

# Investigating Digital Supply Chain Transformation Drivers: *An Empirical Study*<sup>1</sup>

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## ABSTRACT

*Digital transformation plays a significant role in delivering solutions to supply chain (SC) and encouraging new drivers of economic development. This research aims at identifying the main elements constituting the digital SC transformation, while highlighting the main requirements and obstacles facing such transformation. The paper analyzes the impact of digital transformation on changing SC characteristics in order to identify the main drivers for transformation. An empirical study is conducted to assess companies' awareness and level of readiness to adopt digital SC transformation and identify the main obstacles facing such transformation. Clear benefits have been identified from SC digital transformation which can impact different performance metrics. Other factors that should not be ignored are to ensure the level of readiness and ecosystem support. The survey identifies cost and lack of a clear methodology for digital SC initiatives as main factors limiting organizations' digital SC transformation. Empirical studies can be conducted to measure the benefits of SC digital transformation based on the performance measures and metrics identified in this paper. The paper provides a road map to deal with the main factors which limit organizations' digital SC agenda at the execution level. This paper proposes a framework capturing the main drivers which can enable digital SC transformation in the business sector. The paper conducts an empirical study to assess the current status in organizations and the obstacles towards digital SC transformation.*

**Keywords:** Supply chain, digital transformation

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<sup>1</sup> Received in 22 March 2021, accepted in 6 May 2021.

## **1- Introduction**

The global trading system has been profoundly influenced by the world's big macro-economic shifts which have been created until today (China-U.S. trade war, emerging economic developments such as cycle economy and shared economy, e-commerce and block chain technology, fourth industrial revolution, and finally Covid-19) which have all exposed many vulnerabilities in corporate strategies (Xu, Xu and Li, 2018). In an incredible twist, the word "value chain 4.0" is being used and transferred from conventional to digital supply chains, so companies will need to re-combine and re-think how to work and organize businesses in order to make companies run better prior to the crisis (Kaynak, Tatoglu and Kula, 2005). A holistic approach to digital supply chain transformation would set the course for streamlined implementation, starting with a digital strategy and a digital operating model. In order to minimize volatility and ambiguity, the supply chain slogan switches from productivity and low-cost procurement to supply chain resilience and visibility (McKinsey, 2016).

This research aims at identifying the main elements constituting the digital supply chain transformation, while highlighting the main requirements and obstacles facing such transformation. The paper analyzes the impact of digital transformation on changing supply chain characteristics from the traditional to digital supply chain in order to identify the main drivers for transformation. An empirical study is conducted to assess the companies' awareness and level of readiness to adopt digital supply chain transformation and identify the main obstacles facing such transformation, upon which future research agenda is proposed.

The research starts with theoretical background in section two to provide an overview of the new features of supply chain in the era of the fourth industrial revolution and digital transformation, in addition to the main drivers for such transformation. In section three, research methodology is illustrated where a survey is conducted to investigate the main requirements and obstacles facing transformation from the traditional to digital supply chain. Section four illustrates the results of the survey. The paper is concluded in section five with the research

findings by providing a road map for digital supply chain implementation, in addition to proposing future agenda for further investigation and research on digital supply chain.

## **2- Literature Review**

Supply chain reconfiguration and conventional regional or functional silos should be resolved. The hallmarks of a truly digital supply chain are highly automated end-to-end operations, versatile bundling of activities and increased visibility. Applying the new digital technology does not inherently mean being digitized. In order to realize the untapped potential of existing resources and expertise, it is all about aligning digital strategies with supply chain priorities and implementing a digital operating model, resulting in a higher level of efficiency (Raab and Cryan, 2019).

### **2-1 Digital Supply Chain (Supply chain 4.0)**

Although the literature contains many ideas for new technologies that could be usable by 2030 (for example: large fleets of self-driving delivery vehicles, or the “smart mirror” in the local clothing store which allegedly enables you to digitally try on clothes by scanning their bar codes), this claim does not rely on the deployment of technologies that do not actually yet exist. There will already be a major effect on the proliferation of current supply chain 4.0 technologies (Ferrantino and Koten, 2019).

The supply chain is increasingly dynamic and internationally reachable (Manavalan and Jayakrishna, 2019), leading to the massive use of emerging technology, robotics and artificial intelligence. Supply chain 4.0 is a smart, value-driven network that leverages new data analytics technologies and techniques to generate value and revenue (Merlino and Spro'e, 2017).

Digital supply chain management's key characteristics are: heading towards centralized procurement/logistics and cost monitoring, emphasizing real-time reaction to customer needs, better forecasting, preparing and sharing sales and operations and knowledge, pressuring for cost reduction and demonstrating reliable cost savings and added

value on service, and working closely with shortening suppliers (Seleme et al., 2019).

There is a limited view of the traditional supply chain but a full view of the digital supply chain; since information is delayed as it passes through each company in a traditional supply chain in addition to the limited visibility of the whole chain hindering effective communication, whereas information is accessible in the digital supply chain. Different preparation cycles result in delays and unsynchronized responses across several levels, as in the conventional supply chain. But in the digital supply chain, real-time reaction to the stage of preparation and implementation allows for a high level of responsiveness while maintaining efficiency (Seyfert et al., 2017)

The future vision of digital supply chain integrates digitalization and automation into the entire supply chain, incorporating all systems, vendors and consumers, and enabling real-time information sharing (Heavey et al., 2019). Among the several elements which can be utilized in SC transformation from Industry 4.0 are: cyber-physical structures and connected robots in the industry, connected primary logistics trucks, automated warehouses, autonomous shared secondary logistics trucks and last-mile delivery drones. The internet of things (IoT) also plays an important role in this process once information is modified in real time during the transport of goods or in warehouses (Mellbye et al., 2017).

