Digital supply chains: unlocking barriers to digital goal setting

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ABSTRACT

There is an urgency for digital supply chain adoption to create value and revenue streams, by leveraging innovative technologies in supply chain management. The uncertainty during the COVID-19 pandemic has further motivated the use of inter- and intra-organisational data to create agile and resilient supply chains. Implementing digital supply chains, however, is difficult and requires conceptual and strategic thinking. The subsequent lack of adoption can be assisted by insights on how to address digital supply chain challenges.

The objective of this research was to provide a practical framework for managers to consider in the adoption of the first step of a digital supply chain strategy, being the digital goal setting step. The qualitative research focused on barriers and enablers that are relevant to digital goal setting and digital supply chains. South African managers were interviewed with insights obtained from seven digital supply chain adopters and seven non-adopters. Further insights were obtained from an interview with a digital supply chain consultant.

A framework was developed that will be useful for managers to identify specific enabling initiatives to unlock barriers to digital goal setting or digital supply chains. Unique barrier and enabler themes for South African manufacturers were identified.

KEYWORDS

Digital supply chains, digital goal setting, supply chains

DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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ABBREVIATIONS

4IR	Fourth industrial revolution
B-BBEE	Broad-Based Black Economic Empowerment
CIO	Chief Information Officer
COVID-19	Coronavirus disease of 2019
DSC	Digital supply chain
DTIC	Department of Trade Industry and Competition
EDI	Electronic data exchange
ERP	Enterprise Resource Planning
GDP	Gross Domestic Product
IoS	Internet of Services
IoT	Internet of Things
IIoT	Industrial Internet of Things
I.T.	Information technology
MES	Management execution systems
RFID	Radio frequency identification
RQ	Research question
SCO	Supply chain orientation
SSCM	Sustainable supply chain management
VPN	Virtual Private Network
VUCA	Volatility, uncertainty, complexity and ambiguity

CHAPTER 1: INTRODUCTION

1.1. BACKGROUND AND CONTEXT

Oliver & Webber (1982:64) defined the term supply chains as an upstream or downstream network of organisations interconnected in various activities to deliver value to customers as a product or service. Supply chain management was defined to be a process of planning, implementing, and controlling supply chain operations to satisfy customer needs effectively (Oliver & Webber, 1982:64). It includes raw materials' movement and storage, inventory and finished goods from its origins to consumption. Even though the two terms of supply chains and supply chain management are often used interchangeably, Martins & Pato (2019: 996) cautioned that the two terms can be independent due to the fact that a supply chain can exist even when it is not managed. The need for resilient supply chain management is highlighted by Grzybowska & Tubis (2022: 1) in a modern business environment that is characterised by volatility, uncertainty, complexity and ambiguity (VUCA). The entrepreneurial challenges include the difficulty to predict on historical trends in such a volatile and unpredictable business environment that includes disruptors such as inflation, the Ukraine-Russian war, a COVID-19 overhang, loadshedding in South Africa and other forces that amplify supply chain disruptions. With the uncertain business environment that one operates in, how then do business leaders navigate through such volatility and still lead competitive and sustainable organisations? A study by Han et al. (2020: 22), in a systematic literature review on supply chain resilience, provided the metrics of readiness, response and recovery to assess the capability of resilient supply chains. This was to adapt to changes using data assessed throughout the supply chain. It is not a new concept, with Porter concurring with the importance of data and technology as a principal driver for competitive advantage (Porter, 1985: 36, 60).

More recently, Büyüközkan & Göçer (2018:157), and the many reviewed studies on Digital Supply Chains (DSCs) that are referenced in this work, are of the opinion that a supply chain transformation has been catalysed by advances in digital technology, brought about by a fundamental shift in how people communicate and collaborate. Smart device usage, instant communication and real-time information are all commonplace and used by people of all ages. This has advanced more rapidly than any innovation in history. The plethora of advanced technology in our

daily lives has changed the way that information is accessed and exchanged. This by evidenced by Büyüközkan & Göçer (2018: 158) reporting 76% of the globe with access to the internet and that 90% of the internet users making online purchases. 43% of businesses were reportedly using big data analytics. The statistics in the 2018 paper predict that in 2020, 37% of all data will be in cloud storage and that 26 billion internet-connected 'things' are to be connected. Furthermore, the analysis from Ivanov & Dolgui (2020: 2904) revealed that the transformation has been accelerated by the COVID-19 pandemic outbreak. Ye et al. (2022: 1) supported this argument in the business environment. These authors agree that globally, people have been forced to rapidly learn how to shop, school, work and meet remotely. Ye et al. (2022: 2-3) further postulated that businesses have also been forced to adapt to the disruptive changes, with supply chains severely affected. Schniederjans et al. (2019: 1) and Donthu & Gustafsson (2020: 284) agreed that changes in industry digitalisation have evolved from being a supply management trend to a necessity for business competitive advantage. This is encapsulated in the definition of a DSC by Büyüközkan & Göçer (2018: 157) as a value-driven and efficient process to create new types of revenue and value by leveraging innovative technologies such as autonomous vehicles, cloud computing, big data analytics and the internet of things in the management of supply chains.

1.2. RESEARCH CONCEPTS

What is known and not known about DSCs?

There are four key elements to the supply chain digitalisation framework, that is derived from the fourth industrial revolution (4IR) or Industry 4.0 technologies, such as big data analytics and additive manufacturing. Rüßmann et al. (2015: 2-5) accounts for these technologies in the nine pillars of 4IR which is supported by the enabling technologies of robotics, blockchains, sensors, internet of things (IoT), radio frequency identification (RFID) and cloud technology (Ivanov et al., 2018: 836-837). The work on DSC referenced in this study detailed the advances of enabling digital technologies and reported that the opportunities and benefits that the digital supply chain ushers are paramount. The advantages of DSCs from these authors were reported to include the improved speed of data and product delivery across the supply chain (Büyüközkan & Göçer, 2018: 160-161). There is improved flexibility in how companies react to supply chain problems (Borangiu *et al*., 2019: 160). Global connectivity has improved through formation of global hubs for

effective local supplies instead of sole orders made across the globe (Büyüközkan & Göçer, 2018: 165). Some companies have benefitted from real-time inventory management through warehouse and inventory monitoring with stakeholders (Srai et al., 2017: 14). There has been the use of smart digital systems that incorporate algorithms and machine-learning for better decision making (Kittipanya-ngam & Tan (2019: 159). Transparency in the value chain has also improved decision making and has demonstrated traceability of origins to show sustainable practices (Kealley et al., 2022: 354-357). Processes have been optimised and there has been removal of duplicated processes (Srai et al., 2017: 14-15) (Zangiacomi et al., 2019: 143-144). Data is now more available to feed innovation (Wong et al., 2019: 13). DSCs have also improved environmental practices (Yadav et al., 2020:2). Some of the challenges that were identified included a lack of a strategy, plan and tools for DSCs (Büyüközkan & Göçer, 2018: 168). It was reported that there is also often poor collaboration with external parties and that this could result in inaccurate data received or a reluctance to share information (Tripathi & Gupta, 2019: 4). There is also a deficiency with the needed capabilities for DSCs adoption, as well as technical limitations with suppliers which could limit digital integration (Jones et al., 2021: 938-939).

What is not widely known is that a digital strategy is difficult to implement (Jones et al., 2021: 938-939). Borangiu et al. (2019: 161) agreed with this view and further stated that end-to-end digital supply chains are challenging and require conceptual strategic thinking. It was also stated that there were many economic, social, policy, governance and technological hurdles in implementation of a digital strategy. As always, there is resistance to change with new technologies (Tripathi & Gupta, 2019: 1) (Mahmood et al., 2019: 245) (Raj et al., 2020: 8) (Stornelli et al., 2021: 15). It is for this reason that supply chain academics have identified research gaps such as frameworks needed to provide guidance on DSC adoption (Büyüközkan & Göçer, 2018: 158). Zangiacomi et al. (2019: 143) also recommended research into challenges and practices with DSC technology investments, transformation path and knowledge sharing.

1.3. RESEARCH PROBLEM

Digital advances have promulgated a supply chain transformation and recent publications agree that COVID-19 has accelerated the process (Ivanov & Dolgui, 2020: 2904) (Wong et al., 2019: 2) (Ye et al., 2022). Büyüközkan & Göçer (2018:

174) argued though that the abundance of information on supply chain digitalisation valorisation was overwhelming to a business decision-maker. Such information included successes and challenges upstream and downstream of the business, within a company's walls and from end-to-end of the supply chain. Büyüközkan & Göçer (2018: 161-163) concluded that there was no cutting-edge study on the topic of DSCs. The research gaps identified by Büyüközkan & Göçer (2018: 168) included roadmaps and guidance for the adoption of DSCs, a lack of tools to assist with problems relating to supply chain issues in a DSC environment, and a lack of insights on how to deal with DSC implementation from a managerial or technical perspective due to a lack of studies on addressing challenges faced. Wu et al. (2016: 17-18) also listed similar fundamental questions for future research, further elucidating that DSCs, although advantageous to businesses, are not fully understood. The research gaps from Wu et al. (2016: 17-18) included information needed to employ smart supply chains, economic value of applications, practical hurdles that inhibit collaboration in the supply chain, and finally in agreeance with Büyüközkan & Göçer (2018), what are the managerial challenges to implementing DSCs.

1.4. PURPOSE AND SIGNIFICANCE OF STUDY

The study is of academic significance as it contributes to the theory of DSCs by examining what are the barriers to implementing a DSC strategy and how firms with DSCs have overcome such challenges. The study further link enablers with barriers; the context to which are selected manufacturing companies in South Africa. The successes and challenges identified can be discussed in business schools within the broader discussion of lean supply chain management and within the context of innovation in business. The research is also of urgent practical benefit as it will help South African manufacturing companies experiencing supply chain challenges in a VUCA environment by addressing a common research gap identified by Büyüközkan & Göçer (2018: 168) and (Wu et al., 2016: 17-18) on getting started with a DSC strategy, establish a competitive edge and future-proof a business with sustainable practices. The research on barriers and enablers to a DSC journey specific to South African manufacturing is limited. This makes the research conducted relevant by adding to the body of South African manufacturing and supply chain knowledge, whilst assisting South African manufacturers that want to exploit the opportunities of DSCs.

The literature review in Chapter 2 will show that a DSC framework involves multiple stages and can be decomposed into several detailed focus areas. The research untaken examined only the challenges and successes associated with the first component (digital goal setting) of the first pillar of the DSC framework (Büyüközkan & Göçer (2018: 169-170). By focusing on digital goal setting in a digitalisation strategy, the intended value of the research is for executives and senior technical managers to understand what is required for them to begin their DSC journey, taking into account the South African manufacturing environment and related aspects. The DSC framework is shown in Figure 1 (adapted from Büyüközkan & Göçer, 2018: 169-170). It maps the key areas of digitalisation, technology implementation and supply chain management as the decomposed vital steps needed for successful DSC implementation. The digitalisation step initiates with a digitalisation strategy that includes digital goal setting, digital strategy formulation and digital formulation. The first step in the DSC journey therefore begins with digital goal setting, which is why it was chosen as the focal point for the research undertaken.

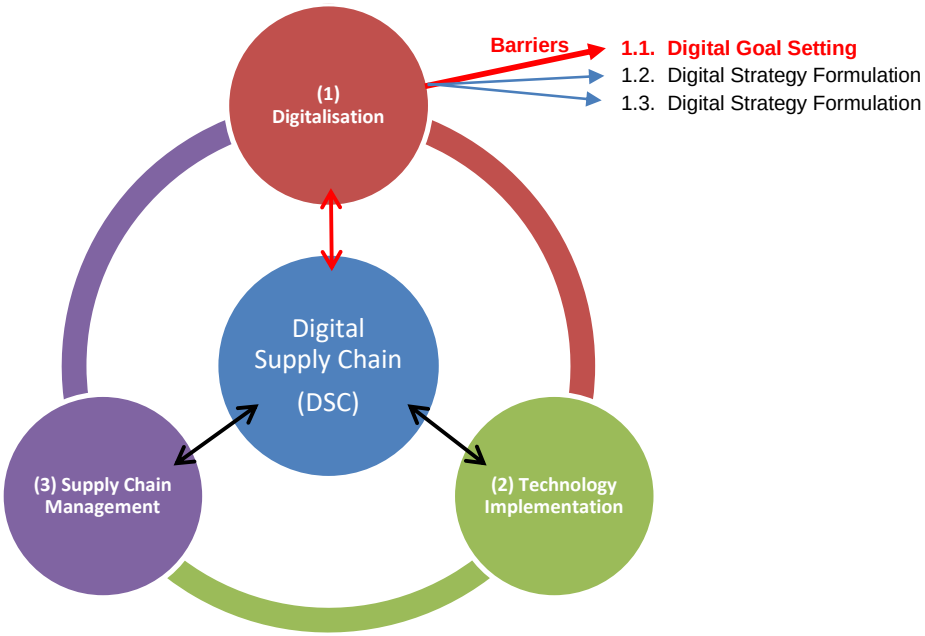


Figure 1. Research focus area: barriers to digital goal setting within a DSC framework (adapted from Büyüközkan & Göçer, 2018: 169-170)

The manufacturing sector was chosen due to the potential of the sector to improve on its contribution of 13% to the South African Gross Domestic Product (GDP) (Naudé & Szirmai, 2012: 47–48) (Statistics South Africa, 2021). Matthee (2021)

reported that the manufacturing sector in countries such as China and Taiwan contribute in excess of 30% to the GDP, which is substantially more than the South African manufacturing sector contribution to the GDP. For South Africa to compete with low-cost producers, strategies such as DSCs may prove advantageous. The literature review will show advances that progressive companies have taken with DSC initiatives to result in more resilient supply chains and sustainable business models. Another reason for the research is the opportunity that DSCs present to the South African sugar industry. It was known through experience in the industry that DSC initiatives were sparse. Lessons learnt from digitalisation of supply chains in other manufacturing sectors would therefore be of benefit to the South African sugar industry.

1.5. CONCLUSION

Literature reveals that the implementation of DSC strategies has progressed from a nascent potential to one that has already resulted in reduced wastage and improved competitiveness for businesses; however, several challenges appear to inhibit wide-scale DSC adoption. A key research gap is the lack of insights on how to deal with DSC implementation from a managerial or technical perspective due to a lack of studies on addressing the challenges faced. This research will be of significance for businesses and academia, as it contributes to the body of DSC knowledge by elucidating the barriers and demonstrating successes on overcoming barriers at the very start of the DSC journey, being the digital goal setting task for the formulation and implementation of the DSC strategy. The research is of particular interest to the author as a manufacturer in an industrial sector that is thought to be data-rich but information poor, in that pockets of extensive data is observed to be resident in inbound, outbound and within the factory operations. This data is not being used to fully benefit the customer and other stakeholders or streamline or future-proof end-to-end operations, inbound, outbound or the manufacturing organisation.

CHAPTER 2: LITERATURE REVIEW

2.1. INTRODUCTION

In this chapter, a review was conducted on the latest literature relevant to supply chains and DSCs. A narrative is established by first examining the evolution of supply chains and then pointing to DSCs as a protagonist in addressing supply chain challenges in a VUCA business environment. This is established by reviewing contributions to the body of knowledge on DSCs and then critiquing these publications in consideration of other academic researchers and industrial accounts of the successes and challenges with DSCs. The constructs used in the review were digital supply chains, digital goal setting and barriers to strategic goal setting. The underlying theme emerging from the review was that although many manufacturing companies benefit from DSCs, most companies have either partially adopted DSCs or not at all due to several barriers faced. The topic of DSCs was found to still be emerging, but it was noted that the number of publications has increased in the last five years. Within this period there were notable increases in publications due to the COVID-19 pandemic and the emergence of blockchain technologies, respectively. The majority of the publications focus on the enabling technologies of a DSC rather than DSC strategies. A limitation of the literature review is that many of the late 2022 and 2023 publications, both in a post-COVID era, are still not accessible in the public domain. The literature review structure is given in Figure 2 showing the link between supply chain management challenges and how DSCs may address these challenges, as well as the relevance of the constructs to the area of supply chains. Both major sections explored, supply chains and DSCs, follow the lower to higher order thinking of Bloom's taxonomy (Wilson, 2016: 4). This is by providing a brief description of each section to recall facts and understand the material and context. The accounts then progress to an analysis and evaluation of the literature to demonstrate the need and urgency of the research undertaken. Publications are compared and contrasted for relevancy and applicability to DSCs.

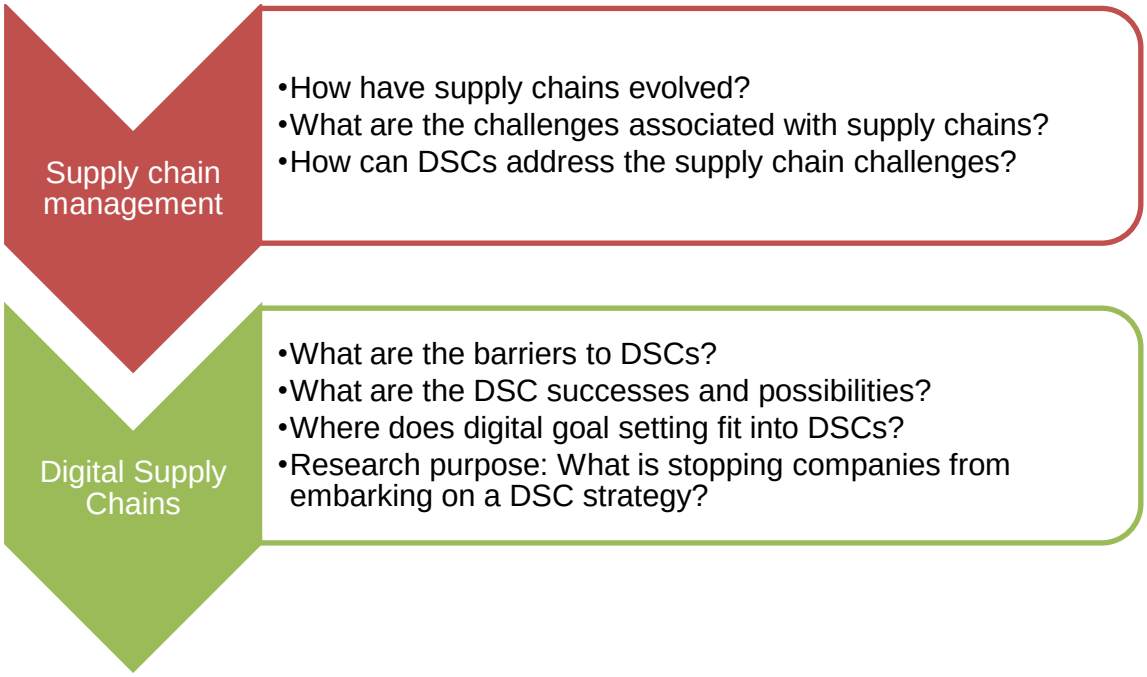


Figure 2. Literature review structure

2.2. SUPPLY CHAIN MANAGEMENT

2.2.1. The evolution of supply chain management

Oliver & Webber (1982: 64) postulated a supply chain model that is focused on customer satisfaction. This is through a network of organisations that is connected in various activities to deliver a product or service to customers. Porter (1985: 36-48) focused instead on value chains and value addition for competitive advantage, reduced costs and improved profits. Value chains serve as a system of primary activities. It includes inbound logistics, operations, outbound logistics, marketing and sales, and service. Other activities supported are procurements, human resource management, technological development and infrastructure. The integrated management of this entire system was purported to yield a cost and/or a differentiation advantage (when a business delivers benefits which exceed those of competitors). Porter (1985: 60) further identified rapid changes in technology as a principal driver for competitive advantage.

Mehmeti (2016: 6) concluded that the management of supply chains and value chains have merged due to increased global competition. It was also positioned that Oliver & Webber's definition of supply chain (1982: 64) has evolved to one that focuses on cost reduction and improved efficiencies of the individual companies within the supply chain, as well as across the entire supply chain. Mehmeti (2016:

6) stated that the enabling factors to the evolution included the implementation of information technology systems and the emergence of trade liberalisation policies for a move to globalisation. The latter also facilitated an increase in the number of multinational manufacturing companies. There was additionally a change in customer needs leading to more focus on customer satisfaction. Daud & Zailani (2011: 2) supported Mehmeti's findings and reported on the evolution in the 1990s of supply chain co-evolution to enable partnering. A further evolution to lean supply management is reported from 2000, with a focus on e-business (electronic business), e-marketing and supply chain management synchronisation to enable networked business channels and agility with exchanges. Liker (2020: 377-382) reported similar practices at Toyota in their 14 lean supply management principles to eliminate waste in a production facility and through the supply chain. Liker & Meier (2006: 1-25) study of Toyota attributed its success to the manufacturer developing it suppliers and partners and seeing them as enterprise extensions rather than as separate entities. This investment in supply chain partners has helped Toyota to develop sustainable long-term relationships and be more globally competitive.

Stevens & Johnson (2016: 9) illustrated the supply chain evolution in Figure 3 and showed the progression to a digitally lead phase. The phase demonstrated the value of data and information for profit and growth by improving process flow and reducing waste. This created agile and resilient businesses, value networks and value clusters. Whilst the authors do not mention DSCs in their work, they posit that supply chain integration is the foundation of supply chain management and that it is underpinned by the characteristics of "joined up thinking, working and decision making" (Stevens & Johnson, 2016: 7). In this regard, it is taken to be similar to DSCs, as the authors mentioned that supply chain integration is enabled by technology and systems. The integration of relationships across the business, customers and suppliers was necessary for operational and strategic integration. Stevens & Johnson (2016) studied the emergence of green supply chain management. Rajeev et al., (2017: 309) also reported on not just the economical lens on supply chain evolution. The environmental and additionally the social factors were reviewed. This lead to the evolution of a sustainable supply chain. Farooque et al. (2019 : 5) found that the environmental and social factors are encompassed in circular economies and its link to sustainability is the reason why there is growing enthusiasm for circular economies in supply chains. de Angelis et

al. (2018: 4) give a European Commission definition of circular economies to be '*In a circular economy the value of products and materials is maintained for as long as possible; waste and resource use are minimised, and resources are kept within the economy when a product has reached the end of its life, to be used again and again to create further value'* (European Commission, 2015).

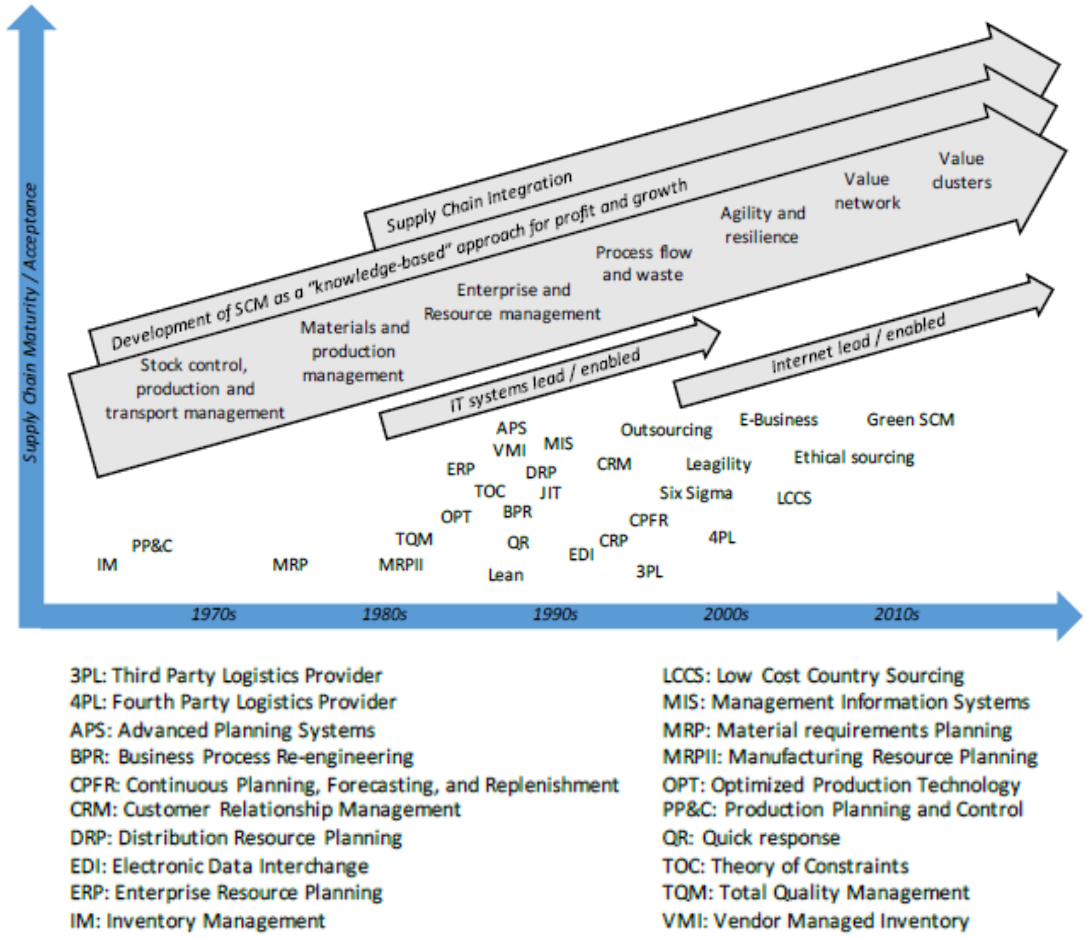


Figure 3.The evolution of supply chain management strategies with associated tools and techniques (Stevens & Johnson, 2016:9)

Through the evolution of supply chains, Min et al. (2019: 49) maintained that the core principles of supply chain management are still intact. It still strategically involved interorganisational collaboration with the purpose of creating customer value. Of direct relevance to DSC strategy is that Supply Chain Orientation (SCO) is still needed for successfully implementing supply chain management; SCO is defined as a recognition by the business of the systemic and strategic nature of the tactical and strategic activities in the management of supply chain flows – a precursor to supply chain management (Min et al., 2019: 45-46).

2.2.2. Challenges associated with supply chain management

Rajah et al. (2018: 4) listed five challenges in the management of supply chains. Firstly, there is a lack of strategic insights and subsequent action taken due to the bullwhip effect, that is when even minor fluctuations in customer demand can cause substantial fluctuations in the downstream supply chain. The second challenge dealt with a business redesign to improve the effectiveness of the supply chain. There were choices of business process re-engineering to improve procedures within and across associations. Mehmeti (2016: 5) reinforced the need to improve supply chain efficiencies and reduce costs as drivers for supply chain evolution. Another driver for evolution was the increase in global competition. Rajah et al. (2018: 4) presented this as the third identified supply chain challenge in dealing with suppliers from different environments and markets. The fourth challenge was on the lack of standardised performance management across the supply chain. Rajah et al. (2018: 4) suggested that Key Performance Indicators and Balanced Scorecards could be introduced for performance management. The fifth challenge advocated for advancement with information systems in supply chains to gain a competitive advantage. This confirmed the validity of Porter's statement (1985: 60) that a principal driver for competitive advantage is changes in technology. Rajah et al. (2018: 4) proposed that e-business frameworks are needed for the advancement with supply chains. Barriers between the use of information technology systems and conventional process performance systems needed to be overcome. Manavalan & Jayakrishna (2019: 926) supported Rajah et al. (2018: 4) and added global competition to the list of key challenges in the supply chain due to globalisation policies erasing many market boundaries.

