in Scotland. Although the majority of companies see supply chain transparency as a priority, Digital Champions are significantly further along the road to achieving end-to-end transparency. They report much greater levels of visibility over product content, supply chain financials on a transaction level and logistics flows in near-real-time. Indeed, nearly half (78%) of Digital Championsimplementing transparency are already able to use a digital twin of their supply chain in Scotland. AI is accelerating supply chain improvements and will become the new norm within Scotland and the entire European region. AI can be an enormously powerful accelerator of key supply chain capabilities, with the potential to drive efficient decision-making and build systems that can autonomously adapt to changing conditions. By applying sophisticated AI methods, such as machine learning and natural language processing, to supply chain capabilities, companies can increase transparency, improve planning and enhance logistics flows. Digital Champions are well ahead of the rest of the sample in this area; they're making more extensive use of data and are more likely to be applying AI to turbocharge key supply chain decisions. But leveraging AI isn't always easy.

The public sector in Scotland is well resourced with access to huge amounts of spend and contract data at a local, sectoral and national level. As well as forming the basis for decisions on how to optimize opportunities for collaboration by putting in place local, sector or national contracts and frameworks, this data can be used to identify opportunities for market development and to gain a sense of the influence the Scottish public sector has on the market. The national sustainable procurement tools provide a starting point for assessing supply chain vulnerabilities. Investing in real-time supply chain analytics can help businesses gain key inventory and forecasting metrics to combat volatility of markets. Over the last thirty years, logistics has undergone a tremendous change: from a purely operational function that reported to sales or manufacturing and focused on ensuring the supply of production lines and the delivery to customers, to an independent supply chain management function that in some companies is already being led by a CSO - the Chief Supply Chain Officer.

REFERENCES

Agrawal, P., & Narain, R. (2021). Analysis of enablers for the digitalization of supply chain using an interpretive structural modelling approach. *International Journal of Productivity and Performance Management*.

Ahmed, H. (2021). *A Mixed-Method Study of Investigating the Effects of Organizational Preparedness of Supply Chain Management Performance in the Food and Manufacturing Industry* (Doctoral dissertation, Case Western Reserve University).

Ajaykumar, G., Mao, A., Brown, J., & Huang, C. M. (2021). FACT: A Full-body Ad-hoc Collaboration Testbed for Modeling Complex Teamwork. *arXiv preprint arXiv:2106.03290*.

Attaran, M. (2020, July). Digital technology enablers and their implications for supply chain management. In *Supply Chain Forum: An International Journal* (Vol. 21, No. 3, pp. 158-172). Taylor & Francis.

Belhadi, A., Kamble, S., Gunasekaran, A., & Mani, V. (2021). Analyzing the mediating role of organizational ambidexterity and digital business transformation on industry 4.0 capabilities and sustainable supply chain performance. *Supply Chain Management: An International Journal*.

Bennett, E. E., & McWhorter, R. R. (2021). Virtual HRD's role in crisis and the post Covid-19 professional lifeworld: Accelerating skills for digital transformation. *Advances in Developing Human Resources*, *23*(1), 5-25.

Bruce, A., Bruce, D. M., Fletcher, I., & Lamprinopoulou, C. (2021). Producing food in a fragile food system–a case study on Isle of Skye, Scotland. In *Justice and food security in a changing climate* (pp. 140-145). Wageningen Academic Publishers.

Cantner, U., Cunningham, J. A., Lehmann, E. E., & Menter, M. (2021). Entrepreneurial ecosystems: a dynamic lifecycle model. *Small Business Economics*, *57*(1), 407-423.

Cheshmberah, M., & Beheshtikia, S. (2020). Supply chain management maturity: An all-encompassing literature review on models, dimensions and approaches. *LogForum*, *16*(1).

Finkenstadt, D. J., & Handfield, R. (2021). Blurry vision: Supply chain visibility for personal protective equipment during COVID-19. *Journal of Purchasing and Supply Management*, 100689.

Generowicz, N., Kulczycka, J., Partyka, M., & Saługa, K. (2021). Key Challenges and Opportunities for an Effective Supply Chain System in the Catalyst Recycling Market–A Case Study of Poland. *Resources*, *10*(2), 13.

Golan, M. S., Jernegan, L. H., & Linkov, I. (2020). Trends and applications of resilience analytics in supply chain modeling: systematic literature review in the context of the COVID-19 pandemic. *Environment Systems and Decisions*, *40*, 222-243.