## **2-2 Benefits of Digitally Transformed Supply Chain**

With the application of emerging technology, especially in the transport sector, the environment and sustainability in the supply chains are gaining more importance. Consequently, this advantage results in a strategic advantage, as it facilitates more agile and accurate decision-making. Furthermore, the system's versatility allows for route adjustments, ensuring individual distribution and customer satisfaction (Manavalan and Jayakrishna, 2019). With the implementation of the supply chain 4.0, the possible advantages which can be accomplished are:

- **Speed:** the predictive demand assessments, industry dynamics, and output data can make the revenue predictions more precise, which can go from monthly to weekly and/or daily. The definition of “predictive transport” by proprietary Amazon means that before the customer orders, the goods can be delivered, minimizing the delivery lead time. That is, the pace is linked to the ability to respond to consumer demand as quickly as possible (Spro'e et al., 2017).
- **Flexibility:** online planning helps businesses to adapt more flexibly to changes in demand, to minimize the planning period and delivery time, and to divert goods to other destinations even once shipped (Manavalan and Jayakrishna, 2019).
- **Individual delivery:** it is anticipated that supply chain 4.0 offers individualized deliveries with consumers seeking more exclusive and individual goods through strategies such as micro segmentation, mass customization and advanced scheduling practices. Drones can be part of the last mile distribution system (Manavalan and Jayakrishna, 2019)
- **Accuracy:** the distribution management system tracks the exact location of the trucks, vehicles and drones, making the deliveries to the customers in real time. Monitoring also helps stakeholders to make faster decisions more accurately (Mellbye et al., 2017).
- **Efficiency:** the automation of activities, such as picking, transport and planning, increases the efficiency of the supply chain. Autonomous systems such as robots, vehicles and drones are therefore used to improve productivity (Mellbye et al., 2017). At the heart of digital supply chains is the universal availability of information. They can allow superior collaboration and coordination across digital channels with the right organizational design and governance, resulting in enhanced efficiency, agility and effectiveness. This gap in performance would push companies with conventional supply chains to adapt (or else risk falling behind competition) and accept emerging digital realities. A modern operating model is all about integrating digital capabilities through the governance, processes, data & performance management, and

IT organizational layers. It enables the requisite levels of integration and process standardization. The advantages of a digital operating model are widely categorized into three categories: business process automation, operational versatility and corporate asset digital management. Automation and centralization of processes help companies make their workers more effective. Better visibility helps businesses to more cost-effectively handle their own as well as contracted assets and leverage the portfolio of clients and goods. Process automation usually results in up to 20% cost savings for the related cost base, while centralization, like off-shoring, helps save up to 50% in cost. In addition, businesses will increase their earnings before interest and taxes (EBIT) margin by 5 percent and, in some cases, even more with digital management of corporate properties (Raab and Cryan, 2019).

A significant level for raising the operational efficiency of supply chains is the reduction of today's digital waste and the introduction of emerging technologies. In the next few years, the potential effect of supply chain 4.0 will be enormous: up to 30 percent lower operating costs and a 75 percent reduction in lost revenue while reducing inventories by up to 75 percent. All these anticipations would dramatically improve the agility of the supply chains. The effect figures are based on the experience provided by multiple research and quantitative measurements. The three-performance metrics are strongly correlated, for e.g. an improved inventory profile would lead to an improved quality of service and lower cost (Ferrantino and Koten, 2019).

The following discussion illustrates how digital supply chain can contribute positively to improving the three-business performance matrix from different perspectives (Seyfert et al., 2016).

**- Supply chain service/lost sales**

Poor customer service is either motivated by a wrong customer promise (e.g. unreasonable lead times), or a wrong inventory profile (it is not available for ordered products and/or inadequate parts delivery). Furthermore, lost sales occur if the goods needed are not available on the shelf or in the system. Consumers will thus opt to turning to another

brand. For both the business to customer (B2C) and business to business (B2B) worlds, this is true. By significantly improving the way a business communicates with the customer, by exploiting all available POS data/market intelligence, significantly improving the forecast output (up to more than 90 percent at the relevant stage, e.g. SKU), and applying demand shaping methods in conjunction with demand sensing to account for systemic changes/trends, the level of service can increase dramatically.

#### **- Supply chain costs**

The costs can be decreased by up to 30 percent, powered by transportation, storage, and the configuration of the overall network. Through applying advanced methods to measure the clean sheet (bottom-up measurement of the 'real' cost of the service), transport and warehousing costs, and by optimizing the network, approximately 50 percent of this improvement can be accomplished - the target should always be to have minimum touch points and minimum kilometers powered, still meeting the customer's desired service level. The savings capacity can be achieved in conjunction with smart automation and efficiency improvement in warehousing, on-board units in transportation, etc. The remaining cost savings can be accomplished by leveraging complex routing techniques, autonomous vehicle leverage, and 3-D printing where possible.

#### **- Supply chain planning**

Planning activities, such as demand planning, S & OP process preparation, aggregate output planning and supply planning, are often time-consuming and mostly manually carried out. Eighty to 90 percent of all preparation activities can be automated with advanced machine support and still maintain higher output compared to manually performed tasks. The S & OP process will shift to a weekly rhythm and scenarios that can be changed in real time will be built on the decision process. The other components, such as operation, supply chain costs, and inventory, have implications for this precision, granularity and speed.

### **- Inventory**

To decouple demand and supply, inventory is used to buffer variation in demand and supply. The uncertainty (the standard deviation of demand/supply or forecast error) would be substantially reduced by introducing new planning algorithms, rendering safety inventory unnecessary. The other critical variable for driving inventory is the lead time for replenishment - with more Lot Size output and quick changeover, the lead time would be greatly reduced. Long transport times, for example from Asia to the EU or the US, would also be reduced due to a large increase in local-local development. Moreover, 3-D printing would decrease the inventory needed. This can lead to an overall reduction in inventory of 75 percent.