Paul et al. (2021:2) re-examined supply chain management challenges emerging from the COVID-19 pandemic and confirmed the validity of the bullwhip effect in supply chain disruptions (Rajah et al., 2018: 4). Furthermore, resource allocation for priority investments was identified as a major constraint, especially with small-to-medium sized businesses in an economically constrained environment. The disruptions also affected consumer buying power and socio-economic conditions. The default operation for businesses was to cater to order backlogs. Still, in doing so, recovery strategies were often not formulated and implemented, with competitive advantage opportunities as a first mover lost. Other more practical challenges included the insolvency of business partners; rebuilding of supply chain

networks; lack of preparedness for recovery; and the global economic recession leading to reduced demand or inconsistency with supply for steady production.

To address these challenges, Paul et al. (2021:2) suggested that managers re-imagine their value chains and that a data-driven supply chain approach be used in order to facilitate the recovery process. This is the basis on which all DSC authors reviewed promote (Büyüközkan & Göçer, 2018) (Jones *et al*., 2021) (Stornelli *et al*., 2021). Paul et al. (2021:2) suggested the data-driven approach to mitigate the shortage of financial and physical resources, help predict disruption, and select which digital technologies to implement to improve operational excellence. A summary of the challenges from Rajah et al. (2018: 4), Manavalan & Jayakrishna (2019: 926) and Paul et al. (2021: 2) is given in Figure 4.

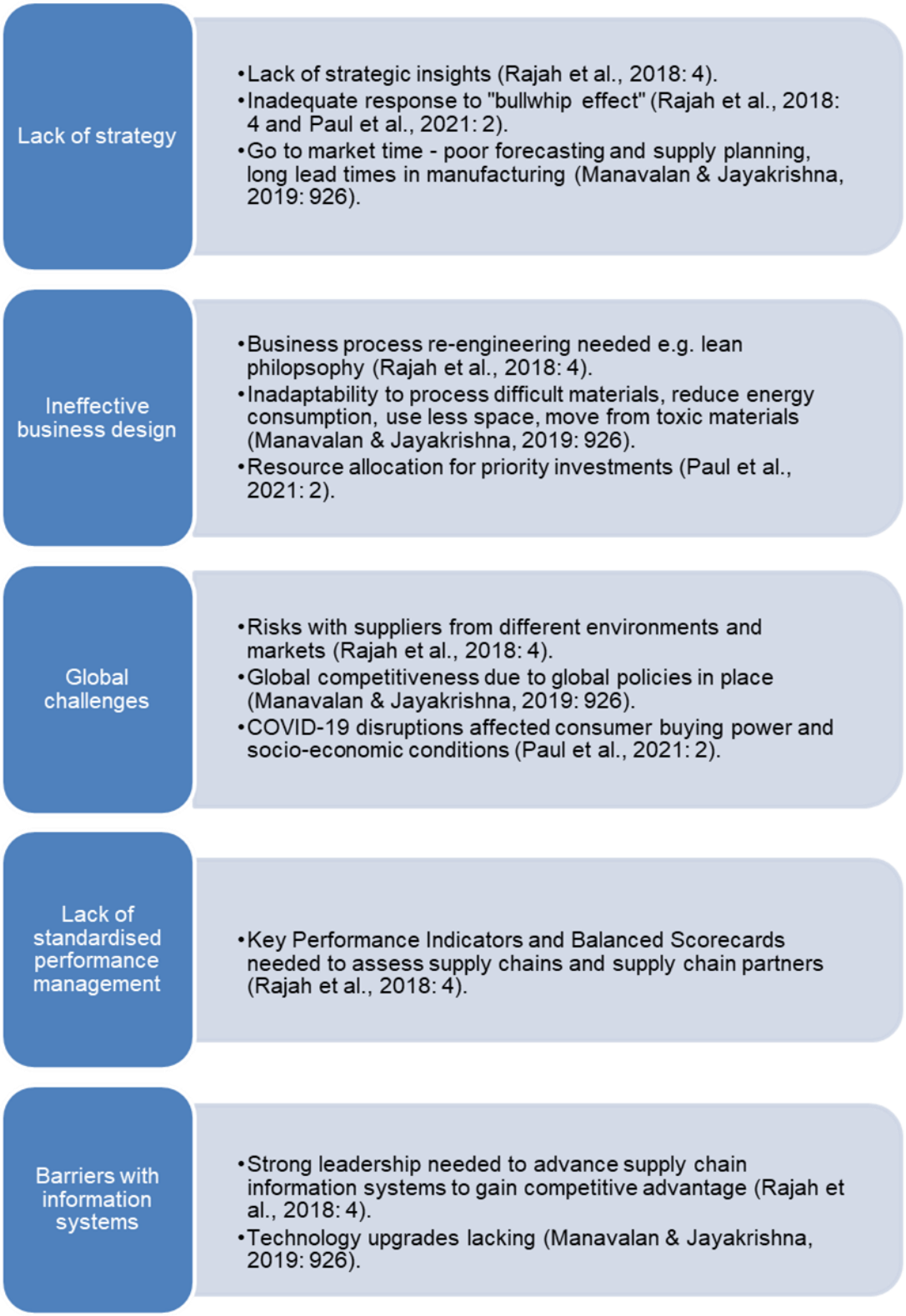


Figure 4. Summary of supply chain challenges from Rajah et al. (2018: 4), Manavalan & Jayakrishna (2019: 926) and Paul et al. (2021: 2)

2.2.3. The evolution to integration with digital supply chains

Mehmeti (2016: 6) identified factors that have led to the evolution of supply chains. These include a company's increased focus on customer needs; the concentration of the sector of manufacturing and the amalgamation into multi-national companies; the need to reduce costs and improve efficiencies; and centralisation and concentrating retail.

Another contributor to supply chain evolution was given Stevens & Johnson (2016: 9) to be the increased usage of Electronic Data Interchange (EDI) systems. These and Enterprise Resource Planning (ERP) systems evolved supply chains due to the proliferation of data availability within an organisation but also in connection with its stakeholders. Srai et al. (2017: 5) showed that this interconnectivity resulted in a transformation of supply chains to link upstream and downstream operations for improved integration, transparency and productivity. Stevens & Johnson (2016: 9) also concur that these data systems have evolved supply chains to a phase of integration. The interconnectivity of data in the evolution of supply chains can be seen in Figure 5 (Stevens & Johnson, 2016: 17).

Furthermore, Figure 5 shows a progression to a collaborative integration model where information, knowledge and intelligence are shared in clusters. The clusters emerge to reduce large coordination costs in companies with large networks. The coordination is outsourced to lead suppliers in the clusters. An example of this is the Zara business model that operates with localised collaborative clusters (Stevens & Johnson, 2016: 17). It was reported that such models are likely in industries with simple services or products, for example Silicon Valley. Such is the criticality of adopting agile and resilient supply chains, that Schreckling & Steiger (2016: 5) encouraged digital transformation in a publication entitled "digitise or drown". The applicability of this view was shared by Gaffley & Pelser (2021: 1) in reference to South African manufacturing leaders. The digital transformation process of South African businesses was classified as being vital to remain competitive. This was especially so in a South African environment with unprecedented change in the economy and society, supporting the idea of VUCA disruptions in the country (Grzybowska & Tubis, 2022: 1)..

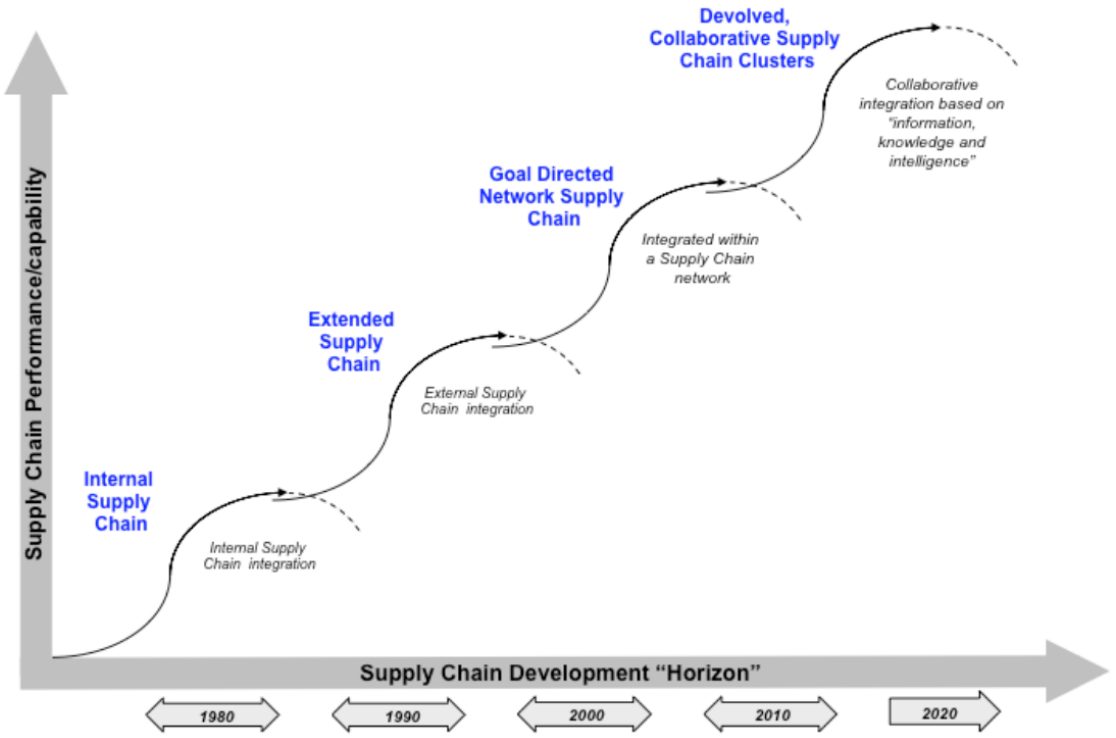


Figure 5. The development of supply chain management to phases of integrated supply chains and to future collaborative supply chain clusters Stevens & Johnson (2016: 17)

2.3. DIGITAL SUPPLY CHAIN CHALLENGES

Kache & Seuring (2017: 27) examined challenges at the intersection of supply chain management and big data analytics for the exploitation of the supply chain. The authors neglected to term the intersection though, which from the literature review conducted was concluded to be central to the discipline of DSCs. The challenges identified by Kache & Seuring (2017: 27) were mostly in the order of governance and compliance. This dealt with the coordination and integration of data with partners, information technology (I.T.) capabilities and infrastructure, and cybersecurity. Other barriers included business strategy and goals, human resources and talent management, financial implications, transformational change, cultural change, and ethical or managerial implications. Similar findings were reported by Yadav et al. (2020: 4) when examining the intersection of sustainability in circular economies and supply chains. This was termed sustainable supply chain management (SSCM) challenges and like Kache & Seuring (2017: 27) made no reference to DSCs. Yadav et al. (2020: 4) added the challenges of low financial return perception, a lack of engagement and empowerment with employees,

inadequate staff training and a lack of non-financial resources, for example, technical and human resources. Both Kache & Seuring (2017: 27) and Yadav et al. (2020: 4) did not categorise the barriers into themes.

In direct reference to DSCs, Wu et al. (2016: 17-18) and Büyüközkan & Göçer (2018: 168) found similar barriers to those reported by Kache & Seuring (2017: 27) and Yadav et al. (2020: 4). Furthermore, Büyüközkan & Göçer (2018: 168) identified several research gaps in dealing with the barriers for the adoption of a DSC strategy. The gaps included a lack of roadmaps and guidance for adoption. Another gap identified was the limited insights for managers to deal with implementation due to few studies addressing challenges faced. Schreckling & Steiger (2016: 5) agreed with the need for research in these areas and gave urgency to the need for the research and for digitalisation having proclaimed “digitise or drown”.

Several authors will argue with the position of Wu et al. (2016: 17-18) and Büyüközkan & Göçer (2018: 168) by contesting that the lack DSC insights. This is due to the proliferation of literature addressing challenges faced (Yadav et al., 2020: 4) (Jones et al., 2021: 938-939) (Stornelli et al., 2021: 8) (Maiti & Khare, 2022: 2809). There does exist a rise in the number of DSC publications from the period 2016-2018 due to the increased usage of blockchain technologies from 2018. A further rise was observed from 2019 due to the disruption of the COVID-19 pandemic to supply chains and the potential of DSCs to mitigate several of these challenges. Despite the rise in publications though, the literature review revealed that the research to date has tended to focus on the enabling technologies of a DSC. There is still a lack of information on specific enabling initiatives to overcome the numerous barriers listed. Lee et al. (2022) supported this view after studying 56 Malaysian manufacturing companies. It was concluded that there was still a lack of skills to overcome DSC barriers and a lack of knowledge on the benefits of DSC adoption.

Jones et al. (2021: 938-939) focused on the top three challenges and barriers to DSCs that was reported by various authors examining past, present and future scenarios. These challenges to DSCs are shown in Figure 6 (reproduced from Jones et al. (2021: 939)) that reflects that authors reviewed. It was reported that there was much overlap from authors and that most of the barriers reported were technical. Other high frequency barriers mentioned were a lack of effective DSC

strategy and a deficiency with technological disruption, that is a lack of the need to move to new technologies. A shortfall of the work from Jones et al. (2021: 938-939) was that it only focused on the top three barriers from each author reviewed. Tripathi & Gupta (2019: 4) listed 12 barriers, whilst Raj et al., 2020 (11-16) listed 15. These authors did not, however, contribute new barrier insights to those identified by Wu et al. (2016: 17-18), Kache & Seuring (2017: 27), Yadav et al. (2020: 4) and Büyüközkan & Göçer (2018: 168).

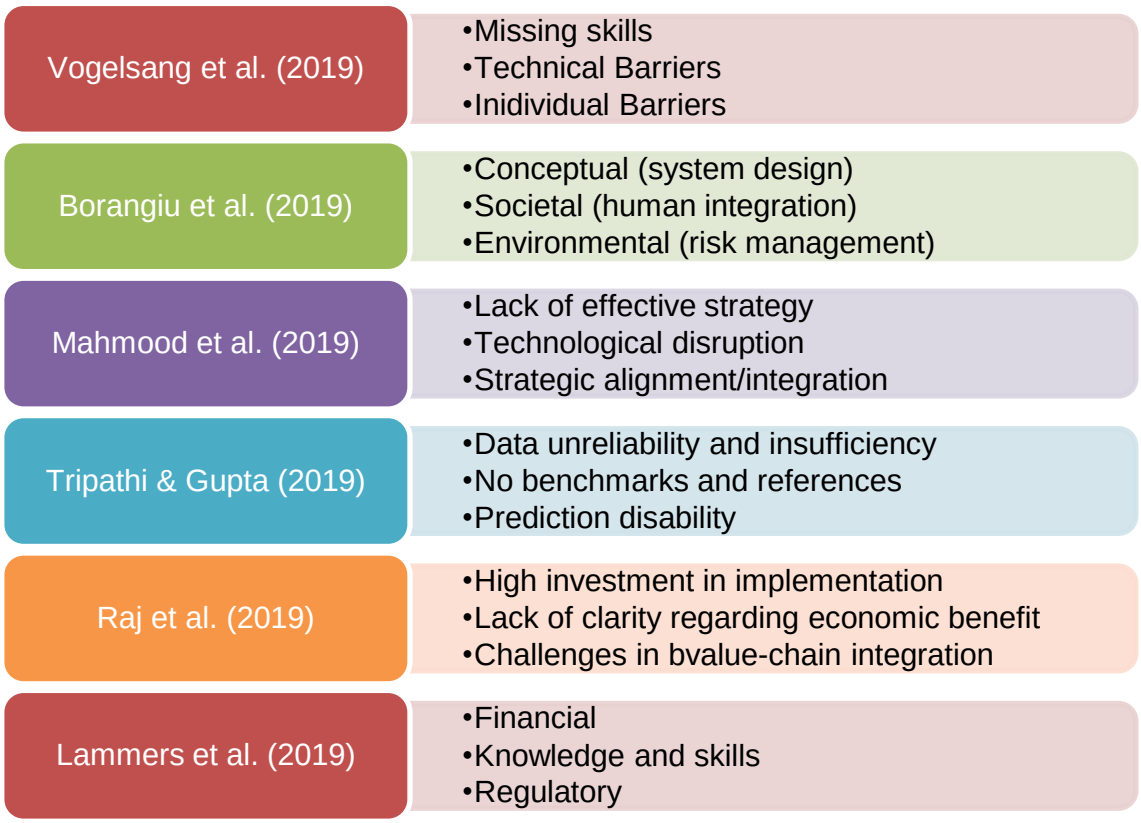


Figure 6. The main challenges and barriers to DSCs and digital transformation

In additional to barriers from the aforementioned DSC authors, Borangiu et al. (2019: 161) provided new insights into future barriers that needed consideration in the present. These included conceptual challenges with future systems and designs; societal challenges for cyber-physical systems to include human integration; and environmental challenges that included waste reduction and energy saving.

In contradiction of their review on DSCs, Jones et al. (2021: 940-941) were of the opinion that leadership mindsets needed to be dealt with ahead of the high

frequency barrier technical matters. Three mindset barriers were identified, a barrier that was not a focus area of the other DSC authors reviewed. Dealing with the perception of technology mindset, Jones et al. (2021: 941) viewed that if one thought of technology as an ever-existing disruptive force, then digital transformation could lead to the survival of an industry. Negatively viewed though, if the mindset was that technology posed a threat to jobs then there would be reluctance to adopt digital initiatives. Education featured strongly as an enabler to counteract the challenges into accepting changes in technology. Fixed mindsets were equated to an inability to learn new technological skills. The opposite and advocated mindset was the growth mindset, which embraced learning for technological advancement. The third group of the mindsets was on the perception of disruptive innovation and how disruptive innovation was managed. An example of this was to not only focus on the needs of the best customers, or to just produce innovations with the highest returns, but view disruption as a means to improve offerings to their most demanding customers.

2.4. DIGITAL SUPPLY CHAIN SUCCESSES

2.4.1. Fourth industrial revolution (4IR) technologies

The success of DSCs has primarily been due to the rapid uptake of the fourth industrial revolution (4IR) technologies (Mehmeti, 2016: 6) (Stevens & Johnson, 2016: 9). Rüßmann et al. (2015: 2-5) discussed nine pillars of technology used in 4IR that benefit manufacturers. These technologies were reported to be the industrial internet of things (IIoT); autonomous robots; simulation; big data and analytics; horizontal and vertical system integration; augmented reality; additive manufacturing; cybersecurity and cloud computing. da Silva et al. (2019: 548) agreed on the nine pillars of technology and their applications. Fanoro et al. (2021: 11) further reported on the integration of 4IR technologies into smart digital factories and the supply chain. The complex network architecture described allowed for secure and reduced cloud computing.

Fanoro et al. (2021: 5) also demonstrated how the various stages of industrial revolutions have progressed through to the fourth industrial and a possible fifth industrial revolution (Table 1). Each of these industrial revolutions are shown to have been catalysed by disruptive inventions that have changed manufacturing completely. Grzybowska & Tubis (2022: 1-2) stated that in such uncertain

environments, resilient supply chains are required that may result in competitive advantages. Changes in technology providing a competitive advantage are supported by Porter (1985: 60). Fanoro et al. (2021: 5) also reported that the objective of the fourth industrial revolution was digitisation and that this was supported by 4IR pillars that were common to da Silva et al. (2018: 548) and Rüßmann et al. (2015: 2-5). Stevens & Johnson (2016: 17) in relation to supply chain evolution (Figure 3) supported the view that recent advances are driven by internet and lead initiatives. This further shows that supply chain evolution and DSCs are closely linked with 4IR advancements (Mehmeti, 2016: 6). Srai et al. (2017: 13) expanded on the objective of the fifth industrial revolution and noted that successful DSCs are those that are connected to their customer through customised e-commerce platforms.

Table 1. The different stages of Industrial Revolution, energy sources, inventions and objectives (reproduced from Fanoro et al., 2021: 5)

IR	Energy Sources	Inventions	Final Objective
1st	Coal and steam	Steam engine	Mechanisation and centralised manufacturing
2nd	Electricity, natural gas and oil	Lighting, telephone, long distance wireless communication, steel production	Industrialisation
3rd	Mixed energy sources including nuclear power, with a move towards renewable sources	Solid-state electronics, robotics, automated processes, programmable logic control	Factory automation and computerisation
4th	Same energy mix as previous but move towards sustainable sources	Cloud computing, Internet of Things (IoT), Industrial IoT (IIoT), blockchain	Digitisation
5th	Likely to be sustainable energy	Massive IoT, autonomous cars, augmented and virtual reality	Customisation and personalisation

2.4.2. DSC scenarios

Schreckling & Steiger (2016: 5) listed the drivers of digitalisation and DSCs emphasising breakthroughs in digital technology; the changes in human behaviour and expectations towards digitalisation; low entry barriers; and the availability of venture capital. Manavalan & Jayakrishna (2019: 936) confirmed these drivers, with emphasis on information technology breakthroughs. The breakthroughs in DSCs

were presented by Srai et al. (2017: 13) in a DSC scenario framework in Figure 7. By demonstrating DSC successes and scenarios, their objective was that organisations use the framework to take a structured approach to DSC initiatives implementation and decision-making. This was in support of and addressing the concerns of Büyüközkan & Göçer (2018: 158) to alleviate the plethora of opportunities that do exist and that become difficult to follow. Furthermore, the Srai et al. (2017: 13) framework is applied to a network model considering inbound, manufacturing, outbound and end-to-end opportunities. The extended focus looks to exploit supply chain collaborative integration (Stevens & Johnson, 2016: 17) (Figure 5). A shortfall of the Srai et al. (2017: 13) DSC scenarios is that it neglected DSC scenarios in with devolved clusters. The opportunity with clusters was pointed out by Stevens & Johnson (2016: 17) and considered to be an industry trend by Srai et al. (2017: 13). Another shortfall of Srai et al. (2017: 13) was that it did not include safety opportunities with DSCs. Kittipanya-ngam & Tan (2019: 160) addressed some safety concerns by using robots for rapid process changes. It was thought that safety is often compromised when rapid production changes are made.

The Srai et al. (2017: 13) DSC scenario framework is further discussed as it will be of practical value to South African manufacturers for the exploitation of DSCs. The discussion takes into consideration the relevant 4IR pillars from da Silva et al. (2018: 548) and Rüßmann et al. (2015: 2-5), as well as DSC case scenarios from other sources.

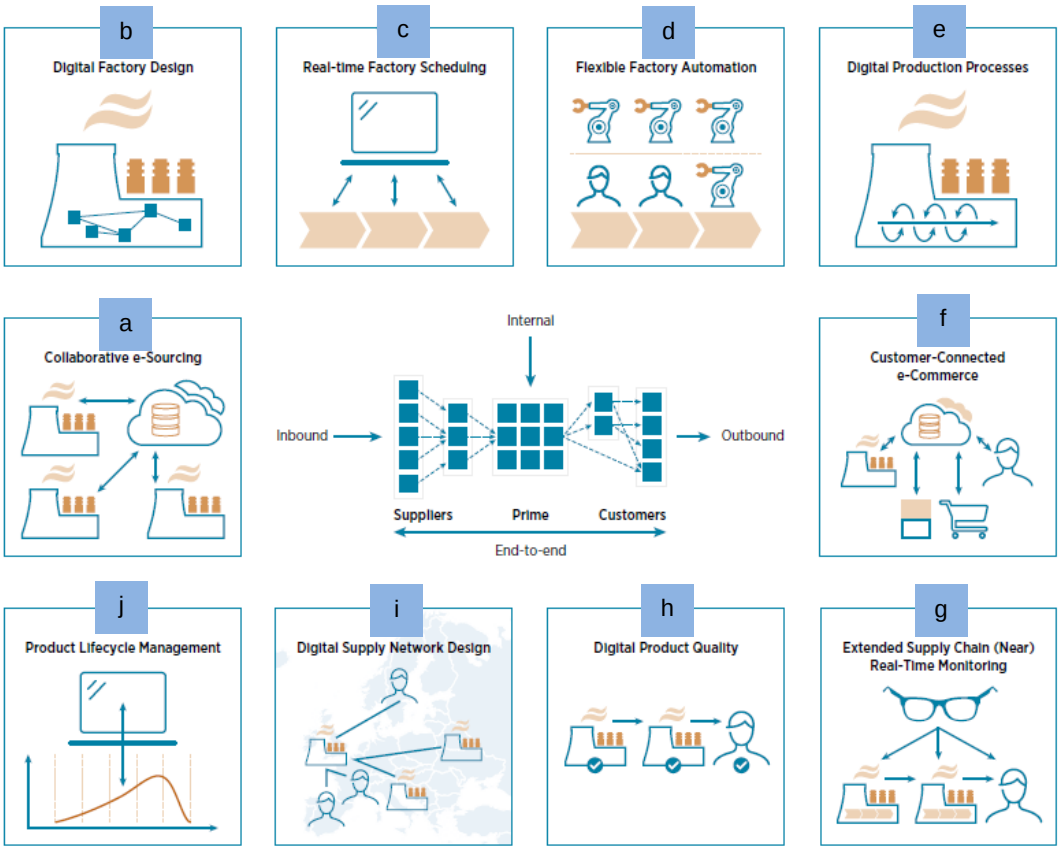


Figure 7. DSC successes and scenarios (Srai et al., 2017: 13)

a. Collaborative e-sourcing:

Principle 11 of the Toyota way (Liker, 2020: 381) holds the view of treating your value chain partners as extensions of your own company. Rajah et al. (2018: 4) presented this as a challenge in supply chains due to the difficulty in dealing with suppliers from different environments. Another challenge with stakeholder collaboration was identified by Tripathi & Gupta (2019: 4) to be data insufficiency and unreliability. Srai et al. (2017: 14) counter these challenges through collaborative e-sourcing with emphasis on data visibility to assist in mitigating sourcing risks from constraints or disruptions. This is characteristic of a digital procurement strategy that addresses the challenges of strategic alignment, engagement with suppliers and required trust (Mahmood et al., 2019: 242). Srai et al. (2017: 14) also report that companies are probing for more than digital sourcing from EDI systems but are instead searching for proactive cautioning systems.

