Gordon Institute of Business Science
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Supply Chain Transiliency: Enduring Epidemics Through Resilience and Business Model Innovation

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Abstract

Beginning in late 2019, the COVID-19 epidemic spread throughout the world, causing unprecedented disruption to global supply chains. Disruptions triggered by disease epidemics differ from other types of supply chain disruptions. Not only does the spread of infection threaten human health and life, but epidemic-related disruptions are also unique in terms of their magnitude, duration, unpredictability, massive supply and demand shifts, and widespread disruption of transport networks. These differences have led scholars to question the adequacy of existing supply chain management theory for imbuing supply chains with the ability to resist, respond to and recover from epidemic-related disruption. A novel concept, supply chain transiliency, has been proposed as a possible alternative approach to better assist supply chains cope with the negative consequences of disruption during epidemics. Supply chain transiliency combines conventional supply chain resilience methods with business model innovations. This exploratory research employs qualitative methods to gain early insights into the potential value of this new approach to supply chain management during disease epidemics, thereby making an initial contribution to theory development, while also providing guidance for supply chain practitioners grappling with COVID-19 and future epidemics.

PLAGIARISM 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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Chapter 1: Introduction to Research Problem

1.1. Introduction

The current COVID-19 epidemic has seen unparalleled disruptions to global supply chains (Ivanov & Dolgui, 2020). Although it is fairly common for supply chains to experience periodic disruptions triggered by numerous natural and man-made events, disease epidemics and their attendant consequences represent a unique and particularly challenging class of supply chain disruption (Ivanov, 2020).

The dramatic and far-reaching consequences of COVID-19 will surely lead to renewed research efforts aimed at imbuing supply chains with an enhanced ability to prepare for, respond to and recover from similar disruptive events in the future (Pournader, Kach & Talluri, 2020). In the supply chain management literature, this ability is known as supply chain resilience.

While supply chain resilience has been studied extensively against the backdrop of numerous supply chain disruptions (Tukamuhabwa, Stevenson, Busby & Zorzini, 2015), some researchers are now arguing that the unique characteristics of epidemics in fact call for new theoretical perspectives to better equip supply chains to withstand, adapt to and recover from epidemic-related disruptions in particular (Sodhi, & Tang, 2020; Craighead, Ketchen & Darby, 2020; Ivanov & Dolgui, 2020). Section 1.1.1. examines these unique characteristics that differentiate epidemics from other types of supply chain disruptions, which give rise to the call for a new approach, and support the theoretical need for this research.

1.1.1. Context: Disease Epidemics as a Special Class of Supply Chain Disruption

To understand the need for a novel theoretical approach, it is necessary to first examine the fundamental differences between epidemics and other categories of supply chain disruptions (Craighead et al., 2020; Ivanov, 2020), such as natural disasters, industrial accidents, logistics failures, labour disputes, collapse of a key supply chain partner, or political strife (Dolgui, Ivanov & Sokolov, 2018; Jabbarzadeh, Fahimnia & Sabouhi, 2018). Epidemics cause disruption that i) is typically long-lived and which has the potential to directly affect large parts of supply chains located in diverse geographies, ii) progresses in time and space in a way that is notoriously difficult to model reliably, making it hard to anticipate the duration and full extent of the disruption, iii) propagates through the supply chain concurrently with the spread of the epidemic through the population, and iv) is characterised by concurrent shifts in supply, shifts in demand and destabilisation of logistics networks (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020).

The unique characteristics of epidemics have forced businesses[1] and their supply chains to respond to COVID-19 disruptions in ways that are in many cases very different to the ways in which they might respond to one of the more common disruptive events, leading scholars to argue that the existing approach of resilience is inadequate when dealing with supply chain disruption under epidemic conditions (Craighead et al., 2020; Ivanov & Dolgui, 2020). Section 1.1.2. outlines a new concept called supply chain transiliency, which, it is hoped, will start to fill this gap in the literature (thereby supporting the theoretical need for this research), and also help scholars and practitioners to better understand and defend against epidemic-related disruptions in the future (thereby fulfilling the business need for this research).

[1] The term business will be adopted and used consistently throughout the report to denote a profit-seeking organisation, regardless of form of ownership (i.e. sole trader, partnership, closed-corporation, public company, private company, etc.).