### **2-3 Implementation of Digital Supply Chain**

As a result of globalization, the current aim of the supply chain is to ensure the adequate integration of operations from suppliers to consumers (Wong et al., 2017). The integration of the supply chain includes coordination, knowledge exchange and standardization of the system, pursuing joint cost, inventory and customer service decisions from the perspective of the entire supply chain (Kang et al., 2018). Integration requires the use of emerging technology to enhance the exchange of information and to enable, in the process, the monitoring of physical goods. Since 2010, automation has been introduced to the supply chain in order to control demand, complexity and integration (Bahrin et al., 2016). With the use of Industry 4.0 technologies, this has increased, resulting in the digital supply chain transformation (Manavalan and Jayakrishna, 2019). To create and quantify long-term value, it is important for a company to incorporate digital initiatives into the overall supply chain strategy. The value creation capacity in the current supply chain should be illustrated by a detailed review process. Identifying market advantages includes top management experience and reviews on currently perceived pain points and best practices in the industry. The identification of examples of broken processes, local instead of global optimization, low visibility (for example, on product/customer profitability or process quality) or sub-critical size of local business units are typical results of an examination of current pain

points. A review of these pain points will directly lead to a digital operating model design principles and value potential (Nutz and Sievers, 2015).

The tendency to introduce digital solutions in silos or through a technology-centric approach is one of the most common issues faced on the path towards digital transformation. A rivalry for resources also occurs when organizations introduce disconnected digital strategies through functions, resulting in inefficiencies and inter-departmental disputes. This poses a possibility of the initiative being a one-off project rather than a program of transformation. Digital transformation is all an enterprise-wide shift to business and less about technology. It is important for a digital supply chain approach to be an integral part of a company's overall business strategy and organizational structure. It obviously has the greatest ability to turn the entire enterprise into a digital operating model, but it also brings the highest complexity and risk.

Regardless of the scope of the transformation, business digital transformation can be accomplished through considering four dimensions, as discussed below (Raab and Cryan, 2019).

**- Supply chain operating and governance model**

As knowledge is no longer location based, a digital operating model encourages a more versatile organizational design. Companies must take a closer look at internal coordination committees and processes, service level agreements, and transfer pricing systems in order to understand the full potential of becoming a multinational company. Demand forecasting and supply network planning, for instance, require information and processes to be implemented across roles and regional units. If this is achieved systematically, the latent synergies in both development and logistics networks are unlocked.

**- Integrated execution**

In order to eliminate waste or non-value-added activities, such as double data entry, the reconciliation of information from different sources or the correction of customer invoices, it is important to integrate the various supply chain functions such as product creation,

sourcing, manufacturing, maintenance, and logistics across locations. The main goal is to design end-to-end systems that give all the data they need for straight-through processing to employees.

- **Integrated supply chain performance measurement**

In a digital operating model, any order or transaction can be tracked using Web 2.0 technologies. Tagging technologies, like barcodes or RFID, provide physical movements with real-time data feeds. By processing and storing data for multi-function and multi-location supply chains, virtualized data centers make available information that has been hidden until now. Combining this operational data with financial information, along with data from external sources, such as market data or benchmark data, can help in making better decisions relative to the reporting methods often used today.

- **Supply chain technology architecture and infrastructure**

The architecture of technology is the design rationale for business processes and IT infrastructures and it represents the criteria of the organization's operating model for integration and standardization. The challenge is to select and incorporate digital technologies and integrated platforms that employ reusable and exchangeable components with minimal investment in time and effort, although many technology specifications may already be in place. A best-in-class example is Walmart's widespread use of innovations, such as demand pattern analysis, RFID, wireless monitoring devices, warehouse labor management systems, vehicle management systems, and voice-directed picking devices, to continuously enhance its supply chain.

The level of business readiness to digital transformation is another issue that should be considered to successfully adopt transformation towards digital supply chain. There are several factors affecting the readiness to tackle digital supply chain (IDB, 2019):

- The level of globalization: companies that are part of global supply chains appear to be more advanced in terms of digital transformation than those based on solely domestic markets. For example, subsidiaries in the automotive sector tend to benefit from the implementation of technology at their headquarters and research

centres. Similarly, tier 1 suppliers of multinational companies appear to show a higher degree of adoption of industry 4 technology to more effectively help inter-organizational linkages.

- The degree of vertical integration: as companies with internalized logistics processes are more likely to have a digital platform that allows the integrated management of manufacturing and logistics processes to be more advanced in terms of digital transformation.
- Competitive industry level: as industries under the threat of disruption from non-traditional players show a greater likelihood of introducing digital transformation to react better to the competitive threat, as large logistics companies develop or acquire digital channels that provide enhanced visibility to customers and thus greater value for supply chain process management

The digital economy is altering industry's ecosystem. More than 60% of the global GDP will be digitalized by 2022, according to the World Economic Forum (WEF). However, since 50 per cent of the world's population is not currently involved in the digital economy, there is considerable growth potential. Companies willing to respond to the needs of these potential customers while remaining competitive must change their business processes and strategies by undertaking a digital transformation (World Economic Forum, 2019).

Governments formulate national plans to support the transition to the future of production and identify a set of goals, guidelines and implementation approaches to direct the business sector of the economy towards the digitization of production processes. The public sector starts to engage in joint private sector projects to build development plans and help private-sector companies start their digital transformation strategy. The industry 4.0 projects also target the digitization of small and medium-sized businesses through training programs, consulting services, implementation of test bed centers and financial incentives. At the same time, governments are shaping the supply chain infrastructure enablers by preparing strategic strategies for the growth of logistics, such as: China's medium and long-term logistics industry development plan, Piano strategico nazionale della portualità e della logistica of Italy, and the efficiency roadmap of

Singapore for logistics and transportation. These projects are aimed at creating gateways (smart ports, multimodal terminals, etc.), digitizing logistics and streamlining customs processes (Inter-American Development Bank and World Economic Forum, 2019).

## **2-4 Proposed Framework towards Digital Supply Chain Transformation**

The previous studies indicated how digital transformation can impact the SC at every point, transforming the way activities are accomplished and the nature of the links between them. Digital SC transformation can play as significant role to enhance SC collaboration and also improve SC efficiency by providing accurate and real-time information regarding raw material availability, inventory level and shipment status (Sadraoui and Mchirgui, 2014).

Digital transformation can provide solutions to the great lockdown problem, improving the durability of the global production system and supply chains and encouraging new drivers of economic development.

Previous studies confirmed the impact of supply chain 4.0 and there are several promising tales. Clear benefits can be identified from supply chain digital transformation and they will impact different performance metrics. However, in order to achieve the full benefits of digital transformation, companies must fundamentally redesign their supply chain constitution. It is not enough to just seek for employing digital technologies.