Kittipanya-ngam & Tan (2019: 160) suggested blockchains as an enabling emerging technology that can assist with collaborative e-sourcing. Wong et al. (2019: 2-3) describe blockchains to be a distributed ledger of data that contains a

constantly growing list of records, called blocks. Kittipanya-ngam & Tan (2019: 160) provided evidence for blockchain usage in examples of DSCs in the Thailand food manufacturing sector. Blockchains were used to provide information on the source of supplies and tracking of storage and movement of goods through the supply chain. A further advantage derived is fewer quality issues encountered. Blockchains were reported to be embedded within the 4IR pillar of big data and analytics (da Silva et al., 2018: 548) (Rüßmann et al., 2015: 2). In this pillar, large datasets are analysed by software to optimise supply chains and support real-time decision making. da Silva et al. (2018: 548) also listed horizontal and vertical system integration as another 4IR that could enable collaborative e-sourcing. This is observed as a fundamental building block for DSCs as it involves the integration of information systems across production and stakeholders as well as link companies, suppliers and customers.

b. *Digital factory design*:

Srai et al. (2017: 14) reported the DSC scenario of using 3D digital modelling to reconfigure factory layouts and design in response to changes in the supply chain. This would mostly be applicable to those businesses with flexible manufacturing systems and would have the advantages of improved takt times and buffers. Rüßmann et al. (2015: 3) prescribed simulations as an enabling 4IR pillar to assist with digital factory design. Such simulations will allow for digital twinning before making physical changes to production. Kittipanya-ngam & Tan (2019: 160) validated this scenario with the example of sensors that monitor the weather and raw material quality as inputs into simulations for factory design and production requirements.

c. *Real-time factory scheduling*:

Real-time factory scheduling is more than just-in-time production. It requires digital process re-engineering in how factories are operated (Srai et al., 2017: 14). Manavalan & Jayakrishna (2019: 940) report upstream alert messages that used in process re-engineering for fewer missed sales and improved productivity. This DSC possibility will require a clear strategy to reap benefits but steer clear of unnecessary costs and complexity. Srai et al. (2017: 14) reported that this DSC scenario is fully benefitted from by an arduous full use of 4IR technologies and real-time communication through ERP, management execution systems (MES) and

cloud computing or systems. Rüßmann et al. (2015: 4) and Ben-Daya et al. (2017: 4722) agree that IIOT devices are an enabler for real-time scheduling. Sensors and equipment in manufacturing are connected, not only by a process control system, but also to communicate and interact. Analytics and decision making can be decentralised and enable real-time responses. An application given is where radio frequency identification (RFID) codes are used so that downstream processes know what manufacturing steps are required or can be bypassed for a particular product. The RFID codes can be used in DSCs to store useful information across the supply chain.

d. Flexible factory automation:

Srai et al. (2017: 14) showed that factory automation flexibility has improved with advances in 4IR technology, collaborative robotics and deep machine learning. The link to DSC can come from an agile response to customisation. Kittipanya-ngam & Tan (2019: 160) supported the Srai et al. (2017: 14) DSC scenario with an example of robots that programmed for customisation. Rüßmann et al. (2015: 3) agreed and added that robots can be used for complex and unsafe tasks for employees. Autonomous robots were suggested to work and learn from humans. Augmented reality was also given by Rüßmann et al. (2015: 5) as an enabler. This technology could be used to give real-time instructions from distant suppliers whilst an employee or robot is working on their equipment.

e. *Digital production processes*:

Additive processes (Rüßmann et al., 2015: 4) like digital printing and laser sintering can result in enhanced customisation and new designs. Srai et al. (2017: 14) classified this as a supply chain disruptor. Rüßmann et al. (2015: 4-5) also held this view and reported that these technologies are used to prototype and manufacture products or components without the need to rearrange the factory design. The set-up time for these changes is minimal.

f. *Customer-connected e-commerce*:

Customer centricity feature prominently in Oliver & Webber's (1982: 64) and Porter's (1985: 36) definitions of supply and value chains. Srai et al. (2017: 15) listed DSC scenarios that enhance customer focus in a digital era. Last mile deliveries were given as an example that can substantially reduce costs but that

offer value to the customers. Kittipanya-ngam & Tan (2019: 160) agreed with this and reported of drones used for last mile food deliveries. Srai et al. (2017: 15) also gave the example of dark stores which focus on high customer concentrations. This involves data-driven decisions to set up business operations near customers. Customer-connected e-commerce highlighted this DSC scenario stating that, at a minimum, businesses must include this DSC initiative as part of their DSC strategy. This could include a configuration personalised to a customer's needs and multiple channel access to the business. Manavalan & Jayakrishna (2019: 940) further motivate this DSC scenario with an example in the aircraft industry, where data from aeroplanes are continuously analysed to improve designs and operation for customer benefit. Kittipanya-ngam & Tan (2019: 160) encouraged the DSC customer connection in an application that monitored inventory for sales and promotion prediction.

g. *Extended supply chain (near) real-time monitoring*:

Extended supply chain monitoring differs from real-time factory scheduling in that it relates to end-to-end supply chains (Srai et al., 2017: 15). Kittipanya-ngam & Tan (2019: 160) evidence this DSC scenario in industry with examples of sensors linked across the supply chain stakeholders to optimise production. Rüßmann et al. (2015: 4) described cloud computing to enable this DSC scenario with data communicated across organisations in milliseconds. Stornelli et al. (2021: 14) questioned the practicality of this DSC and raised a cybersecurity threat with the increased connectivity of management and production systems. More complex identity and access management for users and machines were presented as enablers. Srai et al. (2017: 15) pointed out a further enabler through the use of outsourced digital watch towers. Independent and accountable service providers could alleviate cybersecurity risks whilst still providing data to minimise supply chain disruptions and empower decision making.

h. *Digital product quality*:

Srai et al. (2017: 15) recommended DSC to enable quality management across the supply chain. Data transparency from end-to-end could benefit all stakeholders from real-time root cause. The resultant merits would include customer satisfaction, problem mitigation, and verification of compliance warranties. Kittipanya-ngam & Tan (2019: 160) listed an example of this scenario in Thailand with digital tracing of

food product quality across the supply chain. Manavalan & Jayakrishna (2019: 940) were of the opinion that the integration of cloud technologies would enhance this DSC scenario. The opinion was validated through the work of Kealley et al. (2022: 354-357) in the Australian sugar industry. Cloud services were used to provide value chain transparency and demonstrate the traceability of origins for sustainable practice warranties.

i. *Digital supply network design*:

This DSC scenario differs from digital factory design in that it involves the entire supply network (Srai et al., 2017: 15). Borangiu et al. (2019: 161) contested this scenario by stating that the conception of such strategic designs are challenging. Srai et al. (2017: 15) stated that the conceptual design thinking is made easier by using modelling tools. The tools look at a multitude of factors that include the key drivers of cost, risk, responsiveness, innovation and resource access. New system design as outputs from simulations could result in step changes to supply chain models.

j. *Product lifecycle management*:

Srai et al. (2017: 15) describes this scenario as an integration of data systems that are product-based with systems that are supply chain-based. The resultant systems provide up-to-date product information that can be accessed throughout the product lifecycle for substantial strides in innovation, improved routes to market and improved portfolio management. The example used earlier was from Manavalan & Jayakrishna (2019: 940) in the aircraft industry to gather data from their product lifecycle for constant innovation.

2.5. DIGITAL SUPPLY CHAIN STRATEGY AND DIGITAL GOAL SETTING

Büyüközkan & Göçer (2018: 169-170) gives progressive decompositions of a simple DSC development and adoption framework that maps out the three stages of digitalisation, technology implementation and supply chain management. They claimed that these steps are vital for supply chain organisational alignment and can be used for any supply chain development. Figure 8 provides sub-steps to each of the three stages of the DSC integration framework and Figure 9 further decomposes the first step of the process, being a digitalisation strategy Büyüközkan & Göçer (2018: 170). Schreckling & Steiger (2016: 16) validates the

framework with a similar framework with the three steps of digital business innovation, digital architecture and value generation.

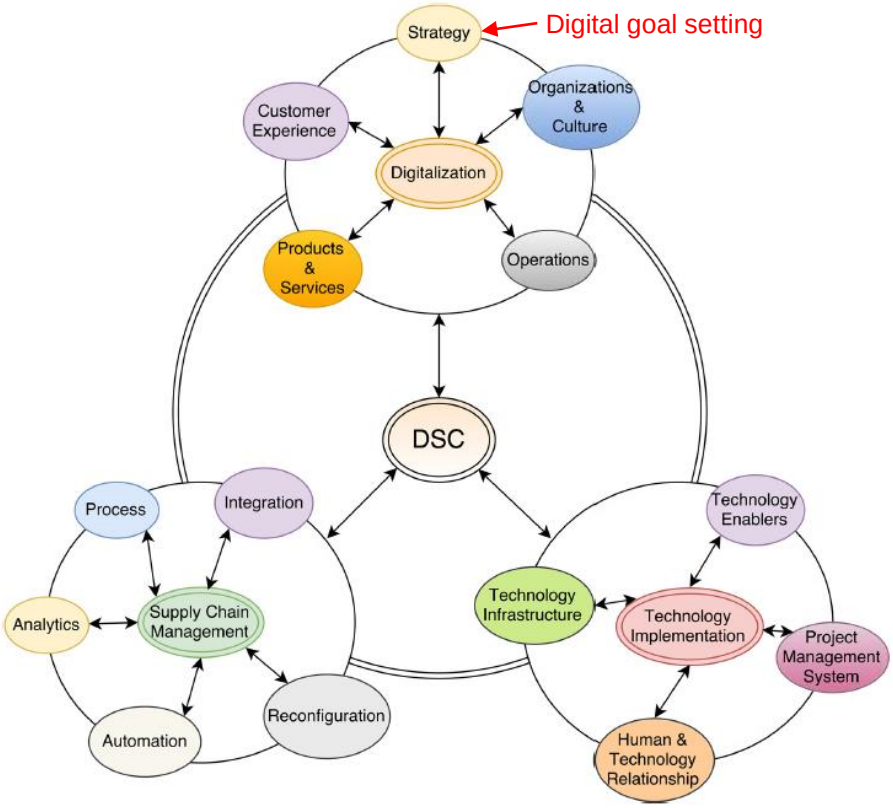


Figure 8. A complete integration framework showing the three keys steps of digitalisation, technology implementation and supply chain management in the development of a DSC (Büyüközkan & Göçer, 2018: 170)

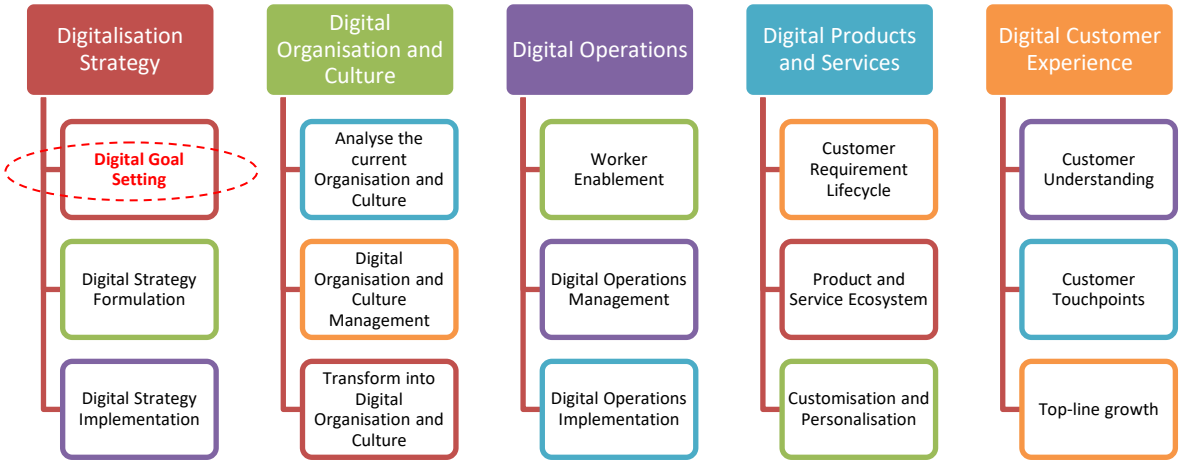


Figure 9. A further decomposition of the first step of the DSC development framework, namely digitalisation (Büyüközkan & Göçer, 2018: 170)

Büyüközkan & Göçer (2018: 169) point out an important insight to those that are new to DSCs. Having a DSC does not mean having the latest technologies but rather alignment of the digital initiatives with the supply chain strategy. DSCs can be adopted to result in improved performance from realising the capabilities of existing resources and knowledge. DSCs begins with digitalisation, which begins with a digitalisation strategy that includes digital goal setting, strategy formulation and strategy implementation (Figure 8). Schreckling & Steiger (2016: 16) concurred with the steps and also frame digital business innovation in three steps being digital dream zone (re-imagine), business model design (design) and business model implementation (transform).

Limited literature could be found that focused specifically on digital goal setting as a step ahead of digital strategy formulation and implementation. Gaffley & Pelser (2021: 9) included digital goal setting in the first five steps of a 7-step model for digital transformation in manufacturing. The steps proposed researching and identifying the digital gap, and then prioritisation of opportunities before business plan and strategy formulation. Porter (1996: 64) institutionalised the importance of the goal setting step, relating to classical strategy, having stated that the choice of activities is the essence to any strategy as it sets you apart from your rivals. Tawse (2019: 250) and Köseoglu et al. (2020: 2) do not differentiate goal setting from strategy formulation. Tawse (2019: 250) uses the strategic terms planning and formulation interchangeably, whilst Köseoglu et al. (2020: 2) aligned with Porter's views on strategic planning (1996:64) by stating instead that strategy formulation is effective in coordinating effort in organisations.

Within the context of DSCs, both Schreckling & Steiger (2016: 16) and Büyüközkan & Göçer (2018: 169) label the re-imagine or goal setting step as a critical step. The authors concur that without clear goals and a strategy, a company will have its focus on addressing current issues rather than strategic ones. Within the digital strategy, digital goal setting is also flagged as being crucial as it sets what the strategy wants to achieve. Schreckling & Steiger (2016: 16) stated that digital goal setting distinctly considers and then sets aside irrelevant concerns to the company that may distract the company from achieving its overall strategic goals. Whilst both sets of authors list challenges to DSCs, these are specific to the technologies that enable digitalisation. The authors do not adequately address the barriers to the digital strategy and goal setting. Xu (2014: 6-13) gives the primary challenges to

developing DSCs but does not report on specific success factors to overcome these challenges. The challenges included a lack of planning with a lack of demand plans and planning tools. There was poor collaboration internally and with associates. Company reservations and information sharing were also challenges. There was a deficiency in DSC knowledge with missing skills, tools and training. Also listed were unagile and inflexible supply chains and an over-reliance on a few suppliers. Xu (2014: 6-13) failed to recognise a critical threat to the adoption of DSCs reported by Maiti & Khare (2022: 2809) to be the increased chances of cybercrimes. Bhargava et al. (2013: 4) dealt with this threat. The solution proposed was to use a trust broker to handle data into and out of a company from and to external sources, respectively.

The research gaps identified by Büyüközkan & Göçer (2018: 169) and supported by Wu et al. (2016: 17-18) are given in Section 1.2. Additionally, Büyüközkan & Göçer (2018: 174) recommend industry case scenarios on the DSC framework (Figure 8) as businesses are likely to have bespoke DSC methodologies which may point to future trends or other needed academic research. Farahani et al. (2016) validate this recommendation with a methodology developed in the automobile industry for developing a DSC. This involves the following steps: (1) define a specific scope within the supply chain management strategy (e.g., production or logistics), (2) identify innovations specific to the scope, (3) investigate user cases to couple supply chain tasks with the technological innovations, (4) determine the case feasibility using technology maturity and reported value derived, (5) set clear goals for a portfolio of prioritised tasks, (6) formulate and implement the strategy, and (7) revisit the exercise regularly (e.g. twice annually).

2.6. UNLOCKING BARRIERS IN DIGITAL GOAL SETTING

The challenges and barriers to supply chain management and DSCs are reported in Sections 2.2.2. and 2.4., respectively; however, there is no link to these barriers and to the first step in the digital strategy, being digital goal setting, which could be found in the literature reviewed.

Stornelli et al. (2021: 5) mapped their research findings onto a conceptual framework showing barriers and enablers for adopting advanced materials into manufacturing. This framework is shown in Figure 10 and appears applicable to form a basis for a framework considering enablers and barriers to DSCs. No

literature on DSCs indicated that the framework was not applicable. Stornelli et al. (2021: 12) further categorised the barriers and enablers and linked these to innovation types.

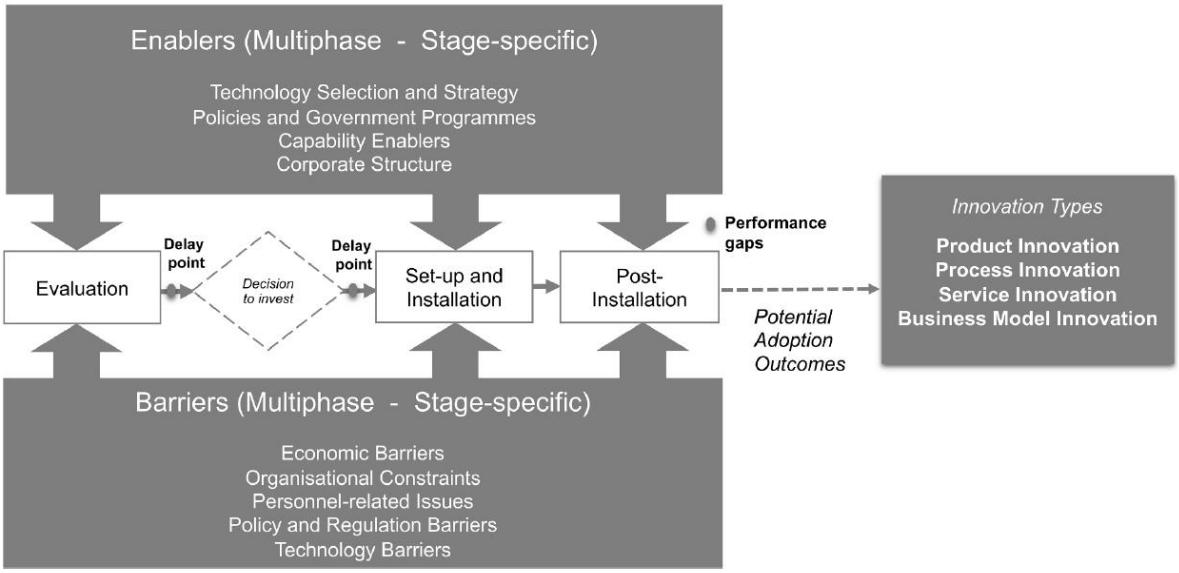


Figure 10. Framework linking barriers and enablers to innovation type outcomes Stornelli et al. (2021: 5)

Gupta et al. (2020: 6-7), investigated barriers to supply chain sustainability innovation, also considered the barrier categories from Stornelli et al. (2021: 5). Not included in the latter was a category on market and networking barriers.

2.7. CONCLUSION

On completion of a literature review on supply chains, digital transformation and the challenges and opportunities prevalent with DSCs, the words of Schreckling & Steiger (2016: 5) precipitate prominently “digitise or drown”. Such is the potential competitive advantage to be ascertained from adopting DSCs in a VUCA business environment. Fanoro et al. (2021: 5) gives the objectives of the fourth and fifth industrial revolutions, with the latter observed to be benefitting in digitalisation processes due to the digitisation in the fourth industrial revolution. Digitalisation to benefit supply chains and transform business models is considered non-negotiable by authors in the field of study.

In Section 2.2, the evolution of, and challenges associated with supply chain management were reviewed. This progressed to a crescendo of opportunity that

DSCs can yield to address supply chain shortcomings. Authors concluded that DSCs could assist managers to re-imagine value chains, with a data-driven approach used to address current challenges, help predict and mitigate disruption, and ultimately improve operational excellence and future-proof businesses.

Various aspects of DSCs were discussed in Sections 2.3. to 2.6. This described the proliferation of 4IR and other digital technologies, from usage and benefits demonstrated within manufacturing, to across the supply chain. The successes to DSCs were presented by Srai et al. (2017: 13) in a scenario framework for a structured approach to DSC initiatives and decision-making. Given the plethora of existing DSC opportunities, the framework can be used by manufacturing and supply chain managers to prioritise DSC initiatives for consideration in a DSC strategy. Research gaps were, however, identified by Wu et al. (2016: 17-18) and Büyüközkan & Göçer (2018: 168) which included a lack of insights on how to deal with DSC implementation from a managerial or technical perspective due to a lack of studies on addressing challenges faced. Figure 8 from Büyüközkan & Göçer (2018: 170) is a complete integration framework that decomposes the three keys steps of digitalisation, technology implementation and supply chain management in DSC development. The first step in the digitalisation stage, being digital goal setting (Figure 9), is focused upon to progress to possible DSC strategy adoption. The literature reviewed did not reveal any useful frameworks specifically dealing with barriers or enablers for digital goal setting within the DSC adoption process.

There was also limited on DSC barriers and enablers specific to manufacturing in South Africa. It is therefore unknown if DSC barriers from international authors like Jones et al. (2021: 938-939) and enablers from Stornelli et al. (2021: 12) are applicable to manufacturing in South Africa. What are the specific challenges and successes that are inherent in South African manufacturing DSCs? Are South African manufacturers missing the skills and knowledge to formulate and implement DSC strategies? Lee et al. (2022) found such missing skills in Malaysia. The research considered the Büyüközkan & Göçer (2018) research gaps and studied 56 Malaysian manufacturing companies. It was concluded that traditional supply chains could be evolved to DSCs for businesses to remain competitive. Lee et al. (2022), however, still remained convinced that Malaysian manufacturing companies did not know how a DSC can improve business performance, with the organisations lacking knowledge on the benefits of DSC adoption.

CHAPTER 3: RESEARCH QUESTIONS

The purpose of this study is to close the research gap between what companies expect of DSCs and their preparedness to execute a DSC strategy, as identified by Büyüközkan & Göçer (2018: 173). Closing the research gap is accomplished by highlighting barriers to the first stage of a DSC strategy, digital goal setting, and linking known enablers to such barriers; the context being medium to large scale manufacturing companies in South Africa. In doing so, the study has academic significance by contributing to the body of knowledge on DSCs and providing business schools with case scenarios of successful implementations for overcoming specific South African challenges.

The research follows the conceptual framework of Stornelli et al. (2021: 8) and applies the lens of DSCs instead of advanced manufacturing technologies (AMT) to their research questions 'Following a stage-based perspective, which types of barriers and enablers are relevant to each stage of the AMT adoption process' and 'What are the linkages between barriers, enabler for different innovation types?'. Emanating from the literature search and following the research lead from Stornelli et al. (2021: 8) in a separate field are the two research questions that this research ascertains:

Research Question 1 (RQ1): From a South African manufacturing manager's perspective, what are the types of barriers and enablers that are relevant to the digital goal setting stage of the digital supply chain adoption process?

Research Question 2 (RQ2): What are the specific enabling initiatives needed to overcome barriers to digital goal setting in the adoption of DSCs?

These two research questions form the second signpost for the study, after the research purpose and the study central intent was established in the preceding chapters. The formulation of the questions follows the structure advocated by Creswell (2016: 184-185) with RQ1 serving as the central question that seeks exploration of the research and RQ2 being the associated sub-question which further focuses the study area but that leaves the research open for other studies. With RQ2, the study area can be progressed to include other steps of the DSC adoption and implementation process.

Combining Figure 8 and Figure 10 is Figure 11 that serves as a conceptual framework for the research in this research. The framework shows the possible progression of digitalisation to the step of digital goal setting and towards potential DSC strategy and adoption. Between digitalisation and the use thereof in supply chains, lies an evaluation (RQ2) of the barriers and enablers identified in RQ 1.

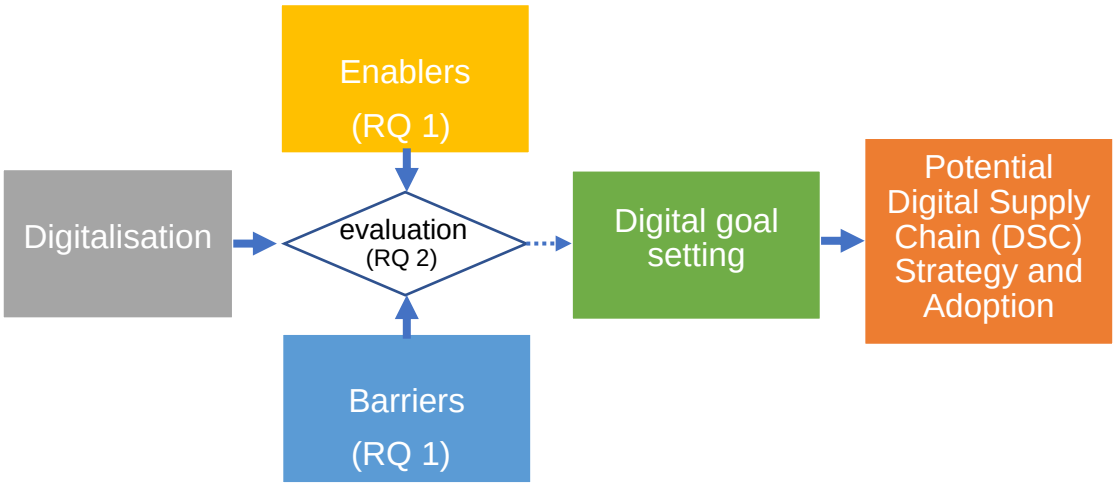


Figure 11. Conceptual framework for this research (adapted from Stornelli et al., 2021: 8)

CHAPTER 4: RESEARCH METHODOLOGY

4.1. INTRODUCTION

The following chapter describes and defends the research design and methodology used to answer the identified research questions in this study. An exploratory and descriptive approach was undertaken for the study, with a pragmatic philosophical lens applied for the data sampling, gathering and analysis. The data was extracted through semi-structured and predominantly virtual interviews. This was with senior and executive manufacturing and supply chain leaders, who would benefit from or have benefited from DSC initiatives. The rationale for the tools selected was demonstrated and at the end of the chapter, the research limitations and quality controls are also reported. To further assist in the understanding of the general research workflow undertaken, Figure 12 is given, which illustrates the golden thread in the research process. The first three parts of the process evidence the approach prescribed by Creswell (2016: 148). It included the establishment of the problem which resulted in this study. This being through a literature review on the general research area and then the problem area to firstly identify literature deficiencies and research gaps. Secondly, the literature review also served to demonstrate the urgency of the study for a targeted audience. It then lastly converged at a research purpose. The approach to Step 4 of Figure 12 is detailed in this chapter and the results, interpretation and conclusions in Step 5 is given in the chapters that proceed.

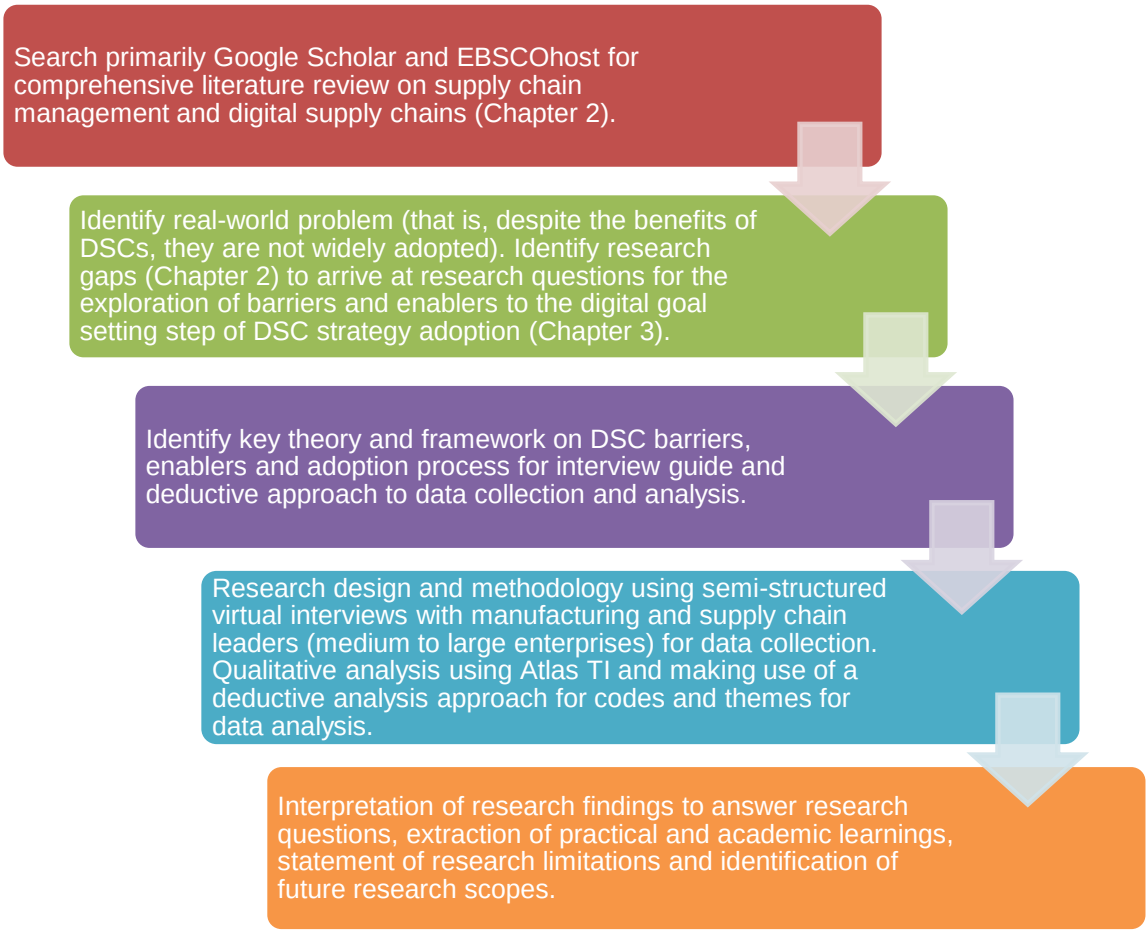


Figure 12. General research workflow and the golden thread of study

4.2. RESEARCH PARADIGM AND DESIGN

Creswell (2016: 31) defined the research design as the procedures of inquiry to the research. Saunders & Lewis (2018: 105) provided a research design framework that assisted in the formulation of the inquiry procedures and that was used to arrive at a research design and methodology for the research study. Figure 13 summarised these choices made. Further details on the research model are given in the research model canvas in Appendix A.