Helo, P., & Shamsuzzoha, A. H. M. (2020). Real-time supply chain—A blockchain architecture for project deliveries. *Robotics and Computer-Integrated Manufacturing*, *63*, 101909.

Helo, P., & Shamsuzzoha, A. H. M. (2020). Real-time supply chain—A blockchain architecture for project deliveries. *Robotics and Computer-Integrated Manufacturing*, *63*, 101909.

Inoue, H., & Todo, Y. (2020). Propagation of the economic impact of lockdowns through supply chains. *VOX, CEPR Policy Portal, April*, *16*.

Ishfaq, R., Davis-Sramek, B., & Gibson, B. (2021). Digital supply chains in omnichannel retail: A conceptual framework. *Journal of Business Logistics*.

Ishfaq, R., Davis-Sramek, B., & Gibson, B. (2021). Digital supply chains in omnichannel retail: A conceptual framework. *Journal of Business Logistics*.

Ivanov, D., & Dolgui, A. (2021). Stress testing supply chains and creating viable ecosystems. *Operations Management Research*, 1-12.

Konovalenko, I., Ludwig, A., & Leopold, H. (2021). Real-time temperature prediction in a cold supply chain based on Newton's law of cooling. *Decision Support Systems*, *141*, 113451.

Kordi, N. E., Belayutham, S., & Che Ibrahim, C. K. I. (2021). Mapping of social sustainability attributes to stakeholders' involvement in construction project life cycle. *Construction Management and Economics*, 1-20.

LeBaron, G. (2021). The role of supply chains in the global business of forced labour. *Journal of Supply Chain Management*, *57*(2), 29-42.

Lejarza, F., & Baldea, M. (2020). Closed-loop real-time supply chain management for perishable products. *IFAC-PapersOnLine*, *53*(2), 11458-11463.

Li, L. (2020). Education supply chain in the era of Industry 4.0. *Systems Research and Behavioral Science*, *37*(4), 579-592.

Lim, A. F., Lee, V. H., Foo, P. Y., Ooi, K. B., & Tan, G. W. H. (2021). Unfolding the impact of supply chain quality management practices on sustainability performance: an artificial neural network approach. *Supply Chain Management: An International Journal*.

Mancini, S., & Gansterer, M. (2021). Vehicle routing with private and shared delivery locations. *Computers & Operations Research*, *133*, 105361.

Modgil, S., Gupta, S., Stekelorum, R., & Laguir, I. (2021). AI technologies and their impact on supply chain resilience during COVID-19. *International Journal of Physical Distribution & Logistics Management*.

Nunes, L. J. R., Causer, T. P., & Ciolkosz, D. (2020). Biomass for energy: A review on supply chain management models. *Renewable and Sustainable Energy Reviews*, *120*, 109658.

Santos, L. A. D. S. (2020). *Demand-Driven Material Requirements Planning (DDMRP) implementation impacts on Supply Chain Management strategic processes: an AHP approach* (Doctoral dissertation, Universidade de São Paulo).

Singh, S., & Agrawal, V. (2021, June). Development of ecosystem for effective supply chains in 3D printing industry-an ISM approach. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1136, No. 1, p. 012049). IOP Publishing.

Tella, A. (2020). Repackaging LIS professionals and libraries for the fourth industrial revolution. *Library Hi Tech News*.

Thompson, M., Hendry, A., & Mead, E. (2021). Three Horizons of Integrating Health and Social Care in Scotland. In *Handbook Integrated Care* (pp. 851-879). Springer, Cham.

Tiedemann, F. (2020). Demand-driven supply chain operations management strategies–a literature review and conceptual model. *Production & Manufacturing Research*, *8*(1), 427-485.

Toorajipour, R., Sohrabpour, V., Nazarpour, A., Oghazi, P., & Fischl, M. (2021). Artificial intelligence in supply chain management: A systematic literature review. *Journal of Business Research*, *122*, 502-517.

Xu, X., Guo, W. G., & Rodgers, M. D. (2020). A real-time decision support framework to mitigate degradation in perishable supply chains. *Computers & Industrial Engineering*, *150*, 106905.

Yermolenko, V., Hafurova, O., Deineha, M., Novak, T., Sinitsky, J., & Ulugov, U. (2021). Landscape approach to formation of system of ecologically balanced use of natural resources: legal framework. In *E3S Web of Conferences* (Vol. 280, p. 09021). EDP Sciences.