Successful digital transformation also needs economic system help. Another factor that should not be ignored is to ensure the level of readiness, requirements and ecosystem support. The previous studies lack a comprehensive view in a one framework of all elements enabling digital supply chain transformation.

Based on the previous discussion, this research highlights the impact of digital transformation on changing supply chain characteristics from traditional to digital supply chain. Previous studies identified the different elements which constitute the digital supply chain transformation. The review illustrates digital transformation benefits and how it impacts different performance metrics. The requirements of

digital transformation along with the level of readiness criteria are concluded. The review shows how ecosystem support can accelerate digital supply chain transformation. Table 1 captures different elements to be considered for SC digital transformation in a one comprehensive framework.

**Table 1: SC digital transformation elements**

Level of awareness	<ul style="list-style-type: none"> <li>- Does the organization have a clear vision for the digital supply chain?</li> <li>- What is, or most likely will be, the aim of the digital supply chain vision?</li> </ul>
Expected benefits	<ul style="list-style-type: none"> <li>- Speed</li> <li>- Flexibility</li> <li>- Individual delivery</li> <li>- Accuracy</li> <li>- Efficiency</li> </ul>
Impact on performance metrics	<ul style="list-style-type: none"> <li>- SC sales</li> <li>- SC cost</li> <li>- SC planning</li> <li>- Inventory</li> </ul>
Implementation requirements	<ul style="list-style-type: none"> <li>- Supply chain operating and governance model</li> <li>- Integrated execution</li> <li>- Integrated supply chain performance measurement</li> <li>- Supply chain technology architecture and infrastructure</li> </ul>
Level of readiness	<ul style="list-style-type: none"> <li>- The level of globalization</li> <li>- The degree of vertical integration</li> <li>- Competitive industry level</li> <li>- Governments national plan</li> </ul>

Source: Conducted by the author

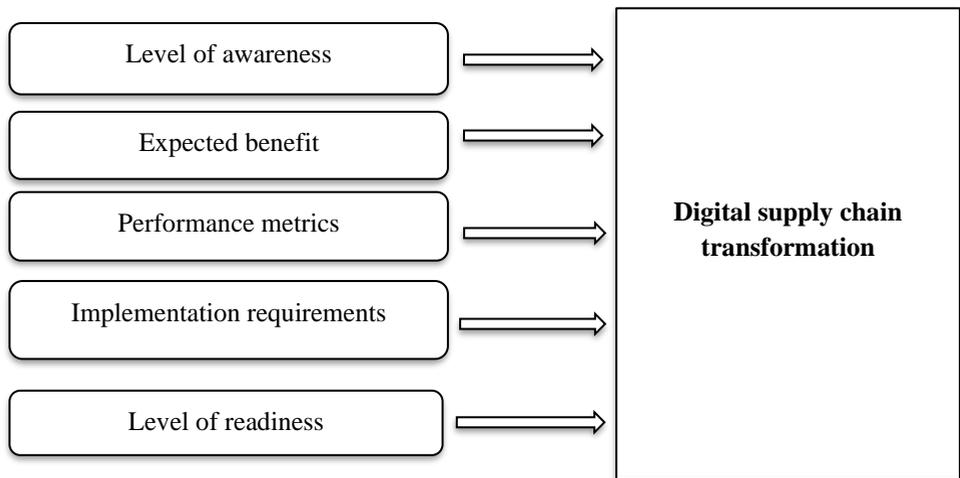
### 3-Methodology

This research aims at identifying the main elements constituting digital supply chain transformation, while highlighting the main requirements and obstacles facing such transformation.

Based on the above discussion, the study proposition to be investigated is “level of awareness, expected benefits, impact on performance metrics, implementation requirements, and level of readiness can drive and facilitate digital supply chain transformation” This research

proposition focuses on the relationship between digital transformation elements and the successful execution of digital supply chain transformation. The study proposition is derived from previous studies in the area as summarized in table 1.

A framework is proposed to investigate digital supply chain transformation in the business sector. Figure 1 illustrates the proposed framework where the digital supply chain transformation is identified as a dependent variable, while (level of awareness, expected benefits, impact on performance metrics, implementation requirements, and level of readiness) are identified as independent variables drive and facilitate digital supply chain transformation.



**Figure 1: Research framework**

Source: Conducted by the author

Based on the research aim and proposition, the following research questions are formulated:

- To what extent do the organizations have the required level of awareness to adopt digital supply chain transformation?
- What are the main benefits expected by organizations from supply chain digital transformation?
- To what extent do the organizations have the level of readiness and implementation requirements facilitating the successful digital supply chain transformation?

- What are the main obstacles facing such transformation?

An empirical study is conducted to test the level of readiness and obstacles facing digital supply chain transformation in the business sector based on the research framework. The proposed framework is tested by a survey conducted with the experts working in the supply chain field in different business sectors to investigate: the level of awareness on how digital supply chain technologies can be applied to unlock hidden value in supply chain, the triggers of supply chain digital transformation and expected benefits, the level of readiness and implementation requirements facilitating the successful digital supply chain transformation. The survey template is illustrated in Appendix 1. According to this survey, questions are classified in four main categories:

- Demographic questions (Questions from 1 to 5)

The questions are used to visualize the respondents who fill out the survey as (Name, Company, Position, Region, and Job function).

- Level of awareness (Questions 6, 7, 8, 11, 12, 15 and 16)

Respondents are asked about the vision of their organizations towards the digital supply chain transformation and the maturity and aim of this vision. In addition, factors that are limiting digital supply chain agenda at the execution level and limiting employees' ability to capture value from utilizing digital opportunities in the supply chain are identified.

- Expected benefits and impact on performance metrics (Questions 9, 13, 14 and 18)

Respondents are asked about: triggers that push organization towards supply chain digital transformation, expected benefits, and activities that can be benefited from supply chain digital transformation.