Research Question 1: From a South African manufacturing manager's perspective, what are the types of barriers and enablers that are relevant to the digital goal setting stage of the digital supply chain adoption process?

Research Question 2: What are the specific enabling initiatives needed to overcome barriers to digital goal setting in the adoption of DSCs?

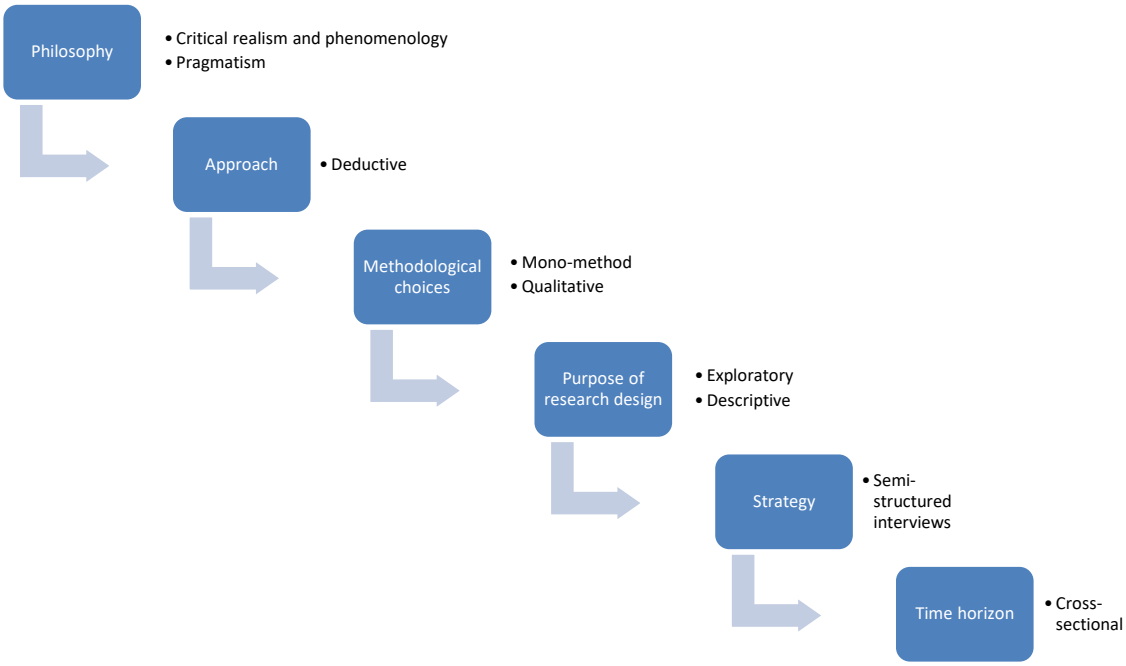


Figure 13. An overview of the research methodology

The research questions signposted in Chapter 3 are a central question (Research question 1) and an associated sub-question (Research question 2). The research questions were addressed through the philosophical lenses of critical realism, phenomenology and pragmatism (Saunders & Lewis, 2018: 108, 111). This was due in part to the answering of the research questions identified being reliant on the interviewees' own manufacturing and supply chain experiences, and also stemming from an underlying reality which may shape observations (critical realism and phenomenology (Myres, 2022: 11). These factors are also be considered as limitations of the research. The pragmatic philosophical lens was attributed to the author intending managers to use practical research findings or solutions to adopt DSCs. Spiggle (1994: 2) described this approach as an inferential process that connects the data obtained with the end product of the research. In subscription to this approach, the researcher generated themes, connections and conclusions, based on the interpretation of the data collected to describe the perceived reality of the area under study (Creswell, 2016: 246). Spiggle (1994: 2) and Flick (2009: 92) agreed that using such a linear analysis has previously resulted in high-quality and innovative research. In this study the approach taken was deductive as the research required testing of theoretical propositions designed for collected information (Saunders & Lewis, 2018: 112) and was a directed content analysis owing to there being an existing theory that could benefit from further research and

analysis (Hsieh & Shannon, 2005: 5). This conformed to the circular interpretive inferential from Spiggle (1994: 2) due to the data being compared to findings of other researchers and vice versa. In reference to the literature review and the data interpreted, casual relationships between variables were explained.

The methodological choice in the research paradigm was for mono-method qualitative research owing to the research aimed at the development of theory (Myres, 2022: 5). It was conducted through the use of semi-structured interviews. The qualitative method was used to obtain in-depth concepts and insights from leaders, followers and non-adopters with DSCs as related to the research questions posed (Flick, 2009: 11). The research design purpose was a combination of exploratory and descriptive designs. The research was deemed exploratory as it was not known what the investigation would reveal. The descriptive research design was due to work aimed to better understand the barriers to the digitalisation of supply chains (Myres, 2022: 7) in the South African manufacturing landscape. The strategy was to use a narrative inquiry in semi-structured interviews. These interviews were held with executives and senior technical individuals in the manufacturing and supply chain sectors for manufacturing companies in South Africa. A cross-sectional time horizon was utilised due to once-off interviews performed. As this represents a snapshot in time, the time horizon was considered cross-sectional.

4.3. RESEARCH METHODOLOGY – POPULATION AND SAMPLE

Universe/Population

Medium to large South African manufacturing companies formed the population for the research. This excluded companies with less than 50 employees. The manufacturing sector was chosen due to it being an area of interest but also due to the potential of the sector to further contribute to the South African GDP (Naudé & Szirmai, 2012: 47–48). Company executives and senior managerial staff formed the target sub-population. This target sub-population was, to be sufficiently experienced with manufacturing and/or supply chains and to be in positions that can influence DSC implementation. Some preliminary questions were also posed to the sub-population to assess each respondent's suitability and determine whether a DSC had been implemented at their company.

Unit of analysis

Two levels of analysis were required. The first level was to interview a target sub-population where manufacturing DSC strategies had been adopted. The second level of analysis was performed at companies where DSC strategies had not adopted. The two-level analysis allowed for the exploratory data collection required to answer Research Questions 1 and 2. It also allowed for triangulation of challenges overcome by respondents from Level 1, with those challenges faced by Level 2 respondents. Where adoption had been successful, it was determined what the specific factors were that enabled the success for Level 2 interviewees to use (Research Question 2). Enablers from the literature review were additionally used to answer Research Question 2. An extra interview conducted with a DSC consultant in South Africa assisted in the triangulation and validation of the research.

Sampling method and size

Fedderke et al. (2017: 122) defined the sampling frame of manufacturing sectors that exist in South Africa. Purposeful sampling was used within the sampling frame to seek out companies with and without DSC adoption. This sampling method was recommended for qualitative research by Creswell (2016: 239) and Flick (2009: 126) for a thorough understanding of the problem and research question. It was found that qualitative research design authors such as Spiggle (1994) and Saunders & Lewis (2018) characterised the research by having a small number of participants but did not quantify the minimum number needed. Creswell (2016: 239) offered the same characterisation but suggested that for phenomenology research designs, a minimum of 3-10 participants would suffice. It was therefore deduced that a minimum sample size of six respondents was needed for the study, with at least 3 interviewed at Level 1 and 2, respectively. For this study, six participants at Level 1 and 2 each, were targeted. A total of 12 interviews was thought to be sufficient, following the minimum number prescribed by Creswell (2016: 239), so that a saturation of responses can be determined (Saunders & Lewis, 2018: 145-146) (Creswell, 2016: 239). The saturation test was used to determine if the number of participants was sufficient. It was done by checking if there was saturation within the sample set, with no new insights revealed after a certain number of interviews held. To ensure that the appropriate number of interviews were held, the author approached all available personal networks. This was

through the GIBS alumni, research supervisor network, LinkedIn connections, and professional supply chain networks such as the Chartered Institute of Procurement and Supply (CIPS – Africa). Industrial engineering websites, such as Engineering news and KwaZulu-Natal Industrial, were also browsed to identify who is undertaking work in the area researched. The schedule of interviews held were randomised to avoid biasing of themes, with an equal of respondents targeted for each level.

Sampling description and suitability

Purposive sampling was performed for the study and restricted mostly to the researcher's network. Therefore, in order to demonstrate the suitability of the participants for the study, the participant details were sought in Interview Question 1 (Appendix D). For the research, the names of the manufacturing companies were removed to maintain the participant's anonymity. With the company identity and all associated familiarity removed, context was provided for each company in its characterisation by the manufacturing sector, company size and relative expenditure towards digitalisation.

4.4. MEASUREMENT INSTRUMENT

In semi-structured interviews with a narrative inquiry, Josselson (2013) stated that the questions must be sufficiently open-ended to direct the responses to interest areas or themes. The interview questions must also allow for an interpretation of the questions by the interviewed persons. The questions for the interviews were plagiarised from Schreckling & Steiger (2016: 15) as their theme of ‘digitise or drown’ was pivotal for the DSC research undertaken. The appropriateness of the questions was confirmed through email correspondence with Jones and Dr Camba (1 November 2022), authors of Jones et al. (2021), which was a key publication referenced in this study. These researchers also used the Schreckling & Steiger (2016: 15) questions in their work that explored barriers and enablers for DSCs.

4.5. DATA COLLECTION

The data gathering process was through virtual semi-structured inquiry interviews with a focus on key themes and questions. This was in consideration of the time constraints of the senior managers interviewed. Due to the complex nature of the research area addressed and a gap in the literature in this area, the semi-

structured interviews were deemed appropriate for data collection and to obtain new insights (Saunders & Lewis, 2018: 158). The semi-structured nature of the discussions facilitated the interview guide usage and allowed for the conversation to be redirected to ascertain new insights (Saunders & Lewis, 2018: 159). A total of 14 interviews were held with senior managers in manufacturing and supply chain with influence or potential influence for the adoption of DSCs. There were seven interviews held with managers at Level 1 and 2, each. This surpassed the minimum of six at each level thought to be sufficient for data saturation (Chapter 4 – sample method and size) and the minimum number of three from Creswell (2016: 239) for phenomenology research designs. Only one interview was held in-person, and this was with the company where the author is employed. An extra interview was held with an individual consultant to gather further insights from their experiences with digital transformation in South African manufacturing. The process for data gathering commenced with obtaining ethical clearance for the research (Appendix B). Participants were approached from the aforementioned sources to determine their suitability of expertise required for the completion of the survey. The suitable candidates were categorised in equal two-level categories. The candidates were asked to complete non-disclosure agreements and consent forms (on a letterhead and with a succinct description of the research intent – Appendix C). The anonymity of each participant was upheld in this research with only details of their manufacturing sector revealed. For each interview, an hour was scheduled through virtual Microsoft Teams meetings using the interview guide (Appendix D) for the semi-structured inquiry interviews. This virtual platform software was chosen due to the services of recordings and transcriptions, which were used to capture responses for analysis. Permission for recordings were sought for each interview. Upon completion of the research, each participant will receive a letter of gratitude. The letter will include a brief description of the research findings, as requested. The data collected from each interview will be stored for a minimum of ten years on a personal hard drive and shared with the research supervisor involved.

4.6. DATA ANALYSIS AND INTERPRETATION

Analysis approach

A deductive analysis approach was utilised as the research took into consideration categories, codes, and themes that were already reported in the literature review

(Stornelli et al., 2021 and Jones et al., 2021) and looked to contribute further to these areas owing to research gaps identified. In particular, a directed content analysis was applied (Hsieh & Shannon, 2005: 7) owing to the research starting with theory, using codes during analysis from the theory and data collected (see

Figure **14**). Some enumerative methods were also employed to better understand the context and importance of the data gathered as advocated by Hsieh & Shannon (2005: 7). Despite the enumeration, the research is still considered qualitative as the assessment was performed to provide latent content analysis in addition to such data as code frequencies. Hsieh & Shannon (2005: 7) refer to such analysis as manifest content analysis in qualitative research.

The software Atlas TI was used for analysis of the data collected. A step-wise approach was undertaken for this process and began with cleaning up of colloquial jargon from the MS Team transcriptions for ease of interpretation. Careful editing was required so as to not alter the quality and validity of the interview responses. The edited transcripts were uploaded onto Atlas TI where each document was tagged with codes derived from Jones et al. (2021: 939). The codes were categorised into barrier and enabler themes derived from Stornelli et al. (2021: 14) and these themes were also tagged in the uploaded documents. The application of the codes and themes is shown in

Figure **14**. The analysis included the incorporation of new codes and themes that best captured responses from the participants. The resultant groups of codes, categories and themes were then linked to show networks and relationships using the code groups, concept cloud and network analysis tools within Atlas TI. To provide richness to the qualitive analysis (Hsieh & Shannon, 2005: 7), frequency enumeration and tagging of insightful quotations were also performed within Atlas TI and used in the interpretation of the data.

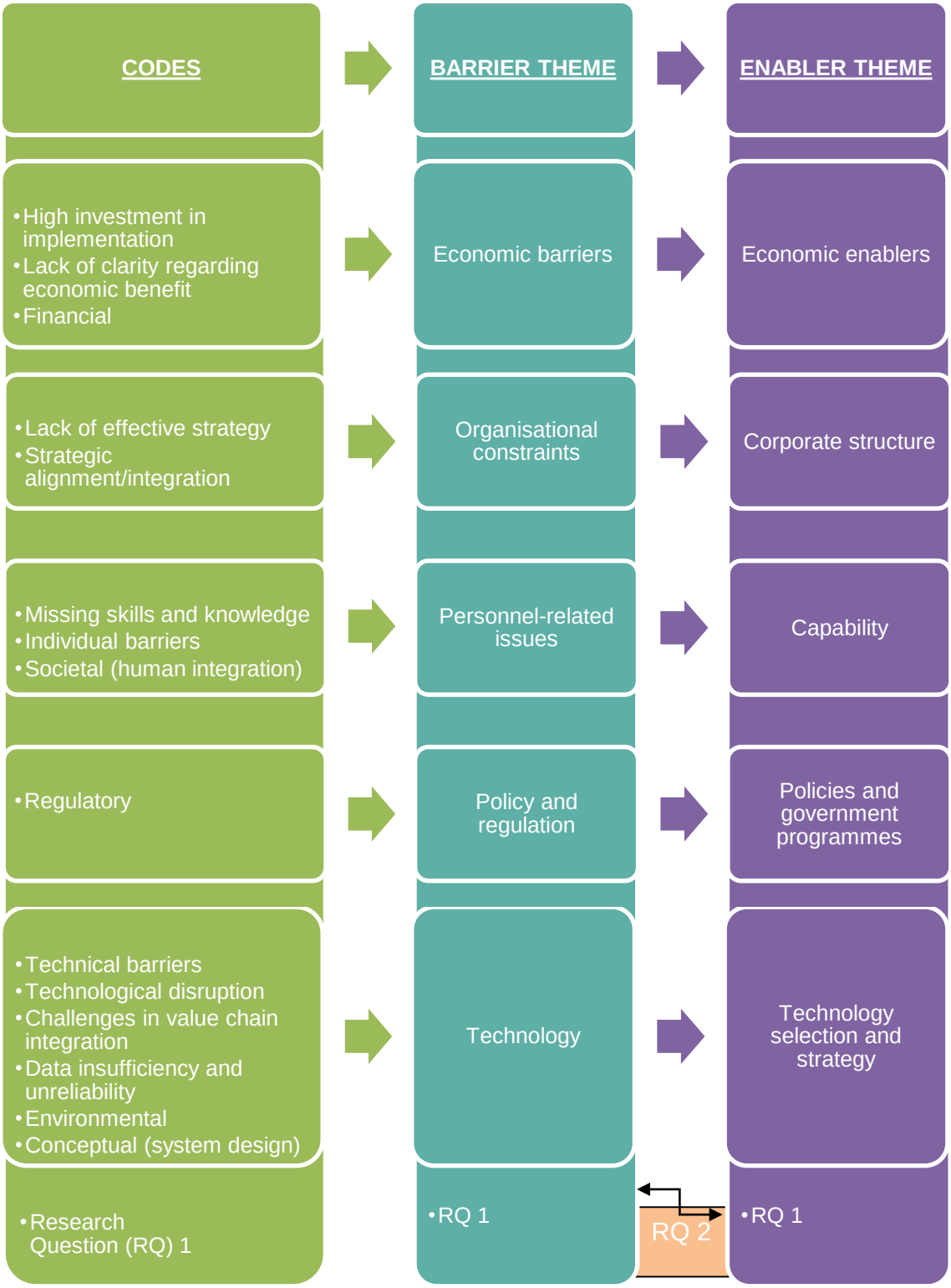


Figure 14. Direct content analysis approach showing the application of codes obtained Jones et al. (2021: 939) and the associations to barrier and enabler themes obtained from Stornelli et al. (2021: 14)

4.7. VALIDITY, RELIABILITY AND BIAS

Quality assurance

To ensure the quality of responses, member checking was performed throughout the research. Cho & Trent (2006:4) label this as the most critical step in credibility assurance. The member checking required the researcher to be objective and rephrase questions slightly if the questions were thought to be misinterpreted by the participant. Clarity on responses were sought on many occasions due to factors like the participant's experience level with supply chains and DSCs, and their ability to interpret questions and vocalise responses. There was no need to seek clarity on responses after the interviews were conducted. Patton (2002: 127) suggested that for some responses where member checking is needed, the responses can be recorded as multiple perspectives instead of a single view. It is also necessary in quality assurance that the data is reliable over time, has internal and external validity, and is representative of all views, being factors of dependability, credibility, transferability and authenticity, respectively. This was critical to quality assurance and done by checking the suitability of each participant for the research before the interview process and then confirming their suitability through the interview process Cho & Trent (2006:4). As the participants were approached from the researcher's own network and from that of professional associates, there were no rejected research participants owing to unsuitable experience in the research areas. Another quality control strategy used was triangulation, which is described by Flick (2009: 444-447) to produce high quality qualitative research. Obtaining perspectives from the two levels of participants, with and without DSC strategies, is an example of the data triangulation used to see if the enablers to overcome barriers from adopters were the same perceived enablers to barriers from those without DSC strategies. Investigator triangulation was also utilised by comparing the findings with researchers investigating a similar research area (Schreckling & Steiger, 2016 and Jones et al., 2021), as well as interviewing a South African consultant with manufacturing digital transformation experience.

Research Limitations

All research will have limitations, and this study is no exception, with the following possible limitations. It is possible that the two-level sample size of seven each may

not be representative of the population examined. Naudé & Szirmai (2012: 47-48) identified 26 different manufacturing sectors in South Africa in their research.

There is also the possibility of bias in the population sectors chosen as this may be primarily dependent on the researcher's existing network, with 4 of the 15 interviews conducted being from the sugar industry in South Africa. Within the sample set, a limitation did exist with the DSC experience of the participants as many of the DSC scenarios and successes found in literature were not mentioned by the participants. If the participants had not adequately considered the adoption of a DSC, then there may be the limitation that the responses received did not sufficiently consider the barriers to adoption. It is also a possible limitation that interview questions could have been misinterpreted leading to non-valid responses; however, as stated above, member checking was performed to reduce and possibly eliminate such a limitation.

Patton (2002: 58) also listed distortion of data by participants by being influenced by the interviewer's responses or reactions to answers or by the participants own bias from work experience. In the interviews conducted, it was a challenge to manage against the concern of data distortion and influence from the researcher due to researcher bias. A further limitation is that the research may be biased towards responses from participants who were willing to participate instead of those who did not participate. Reasons for not participating in the research may include not wanting to divulge DSC competitive advantages or not obtaining company permission to participate. An example of this was a large South African sugar company that did not want to participate in the interviews due to the researcher being from a rival firm and so as not unintentionally to share any strategic advantages.

Consistency matrix

A consistency matrix is given in Appendix E that relates the research questions to sections in the literature review, associated interview questions and the analysis technique utilised. The consistency matrix helped the researcher to align the various aspects of the research and research questions to the interview guide.

4.8. ETHICAL CONSIDERATIONS

Ethical clearance for the research was obtained from the Gordon Institute of Business Science (GIBS) Masters Research Ethical Committee (Appendix B). Only then did the process of data collection commence from research participants. Before each interview, a signed copy of the research consent form (Appendix C) was received. The consent form included a description of the research to be undertaken so that the company could be sought if needed. A video was also produced to introduce DSCs to the participants as it was thought to a complex subject that manufacturers may not be entirely understand. The purpose of the video was also to create a clear distinction between DSCs and 4IR within the factory (Madho, 2022 – An introduction to digital supply chains – YouTube video). The content of the consent form was also reviewed before the interview commenced, with emphasis on the confidentiality of information received, that anonymity of the participants would be maintained. If the participant was uncomfortable with any question then they were free to skip it or speak about the area addressed in general terms without reference to their company. Permission for recording the sessions, as a quality control for data gathering, was sought ahead of the interview guide questions. Cresswell (1998: 133) provided a useful table for ethical considerations in qualitative, quantitative and mixed methods research. The Cresswell (1998: 133) table was not consulted before embarking on the research; however, all types of ethical issues raised were complied with prior to commencing with the study, on commencement, whilst collecting and analysing the data and in the final phase of data reporting, sharing and storing. It is suggested that the table from Creswell (2016: 133) is presented to researchers in academic institutions as it provides a detailed list of ethical issues and how to deal with them.

CHAPTER 5: RESULTS

5.1. INTRODUCTION

Chapter 5 provides the key findings from the interviews conducted with managers of seven manufacturing organisations that have adopted a DSC strategy (Level 1) and seven organisations that have not undertaken a DSC strategy. The results from an extra interview conducted with a DSC consultant specialising in manufacturing is also presented for triangulation purposes, together with the findings from interviews with manufacturers.

The chapter begins by describing the sample for background and the context of the research results. The background also demonstrates the suitability for the sample criteria required. The key themes emerging from a qualitative analysis process are then presented in relation to the two research questions identified in Chapter 3. Impactful and insightful quotations from the participants were also identified and are presented with the results of theme network analyses to address the research questions.

5.2. SAMPLE DESCRIPTION AND SUITABILITY

Table 2 displays the characterisation of fifteen participants for the study. The identity of each participant was protected by the removal of individual names, with the participant instead allocated a code for referrals. The category of Level 1 is assigned to those that adopted DSC strategies and Level 2 to those that did not adopt a strategy, as determined from the interviews.

Purposive sampling was performed for the study and restricted to the researcher's own network and others listed in Section 4.3. – sampling method and size. Therefore, in order to demonstrate the suitability of the participants for the study, the participants' positions have been included in Table 2. The names of the manufacturing companies were also removed to maintain the participant's anonymity. With the company identity and all associated familiarity removed, context is provided for each company in its characterisation by the manufacturing sector, company size and relative expenditure towards digitalisation. The companies are well entrenched in the manufacturing sectors with a minimum operation of 30 years. Table 2 further denotes which of these manufacturing companies are multinational organisations. Only one of the companies interviewed

does not currently operate in South Africa; however, this company was still included in the study due to having operated in South Africa for several decades and only recently having stopped South African manufacturing. The company's size has been considered as medium if the number of employees is 50-300 staff. A large company was considered to have more than 300 employees. The appetite for digitalisation was gauged by the approximation of profit spent on manufacturing technological expenditure. For this research, approximations of less and more than 5% was considered to be low and high expenditure, respectively.

Also included in Table 2 is the characterisation of Participant P15. Whilst P15 is a DSC consultant to South African manufacturers and not a manufacturing entity akin to P1-P14, participant P15's own research and experience in the area of study, represented both Level 1 and 2 insights, although restricted to mostly medium-sized companies with a low digital spend. The insights from P15 were utilised for data triangulation with the findings from manufacturers in this research.

Results to further demonstrate the suitability of participants for the research undertaken, is the concept cloud shown in Figure 15. The concept cloud was obtained utilising Atlas TI, with the software generating key concepts from the documents and coding for each participant. Some Atlas TI identified concepts were removed from Figure 15 to maintain the anonymity of participants. Mentions of terms like DSC, customer, strategy, market, cost, value, cluster, network, technology, system, enabler, barrier, time and supply from participants demonstrate their suitability for the research undertaken.

Table 2. Description of research participants

Participant code	DSC Level	Manufacturing sector	Participant position	Company size	Digitalisation spend
P1	1	Textiles	Chief Operating Officer	Medium	High
P2	1	Basic chemicals*	General Manager	Large	High
P3	1	Transport equipment*	General Manager	Medium	High
P4	1	Beverages*	Supply Chain Director	Large	High
P5	1	Beverages*	General Manager	Large	Low
P6	1	Food*	Supply Chain Director	Large	Low
P7	1	Food	General Manager	Large	Low
P8	2	Food	Head of Procurement and Supply Chain	Large	High
P9	2	Food	Chief Operating Officer	Large	Low
P10	2	Motor vehicles*	Head of Procurement and Supply Chain	Large	High
P11	2	Textiles	Supply Chain Manager	Large	Low
P12	2	Basic chemicals	General Manager	Medium	Low
P13	2	Food	General Manager	Large	Low
P14	2	Food	General Manager	Large	High
P15	1+2	SA manufacturing	Consultant	Medium	Low

** Multinational company that operates in South Africa or has previously done so*

Figure 15. Concept cloud showing the key concepts generated by Atlas TI in data analysis to validate relevancy to research area and demonstrate suitability of participants interviewed

5.3. DATA SATURATION

Following the discussion in Section 4.3. on research methodology and sampling size, data saturation is a technique that is commonly used to show if an adequate number of interviews were performed in qualitative research. Theoretical data saturation is commented on in Section 4.3. (Creswell, 2016:239) and is a guideline to the number of interviews needed until no new themes emanate from the research. A minimum number of three to six interviews for phenomenology research designs were prescribed by Creswell (2016:239) and so a minimum number of six interviews were targeted for Levels 1 and 2, being DSC strategy adopters and non-adopters, respectively. Figure 16 shows that seven interviews were conducted at Levels 1 and 2, each. No new codes were obtained from the 7th interview at each level.