- Level of readiness and implementation requirements (Questions 10, 17, and from 19 to 29)

The level of readiness is investigated in terms of the level of globalization, degree of vertical integration and competitive industry level. Implementation requirements are investigated based on the most essential requirements extracted from literature (supply chain

operating and governance model, integrated execution, integrated supply chain performance measurement, and supply chain technology architecture and infrastructure)

## **4- Survey Results**

Online survey software “Google Form” was used to conduct the survey. Google Form tool can be entirely customized and provides real-time responses. The survey is conducted on a random sample of 55 experts occupying managerial positions in the supply chain field in different business sectors (manufacturing activities, supply chain management and purchasing activities, customer service, transportation, demand planning, and inventory and warehousing management). Most respondents work in Africa and the MENA region, while the rest work in Asia and other regions. The following subsections illustrate the results:

### **4-1 Level of Awareness**

The majority of respondents (62%) confirm that their organizations have a clear vision of the digital supply chain. The survey declares that organizations’ digital supply chain vision tackles different objectives. Twenty per cent of respondents show that connectivity-led (using technology to create a more end-to-end connected supply chain) is the main objective of a digital supply chain vision. Eighteen per cent of respondents show that performance-led (using technology to drive performance and reduce cost) is the main objective of a digital supply chain vision. Nine per cent of respondents show that agility-led (designing a customer-driven supply chain that is agile and responsive) is the main objective of a digital supply chain vision. While the majority of respondents (53%) believe that a digital supply chain vision should serve all of the above objectives (connectivity-led, performance-led and agility-led).

### **4-2 Expected Benefits and Impact on Performance Metrics**

The respondents are asked about the most likely benefits of applying digital technologies or capabilities to the supply chain, 63.6% of respondents consider cost reduction as the most expected benefit from supply chain digital transformation. The majority of respondents

believe that the adoption of digital supply chain solutions in their organizations can lead to cost reduction over the coming 1-3 years. Thirty-one per cent of respondents expect cost reduction of more than 15%, while 57% of respondents expect cost reduction within the range 15% to 5%.

#### **4-3 Level of Readiness and Implementation Requirements**

Twenty-nine per cent of the respondents argue that leadership drives the shift toward digital or advanced supply chain capabilities, 21% believe that a business unit should drive the shift toward digital or advanced supply chain capabilities, 4% answer Ad-Hoc/experimental, and only 2% answer IT, however most respondents (57%) confirm that all of these elements should be considered to achieve governance.

Fifty-four per cent of respondents strongly agree or agree that their organizations are planning for a supply chain integration project.

The survey reveals that 79% of the respondents strongly agree or agree that their organizations are taking a closer look into internal alignment committees and procedures, service level agreements, and transfer pricing schemes. Fifty-two per cent of respondents believe that their organizations are at the developing or intermediate level of horizontal-value chain integration, while 14% have reached the advanced level. Twenty per cent of respondents cannot evaluate the level of horizontal – value chain integration in their organization and only 14% of respondents believe that their organizations still have a basic level of horizontal- value chain integration.

The majority of respondents (80%) strongly agree or agree that their organizations' trading partners share proprietary information with their organization. Fifty-eight per cent of respondents believe that their organizations are at developing or intermediate levels of vertical – value chain integration, while 13% have reached advanced levels. Sixteen per cent of respondents cannot evaluate the level of vertical – value chain integration in their organization and only 9% of respondents believe that their organizations still have a basic level of vertical – value chain integration.

The majority of respondents (68%) strongly agrees or agrees that their organizations have continuous improvement programs that include its key suppliers. The survey reveals that 77% of respondents strongly agree or agree that their organization helps its suppliers to improve their product quality and it actively involves its key suppliers in new product development processes.

Although the survey reveals that the majority of organizations have the potential level of governance and integration as key requirements towards digital supply chain transformation, they cannot still capture the digital supply chain transformation at the execution level. The majority of respondents (84%) strongly agrees or agrees that resilience is a top priority, which most executives associate with flexibility, agility, and visibility, however the level of readiness towards digital supply chain transformation is still not mature.

Twenty-nine per cent of respondents believe that their organizations still have a limited or basic maturity level towards implementing digital supply chain solutions, while 36% believe that their organizations are starting to develop their maturity level towards implementing digital supply chain solutions. Twenty-three per cent are at the intermediate stage, while only 13% are at the advanced level.

Fifty-two per cent of respondents declare that their organizations are still in the basic or developing phases to achieve the proper planning for transformation to a digital supply chain, while only 20% believe that their organizations are in an advanced stage.

Forty-two per cent of respondents rate their organizations at basic or developing stage in choosing the right technology partners, while 27% rate their organizations at an intermediate stage and only 22% rate their organizations at an advanced stage.

The majority of respondents (46%) expect that the level of investment in digital supply chain projects in their organizations over the next 12 months will not exceed 5% of revenue, while (38%) cannot expect the level of investment in digital supply chain projects over the next 12 months. Only 16% expects to achieve more than 5% of revenue.

The survey results confirmed the research proposition. Based on the above responses, “level of awareness, expected benefits, impact on performance metrics, implementation requirements, and level of readiness can drive and facilitate digital supply chain transformation”. Based on survey responses, table 2 extracts supply chain digital transformation elements (illustrated in table 1) at execution level.

**Table 2: SC digital transformation elements at execution level**

Level of awareness	<ul style="list-style-type: none"> <li>- (62%) of respondents confirm that their organizations have a clear vision of the digital supply chain</li> <li>- The aim of the digital supply chain vision: connectivity-led, performance-led and agility-led</li> </ul>
Expected benefits	<ul style="list-style-type: none"> <li>- Agility</li> <li>- Enhancing customer service</li> <li>- Enhancing risk management capabilities</li> <li>- Achieving top line growth</li> <li>- Compliance and control</li> <li>- Enhancing visibility and transparency</li> <li>- People and capability development</li> <li>- Enhancing safety and</li> <li>- Accelerating the pace of innovation and time to market.</li> </ul>
Impact on performance metrics	<ul style="list-style-type: none"> <li>- Cost reduction</li> <li>- Performance improvements</li> </ul>
Implementation requirements	<ul style="list-style-type: none"> <li>- Governance</li> <li>- Integration</li> </ul>
Level of readiness	<ul style="list-style-type: none"> <li>- The level of resilience</li> <li>- The degree of vertical and horizontal integration</li> <li>- Choosing the proper digital supply chain solutions</li> <li>- Level of investment in digital supply chain projects</li> </ul>

Source: Conducted by the author

## 5- Survey Findings

This section illustrates research findings to answer research questions, upon which the research will be concluded in the next section.