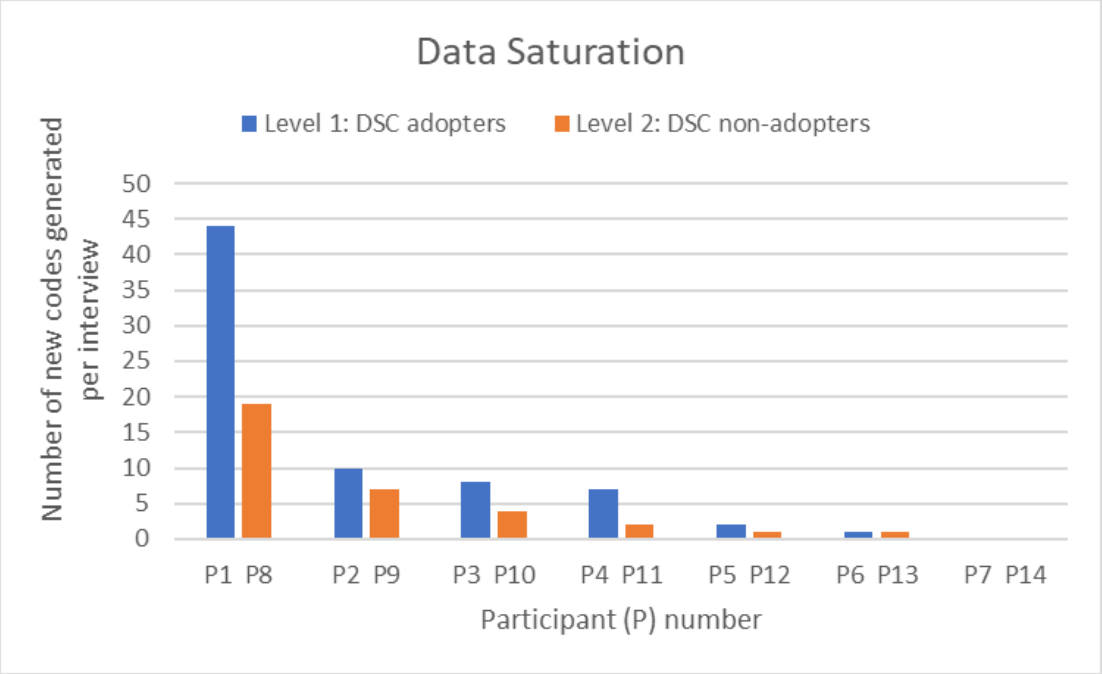


Figure 16. Number of new codes generated per an interview with Level 1 and Level 2 participants to show data saturation at each level

5.4. RESEARCH QUESTION 1 RESULTS

Chapter 3 outlines Research Questions 1 and 2 (RQ1 and RQ2) that precipitate from the literature review in Chapter 2. In addressing the research questions, there is scholastic importance to close an identified research gap from the literature review; however, there is also practical importance for South African manufacturers

to overcome the inertia to the first step in DSC strategy adoption, being digital goal setting.

Research Question 1 (RQ1): From a South African manufacturing manager's perspective, what are the types of barriers and enablers that are relevant to the digital goal setting stage of the digital supply chain adoption process?

Figure 17 gives the approach taken in addressing RQ1. The barriers and enablers to adopting a DSC strategy are presented, including those that are specific to South African manufacturers. The filter of digital goal setting is then used to address RQ1 by extracting those barriers and enablers that are relevant to South African manufacturers for getting started with DSC opportunities.

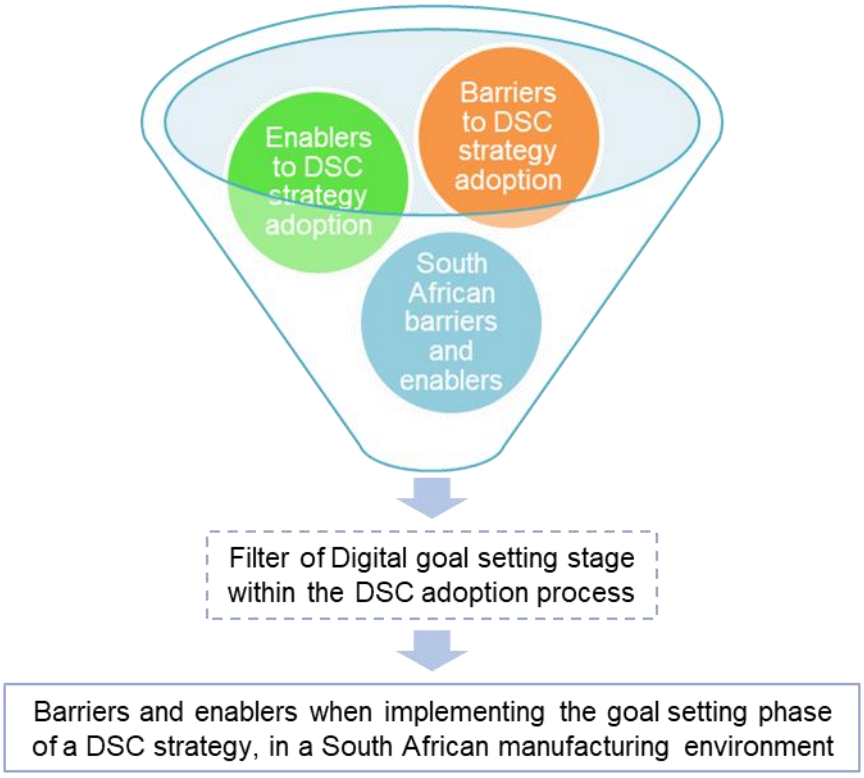


Figure 17. An overview of the research results presented to address Research Question 1

5.4.1. Barriers to DSC strategy adoption

The network of assigned codes from the interviews and their associated barriers themes is shown in Figure 18. As per Chapter 4, a deductive analysis approach was utilised that consider codes and themes from the literature review. From the

interviews conducted was the code of data sharing within the theme of technology barriers. A new theme of corporate culture was assigned to new codes of generational, ethics and change management.

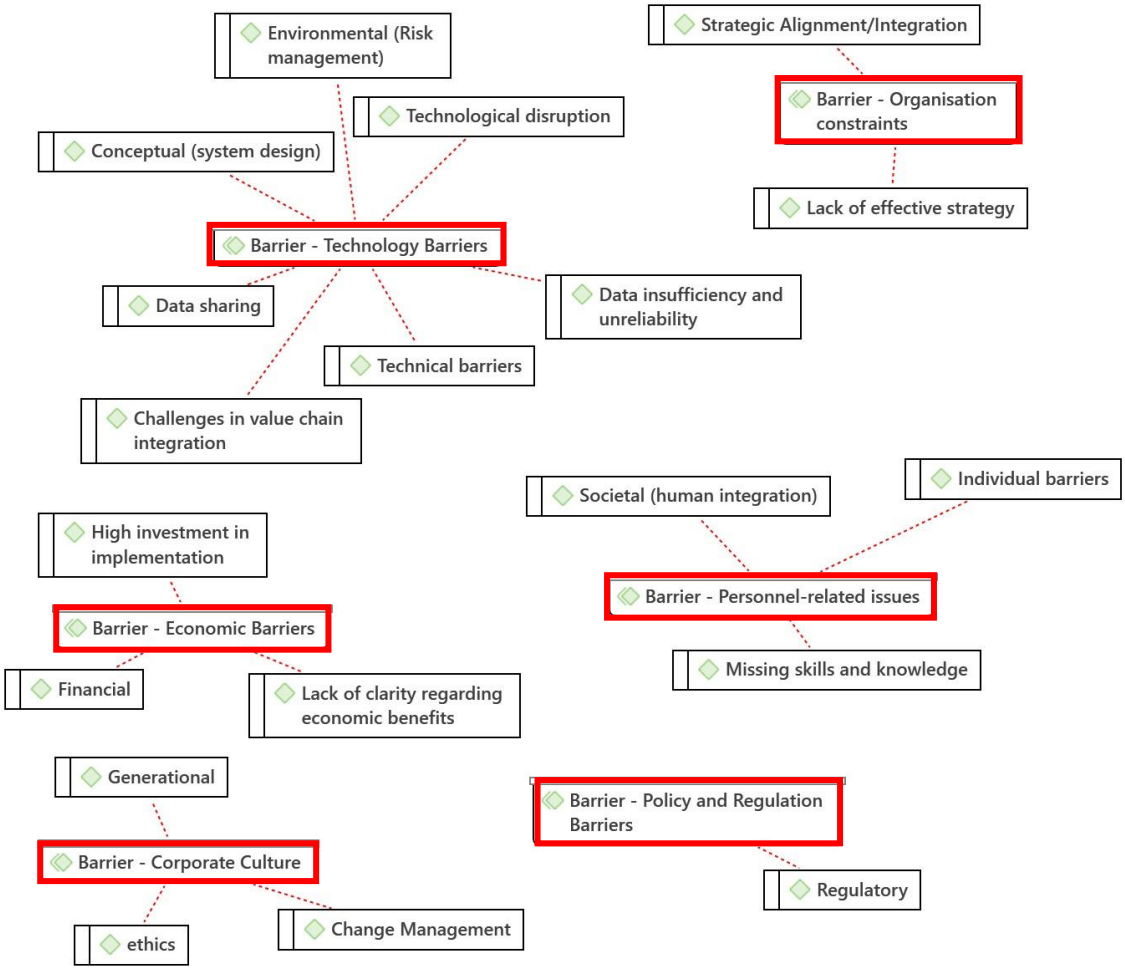


Figure 18. Barrier codes and associated barrier themes to the adoption of a DSC strategy (generated using Atlas TI)

The codes and barriers from Figure 17 are rearranged in Table 1 after being sorted by the frequency of code occurrence in the interviews. The table also includes those codes mentioned in the literature review but not derived from the interviews conducted.

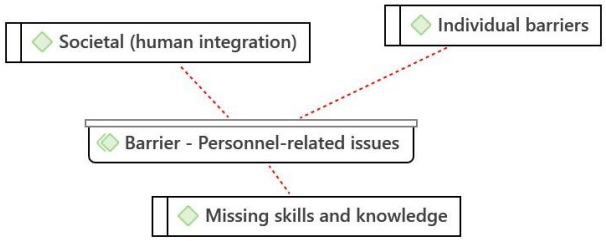
Table 3. Barrier themes and codes as sorted by frequency of code occurrence in interviews

Barrier theme	Code	Frequency	Code found in literature
Personnel-related issues	Missing skills and knowledge	20	Yes
Corporate culture	Change Management	19	No
Economic barriers	Financial	14	Yes
Organisational constraints	Lack of effective strategy	10	Yes
Technology barrier	Technical barriers	9	Yes
Technology barrier	Challenges in value chain integration	9	Yes
Technology barrier	Data sharing	6	No
Economic barriers	Lack of clarity regarding economic benefit	4	Yes
Corporate culture	Generational	3	No
Economic barriers	High investment in implementation	2	Yes
Personnel-related issues	Societal (human integration)	2	Yes
Policy and regulation	Regulatory	2	Yes
Technology barrier	Technological disruption	2	Yes
Corporate culture	Ethics	2	No
Personnel-related issues	Individual barriers	1	Yes
Technology barrier	Data insufficiency and unreliability	1	Yes
Technology barrier	Environmental	1	Yes
Organisational constraints	Strategic alignment/integration	0	Yes
Technology barrier	Conceptual (system design)	0	Yes

The results from Figure 18 and Table 3 are categorised in Sections 5.4.1.1. – 5.4.1.6. according to their barrier themes. Only the top six code frequencies in

Table 3 and those that did not appear in the literature reviewed are further provided to give insights for the data analysis. Quotations from the research conducted are also provided to give insights for the data analysis.

5.4.1.1. Research findings for barrier theme Personnel-related issues



There were no unique codes generated for the barrier theme Personnel-related issues. The highest recurring codes for this theme was Missing skills and knowledge (frequency 20). The codes Societal (human integration) and Individual barriers had frequency counts of 2 and 1, respectively.

The following quotations were selected from the participants relating to missing skills and knowledge, to provide insights for the data analysis. The quotations highlight the DSC skills gaps that does exist in South African manufacturing companies. The skills gap was not restricted to the general workforce but included company leaders as well.

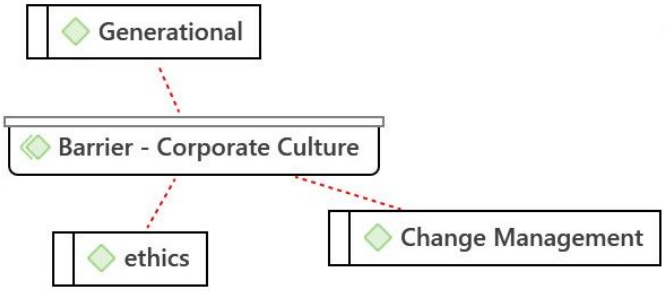
P9: "*Missing skills and knowledge is the biggest barrier that I see where I work. When you talk to these concepts, people don't know what you're talking about. I'm talking about very senior people. They they're not aware. A lot of these senior people are in accounting or in marketing. So, if you look at the CFO's and MD's of companies they are traditionally Chartered Accountants. Accountants lack knowledge about systems, knowledge about factories, knowledge about manufacturing. There isn't an appetite for risk. They may be a little more conservative in terms of new technologies.*"

P11: "*When we look at challenges, there is a lack of skills and a lack of competence, so the lack of competence which talks to skills.*"

P8: "*Skills was the biggest barrier we had.*"

P8: "*There is a skills gap. So, I think you've got to develop your people as a nation to get better insights. I find it interesting that there are some really bright people, really strong, really good people to develop."*

5.4.1.2. Research findings for barrier theme Corporate culture



The barrier theme Corporate culture is a unique theme emanating from the research conducted. There were 3 unique codes generated for the barrier theme Corporate culture. The highest recurring codes for this theme was Change management (frequency 19). The codes Generational and Ethics had frequency counts of 3 and 2, respectively.

The following quotations were selected from the participants relating to Change management, to provide insights for the data analysis. The quotations highlight the role of leadership with change management.

P1: "*So one barrier is getting customers to subscribe to change.*"

P9: "*Change management. Struggle with the age gap and the way technology is moving."*

P2: "*So definitely change management. I also think you know it has to do with the people at the top. I think people leadership is super important. That sponsorship and why we doing this, and the drumbeat. Then workforce capacity. We were trying to overlay these initiatives on a strained workforce, and I just don't think they have the bandwidth to take it in.*"

P5: "*Culture of the business and how fearless we are to adopt new ideas and thoughts, how innovative and what's the appetite for innovation within a business as well."*

P3: "*It's all about trust."*

The following quotations were selected from the participants relating to Generational, to provide insights for the data analysis. The quotations highlight the relationship between technology adoption with older and younger generations. It was also pointed out that it was important not to stereotype generations as there are some older generation staff that have an affinity for technology.

P5: "*And true to that, we saw that in the last year we had our Global Vice President of supply being replaced. He was a 62-year-old individual and being replaced by a 44-year-old. And I can tell you why. It's because of the embracing of technology.*"

P15: "*I think your barriers are largely Generational. And fear of technology. And largely, a guy who's in his 60s, his managerial style is on the bus. I'm going to take my team away to the bush, and they are going to listen to me talking about us for three days. We are beyond that. Your youngsters today, your 22-year-olds, they're sitting multitasking. They are participating in the strategy.*"

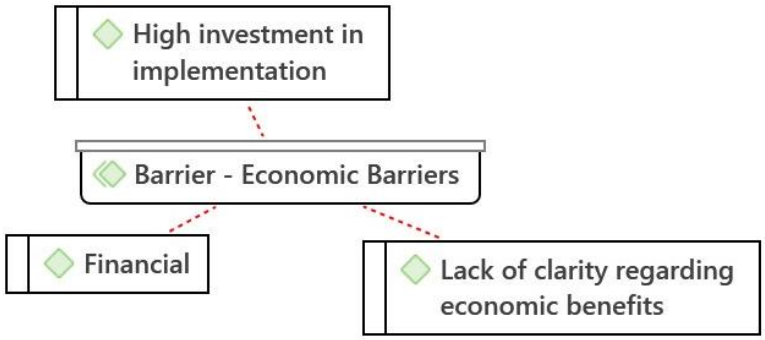
P15: "*And within generations, there is a side, in that there are a lot of good engineers that might be 65 but they think like 25-year-olds. So, one must not box the generational context*. *It's resistance to learning and understanding technology. You've got it open up. You've got to embrace it.*"

The following quotations were selected from the participants relating to Ethics, to provide insights for the data analysis. The quotation highlights that companies are concerned with ethics and sustainable practices.

Quotations pertaining to code Ethics:

P8: "*Primark is a clothing retailer that provides smart-end fast fashion that is cheap. They're the only supplier that we know of that actually lists all of their own manufacturing suppliers on their website. They have 100 people auditing their suppliers across the world. Their focus has been about modern slavery, about ethics, about sustainability*."

5.4.1.3. Research findings for barrier theme Economic barriers



There were no unique codes generated for the barrier theme Economic barriers. The highest recurring codes for this theme was Financial (frequency 14). The codes Lack of clarity on economic benefits and High investment in implementation had frequency counts of 4 and 2, respectively.

The following quotations were selected from the participants relating to the code Financial, to provide insights for the data analysis. The quotations highlight the hurdle that finances posed as a barrier to DSC adoption. This was due to a perceived low initial return on investment and the availability of capital in a constrained and uncertain business environment.

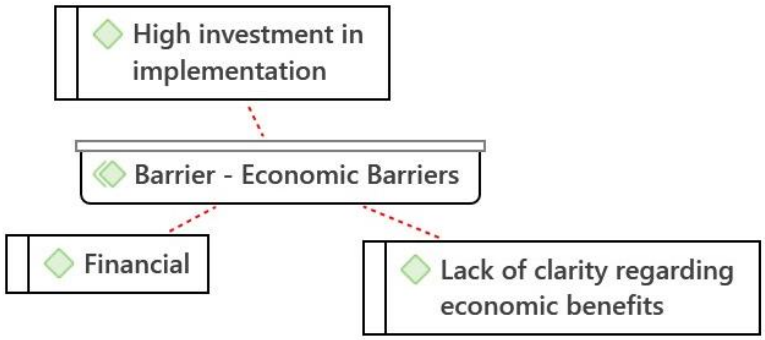
P1: "*Financial commitment from retailers and consumers are another barrier. They're not looking at the benefits of digital supply chains but rather additional costs being incurred right now.*"

P1: "*The biggest challenge is the access to the funds for digitisation. Because there's no return immediately on the bottom line.*"

P4: "*Cash flow is a big problem now. The pandemic, the war in Ukraine and the hyperinflation that we've experienced as a result of that has caused many businesses to go out of business. And to compensate for a drop margins, the shareholders are holding back with cash and are restricting our capital expenditure. I think that will be the biggest barrier.*"

P12: "*We were dealing with a lot of other small to medium sized businesses, so the supply chain got more and more complex. It things in the supply chain go wrong, it can tie up so much of working capital. This will literally push you over the edge.*"

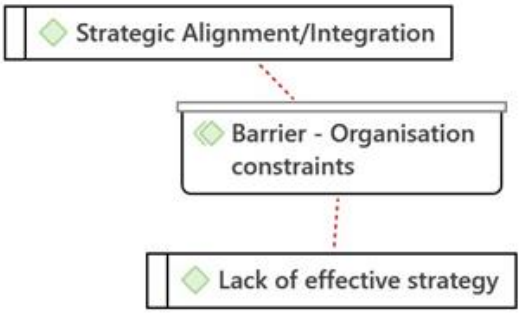
5.4.1.4. Research findings for barrier theme Economic barriers



There were no unique codes generated for the barrier theme Economic barriers. The highest recurring codes for this theme was Financial (frequency 14). The codes Lack of clarity on economic benefits and High investment in implementation had frequency counts of 4 and 2, respectively.

The following quotations were selected from the participants relating to the code Financial, to provide insights for the data analysis. The quotations highlight the hurdle that finances posed as a barrier to DSC adoption. This was due to a perceived low initial return on investment and the availability of capital in a constrained and uncertain business environment.

5.4.1.5. Research findings for barrier theme Organisational constraints



There were no unique codes generated for the barrier theme Organisation constraints. The highest recurring codes for this theme was Lack of effective strategy (frequency 10). The code Strategic alignment/integration did not emanate from the research.

The following quotations were selected from the participants relating to the code Lack of effective strategy, to provide insights for the data analysis. The quotations

highlight that buy-in for DSC is required from leaders and noted that it takes time and energy to implement such systems. The drive for the strategy needs to come from leaders.

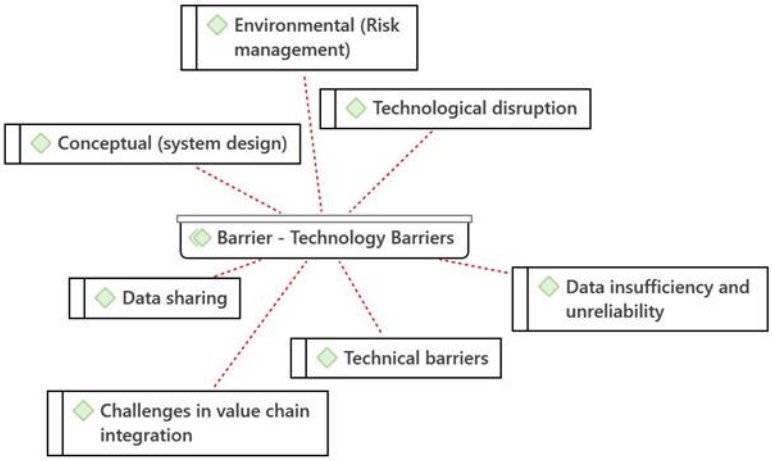
P2: " *When you are living from hand to mouth, it is pretty much survival for the next day. And let's see what tomorrow holds. But I think that was really predicated on the organizational culture. Capex was impossible to get from executives. They wanted to turn around the business by addressing fixed costs without an appetite to spend an outlay any amounts of money. To drive efficiencies wasn't really there.*"

P11: "*Lack of leadership drive*".

P3: "*So buy-in from the top level is needed. If it exists.*"

P7: "*It takes time and energy*".

5.4.1.6. Research findings for barrier theme Technology barriers



There was 1 code generated for the barrier theme Technology barriers that was different to those derived from Jones et al. (2021: 939), being data sharing (frequency 6). The highest recurring codes for this theme were Technical barriers and Challenges in value chain integration (frequency 9, each). The codes Technological disruption, Data insufficiency and unreliability, Environmental (Risk Management) and Conceptual (system design) had frequency counts of 2, 1, 1 and 0, respectively.

The following quotations were selected from the participants relating to the code Technical barriers, to provide insights for the data analysis. The quotations highlight the old I.T. infrastructure and systems across the supply chain that are not aligned.

P10: "*I think that's one of the sorts of key barriers that I see with regards to these systems is having systems that can talk to each other. Suppliers all have different systems."*

P8: "*In the technology space we have very old legacy I.T. infrastructure*."

P13: "*It will also be about availability of digital platforms with your stakeholders as well because it's no good with you having this fancy digital supply chains platform when those that you want to communicate with don't have similar systems.*"

The following quotations were selected from the participants relating to the code Challenges in value chain integration, to provide insights for the data analysis. The quotations highlight that integration extends to more than data but also to alignment of strategies and goals to foster collaboration. Trust is quoted for the integration.

P2: "I *want to mention one very important thing that happens with these types of initiatives. People just throw everything at it, without understanding the value chain and don't value stream map the supply chain. So, there's a lack of supply chain integration through data, through process usage, insights, everything. And as a result, we think there's one solution that's going to fix everything. It is imbalance in the supply chain.*"

P3: "I*t requires a lot of buy-in, not only from within the organisation, but it requires buy-in from across the supply chain partners because the more supply chain partners that buy into it and understand the benefits that can come out of digitisation, that then allows the cost to be shared and it allows monetisation to happen a lot easier. It's about trust. It's about being able to see that collaboration exists within the supply chain and it's about getting everyone on the same page in terms of this, a future vision whereby it becomes a lot clearer how all parties in the supply chain can actually benefit through digitising.*"

P8: "*It's about breaking comfort zones. It's breaking it, going through those interfaces, maybe between companies.*"

The following quotations were selected from the participants relating to the code Data sharing, to provide insights for the data analysis. The quotations highlight that the need to protect intellectual property and competitive advantage through cybersecurity.

P1: "*… and sharing information confidentiality. People are hesitant to share because they think that you will use it against them. They are also scared about if someone else, like a competitor, will get that information. And the problem is a lot of suppliers work with competing manufacturers.*"

P6: "*So I don't think they've got access to our SAP system to import that sort of information. Then there's a question of whether they should.*"

P10: "*Suppliers are generally reluctant to share bad news. So that's a barrier.*"

5.4.2. Enablers to DSC strategy adoption

The enablers to DSC strategy were obtained from a deductive analysis approach using themes in the literature review. The themes from the research conducted are given in Table 4 in descending order from the highest frequency of theme association. The table also includes those themes to which specific enablers mentioned did not fit the themes found in literature.

Table 4. Enabler themes as sorted by frequency of occurrence in interviews

Enabler theme	Frequency	Enabler theme found in literature
Capability enablers	30	Yes
Leadership mindset	27	No
Technology selection and strategy	22	Yes
Customer demand	10	No
Corporate Structure	6	Yes
Policies and government programmes	5	Yes

The results from Table 4 are categorised in Sections 5.4.2.1. – 5.4.1.6. according to their enabler themes and quotations pertaining to each theme to provide insights for data analysis.

5.4.2.1. Research findings for enabler theme Capability enablers

The Capability enabler theme was assigned to the barrier theme of Personnel-related issues. The enabler theme was derived from literature and had the highest frequency count from all of the enablers of 30.

The following quotations were selected from the participants relating to the enabler theme Capability enablers, to provide insights for the data analysis. The quotations highlight that capability can be developed from training and that this training is required at all organisational levels. Capability was also quoted as something that can be recruited.

P15: "*It's another whole learning process. And that is where technology has to be taught into organisations. Loreal, for example, when they decided they needed to do smarter market demand creation, they hired 5000 digitally capable people to train the global workforce into digital capability."*

P8: "*The biggest barrier we had was skills. So we reorganised the function, by bringing in an engineering team and new skills*".

P13: "…*you would bring people in to train and obviously hold their hand through the process of implementation and post implementation.*"

P5: "*So we need to bring people in from more developed markets to help us understand what's really out there and then bring in some global best practice*."

P3: "*The opportunity that arises is that there's definitely a push for a renewal of skills. So, you're able to bring your skills into a market and being able to train and develop. Channelling developed individuals would help with digitisation and being able to work together with these technologies, I think that's definitely an opportunity.*"

5.4.2.2. Research findings for enabler theme Leadership mindset

The Leadership mindset enabler theme was a unique theme emanating from the research for the unique barrier theme Corporate culture. The enabler theme had a frequency count of 27.

The following quotations were selected from the participants relating to the enabler theme Leadership mindset, to provide insights for the data analysis. The quotations highlight that the influence that leaders have in driving change, sustainability, ethics and innovation. Various thoughts on change management were also captured.

P6: "*Inherently people have got a level of anxiety around the change" … "What you want is almost a burning platform for change."*

P8: “*That's not the issue, it's the process management, the change management to embed with users to make it work effectively. And resistance to change is the challenge, so that for me, the business change programme, is more critical than just the system element, because it really is.”*

P8: “*Sustainability in supply. Making sure the workers and the ethics around modern slavery are absolutely 100%*.”

P13: “*Also, you want the buy-in of your people because you'd have a lot of people push back, especially when there's something new and it's change management that you must have in place. Where you would bring people in to train and obviously hold their hand through the process of implementation and post implementation.”*

P14: "*On change management, don't be in a rush. Communicate in advance and explain to everybody why you're doing it so that they understand what you're doing. You don't tell them this is what we're going to do. You go through the process, explain to them, you ask them questions, and often you know, as you know, I didn't know very much about technology at all, so by just sitting down with the guys and getting their feedback, getting their good ideas, your plan gets better. Number one and number two, you get their bond. It's the solution but it is also their solution. And so, it’s just a change management thing. Go slowly. Don't be in too much of a rush and genuinely get feedback to get your plan sharper and get increased buy-in from your team. Simple."*

P9: “*Change management, there is a struggle with the age gap and the way technology is moving. And I think, in industries that don't make good profits. I think they'll be keener than sometimes places that make good healthy profits and have a regular customer base.”*

5.4.2.3. Research findings for enabler theme Technology selection and strategy

The Technology selection and strategy enabler theme was assigned to the barrier theme of Technology barriers. The enabler theme was derived from literature and had a frequency count of 22.

The following quotations were selected from the participants relating to the enabler theme Technology selection and strategy, to provide insights for the data analysis.

The quotations highlight that technical barriers are a problem for South African manufacturers. The leader's role in driving technology was also highlighted.

P1: "*Some of them (customers) still have very manual systems. We had to digitise their information for integration to the supply chain for them to give us information up front… Once the ERP system was modified and data was obtained from customers, a few customers did see the benefits of collaboration and then started to digitise themselves… speed to market is your advantage throughout the value chain… co-align production… training for customers is provided… consistency of quality… we know beforehand what is coming in, where it's coming from, where it was produced so that our operating procedures are bespoke for that product.*"

P2: "*The mindset change we did was to use some very simple elementary projects.*"

P4: "*Your information is obtained timeously, and it's not delayed. You can see it now, to make decisions quickly and it's easy to pivot if you were going in the wrong direction. So, we know that the enablers in terms of efficiencies will make the business case for digitisation stronger. And everybody has realised that in terms of the leadership of all organisations. Some are saying it's difficult to make business cases, but actually a lot of senior leadership are demanding that we digitise because they know the value of digitisation.*"

P12: "*A differentiator that rubbed off on me was that these guys have got passion."*

P15: "*I think the enablers would be for us to lead the organisation's digital transformation. And digital strategy development. Because it's coded come from the top. So, in terms of enabling, us CEO's must actually lead."*

P13: "*I think the opportunity is there because it's very few companies that have gone this route… First mover advantage. Branding. Establishing yourself as a leader in in this industry.*"

5.4.2.4. Research findings for enabler theme Customer demand

The Customer demand mindset enabler theme was a unique theme emanating from the research. As such it was not assigned a corresponding barrier theme. The enabler theme had a frequency count of 10.

The following quotations were selected from the participants relating to the enabler theme Customer demand, to provide insights for the data analysis. The quotations highlight that customers are demanding DSC integration.

P2: "*Customers want to partner with a forward-thinking organisation that they want to trust. I think everything is based on trust for us."*

P5: "*Our consumer is very open to innovation and very open to new ideas. Our customers are hungry for it. So, if you had to sit down and pitch to your customer how you're going to increase the margin through technology, they would listen right?"*

P4: "*Look at the customers are asking for it. They are demanding it. Well, if you don't change fast enough, you might find yourself out of business customers. We wanted it to be easy for them to do business with us. We know that. And if they see us as being behind, we will certainly lose business. So, we are quite aware that's the pressure. And we also want our customers to have the good experience with us as they interact with us. And we know that. Through this? And digitisation. We will be able to exploit the opportunities around efficiency faster. Be quick to make decisions. If you've got the visibility of the supply chain. "*

P3: "*So from a customer's perspective, it is better if you know the supply chain from not only from efficiency point of view, but also a cost point of view. The moment you start including all these enabling technologies towards utilisation, the challenge then becomes how you monetise it. That there's sufficient return and that there is sufficient win with the customers."*

5.4.2.5. Research findings for enabler theme Corporate structure

The Corporate structure enabler theme was assigned to the barrier theme of Organisation constraints. The enabler theme was derived from literature and had a frequency count of 6.

The following quotations were selected from the participants relating to the enabler theme Corporate structure, to provide insights for the data analysis. The quotations highlight the need for skilled digitalisation executives to drive DSCs.

P1: "*Our executive buy-in was from surveys with potential customers... Senior management recognised the need for a DSC strategy for competitive advantage as*

in a changing world, people were looking at ease of doing business and improving their businesses."

P15: "*Loreal recruited a lady that came in as the Chief Executive and was entrusted with leading the digital transformation of that organisation... leveraged digital capability to steer the entire business in that direction… appointed Chief Information Officer and Chief Data Officer new roles that emerged through the digitisation of the business."*

P11: "…*we had a Chief Information Officer and Chief Digital Transformation Specialist… Unilever was pretty much the same.*"

5.4.2.6. Research findings for enabler theme Policies and government programmes

The Policies and government programmes enabler theme was assigned to the barrier theme of Policy and regulation barriers. The enabler theme was derived from literature and had a frequency count of 5.

The following quotations were selected from the participants relating to the enabler theme Policies and government programmes, to provide insights for the data analysis. The quotations highlight the need for government intervention with policies and regulations to promote DSCs. Initiatives with masterplans and manufacturing clusters have positively promoted the use of DSCs in the South African textile sector.

P1: "*… and sharing information confidentiality. People are hesitant to share because they think that you will use it against them. They are also scared about if someone else, like a competitor, will get that information. And the problem is a lot of suppliers work with competing manufacturers. The textile master plan has helped where we are trying to align with our stakeholders.*"

P1: "*There has been also some work with other partners in the industry, like clusters and organisations. They have requested us to be part of their digital supply chain, by actually subscribing and so then they can have some traceability with products. There's a thing called better cotton initiative, it's called PCI, with companies like Woolworths onboard. PCI is Payment card industry and looks at safeguarding and protecting customers' account data. Then there is BCI or Better Cotton initiative. So today actually they actually trace the product back to the farmer*

who grows a cotton. Throughout the value chain, right to manufacture. It is a service that you have to subscribe to. You need to then report on your processes or where you actually sourced where you manufacture and in that gets sold."

P2: "*If you are engaged in this organisation, I think you need an appropriate level of policies and frameworks. You know, contractual frameworks that link all components, that's data manufacturing, logistics problem, service providers, the procurers. Another place is even the customers that then feeds into the bigger picture. I don't think you know you can just do it internally, so it needs to have that very comprehensive view."*

P11: "*And I think also that there needs to be drive from a South African perspective, from government as well. The DTIC needs to fund the right sustainable initiatives."*

5.4.3. Specific South African barriers and enablers to DSC strategy adoption

In addition to the general barriers and enablers reported to DSC strategy adoption, the participants were also asked to identify opportunities and challenges that were specific to operating in South Africa (SA).

Two terms applicable to conditions are explained. The first is loadshedding, which is an action by the state-owned energy enterprise to interrupt energy supply to the power grid to reduce the load on the energy generating plants (Dictionary.com, accessed 2 February 2023). The second term is Broad-based black economic empowerment (B-BBEE), which is a South African Act to promote economic transformation and promote the participation of South African black people in the economy (thedtic, accessed 2 February 2023).

The only SA opportunity identified was from P4 that mentioned the availability of digital vendors.

P4: "*We've got access to these international customers like Microsoft. If you look at our companies here like Altron Karabina (Microsoft), they have got good representative here. And even SAP has got offices here with consultants. So, in terms of viability of skills locally, there's certainly no shortage and with capability, I think we are right up there with the best in the world."*

The challenges identified by the participants, in the order of most mentions, were digital connectivity, loadshedding, high rate of unemployment and resistance to digital transformation, unions, threat of global warming, broad-based black economic empowerment (B-BBEE) and contrary to P4 was a limited number of digital vendors. Some quotations are given relating to the challenges in order to provide context for discussion.

Quotations pertaining to the SA challenge of digital connectivity

P4: "*Obviously the limitations here is the 3G or now 5G coverage*".

P5: "*We can't go outside South Africa because of network challenges and connectivity*".

P7: "*IT is a challenge. We still can't keep connectivity during loadshedding".*

P8: "*Networks and bandwidth is definitely a key issue*".

Quotations pertaining to the SA challenge of loadshedding

P5: "*With the loadshedding and the energy situation, the cost to produce and manufacture has shot up*."

P3: "*The reliability of energy, I think that does play a part because a core component of being able to be digital is that you always have uptime and real time information, which is one of the core benefits. And the unreliability of energy supply means that you need to spend a lot of effort in in ensuring reliability of energy before embarking or before fully benefiting from your digitalisation strategy*".

P10: "*Load shedding, obviously some suppliers still get it.*"

Quotations pertaining to the SA challenge of high rate of unemployment and resistance to digital transformation

P3: "*The South African landscape is different to other areas where automation and digitising is easier accepted. So with that and generally in Africa, it comes with a bit of resistance. Particularly, there's always this concern around unemployment and labour. There are also the challenges and resistance, particularly from unions that would be concerned around employment.*"

P15: “*We are a growth population growth country, so small technologies do they work in South Africa, yes they do. But is it ethical to have them working and costing people jobs?”*

P2: “I’ll give you both my view and challenge being the fact that we have a high unemployment rate, and there's a lot of myths around digital supply chain that it's going to cannibalise jobs.”

Quotations pertaining to the SA challenge of unions

P3: “…*there's always this concern around unemployment and labour. There are also the challenges and resistance, particularly from unions that would be concerned around employment.*”

P2: “*A lot of the issues then went in towards labour relations and we had to get unions involved because people felt like their jobs were under threat, which is a big concern in this in this country, so it becomes an issue.*”

Quotations pertaining to the SA challenge of threat of global warming

P4: “*Gartner, they're telling us that we got the issue of disasters is going to continue in Africa, especially in southern Africa. And we're going to continue having floods and all of these Global warming type of events. That’s going to interrupt our supply chains.*”

Quotations pertaining to the SA challenge of B-BBEE

P1: “*Some customers demand business is done with B-BBEE compliant partners. Our problem is that some of our suppliers are overseas-based. With the pressure to maintain your B-BBEE rating, you are forced to try to use a lot of the small enterprises, medium sized enterprises which are limited in the digital age. These businesses are usually one-man bands, with manual systems such as reading notes. Running those businesses digitally is different as you have your own organisation to run.”*

Quotations pertaining to the SA challenge of limited number of digital vendors

P5: “*It's always a challenge finding the right suppliers to provide the services that you need. I think in South Africa, it's not as easy as in more developed markets. So, finding the right people of right organisations to partner with, to implement, is a*

challenge. To give you an idea about the data collection that we do, we could only find 2 suppliers within South Africa that could do it for us."

5.4.4. Barriers to digital goal setting in DSC

In addition to the barriers to adoption of a DSC strategy, participants were also asked to point out any particular barriers to the first step of the DSC development journey, namely, digital goal setting. The participants were adequately briefed on the step of digital goal setting within a DSC strategy in the introduction to the interviews, as well as in the introductory video shared.

Only four participants distinguished differences between general DSC barriers and barriers specific to digital goal setting barriers. Quotations from these participants are presented with the results of theme network analyses (Figure 19) to address Research Question 1).

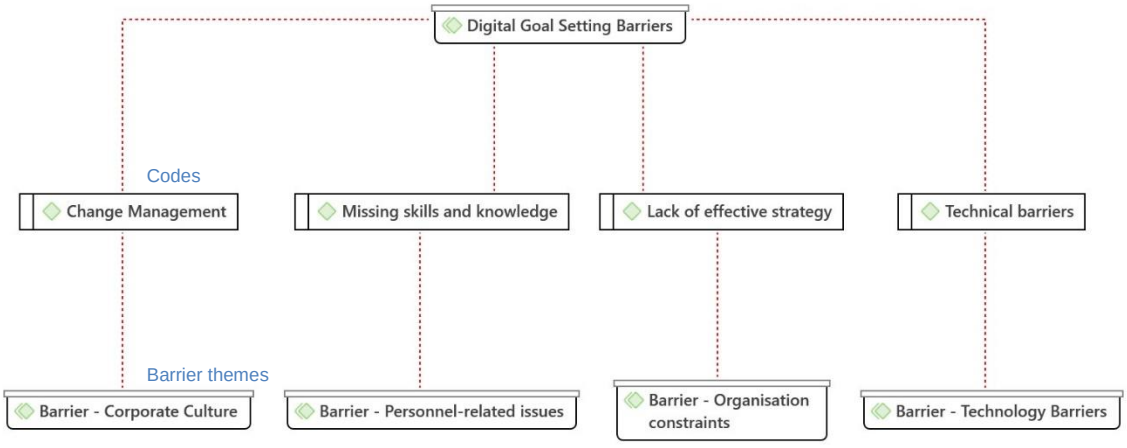


Figure 19. Codes and associated themes that are barriers to the digital goal setting step of a DSC strategy (generated using Atlas TI)

P1: "*It has to do with buy-in from executives... Senior management recognised the need for a DSC strategy for competitive advantage as in a changing world, people were looking at ease of doing business and improving their businesses. Planning was important. Businesses wanted more information, they wanted to know when they were getting their orders so they could plan accordingly.*"

P1: "*Exposure to international best practices is an enabler. Our cluster visit to Zara exposed us to how they were using DSCs and data and AI to plan their systems, change their operations, quick responses, quick turnarounds, less wastage, with a lean philosophy adopted."*

P9: "*I think the biggest is knowledge. I think the world's moving very, very fast and I think South Africa is usually behind the curve on a lot of things. I think the biggest one is a desire to knowledge. People don't really understand what a blockchain is, so people are apprehensive towards it."*

P9: "*Also time. I think with time we could probably do it, if we had a few examples, and you drive it. But I don't think it'll be an easy sell. I do believe that we will need strategic partners.*"

P11: "*Role of leadership in terms of being that first hurdle to digital goal setting. When it comes to setting the pathway on the way forward, it largely depends on leadership*."

P15: "*This is such a good question. I don't think they understood what goals they wanted from their digital strategies and capabilities. They don't know… In digital goal setting there is uncertainty. I think you can say that's across the board. People don't know what they want. With 4IR technologies, you have to read about it, synthesise it and see how that applies to strategy."*

5.5. RESEARCH QUESTION 2 RESULTS

Research Question 2 (RQ2) is the associated sub-question to RQ1.

Research Question 2 (RQ2): What are the specific enabling initiatives needed to overcome barriers to digital goal setting in the adoption of DSCs?

The results for RQ2 are presented in Figure 20. It represents a combination of the direct content analysis approach in

Figure 14 with the RQ1 results from Figure 19. Figure 21 gives the results of specific initiatives from participant responses (Section 5.4.2.) linked to the digital goal setting enablers identified.

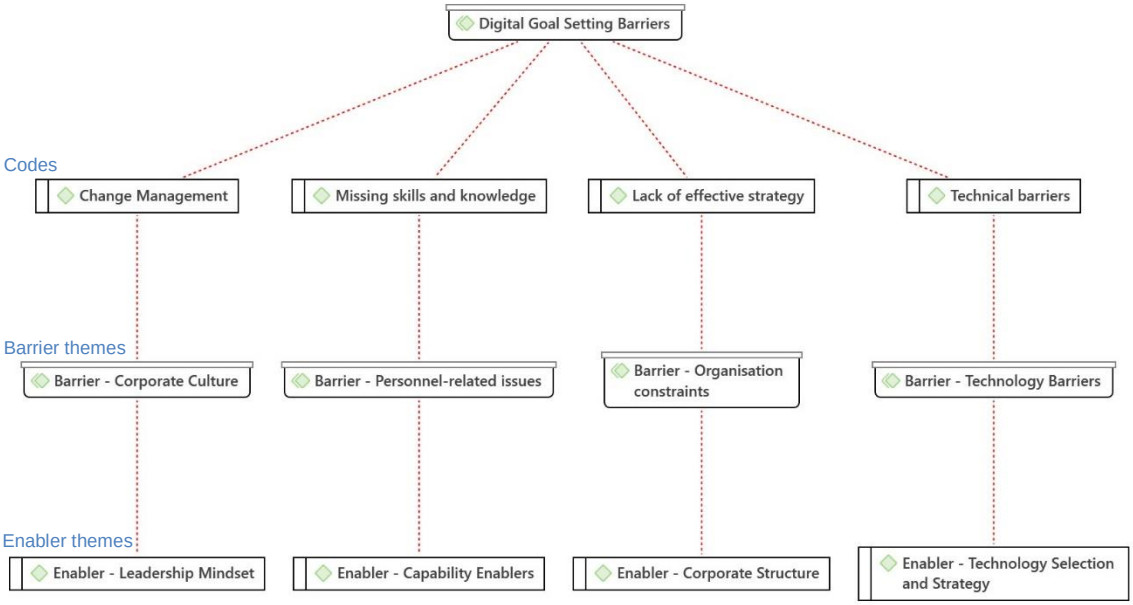


Figure 20. Linkages between barriers and enabler themes to the digital goal setting step of a DSC strategy (generated using Atlas TI)

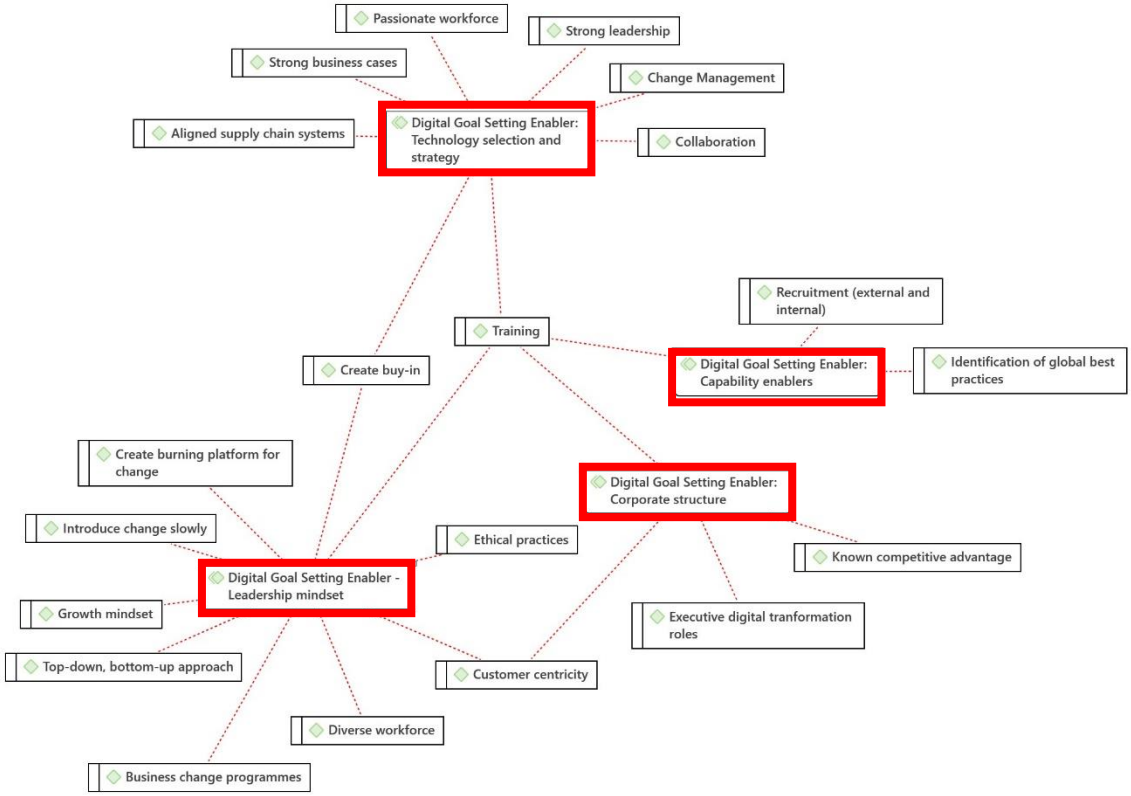


Figure 21. Specific initiatives from participant responses linked to digital goal setting enablers (generated using Atlas TI)

5.6. CONCLUSION

Chapter 5 presented the results for the two research questions derived in Chapter 3. The sample description and key concepts from the interviews validate the sample set's suitability for the research purpose. This was from a demonstration that the sample set was South African manufacturers from medium to large companies with adequate supply chain experience or positions that could influence supply chain digitalisation. Data saturation was shown at Levels 1 and 2, being DSC adopters and non-adopters, with no new codes derived in the 7th interview of both levels.

The first part of the approach to address Research Question 1 was to extract from the interviews the barriers and enablers to DSC strategy adoption. From the general barriers to DSCs, a new theme of corporate culture emerged from the generational, ethical and change management barriers codes. This was assigned an enabler theme of leadership mindset. Data sharing was identified as a new barrier to the theme of technology barriers. Customer demand was found to be a new enabler theme. Specific to South African manufacturing, the challenges were reported to be digital connectivity, loadshedding, high rate of unemployment and resistance to digital transformation, unions, threat of global warming, broad-based black economic empowerment (B-BBEE) and a limited number of digital vendors. The latter was contrary to another participant o identified digital vendors' availability in South Africa as an opportunity. This contradiction is supported by the highest frequency barrier mentioned including missing knowledge.

Of the fifteen interviews conducted, only four participants could identify barriers specific to the first stage of the DSC strategy adoption process, being digital goal setting. The results show that the digital goal-setting barriers had themes of personnel-related issues, organisational constraints, technology barriers and the new theme identified of the corporate culture. The established enabler themes were applied to the digital goal setting barriers to show which specific enabler action items would assist in overcoming the hurdles to digital goal setting. Of the enabler initiatives, there was a commonality with the creation of organisational buy-in and customer centricity across two enablers. The initiative of digitalisation training was found to be common across all four digital goal setting enablers identified.

CHAPTER 6: DISCUSSION OF RESULTS

6.1. INTRODUCTION

Semi-structured interviews were conducted with manufacturing managers, where these participants were either an adopter or a non-adopter of a DSC strategy. The results of the qualitative analysis performed on the data collated using ATLAS TI was given in Chapter 5 and are discussed in detail in this chapter together with the literature research undertaken in Chapter 2. For the deductive analysis approach taken, the codes were derived from the most recent comprehensive work found on DSC barriers (Jones et al., 2021: 939). The codes were then categorised into barrier and enablers themes which are similar to the themes reported by Stornelli et al. (2021: 14).

The objective of the discussion in Chapter 6 was to converge on conclusive findings for the two research questions posed in Chapter 3. This is done by comparing and contrasting the results to the body of literature reviewed in Chapter 2. The discussion then proceeds to apply the model from Stornelli et al. (2021: 5) in the context of the digital goal setting step of a DSC strategy to add to the body of knowledge on DSCs. The insights are of practical value to manufacturing managers and relevant employees, particularly in South Africa, to begin or improve their DSC journeys and ultimately benefit stakeholders.

The sample criteria given in Chapter 4 was aimed at the leaders interviewed to be from medium and large manufacturing companies to provide perspectives applicable to South African manufacturing businesses. The managers were required to have substantial supply chain experience or be in positions that could influence supply chain initiatives. Interview Question 1 sought participant and company details, while the remaining questions explored supply chain and DSC constructs relevant to the research questions. The sample criteria for the type of manager and company interviewed were met, as confirmed in the responses captured in Table 2 (Section 5.2.). The concept clouds generated from the interviews (Figure 15, Section 5.2.) confirmed the appropriateness of responses from the participants and their experience suitability. Meeting these sample criteria and having achieved data saturation from the interviews (Figure 16, Section 5.3.) provides credibility to the research findings.

6.2. DISCUSSION OF RESULTS FOR RESEARCH QUESTION 1

Research Question 1 (RQ1): From a South African manufacturing manager's perspective, what are the types of barriers and enablers that are relevant to the digital goal setting stage of the digital supply chain adoption process?

Research Question 1 served as the central question for the study conducted. To reach the barriers relevant to the digital goal setting step of a DSC strategy, the barriers to the larger area of DSC strategy adoption was first sought - this was to ascertain all challenges facing the manufacturing company interviewed. Interview question 4 was used for this purpose, with a sub-question then seeking out barriers specifically to the digital goal setting step, which signified the first step of the DSC journey (Büyüközkan & Göçer, 2018: 170).

Enablers were sought in Interview question 5 and all other interview questions were posed to provide further insights into the fundamental Interview questions 4 and 5. By following this sequence of questioning, the research was able to explore and deduce on what is preventing manufacturing companies in benefitting from the potential of DSCs and what actions has facilitated adoption with other manufacturers. In this section, the discussion follows the aforementioned sequence. The barriers to the overall adoption of DSCs are first discussed before the discussion delves into the barrier and enabler themes emergent from Research Question 1, as relevant to digital goal setting.

6.2.1. Discussion on the barriers to DSC strategy adoption

This section discusses the general themes that emerged in prohibition of a DSC strategy, that is the barrier themes which has a negative influence on adoption. For the deductive analysis approach taken in the qualitative analysis, the barrier codes and themes were derived from Jones et al. (2021) that reported on the work of several other authors examining barriers. Barriers specific to South African manufacturing managers are also discussed in this study.

The barrier themes that emerged from this study, in the order of theme occurrence, were technology barriers, corporate culture, personnel-related issues, economic barriers, organisational constraints, and policy and regulation barriers. The results from the study show that of the barrier themes, only the theme of policy and

regulation was mentioned exclusively by the level of DSC adopters. All other themes were common across both levels of DSC adopters and non-adopters. The study conducted also resulted in the emergence of the barrier theme of corporate culture. The perspective of South African manufacturing managers on challenges specific to operating in South African was attained through Interview question 15. Responses to this question is incorporated into the discussion on barrier themes.

6.2.1.1. Discussion on the barrier theme Technology barriers to DSC strategy adoption

The barrier theme of Technology barriers included technical barriers, technological disruption, challenges in value chain integration, data insufficiency and unreliability, environmental and conceptual (system design) was reported by Jones et al. (2021: 939) (Stornelli et al., 2021: 14). The research outputs agreed with these barriers being relevant as the same codes could be found in the participants' feedback. Contradicting the top technology barriers from Jones et al. (2021: 939); however, code data sharing emerged as the third ranking technology barrier, ranking higher than technology challenges in value chain integration. A shortfall of the Jones et al. (2021: 939) work was that it generalised the theme of technical barriers. It referenced the work of Vogelsand et al. (2019: 4939) which sub-coded technical barriers to include the barrier of data security. In the research study, the concern raised by interview participants on data sharing was that competitors might gain access to the data to compromise any competitive advantage. Several other studies agreed that data sharing is a high-ranking barrier to manufacturers (Vogelsand et al., 2019: 4939) (Tripathi & Gupta, 2019: 4) (Raj et al., 2020: 11-16) (Stornelli et al., 2021: 5). da Silva et al. (2018: 548) and Rüßmann et al. (2015: 2-5) substantiate the importance of cybersecurity in data management by including it in their nine pillars of technology used in 4IR manufacturing (Rüßmann et al. (2015: 4). The need for more complex identity and access management for users and machines was advocated due to increased management and production systems connectivity. The theme of Technology barriers was found in the study to be the largest barrier to the adoption of DSCs amongst the participants interviewed. This was supported by numerous authors stating that the barriers faced are heavily related to technology (Jones et al., 2021: 938) (Tripathi & Gupta, 2019: 4) (Mahmood et al., 2019: 242) (Raj et al., 2020: 11-16). Stornelli et al. (2021: 14) categorised the theme by finding that Technology barriers are less significant in the

evaluation phase of a strategy but have a high relevance to the set-up and installation, and the post-installation phases. The results of the study performed (Figure 19) contradicts Stornelli et al. (2021: 14) showing that the theme of technology barriers does feature amongst the barriers to digital goal setting, being part of the evaluation phase.

A South African barrier identified in the study that was categorised as a Technology barrier was digital connectivity. The participant feedback was that any of the benefits of DSCs are real-time data handling to enable agility with supply chains. The generally poor data connectivity quality and connectivity loss during loadshedding was thought to negate the DSC advantages. Further barriers highlighted from Technology barriers was a lack of digital vendors. Two participants contradicted each other by reporting that there was an adequate number of digital vendors in South Africa in one interview and then a lack of vendors in another interview. The lack of digital vendors is concluded to be a barrier and not an opportunity due to only two digital vendors reported by both participants. This can be related to a lack of awareness and exposure to what are the digital vendor's offerings available; as we know, demand encourages supply.

6.2.1.2. Discussion on the barrier theme Corporate culture to DSC strategy adoption

Corporate culture was identified as a barrier theme that is evident in this study, but that is not mentioned as a theme, but as a barrier by Borangiu et al. (2019), Vogelsand et al. (2019), Tripathi & Gupta (2019), Mahmood et al. (2019), Lammers et al. (2019), Raj et al. (2020) and Jones et al. (2021). It is in Schein's (2010: 26) second level of culture, espoused beliefs and values that DSC barrier codes originate in the research. The barriers identified are generational, ethics and change management.