1. To what extent do the organizations have the required level of awareness to adopt digital supply chain transformation?

It has been found that majority of business sector has a clear vision of the digital supply chain, however organizations' digital supply chain vision tackles different objectives. The main trigger to consider digital supply chain transformation as an essential step is the cost reduction. Adopting new commercial or business models is placed as the second trigger towards digital supply chain transformation. Rapid advancements in technology and access to its applications come as the third reason to consider digital supply chain transformation. While buyer or customer behavior and preferences is considered as the fourth reason pushing organizations to adopt digital supply chain transformation, followed by quality and fear of being left behind by competitors. In addition to other reasons that might push the organizations to plan for digital supply chain transformation, such as the need to retain and develop talent, regulatory changes in the industry and requirements from suppliers or trading partners.

2. What are the main benefits expected by organizations from supply chain digital transformation?

Cost reduction and performance improvements (e.g. throughput, improvements in product quality) can be the most important benefits achieved from digital supply chain transformation. In addition, other expected benefits from digital supply chain transformation can be accomplished: adopting agile and dynamic operating models, enhancing customer focus and customer service, enhancing risk management capabilities, achieving top line growth through new customer propositions, compliance and control, enhancing visibility and transparency, people and capability development, enhancing safety and accelerating the pace of innovation and time to market.

Various supply chain activities expect benefits from digital supply chain transformation. Logistics and fulfilment activities can get the greatest benefit of digital supply chain transformation, followed by sourcing, procurement and demand forecasting. Warehousing is identified at the third rank among supply chain activities that can be positively impacted by digital supply chain transformation. Also other supply chain activities are expected to benefit from digital supply chain transformation: customer service and quality activities,

people/capability development, end-to-end network and commercial applications (price, promotion and profitability management, manufacturing, new product development and maintenance, and repair and operations (MRO).

3. To what extent do the organizations have the level of readiness and implementation requirements facilitating the successful digital supply chain transformation?

The level of governance and integration have been found as key requirements towards digital supply chain transformation. The study reveals that the majority of organizations are aware of the importance of governance and work on developing the integration capabilities among different business processes within the organization and between the organization and its partners in the extended supply chain.

4. What are the main obstacles facing such transformation?

Cost has been identified as the main factor that are limiting an organization's digital supply chain agenda at the execution level, while the lack of a clear methodology for digital supply chain initiatives is ranked as the second obstacle. Partners are defined as the third factor since they might limit the ability to make system-wide changes and improvements. Other obstacles also have been reported such as ambiguity around business strategy and firm performance, cyber security risks/threats, internal skills and capabilities, legacy systems, the inability to agree on a business case and past failures in capturing value from technology in general.

## **6- Conclusion**

The digital economy is changing industries drastically, and it is driven by consumer requirements and behavior. The business processes and strategies of companies must be able to sustain this growth, estimated at trillions of dollars. The implementation of these technologies will be accompanied by a new environment where people work with machines, which requires the consideration of legal aspects, liabilities, insurance and ethics.

A survey conducted with the experts working in the supply chain field in different business sectors to assess the level of awareness, expected

benefits and level of readiness that organizations have for supply chain digital transformation. The survey declares that the majority of organizations have a clear vision of the digital supply chain with the aim to improve connectivity, performance and agility level. The survey reveals that the majority of organizations are aware of the importance of governance and work on developing the integration capabilities vertically and horizontally.

The survey confirms expected performance improvement from digital supply chain transformation, particularly cost reduction, level of agility, time, customer service, risk management, development and innovation. Different supply chain activities can be impacted positively from digital supply chain transformation (demand forecasting, sourcing and procurement, manufacturing, logistics and fulfilment, customer service and quality, new product development and maintenance)

The survey identifies cost and lack of a clear methodology for digital supply chain initiatives as main factors that are limiting organization's digital supply chain agenda at the execution level. The level of readiness towards implementing digital supply chain solutions is still not mature. The majority of organizations are still in the basic or developing phases to achieve the proper planning for transformation to a digital supply chain and choosing the right technology partners, in addition the level of investment in digital supply chain projects is still limited.

This paper proposes a framework capturing the main drivers enabling digital supply chain transformation in the business sector. The paper conducts an empirical study to assess the current status in organizations and obstacles towards digital supply chain transformation. Further research can provide a road map to deal with the main factors identified in this paper which are limiting an organization's digital supply chain agenda at the execution level. Empirical studies can be conducted to measure the benefits of supply chain digital transformation based on the performance measures and metrics identified in this paper.

### **Acknowledgement**

The researcher would like to thank Miss Dina ElWakkad for her great effort to help in distributing survey and gathering responses.

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## Appendices

### Appendix 1

1. Name	----
2. Company	----
3. Position	<ul style="list-style-type: none"> <li>- Leadership (CXO, VP)</li> <li>- Sr. Management (director/ sr. manager)</li> <li>- Mid Management (manager/ asst. manager)</li> <li>- Team leader</li> <li>- Junior team member</li> </ul>
4. Region	<ul style="list-style-type: none"> <li>- Europe</li> <li>- North America</li> <li>- Asia</li> <li>- Africa</li> <li>- MENA</li> <li>- Global</li> </ul>
5. Your job function focuses on	<ul style="list-style-type: none"> <li>- Supply chain Management</li> <li>- Purchasing</li> <li>- Manufacturing</li> <li>- Inventory management</li> <li>- Demand planning</li> <li>- Warehousing</li> <li>- Transportation</li> <li>- Customer service</li> </ul>
6. Your organization has a clear vision of the digital supply chain	<ul style="list-style-type: none"> <li>- Strongly agree</li> <li>- Agree</li> <li>- Neutral</li> <li>- Disagree</li> <li>- Strongly disagree</li> </ul>
7. What is, or most likely will be, the aim of your digital supply chain vision?	<ul style="list-style-type: none"> <li>- Performance-led (adopting digital to drive performance and reduce cost)</li> <li>- Connectivity-led (using technology to create a more end-to-end, connected supply chain)</li> <li>- Agility-led (designing a customer-driven supply chain that is agile and responsive)</li> <li>- All of the above</li> </ul>
8. How would you rate the maturity of your digital supply chain vision?	<ul style="list-style-type: none"> <li>- Basic (business ambitions are understood, but not supported by a</li> </ul>

	<p>well-rounded digital supply chain strategy)</p> <ul style="list-style-type: none"> <li>- Developing (a strategy is emerging, and initiatives are being aligned to agreed business outcomes)</li> <li>- Intermediate (strategy has largely been developed and is now being refined to deliver specific target business outcomes)</li> <li>- Advanced (a well-defined strategy is in place, aligned to business goals and being executed)</li> </ul>
<p>9. What is driving the shift toward digital or advanced supply chain capabilities? [Select all that apply]</p>	<ul style="list-style-type: none"> <li>- Cost reduction</li> <li>- Regulatory changes in the industry</li> <li>- Buyer or customer behavior and preferences</li> <li>- New commercial or business models</li> <li>- Rapid advancements in technology and access to these</li> <li>- requirements from suppliers or trading partners</li> <li>- The need to retain and develop talent</li> <li>- Fear of being left behind by competitors</li> <li>- Quality</li> <li>- Others</li> </ul>
<p>10. Who is driving the shift toward digital or advanced supply chain capabilities? [Select all that apply]</p>	<ul style="list-style-type: none"> <li>- Leadership</li> <li>- Business units</li> <li>- Ad-Hoc / Experimental</li> <li>- All of the above</li> <li>- Other</li> </ul>
<p>11. Which factors (if any) are limiting your organization's digital supply chain agenda at the executive level? [Select all that apply]</p>	<ul style="list-style-type: none"> <li>- Lack of top-level sponsorship for digital supply chain initiatives</li> <li>- Ambiguity around business strategy and firm performance</li> <li>- Culturally our organization has always been slow to adopt new technology</li> <li>- Our internal skills and capabilities are limiting progress</li> <li>- The value from digital supply chain is unclear</li> <li>- Perceived cyber security risks/threats</li> <li>- Legacy systems too complicated and numerous to unravel</li> </ul>

	<ul style="list-style-type: none"> <li>- Lack of clear ownership</li> <li>- Other pressing issues concerning the day-to-day operations take precedence</li> <li>- Other</li> </ul>
<p>12. How would you rate your organization's understanding of how digital capabilities can be applied to unlock hidden value in your supply chain?</p>	<ul style="list-style-type: none"> <li>- Basic - limited knowledge of value levers or associated digital technologies or capabilities that can be used to drive value</li> <li>- Developing - early start into exploring opportunities arising from digital technologies or capabilities</li> <li>- Intermediate - good understanding of where the biggest opportunities are, but unsure about how to select the right technologies or capabilities to deliver business value</li> <li>- Advanced - strong capability in identifying opportunity areas and applying the right technology or automation to capture lasting value for the business</li> <li>- Don't Know</li> </ul>
<p>13. Which areas of the supply chain will see the greatest benefit from digital? [Select up to three options]</p>	<ul style="list-style-type: none"> <li>- Sourcing and procurement</li> <li>- Demand forecasting/planning</li> <li>- Commercial applications (price, promotion and profitability management)</li> <li>- Customer service</li> <li>- Warehousing</li> <li>- Manufacturing</li> <li>- Logistics and fulfilment</li> <li>- New product development</li> <li>- Maintenance, repair and operations (MRO)</li> <li>- End-to-end network</li> <li>- Quality</li> <li>- People/capability development</li> <li>- Other</li> </ul>
<p>14. What are the most likely benefits of applying digital technologies or capabilities to your supply chain? [Select up to three options]</p>	<ul style="list-style-type: none"> <li>- Performance improvements, e.g. throughput, improvements in product quality</li> <li>- Cost reduction</li> <li>- Enhanced customer focus and customer service</li> </ul>

	<ul style="list-style-type: none"> <li>- Enhanced safety</li> <li>- Top line growth through new customer propositions</li> <li>- Accelerated pace of innovation and time to market</li> <li>- Agile and dynamic operating models</li> <li>- People and capability development</li> <li>- Enhanced risk management capabilities</li> <li>- Compliance and control</li> <li>- Enhanced visibility and transparency</li> <li>- Other</li> </ul>
<p>15. What factors are limiting your organization's ability to capture value from existing digital opportunities in the supply chain? [Select all that apply]</p>	<ul style="list-style-type: none"> <li>- No clear methodology exists</li> <li>- Ambiguity around specific technologies and capabilities</li> <li>- Past failures in capturing value from technology in general</li> <li>- Cost</li> <li>- Other more pressing issues prevent meaningful developments</li> <li>- Unable to agree on a business case</li> <li>- Supply chain does not get the funding it needs to modernize legacy processes</li> <li>- Leadership is divided on key issues that affect our supply chain</li> <li>- We do not have the right skills and knowledge</li> <li>- Our partners limit our ability to make system wide changes and improvements</li> <li>- Other</li> </ul>
<p>16. Please select the level of awareness and understanding of digital supply chain technologies within your organization</p>	<ul style="list-style-type: none"> <li>- Limited - (or no understanding of digital supply chain)</li> <li>- Basic-knowledge of digital supply chain technologies</li> <li>- Developing - knowledge of a growing number of digital supply chain technologies</li> <li>- Intermediate - good knowledge of a selection of the latest digital supply chain technologies</li> <li>- Advanced - comprehensive knowledge of the latest cutting-edge digital supply chain technologies</li> </ul>
<p>17. Which statement best describes your organization's maturity towards</p>	<ul style="list-style-type: none"> <li>- Limited - do not have an approach to</li> </ul>