Participants described the generational barrier as a 'fear of technology' and not embracing new technology. The participants were of an opinion that older generations that are not used to new technologies, although it was advised that this trait could not be stereotyped as there are older generations with an affinity for technology and digital advances. Ethics was found to be another espoused belief or value also reported by (Schein, 2010: 26), as participants used it in the context of avoiding modern slavery and having sustainable and moral business practices. The

several authors in this section that mentioned the code of change management agree that it is a vital barrier to DSCs for consideration. Our findings revealed that change management was the second most significant barrier for South African manufacturers to DSC adoption. Vogelsand et al. (2019), Tripathi & Gupta (2019), Mahmood et al. (2019), Raj et al. (2020) and Stornelli et al. (2021: 15) refer to resistance to change with new technology and processes. These authors, though refer to the resistance to change from employees and neglect to distinguish between resistance from individuals and corporate culture. Our research showed that change management was presented as a challenge mostly as a corporate culture challenge than challenges from individuals. Raj et al. (2020: 15) agreed that change management is a complex challenge for organisations in a digital era. The change was considered to be once transactional; however, with digital platforms and open-ended systems, change has become transformational and requires careful management.

6.2.1.3. Discussion on the barrier theme Personnel-related issues to DSC strategy adoption

The study findings show that the barriers of societal (human integration) and individual barriers were minor concerns; however, the barrier of missing skills and knowledge was the biggest concern for South African manufacturers when considering DSCs. The barriers codes of missing skills and knowledge, societal (human integration) and individual barriers (Jones et al., 2021: 939) were assigned the barrier theme of Personnel-related issues (Stornelli et al., 2021: 14).

The skills gap was not restricted to an organisational level but applied to company leaders and workers. The criticality of skills and knowledge shortage is validated in that each of the DSC barrier authors examined reported on its need (Borangiu et al., 2019: 161) (Vogelsand et al., 2019: 4939) (Tripathi & Gupta, 2019: 4) (Mahmood et al., 2019: 242) (Lammers et al., 2019: 4-6) (Raj et al., 2020: 11-16) (Jones et al., 2021: 939) (Stornelli et al. 2021: 14). Raj et al. (2020: 14) further reported that it is the lack of such skills that restricts organisations from engaging with solution providers and therefore gaining progress with digitalisation. Companies were thought to require a more qualified workforce in the future. This statement is particularly important to developing countries with high unemployment

rates. The urgency with addressing the skills and knowledge gap was substantiated with the barrier being having the highest number of recurring codes from interviews.

This study also showed that some South African manufacturing managers, and their company unions, felt that digitalisation and DSCs could add to the unemployment problem in South Africa by cannibalising jobs. Naudé & Szirmai (2012: 16-18) quantify this statement by showing the need for labour-intensive manufacturing in developing countries to grow the economy before digital advancement. This is contrary to the 'digitise or drown' statement from Schreckling & Steiger (2016: 5). This research also showed a non-partial group that was aware of the benefits of DSCs in a competitive business environment that suggested an approach of a careful selection of DSC ventures to not result in rapid job losses.

An interesting perception from the research (from engineering manufacturing managers) was that South African companies are mostly led by Chartered accountants and finance managers who were labelled technology averse. This claim was not investigated but is suggested as a research topic from a South African manager's perspective relating to DSCs.

6.2.1.4. Discussion on the barrier theme Economic barriers issues to DSC strategy adoption

The financial barriers lack of clarity regarding economic benefits and high investment in DSC implementation from Jones et al. (2021: 939) were similar to the research conducted. Contrary to expectations, the Economic barrier theme did not feature in the top three identified barriers as found by Jones et al. (2021: 939), although it still ranked highly as fourth. The magnitude of the barrier is further demonstrated by the research showing that the individual barrier of financial issues was ranked third amongst all the barriers identified in the study.

Some of the prominent concerns from the interviews included having to operate in a business environment where cash flow has become a problem. Common reasons mentioned amongst participants was some companies were still reeling from the COVID-19 pandemic, the Ukraine-Russia conflict and hyperinflation, being typical of a VUCA environment (Grzybowska & Tubis, 2022: 1). The dilemma of being cash-strapped but knowing that DSCs can assist in dealing with supply chain uncertainty, substantiates the need for digital goal setting in a DSC strategy so that

impactful and low risk initiatives are prioritised. Gaffley & Pelser (2021: 1, 9) motivated for the appointment of a Chief Information Officer in larger companies to help prioritise strategic initiatives.

6.2.1.5. Discussion on the barrier theme Organisational constraints to DSC strategy adoption

The Organisational constraints barrier theme included the two barriers of lack of effective strategy and strategic alignment/integration Jones et al. (2021: 939). Both of these barriers were found in the study; however, South African manufacturers highly featured the former, whereas the latter was less mentioned. Mahmood et al. (2019: 242) and Stornelli et al. (2021: 14) agree with this finding and also found strategic alignment/integration of lesser relevance. A shortcoming in investigating this barrier, though may be that these authors, as well as this study, interviewed only senior staff in organisations. Martin (2010: 5) and the research participants held the view that strategies fail due to poor execution practices, such as a company leader dictating a strategy and expecting others to follow it mechanically. Following the suggested strategy as a choice cascade, the perspectives of middle and operational manufacturing managers in contrast to those of executives is recommended to be researched for the DSC barrier of strategic alignment/integration.

A third organisation constraint barrier of top management engagement was recognised by Mahmood et al. (2019: 245) which was not accounted for as a barrier by Jones et al. (2021: 939). This barrier was not considered separately but rather incorporated into the barrier of lack of effective strategy. Mahmood et al. (2019: 245) stated that top leadership have a pivotal and vibrant role in determining the magnitude of digitalisation transformation and then starting off the transformation. Mahmood et al. (2019: 245) also suggested that these leaders should not sit back in the implementation ofimplementing the transformation but play active roles. The research conducted also found the leadership role to be fundamental in the success of DSC adoption. Participants motivated for buy-in for digitalisation starting from the top level and that there needed to be a drive for this transformation. A leader’s role was reported to include setting a drumbeat and setting the pathway forward with digitalisation.

A risk to South African operations was reported to be the threat of global warming, with a consulting company advising that the spate of recent poor weather patterns is going to continue. Leaders needed to recognise this threat and implement strategies for agility in dealing with such uncertainty.

6.2.1.6. Discussion on the barrier theme Policy and regulation barriers to DSC strategy adoption

The regulatory barrier in the theme of Policy and regulation barriers was mentioned only by DSC adopters. It was evident from the interviews that regulations and policies in industry masterplans accelerated DSC initiatives within the industry by aligning the manufacturing company with stakeholders within a cluster. These initiatives would have otherwise been difficult to initiate due mainly to the barrier themes of technology barriers, economic barriers and personnel-related issues. The South African government's involvement in this cluster was vital to its successes as reported by a participant in the textile industry where the government played a positive role in the setting up of an industry masterplan and clusters. Stornelli et al. (2021: 14) recognised the regulatory barrier and listed a lack of government support within the theme of Policy and regulatory barriers. Another barrier identified was that of a threat to intellectual property. Whilst this barrier code was not used separately, the research did show this to be a barrier with the concern of cybersecurity and the loss of intellectual property amounting to a loss in competitive advantage. This was incorporated into the data sharing barrier in the technology barriers barrier theme. The threat of cybersecurity was supported by Kache & Seuring (2017: 27).

Other barriers specific to operating in South Africa were reported to be electricity loadshedding and the B-BBEE programme. These barriers were thought to constrain DSC adoption and were categorised with the theme of Policy and regulation barriers as national programme amendments could benefit manufacturers.

6.2.2. Discussion on the barriers relevant specifically to digital goal setting

Only four of the participants interviewed could distinguish between the general barriers facing DSC adoption and those specific to the initial step of digital goal setting. The result was not expected as participants had adequately been informed

on the step of digital goal setting within a DSC strategy in the introduction to the interviews and in the introductory video shared. The research finding is triangulated with the results from Interview questions 11 and 12. These questions dealt with the assessment and prioritisation of digital opportunities and if the evaluation process included research of industrial case studies and innovation maturity studies. Gaffley & Pelser (2021: 9) consider these steps to be vital in the steps towards digital transformation in manufacturing. The research showed that only one participant extensively researched and identified the digital gap before goal setting and strategy formulation. This participant also revealed the highest number of codes in the research and showed the most extensive DSC strategy among all the participants interviewed. In relation to the Stevens & Johnson (2016: 17) supply chain development horizon, it appears to be the only company interviewed that has progressed from a goal directed network supply chain to a devolved, collaborative supply chain cluster. Other DSC adopters interviewed have not made this progressive step yet, and it is concluded that this is due to not having set and prioritised their digital goals. Porter (1996: 64) motivated the use of goal setting for competitive advantage. The interviews showed that only one company interviewed adhered to this principle, with the other DSC adopters working instead on pain points. Tawse (2019: 250) and Köseoglu et al. (2020: 2) do not differentiate goal setting from strategy formulation, as was with all the participants interviewed with the exception of one.

The research's four digital goal-setting barrier themes deal with corporate culture, personnel-related issues, organisational constraints and technology barriers. Figure 19 (Section 5.4.4.) shows the linkages between these barrier themes and the codes change management, missing skills and knowledge, lack of effective strategy and technical barriers, respectively. As discussed in Section 6.2.1.2., corporate culture is a barrier theme that was lacking in the literature reviewed but prominent in the research conducted.

6.2.3. Discussion on the enablers relevant to digital goal setting

Figure 20 (Section 5.5.) shows the research results which links enabler themes to those barrier themes and individual barrier codes that are relevant to digital goal setting. This section discusses only these corresponding enabler themes.

6.2.3.1. Discussion on the digital goal setting enabler theme of Leadership mindset

The enabler theme Leadership mindset was assigned to the barrier theme of corporate culture and the barrier code of change management. Jones et al. (2021: 940-941) spoke to leadership mindset in the context of a barrier and not as an enabler. The mindset barrier was considered as something that needs to be dealt with ahead of technical and other matters. This research uses the lens of leadership mindset as an important enabler to the barrier theme of corporate culture, in particular to the barrier of change management. Change management was determined to have the second highest frequency of occurrence to the barrier of missing skills and knowledge. These rankings are consistent with the findings from Jones et al. (2021: 940) that correlate education strongly with overcoming technology-adverse and fixed mindsets.

Leadership mindset is also suggested as an enabler theme to the ethics and generational DSC corporate culture barriers, which are not specific to digital goal setting. To overcome the corporate culture barrier theme, the Jones et al. (2021: 940) view of mindset categories is used as an enabler with the qualities of having a positive perception of technology, a growth mindset in competency and a positive observation of disruptive innovation in DSC strategy.

6.2.3.2. Discussion on the digital goal setting enabler theme of Capability enablers

Stornelli et al. (2021: 14) gave the enabler theme of Capability enablers for personnel-related issues. As related to the digital goal setting, the specific barrier that stemmed from the research was missing skills and knowledge. As discussed in the preceding section, missing skills and knowledge ranked highest in terms of frequency of barriers mentioned. Jones et al. (2021: 940) found that education as a capability enabler was relevant to the barrier of leadship mindsets. From the interviews conducted, it was evident that the education capability enabler was not restricted to leaders. Training or recruiting of all staff was suggested by participants. They agreed having digitally capable leaders required as protagonists for digitalisation transformation. Furthermore to having capabilities ‘across the board’ for successful implementation. Such capability would address change management concerns in the implementation of a strategy (Martin, 2010: 5). Stornelli et al. (2021: 16) agreed with the critical positioning of capability enablers

having concluded that better productivity outcomes resulted with manufactuers instituting strategic training programmes.

6.2.3.3. Discussion on the digital goal setting enabler theme of Corporate structure

The enabler theme of Corporate structure was assigned to the barrier theme of organisational constraints (Stornelli et al., 2021: 14). The specific digital goal setting barrier identified was a lack of effective strategy. Stornelli et al. (2021: 15) suggested that Corporate structure enablers needed to include the appointment of effective champions that could develop and implement compelling business cases. An additional enabler was needed to overcome inter-organisational challenges. The interview findings were similar with internal and external recruiting and training needed as enablers.

6.2.3.2. Discussion on the digital goal setting enabler theme of Technology selection and strategy

The highest frequency theme of barriers was found to be technology barriers. For the deductive analysis approach, the enabler theme assigned for this barrier theme was Technology selection and strategy (Stornelli et al., 2021: 14). Within this barrier theme and specific to digital goal setting was the barrier code of technical barriers. Vogelsand et al. (2019: 4940) expand on technical barriers with sub-codes.

The first sub-scode from Vogelsand et al. (2019: 4940) was the barrier of dependence on other technologies. The research supported Vogelsand et al. (2019: 4940) that incompatible software between stakeholders required the enabler of bespoke programming for DSC communications. The second sub-code from Vogelsand et al. (2019: 4940), risks with data security, was also verified in the research (Section 6.2.1.1.). Borangiu et al. (2019: 161) present an enabler for this barrier with the high availability of manufacturing cloud services. In such systems, local networks have firewall protection. Communications to the cloud and in the cloud are done through a virtual private network (VPN) where the data is encrypted and therefore deemed safe. This enabler the data security barrier was not mentioned in the interviews carried out. A participant in the form of trust brokers for data presented an alternate solution. The use of commercially available data brokers was verified by Bhargava et al. (2013: 4) and also by Srai et al. (2017: 9) in

the form of data watch towers that Enterprise Data System providers offer. The final sub-code, limitations of infrastructure currently in place, was not expanded upon by Vogelsand et al. (2019: 4940). Whilst this limited internal infrastructure did not emerge from the interviews, most participants did largely commented on enablers needed for digital connectivity issues to fully exploit DSC opportunities. Raj et al. (2020: 13) agreed with this specific enabler and stated that all channels needed integration, preferably with high speed connectivity.

6.2.3. Summary of discussion for Research Question 1

The general DSC barrier themes that emerged from the research, in the order of theme occurrence, were technology barriers, corporate culture, personnel-related issues, economic barriers, organisational constraints, and policy and regulation barriers. A new theme that emerged from the study was that of corporate culture. This was not identified as a theme in the barrier literature reviewed, but rather as a stand-alone barrier. In the study, the codes of change management, generational and ethics barriers were categorised into the barrier theme. The enabler theme of leadership mindset was assigned to the corporate culture barrier, with qualities of having a positive perception of technology, a growth mindset in competency and a positive observation of disruptive innovation in DSC strategy.

From the study, only four participants could distinguish between the general barriers facing DSC adoption and those that are specific to the initial step of digital goal setting. This was despite being adequately informed on the research objective and on digital goal setting. The four digital goal setting barrier themes from the research were found to be corporate culture, personnel-related issue, organisational constraints and technology barriers. These are linked to the barrier codes of change management, missing skills and knowledge, lack of effective strategy and technical barriers, respectively. The corresponding enabler themes for the barrier themes are leadership mindset, capability enablers, corporate structure, and technology selection and strategy.

The research study also showed that only one company extensively researched industrial cases and innovation maturity studies. This was done as part of identifying the digital gap before goal assessment and setting. The same participant was found to have the most extensive set of codes and the largest set of DSC

initiatives. All other DSC adopters launched strategies based on addressing the largest pain point.

6.3. DISCUSSION OF RESULTS FOR RESEARCH QUESTION 2

Research Question 1 was the central question for research exploration. Research Question 2 was the associated sub-question which focused the study area. This section discusses the various specific enabling initiatives needed to overcome barriers to digital goal setting. The enabling initiatives that are reported are a combination of participant responses and literature reported on the corresponding barrier.

Research Question 2 (RQ2): What are the specific enabling initiatives needed to overcome barriers to digital goal setting in the adoption of DSCs?

6.3.1. Discussion on initiatives identified for the various enabler themes to digital goal setting

6.3.1.1. Discussion on initiatives identified for the enabler theme of Leadership mindset

The specific barrier identified by participants relating to the barrier theme of corporate culture was change management (discussed in Section 6.2.1.2.).

The enabling initiatives mentioned by participants included the creation of a burning platform for change. This was thought to address the inherent level of anxiety that people have around change. Participants also reported that buy-in for the digitalisation transformation was also required from not only senior leaders but also across the workforce. Such buy-in could be attained from recruitment but also from training to create a diverse workforce. With the workforce adept with digitalisation initiatives, strategic implementation was less likely to fail (Martin, 2010: 5). Participants also reported that the required drive from leadership was to be inherent in the leader's mindset. An enabling mindset here was agreed to having a positive perception of technology, a growth mindset in competency and a positive observation of disruptive innovation in DSC strategy (adapted from Jones et al., 2021: 940). Any change introduced was also recommended to be ethical, done slowly and administered through business change programmes. Company leaders that valued customer-centricity was also deemed as an enabler to change

management. Participants reported that customers were driving DSCs particularly for sustainable practices and that change management was less challenging for leaders that motivated on the basis of customer-centricity. The drive from customers was that they wanted to partner with progressive companies. Customers in business-to-business transactions wanted innovation and ease of doing business. From the study it was observed that the most common DSC initiative in place was that of customer connected e-commerce (Srai et al., 2017: 13).

6.3.1.2. Discussion on initiatives identified for the enabler theme of Capability enablers

The specific barrier identified by participants relating to the barrier theme of personnel-related issues was missing skills and knowledge (discussed in Section 6.2.1.3.).

As mentioned in the preceding section, training of all organisation levels was found to be critical as an enabler to digital goal setting and DSC adoption (Jones et al., 2021: 940). The training was promoted by participants as the only common initative to each enabler theme for digital goal setting. This common-set validates its priority, as does it directly address the most frequently mentioned barrier from the participants, which is missing skills and knowledge. Stornelli et al. (2021: 16) had similar findings and concluded that strategic training programmes improved outcomes with DSCs and productivity. Another means of obtaining the right skills and knowledge in the right areas is through recruitment. Participants spoke to cases where recruitment from successful DSC adopters was an enabler. Such recruits were more knowledgeable on best practices. Gaffley & Pelser (2021: 1, 9) encouraged Chief Information Officer (CIO) appointments for large companies to prioritise strategic initiatives. Internal recruitment was also suggested by the participants and involved the promotion of digitally skilled employees into positions of influence.

6.3.1.3. Discussion on initiatives identified for the enabler theme of Corporate structure

The specific barrier identified by participants relating to the barrier theme of organisational constraints was lack of effective management (discussed in Section 6.2.1.5.).

The research also found that executive transformation roles were vital to overcome the organisational constraint of a lack of effective management. To overcome ineffective management, Stornelli et al. (2021: 15) suggested the appointment of effective champions that could develop and implement effective business cases. Gaffley & Pelser (2021: 1, 9) shared this recommendation by motivating for such positions as a Chief Information Officer. Common to the theme of Capability enablers, training and customer-centricity (Oliver & Webber, 1982: 64) were also communicated by interview participants. As discussed in Section 6.3.1.1., the enabler of digitalisation-driven executives could help overcome inter-organisational challenges (Martin, 2010: 5). The research also showed that a known competitive advantage could also assist in overcoming effective management and enabling digital goal setting. It was communicated by a participant that DSC advances could be focused on the area of competitive advantage, promoted by Porter (1996: 64).

6.3.1.4. Discussion on initiatives identified for the enabler theme of Technology selection and strategy

Participants specifically identified technical barriers concerning the theme of technology barriers (discussed in Section 6.2.1.1.).

Aligned supply chain systems, even bespoke plug-in systems, were found to overcome technical barriers for digital goal setting. Vogelsand et al. (2019: 4940) had also identified this to be a technical that required a solution due to technologies and systems being dependent on other technologies.

Not resultant from the research in relation to digital goal setting enablers, but attributed to the theme of technology barriers, was the barrier of data sharing. Vogelsand et al. (2019: 4940) identified risks with data security as a technical barrier. Enablers are therefore considered here. As reported earlier, Borangiu et al. (2019: 161) presented an enabler to data security concerns, being high availability manufacturing cloud services that use firewall protection and VPNs to secure communications. Data hosts were also presented as a solution in the research study by participants. Vogelsand et al. (2019: 4940 also presented infrastructure as a barrier. Digital connectivity was identified as a barrier by research participants and listed high speed and reliable connectivity as an enabler. Raj et al. (2020: 13) supported this enabler.

Other enablers dealing with overcoming the technical barriers have dealt with in Sections 6.3.1.1.-6.3.1.4. The enablers include the need for strong business cases, strong leadership and change management. The participants also recommend business collaboration and a passionate, pro-digitalisation workforce as enablers to overcome technical barriers.

6.3.2. Summary on discussion for Research Question 2

The various specific enabling initiatives needed to overcome barriers to digital goal setting were discussed in Section 6.3.1. The enabling initiatives that were reported combined participant responses and enablers found in literature on the corresponding barrier. These findings are shown in Figure 22 in the research conclusion (Chapter 7).

For the enabler theme of Leadership mindset, the specific enabling initiatives to overcome the digital goal setting barrier of change management were found to: Create a burning platform for change; introduce change slowly, leaders to have a growth mindset; a top-down and bottom-up approach is needed at all organisational levels for strategy formulation to mitigate possible change management issues in strategy implementation; business change programmes are needed; a customer-centric approach is needed for change management buy-in at all organisational levels; ethical practices motivate change positively; and buy-in and training for change is needed at all levels.

For the enabler theme of Capability enablers, the specific enabling initiatives to overcome the digital goal setting barrier of missing skills and knowledge were found to: The creation of executive transformation roles that are knowledgeable about digitalisation to drive DSCs; recruitment of external skills and promotion of internal skills; identification of global best practices for DSC strategy formulation; and training at all organisational levels.

For the enabler theme of Corporate structure, the specific enabling initiatives to overcome the digital goal setting barrier of lack of effective management barriers were found to: The creation of executive transformation roles to drive DSCs; champions within the business to drive business cases; the organisation's competitive advantage to be known and driven to exploit relevant DSCs; customer-centricity for an effective business strategy; and training for all organisation levels.

For the enabler theme of Technology selection and strategy, the specific enabling initiatives to overcome the digital goal setting barrier of technical barriers were found to: Strong business cases for strategic DSC initiatives; aligned supply chain systems for ease of data connectivity; bespoke solutions to interface with different systems across and within organisations; cybersecurity to alleviate data sharing and loss of intellectual property or competitive advantage concerns; a digitalisation passionate workforce to drive DSCs; strong leadership to motivate and drive DSC strategy with prioritised initiatives; change management programmes; and buy-in and training on technical matters is needed at all levels.

6.4. CONCLUSION

Chapter 6 was a discussion of the research findings from Chapter 5. The types of barriers and enablers were identified and discussed that are relevant to the implementation of the digital goal setting phase of a DSC strategy in a South African manufacturing environment. This established the findings for Research Question 1. The specific enabling initiatives needed to overcome barriers to digital goal setting were also identified and discussed. This established the findings for Research Question 2. The findings for Research Questions 1 and 2 are integrated in a framework that can be used by South African manufacturing managers to unlock barriers to digital goal setting for DSC strategy adoption. The framework is presented in Chapter 7, the concluding chapter of the study, as Figure 22.

CHAPTER 7: CONCLUSION

7.1. INTRODUCTION

There is an urgency for the adoption of a digital supply chain (DSC) strategy in manufacturing companies. Büyüközkan & Göçer (2018: 157) define DSCs to be a value-driven and efficient process, to create new types of revenue and value, by leveraging innovative technologies in supply chain management. The enabling technologies were highlighted by Rüßmann et al. (2015: 2-5) as the nine pillars of technologies used in the fourth industrial revolution (4IR). The criticality of adopting agile and resilient supply chains was encapsulated by Schreckling & Steiger (2016: 5) in the title of their digital transformation publication 'digitise or drown'. Gaffley & Pelser (2021: 1) supported the applicability of this view to South African manufacturers that operated in a business environment with unprecedented change in the economy and in society.

A DSC scenario framework was presented by Srai et al. (2017: 13) to assist decision-making. The reported successes ranged from collaborative electronic sourcing for stakeholders to an extended end-to-end supply chain for near real-time monitoring of business processes and influencing factors. The objective of the scenarios was to result in a more responsive and resilient supply chain with improved customer satisfaction. Despite also offering improved profitability, Büyüközkan & Göçer (2018: 174) argued the majority of businesses were not adopting DSCs. Wu et al. (2016: 17-18) supported the idea of Büyüközkan & Göçer (2018: 174) and suggested that DSCs are not fully understood by businesses. The research gaps identified by these authors were similar. The gaps included a lack of roadmaps and tools for DSC adoption, and a lack of insights on how to deal with DSC implementation from a managerial perspective due to a lack of studies on addressing challenges faced.

The main objective of the study undertaken was to address the research problem presented by Büyüközkan & Göçer (2018: 174) and Wu et al. (2016: 17-18). This is namely, that despite the numerous advantages of DSCs in a volatile, uncertain, complex and ambiguous (VUCA) operating environment (Grzybowska & Tubis, 2022: 1), DSCs are not being adopted. The DSC literature reviewed failed to demonstrate specific enabling initiatives to overcome barriers but reported mostly on enabler themes instead (Jones et al., 2021: 938-939) (Stornelli et al., 2021: 8).

The focus area of the research undertaken was narrowed from the extended DSC to the first step of the DSC journey, being the digital goal setting step (Büyüközkan & Göçer, 2018: 170) that precedes strategy formulation and integration. The importance of a goal setting step was purported by Porter (1996: 64) to be the choice of activities that differs a business from rivals. The research purpose was to find out what is stopping managers from embarking on the first step of the DSC journey and what are the associated enablers to overcome the barriers to this digital goal setting step. The context to the research was South African medium and large manufacturing companies. South African operations presented different barriers to those in international publications.

Two research questions are given in Chapter 3 that were arrived at from the literature review performed in Chapter 2. To answer the research questions, semi-structured interviews were conducted with South African manufacturing managers, where these participants were either an adopter or a non-adopter of a DSC strategy. Data saturation and sample suitability were demonstrated with seven participants at adopter and non-adopter level, each. The research methodology is given in Chapter 4. An extra interview was held with an individual consultant to gather further insights from their experiences with digital transformation in South African manufacturing. To converge at conclusive findings for the two research questions, the results of the qualitative data analysis in Chapter 5 were compared and contrasted to the body of literature reviewed in Chapter 2. This discussion appears in Chapter 6.

Chapter 7 of the research presents the study findings. The findings are integrated into a framework that shows specific enabling initiatives to overcome associated digital goal setting barriers and result in the adoption of a DSC strategy. The academic and practical contributions of the study are discussed. The chapter then reflects on the limitations to the study and concludes with recommendation for future research.

7.2. SUMMARY OF PRINCIPLE CONCLUSIONS FOR RESEARCH QUESTION 1

Research Question 1 served as the central question for the study conducted.

Research Question 1: From a South African manufacturing manager's perspective, what are the types of barriers and enablers that are relevant to the digital goal setting stage of the digital supply chain adoption process?

To answer Research Question 1, a deductive analysis approach was used for the qualitative analysis. Barrier codes were derived from Jones et al. (2021: 939) and categorised into barrier and enabler themes from Stornelli et al. (2021: 14).

7.2.1. Conclusions on general DSC barriers

Before the barriers to digital goal setting were studied, the general barriers to DSC adoption were examined. This approach validated the research undertaken by showing that the themes emanating from the work matching those in the literature review (Jones et al., 2021: 939) (Stornelli et al., 2021: 14). The general DSC barrier themes from the study, in the order of recurring code frequency, were technology barriers, corporate culture, personnel-related issues, economic barriers, organisational constraints, and policy and regulation barriers. Figure 18 In Section 5.4.1. gives the barrier codes and associated barrier themes for DSC adoption.