<p>implementing digital supply chain solutions?</p>	<p>deliver digital solutions</p> <ul style="list-style-type: none"> <li>- Basic - the approach is ad-hoc and based around technology modernization or improving legacy systems</li> <li>- Developing - we use a traditional approach i.e. vendor selection followed by project delivery - limited technology piloting</li> <li>- Intermediate - our delivery approach is focused on incremental development i.e. piloting use cases, assessing feasibility and then scaling the capability</li> <li>- Advanced - we actively scan the market for capability and look to adopt tested solutions whilst actively piloting innovative use cases internally and within our partner network</li> </ul>
<p>18. How much value do you expect to be delivered through the adoption of digital supply chain solutions over the coming 1-3 years?</p>	<ul style="list-style-type: none"> <li>- (0-5%) reduction in operational cost baseline</li> <li>- (5-10%) reduction in operational cost baseline</li> <li>- (10-15%) reduction in operational cost baseline</li> <li>- (15%+) reduction in operational cost baseline</li> </ul>
<p>19. What level of investment in digital supply chain projects is expected over the next 12 months?</p>	<ul style="list-style-type: none"> <li>- Don't know</li> <li>- 0% of revenue</li> <li>- 1-2% of revenue</li> <li>- 2-5% of revenue</li> <li>- 5%+ of revenue</li> </ul>
<p>20. To what extent your company expects to double its level of vertical – value chain integration</p>	<ul style="list-style-type: none"> <li>- Basic</li> <li>- Developing</li> <li>- Intermediate</li> <li>- Advanced</li> <li>- Don't Know</li> </ul>
<p>21. To what extent your company expects to double the level of horizontal – value chain integration</p>	<ul style="list-style-type: none"> <li>- Basic</li> <li>- Developing</li> <li>- Intermediate</li> <li>- Advanced</li> <li>- Don't know</li> </ul>
<p>22. Your organization helps its suppliers to improve their product quality and it actively involves its key suppliers in new product development processes</p>	<ul style="list-style-type: none"> <li>- Strongly agree</li> <li>- Agree</li> <li>- Undecided</li> </ul>

	<ul style="list-style-type: none"> <li>- Disagree</li> <li>- Strongly disagree</li> </ul>
23.How would you rate your organization's choosing the right technology partner	<ul style="list-style-type: none"> <li>- Basic</li> <li>- Developing</li> <li>- Intermediate</li> <li>- Advanced</li> <li>- Don't know</li> </ul>
24.How would you rate your organization's achieving the proper planning for transformation to a digital supply chain	<ul style="list-style-type: none"> <li>- Basic</li> <li>- Developing</li> <li>- Intermediate</li> <li>- Advanced</li> <li>- Don't know</li> </ul>
25.Your company is planning a supply chain integration project soon	<ul style="list-style-type: none"> <li>- Strongly agree</li> <li>- Agree</li> <li>- Undecided</li> <li>- Disagree</li> <li>- Strongly disagree</li> </ul>
26.Your organization has continuous improvement programs that include its key suppliers	<ul style="list-style-type: none"> <li>- Strongly agree</li> <li>- Agree</li> <li>- Neutral</li> <li>- Disagree</li> <li>- Strongly disagree</li> </ul>
27.Your company takes a closer look into internal alignment committees and procedures, service level agreements, and transfer pricing schemes	<ul style="list-style-type: none"> <li>- Strongly agree</li> <li>- Agree</li> <li>- Undecided</li> <li>- Disagree</li> <li>- Strongly disagree</li> </ul>
28.Your organization's trading partners share proprietary information with your organization	<ul style="list-style-type: none"> <li>- Strongly agree</li> <li>- agree</li> <li>- neutral</li> <li>- disagree</li> <li>- strongly disagree</li> </ul>
29.Resilience is a top priority, which most executives associated with flexibility, agility, and visibility.	<ul style="list-style-type: none"> <li>- Strongly agree</li> <li>- Agree</li> <li>- Undecided</li> <li>- Disagree</li> <li>- Strongly disagree</li> </ul>

Source: Conducted by the author

## نحو التحول إلى سلسلة الإمداد الرقمية: دراسة تطبيقية

د. سارة حسن الجزار

### ملخص البحث باللغة العربية

يلعب التحول الرقمي دوراً مهماً في تقديم حلول لسلسلة الإمداد وتحفيز التنمية الاقتصادية. يهدف هذا البحث إلى التعرف على العناصر الرئيسية اللازمة لتحقيق التحول الرقمي لممارسات سلسلة الإمداد، مع إبراز المتطلبات والعقبات الرئيسية التي تواجه هذا التحول. يتناول البحث تأثير التحول الرقمي على تغيير خصائص سلسلة الإمداد من أجل تحديد المحددات الرئيسية للتحول الرقمي لسلسلة الإمداد. تم إجراء دراسة تطبيقية لتقييم مدى وعي الشركات ومستوى استعدادها لاعتماد التحول الرقمي لممارسات سلسلة الإمداد مع تحديد العقبات الرئيسية التي تواجه مثل هذا التحول بالشركات. أسفرت الدراسة الاستقصائية التي تم إجرائها بالشركات - لعدد خمسة وخمسون استقصاء - إلى أن التكلفة والافتقار إلى منهجية تعد عوامل رئيسية تحد من تحول المؤسسات إلى سلسلة الإمداد الرقمية وتطبيقاتها. تقدم الورقة البحثية خارطة طريق للتعامل مع العوامل الرئيسية التي تحد من تنفيذ تطبيقات التحول الرقمي لسلسلة الإمداد بالمؤسسات. حيث تقترح هذه الورقة إطاراً للمحددات الرئيسية التي يمكن أن تمكن من التحول الرقمي لسلسلة الإمداد في قطاع الأعمال.

الكلمات الدالة: سلسلة الإمداد، التحول الرقمي

### Suggested Citation according to APA Style

Elgazzar, S. H. (2021). Investigating Digital Supply Chain Transformation Drivers: An Empirical Study. *Journal of Alexandria University for Administrative Sciences, Faculty of Commerce, Alexandria University* 58(5), 139 – 170.