A new theme that emerged from the study was that of corporate culture. This was not identified as a theme in the barrier literature reviewed, but rather as a stand-alone barrier (Vogelsand et al., 2019: 4943) (Tripathi & Gupta, 2019:3). Tripathi & Gupta (2019:3) describe organisational culture as the way that people work. It is concluded that the barrier theme of corporate culture is an important finding of this research due to it incorporating the codes change management, generational and ethical barriers. The code change management was found to be a unique code that was not found in literature. A number of studies do mention a resistance to change with new technology (Vogelsand et al., 2019: 4940; Tripathi & Gupta, 2019: 4; and Raj et al., 2020: 15). These authors though refer to the resistance to change from employees and neglect to distinguish between resistance from individuals and corporate culture. The study showed that change management was the second most frequently mentioned code (frequency of 19) behind missing skills and knowledge (frequency of 20). The code generational was also a unique code from the research. It was of less significance to change management as it had a frequency count of 3 recurring codes. Participants in the research described the generational barrier as a 'fear of technology' and not embracing new technology.

The participants linked this resistance to generational gaps and affinity towards technology. It was advised that this trait should not be stereotyped as there are older generations with an affinity for technology and digital advances.

7.2.2. Conclusions on general DSC enablers

The top three DSC enabler themes from the research were capability enablers (frequency of 30 recurring codes); leadership mindset (frequency of 27); and technology selection and strategy (frequency of 22).

The new enabler theme of leadership mindset was assigned to the new corporate culture barrier theme. The enabler theme was positively affected by a positive perception of technology; a growth mindset in competency as opposed to a fixed mindset with a reluctance to learn; and a positive observation of disruptive innovation in DSC strategy (Jones et al., 2021: 940).

7.2.3. Conclusions on barriers and enablers to digital goal setting

Only four participants from the study could differentiate between general DSC barriers, and barriers specific to the initial step of digital goal setting. This was despite being adequately informed on the research objective and digital goal setting. The four digital goal setting barrier themes from the research were found to be corporate culture, personnel-related issue, organisational constraints and technology barriers. These were linked to the barrier codes of change management, missing skills and knowledge, lack of effective strategy and technical barriers, respectively. The corresponding enabler themes for the barrier themes are leadership mindset, capability enablers, corporate structure, and technology selection and strategy. The combination of codes and themes for the barriers and corresponding enablers directly answer Research Question 1. Figure 19 in Section 5.4.4. gives the barrier codes and themes for the digital goal setting step of a DSC strategy. Figure 20 and Figure 21 in Section 5.5. gives the digital goal setting barrier and enabler themes, and the enabler themes with enabling initiatives, respectively.

The research study also showed that only one company of the 14 companies interviewed, had extensively researched industrial cases and innovation maturity studies. This was done as part of identifying the digital gap before goal assessment and setting. The same participant was found to have the most extensive set of

codes and the largest set of DSC initiatives. All other DSC adopters launched strategies based on addressing the largest pain point. This is an important finding as it points out that getting started with a DSC journey means acting on the highest prioritised digital goal as a start. The process of digital goal setting will enable a company to exploit the many areas of potential supply chain improvements (Srai et al., 2017: 13).

7.3. SUMMARY OF PRINCIPLE CONCLUSIONS FOR RESEARCH QUESTION 2

Research Question 2 (RQ2) is the associated sub-question to RQ1.

Research Question 2 (RQ2): What are the specific enabling initiatives needed to overcome barriers to digital goal setting in the adoption of DSCs?

Figure 22 directly answers Research Question 2. It is a framework that links digital goal setting barriers and barrier themes, to enabler themes and enabler initiatives, all specific to the digital goal setting step of a DSC strategy. The framework shows that in consideration of supply chain digitalisation, the barriers and enablers need to be evaluated and assessed before a decision is taken to invest in prioritised digital goals and initiatives in a DSC strategy. The framework can be used to link specific digital goal setting enabler initiatives with corresponding barriers faced.

A key enabling initiative was found to be training. This was common across all four enabler themes. A skilled and knowledgeable workforce were able to overcome the barrier themes of corporate culture, personnel-related issues, organisational constraints and technology barriers. The role of driven and knowledgeable leaders was also frequently mentioned by participants. The leadership role was strongly supported by the DSC consultant in the 15th interview, as well as by Gaffley & Pelser (2021: 1). These authors were of the opinion that the appointment of a Chief Information Officer was critical to the success of a DSC strategy. The view was supported in the study with participants suggesting the appointment of skilled digitalisation executives. The study participants also concurred that if training was not possible to address the skills gap then these skills needed to be recruited.

Customer-centricity was also found to be an enabling initiative that was unique to the study. It was concluded from the study that customers were in favour of DSCs to show sustainable practices. This was supported by the work of Kealley et al.

(2022: 354-357) that showed traceability of product to origins and suppliers for sustainability certification. Change management was also reported to less challenging for leaders that motivated on the basis of customer-centricity. Further from the study, customers were found to want to partner with progressive and innovative companies.

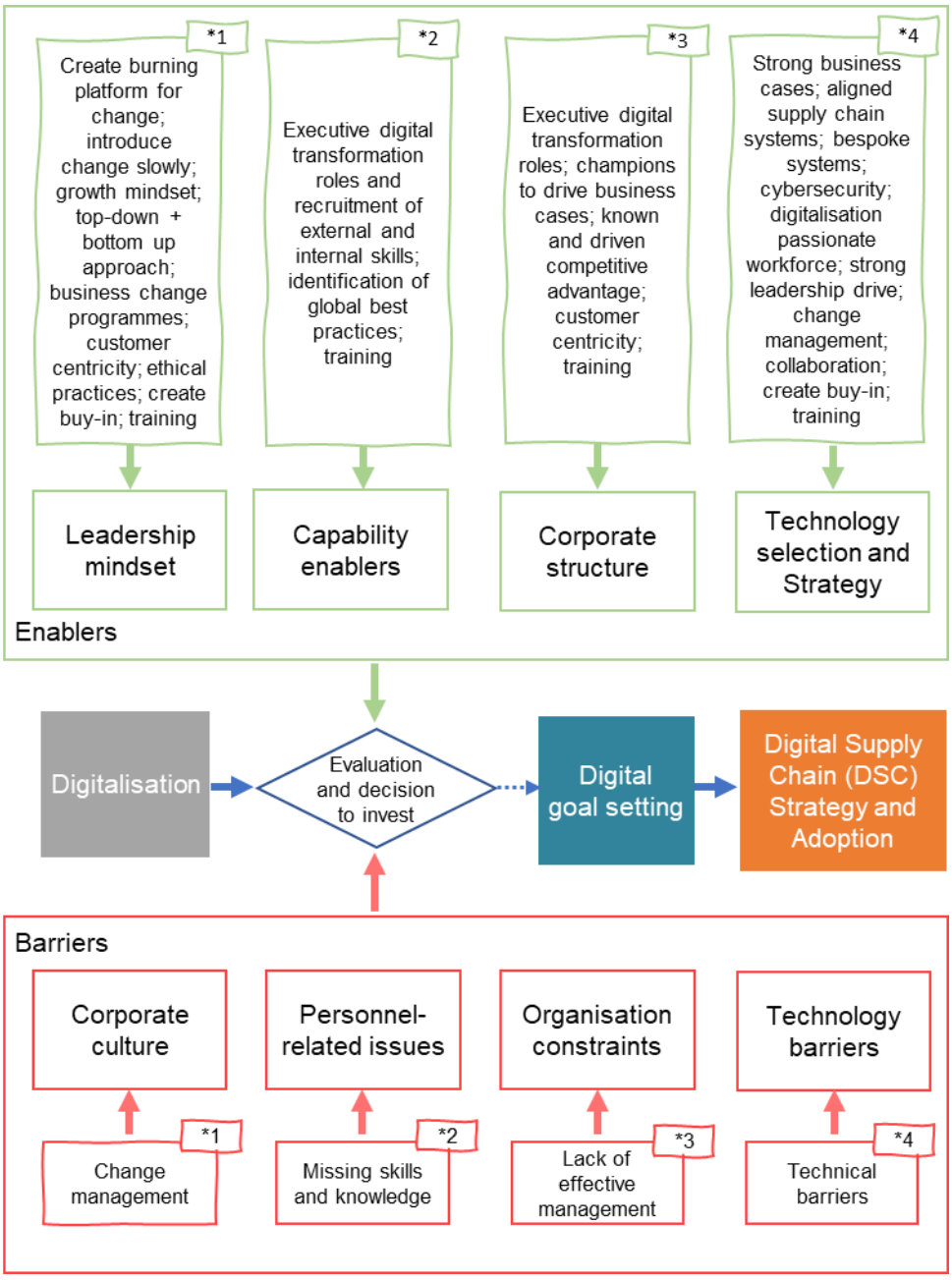


Figure 22. Framework for unlocking barriers to digital goal setting for adoption of a digital supply chain strategy

Source: Author's Own

*Enablers and barriers are numbered so that Enabler *1 is used to overcome Barrier *1, etc.

7.4. ACADEMIC CONTRIBUTION OF THE STUDY

The study is of academic significance as it contributes to the theory and body of knowledge of DSCs. Several studies focused on the barriers to DSC adoption (Jones et al., 2021: 938-939) (Stornelli et al., 2021: 8). A shortfall of these studies was that the research area was across an extended DSC network; this broad approach resulted in enabler themes rather than specific enabling activities to overcome barriers. The focus area of the research undertaken was therefore narrowed to the first step of the DSC journey. Büyüközkan & Göçer (2018: 170) pointed this to be the digital goal setting step that precedes strategy formulation and integration. By focusing on the first step of the DSC journey, the research was able to identify codes and themes for barriers and enablers, specific to the digital goal setting step of DSC strategy. In this way, the research conducted contributes to the DSC body of knowledge by concluding on the specific enabling initiatives needed to overcome the barriers that are relevant to digital goal setting. The digital goal setting specific barriers and enabling initiatives are unique to this research from the literature reviewed.

In addition to the digital goal setting enablers and barriers, new codes and themes emerged from the research that was not found in the literature reviewed. A unique barrier theme of corporate culture was found in the study that is relevant to DSCs as well as digital goal setting. The theme contained the codes of change management, generational and ethics. Change management and generational are also unique barrier codes. This validates the importance of the corporate culture finding. The code change management had the second highest frequency of mentions in the interviews (19) behind missing skills and knowledge (20). To address the new barrier theme of corporate culture, the new enabler theme of leadership mindset was assigned. Leadership mindset was concluded to be an enabler to the codes of change management, generational and ethics. This is also a contribution to the DSC body of knowledge. Leadership mindsets are viewed as barriers by Jones et al. (2021: 940) but are viewed as enablers in this research.

Another academic contribution is the set of enablers and barriers that are specific to South African manufacturers. The literature reviewed were mostly international publications and from the research conducted, it was concluded that the barriers and therefore enablers needed for South African DSC adopter are different to international companies. The South African data collated will be useful for local

South African business schools that examine supply chain opportunities in the country.

7.5. PRACTICAL CONTRIBUTION OF THE STUDY AND IMPLICATIONS FOR MANAGEMENT

The research is of important practical value for South African manufacturers to overcome the hurdles to digital goal setting and get started with their DSC journeys for business sustainability and growth. Naudé & Szirmai (2012: 47-48) evidenced the potential of the sector to contribute more to the South African economy. The framework given in Figure 22 provides easy to follow and practical information for manufacturers on enabler initiatives for any specific barriers identified to digital goal setting. In reference to the DSC general barriers and enablers, new themes, barriers and enablers were identified that are of direct relevance to South African manufacturers. The information presented in the frameworks in this research will allow the DSC non-adopters interviewed to benefit from DSC adopters interviewed. Similarly, the frameworks will allow for DSC adopters interviewed to learn about enablers from each other. These learnings are applicable to all South African manufacturers considering DSC adoption.

Some of the learnings applicable to South African managers, in particular include the enablers to change management. It was concluded that any change introduced was also recommended to be ethical, done slowly and administered through business change programmes. All levels of the organisational also needed to be involved in strategy formulation so as to mitigate change management issues in strategic implementation. South African specific challenges of B-BBEE expectations and union influence can be change-managed by early involvement in a top-down and bottom-up approach to strategy formulation.

In the study, participants specifically identified technical barriers concerning the theme of technology barriers (discussed in Section 6.2.1.1.) that will be of use to South African managers. The recommendations included compatible supply chain systems for ease of data connectivity. South African manufacturers often deployed bespoke systems to plug-in into larger commercial ERP systems later procured. The participants also recommended business collaboration and a passionate, pro-digitalisation workforce as enablers to overcome technical barriers.

An important finding in the research was the enabling DSC role of clusters in the textile industry. The clusters were initiated through government interventions such as masterplans and sustainable practice initiatives. Operating within these clusters allowed for easier facilitation of company data interconnectivity for DSCs. Working in clusters that involved the government also alleviated data sharing concerns. The formation of such clusters and masterplans with government is advised for DSC adoption on the basis of successes reported in the South African textile industry.

The study revealed a needed caution for South Africans in their digitalisation campaigns. Some participants felt that digitalisation and DSCs could add to the unemployment problem in South Africa by cannibalising jobs. The research showed a non-partial group that was aware of the benefits of DSCs in a competitive business environment had suggested an approach of a careful selection of DSC ventures to not result in rapid job losses.

A risk to South African operations from one prominent company's response in the interviews was the threat of global warming. The company had worked with a large consulting company that advised that the spate of recent poor weather patterns in southern Africa was going to continue. Leaders needed to recognise this threat and implement strategies in their supply chains for agility in dealing with such uncertainty.

7.5. REFLECTION ON STUDY LIMITATIONS

All research will have limitations, and this study is no exception. An account of the Research Methodology limitations is given in Section 4.7. A few further limitations are reflected on in this section.

Researcher bias. There is researcher bias that is inherent in all qualitative research. The interpretation of data can be subjective (Saunders & Lewis, 2018: 202). To minimise this bias, member checking Cho & Trent (2006:4) was performed all through the interview to ensure the correct of response interpretation.

Sample bias. Purposive sampling was performed for the target research population and this primarily dependent on the researcher's network. To mitigate this bias, the network approached were also to recommend other possible interview participants. In this way, five of the 15 interviews were not directly from the researcher's network. Another sample bias is the non-participation of firms with extensive DSC

initiatives due to not wanting to give any competitive advantages. This bias is concluded to be minimal as only one company approached did not want to participate in the interview due to possible unintentional intellectual property leakage. This was from a company that was a competitor to the researcher's employer. The sample bias of a limited sample size was concluded to be minimal as data saturation was demonstrated.

Time horizon. A cross-sectional time horizon was utilised due to once-off interviews performed. The barriers and associated enablers are likely to be dependent on a timeline, for example, the barriers during the COVID-19 pandemic and after the pandemic (when the interviews were conducted) would have been very different. Due to supply chains having mostly normalised in a post-pandemic timeframe, this limitation was also thought to have minimal effect on the research conducted.

Sample suitability. Although the sample was demonstrated to be suitable with the participants meeting the criteria to address the research questions, only one company was found to have fully assessed DSC opportunities in their adoption of a DSC strategy. The initiatives at this company were extensive in comparison to the other DSC adopters that prioritised their DSC initiatives on company pain points. With six of the seven DSC adopters not having reviewed industrial case scenarios of DSC implementation, the barriers identified could be biased to not include some barriers identified by the one DSC adopter that did review the scenarios. The codes derived from the latter adopter were the highest from the interviews. Whilst some bias may exist with the sample suitability, the general barriers identified in the study were validated by the same barriers found in literature. The emergence of new codes and themes also provide evidence that the sample suitability bias was minimal.

7.6. RECOMMENDATIONS FOR FUTURE RESEARCH

A shortcoming in the DSC literature reviewed, as well as in this study conducted, was sample bias due to interview participants being mostly or entirely senior managers or executives. Martin (2010: 5) and the research participants held the view that strategies fail due to poor execution practices. This can include practices of a company leader dictating a strategy and expecting others to follow it mechanically. Following the suggested strategy as a choice cascade from Martin (2010: 5), the perspectives of all organisational levels in contrast to those of

executives is recommended to be researched for the DSC barrier of strategic alignment/integration.

A perception from the research (from engineering manufacturing managers) was that South African companies are mostly led by Chartered accountants and finance managers who were labelled technology averse. This claim was not investigated but is suggested as a research topic from a South African manager's perspective relating to DSCs.

7.7. CONCLUDING STATEMENTS

This research study aimed to address the research gap identified by Wu et al. (2016: 17-18) and Büyüközkan & Göçer (2018: 174). These researchers suggested future studies that results in roadmaps and tools for digital supply chain adoption. Furthermore, insights needed to be provided for managers on how to deal with digital supply chain implementation due to a lack of studies on addressing challenges faced. The research conducted has provided a practical framework and insights for managers to consider in the adoption of the first step of a digital supply chain strategy, being the digital goal setting step. The framework could be useful for managers to identify specific enabling initiatives to unlock barrier to digital goal setting or digital supply chain adoption. The enablers and barriers may be particularly useful to South African manufacturers due to them being identified by a sample population of fellow South African manufacturers. This included unique themes emanating from the study, such as the barrier theme of corporate culture which contained the individual barriers of change management, generational and ethics. Change management and generational also being unique barriers identified from the participant's responses. Key recommendations from the study include the appointment of a digitalisation transformation executive and the use of masterplans and manufacturing clusters in South Africa to exploit digital supply chain opportunities.

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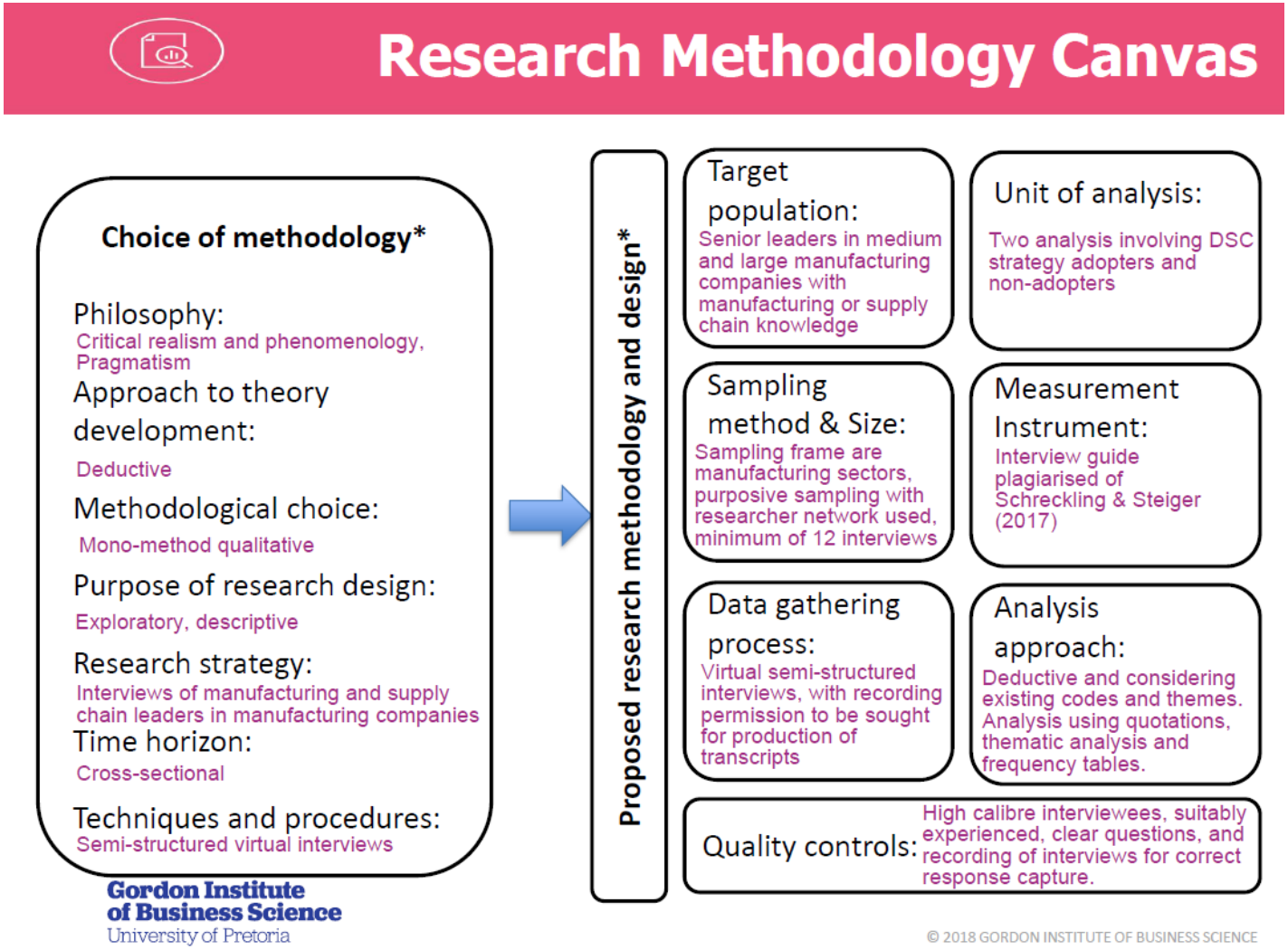
APPENDIX A – RESEARCH MODEL CANVAS



APPENDIX B – ETHICAL CLEARANCE

--- Forwarded message ---------
From: **Masters Research** <MastersResearch@gibs.co.za>
Date: Fri, 11 Nov 2022 at 13:48
Subject: Ethical Clearance Approved
To: 21828505@mygibs.co.za <21828505@mygibs.co.za>
Cc: Masters Research <MastersResearch@gibs.co.za>

Gordon Institute of Business Science
University of Pretoria

ETHICAL CLEARANCE APPROVED

Dear Shaun Madho,

Please be advised that your application for Ethical Clearance has been approved.
You are therefore allowed to continue collecting your data.
We wish you everything of the best for the rest of the project.

Ethical Clearance Form

Kind Regards

Masters Research

Gordon Institute of Business Science, University of Pretoria

Main Tel: +27 11 771 4000
Direct Tel:

Email: mastersresearch@gibs.co.za

APPENDIX C - CONSENT FORM

Dear Participant

I am currently a student at the University of Pretoria's Gordon Institute of Business Science and completing my research in partial fulfilment of an MBA. The program is manufacturing focused with classes conducted at the Toyota Wessels Institute for Manufacturing Studies (TWIMS).

My research aims to understand the barriers and enablers to implementing digital supply chains in manufacturing firms. A digital supply chain can be defined as a value-driven and efficient process to create new types of revenue and value by leveraging innovative technologies such as autonomous vehicles, cloud computing, big data analytics, the internet of things, etc. in the management of supply chain processes (Büyüközkan & Göçer, 2018). The purpose of the interview is to obtain insights from your personal experience related to the topic, with the interview expected to last about an hour, and will help us understand how digital supply chains can be implemented and what value it can deliver to South African manufacturers.

Your participation is voluntary and you can withdraw at any time without penalty. All data will be reported without identifiers, ensuring your confidentiality is maintained. If you have any concerns, please contact my supervisor or me. Details are provided below. Please consent to the interview if you wish to participate by signing below.

Researcher details	Shaun Madho	21828505@mygibs.co.za	+27 83 599 2589
Supervisor details	Dr Malika Khodja	malika.khodja@twimsafrica.com	+27 79 720 5871

Signature of Participant: _____

Date: _____

Signature of Researcher: _____

Date: _____

APPENDIX D – INTERVIEW GUIDE

Organisation: Start time:

Job Title: End time:

Thank you for agreeing to this interview. Your time and input into the research are greatly appreciated and I hope the interview inspires your company to further work with Digital Supply Chains (DSC).The research is entitled 'DIGITAL SUPPLY CHAINS: UNLOCKING BARRIERS TO DIGITAL GOAL SETTING'.

A digital supply chain can be defined as a value-driven and efficient process to create new types of revenue and value by leveraging innovative technologies such as autonomous vehicles, cloud computing, big data analytics, the internet of things, etc. in the management of supply chain processes. There are several examples of how manufacturing companies have benefitted from the implementation of DSCs. These include an Australian sugar company that uses blockchain technology to show the traceability of sugarcane (from farm to fork), which has enabled market premiums from a sustainably sourced product, and sustainability credits and alternate finance received. Smart farming practices include the use of Internet of Things (IoT) sensors to detect diseases, weather patterns and predict product yields. Other value derived includes inventory tracking, information sharing and joint ordering; combining product sales and after-sales service from real-time monitoring of products sold; enhancement of lean supply chain practices, etc. A literature search on DSCs has revealed that the plethora of information available can be overwhelming to decision-makers and can hinder the progress of a DSC strategy. An integrated DSC implementation will include digitalisation, technology implementation and supply chain management. Within the digitalisation strategy lies digital goal setting, digital strategy formulation and digital strategy implementation. The research examines barriers to the goal setting step in DSCs and seeks to learn from successful implementors on the steps taken to overcome such barriers.

This research is of a sensitive nature; however, I encourage you to speak freely as you can be certain that the information you share will remain confidential and you will remain anonymous. You are also free to withdraw at any time without penalty. Before we start, I will take you through the interview consent form. I would also like

to request your permission to record this interview, as well as take notes during the interview.

GUIDE TO QUESTIONS

The research is qualitative and not all of the interview questions below may apply due to companies being in different stage of their DSC journey. You are welcome to seek clarity on any of the questions asked.

No.	Question Guide
1	Please provide a brief overview of your company. What is your manufacturing sector? What is your role in the company? How many employees does your company have? What is your company's annual profits? What is your annual budget allocated for technology upgrades?
2	Has your company adopted a Digital Supply Chain (DSC) strategy? How do you compare to your stakeholders and competitors?
3	What has been your successes with the adoption of DSCs?
4	What has been the barriers with the adoption of DSCs? Has there been any barriers in particular with the first step of the DSC development journey, namely digital goal setting?
5	What has been or what do you think are the enablers to overcome the barriers faced?
6	What are the benefits and value of DSCs for your business? Do you think that DSCs is a technology disruptor in your industry?
7	How fast must your company act?

	Do you believe that your company is doing enough in with DSCs?
8	What types of enterprise systems do you have to control product data within your company? What Enterprise Resource Planning (ERP) system does your company currently utilise?
9	What capabilities do you need in the digital age?
10	How does DSC affect your existing customers and other stakeholders?
11	Have your digital opportunities been assessed and prioritised? How automated is your material handling system? Are you currently using any robotics for material handling?
12	Have industrial case studies and innovation maturity studies been investigated as part of your evaluation process?
13	What resources and systems do you require for implementation of a DSC strategy? Are there any restrictions with flow of information or material as relevant to supply chains? What is the primary medium for data exchange between customer and suppliers?
14	How often is your supply chain or DSC strategy revisited?
15	Are there any DSC opportunities or challenges specific to operating in South Africa?
16	What effect has the COVID-19 impact had on your business? How has COVID-19 affected your DSC strategy? How would a DSC have assisted you during the pandemic?

APPENDIX E – CONSISTENCY MATRIX

Research Questions	Sections in literature review	Data collection tools	Analysis technique
Research Question 1 (RQ1): From a South African manufacturing manager's perspective, what are the types of barriers and enablers that are relevant to the digital goal setting stage of the digital supply chain adoption process?	Section 2.3.3. DSC scenarios and case studies Section 2.4. DSC challenges Section 2.5.: DSC strategy and digital goal setting	Interview Guide – Appendix D Questions 1-16	Directed content analysis
Research Question 2 (RQ2): What are the specific enabling initiatives needed to overcome barriers to digital goal setting in the adoption of DSCs?	Sections 2.3.3., 2.4. and 2.5. as above Section 2.6.: Unlocking barriers in Strategic Goal Setting	Interview Guide – Appendix D, Questions 5-9, 11-13, 15-16	Direct and thematic content analysis