1.1.2. Supply Chain Transiliency: A Novel Approach for Managing Epidemic-Related Disruptions

In an attempt to provide an alternative theoretical lens, Craighead et al. (2020) proposed a new concept, called supply chain "transiliency." A combination of the words transformability and resilience (Craighead et al., 2020), transiliency describe the ways in which businesses around the world have been rapidly transforming their business models to realign their supply chains to a radically altered business environment, by transforming some processes while restoring others (Craighead et al., 2020), in order to counter dramatic shifts in supply and demand, access to markets, as well as restrictions on the ability of businesses to operate in their normal ways due to government-imposed lockdowns (Ivanov, 2020). To understand why it is often necessary to rapidly transform business models in response to epidemics, Section 1.1.3. examines the relationship between business models and the external business environments in which they operate.

1.1.3. The Need to Transform Business Models in Response to Epidemics

For a business model to effectively create value and capture a portion of the value created for the business, all of its elements must be fully aligned to the external business environment. Even during non-epidemic conditions, businesses exist and operate in environments that are rarely static, so continued strategic alignment between a business model and the environment cannot be taken for granted. In a global business environment that is increasingly dynamic and fast-changing, businesses may find it necessary to tweak their business models on a regular basis to realign them to emerging and evolving market trends. However, in the case of disease epidemics such as COVID-19, transformation of business models is particularly important, not only for sustaining business performance, but in many cases, for ensuring business survival.

The need to transform business models, which distinguishes supply chain transiliency from supply chain resilience, stems from the observation that the impacts of epidemic-related disruptions on a business's external environment are often so severe, long-lived, dynamic and unpredictable, that they can destroy the crucial business model – business environment alignment, by temporarily rendering one or more key elements of the business model ineffective. In such cases, supply chain resilience methods are not, on their own, sufficient to prevent damage to the business (and, by implication, its supply chain), and thus focus must shift from returning to the status quo to redesigning for the new reality, involving one or more changes to the fundamental logic of the business – in other words, changes to its business model. This is where supply chain transiliency departs fundamentally from the established concept of supply chain resilience, that is, by proposing business model innovations as an essential and potent weapon for defending against epidemic-related supply chain disruptions.

While different business models are impacted by epidemic-related disruptions in different ways, the common motivation among most businesses that have innovated their business models during COVID-19 was to adapt to shifts in their business environments that were large enough and sustained enough to knock key business model elements out of alignment, thereby rendering their existing business model(s) either suboptimal or totally redundant/obsolete/ineffectual. COVID-19 has undermined key elements of many businesses' existing business models by incapacitating *key partners*, disrupting *key activities*, affecting the availability of *key resources*, altering *value propositions*, disrupting regular sales and distribution *channels*, shifting demand in *customer segments*, impacting *customer relationships*, changing *cost structures*, and shrinking *revenue streams*.

To realign business models to the changing realities of COVID-19, Section 1.1.4., introduces the concept of business model innovation.

1.1.4. Business Model Innovation

In response to COVID-19, many businesses have rapidly adjusted their product and service mixes, switched or added sales channels, and targeted new customer segments. Some have even changed industries entirely or entered altogether new markets. By transforming these and other parts of their business models, they are engaging in a process known in the innovation literature as Business Model Innovation (BMI). Business Model Innovation is most often viewed as a means of creating and/or sustaining competitive advantage over rivals.

However, during times of crisis, the utility of BMI extends far beyond a desire to stay ahead of the competition. While it is true that some managers transformed their business models simply to seize a temporal opportunity they had sensed in the market, many more managers were forced, out of sheer necessity, to make sometimes drastic business model changes to counteract the grave threats posed by COVID-19, and avoid potentially devastating consequences that failure to transform could have had for their businesses. Section 1.1.5. provides an overview of some of the severe consequences that failure to transform an affected business model can have for a business, using an illustrative example of a well-known South African business.

1.1.5. Consequences of Failure to Transform Business Models in Response to COVID-19

Although few businesses have been left unscathed by the pandemic, the impacts of COVID-19 on businesses have varied considerably, ranging from minor inconveniences to existential threats, depending on factors such as nature of the business, its size, its industry, its geographic location, regulatory measures taken by local and foreign governments, and many other variables. As the following example demonstrates, failing to transform an affected business model appropriately and rapidly enough can have dire consequences for a business, up to and including business failure. Where this occurs at a critical node, the entire supply chain may even be at risk, as the following example demonstrates.

Edcon

In South Africa, one of the most high-profile casualties of COVID-19 was retail giant Edcon, the owner of well-known clothing chains Edgars and Jet. Weakened by years of poor economic growth and weak consumer spending, coupled with several questionable strategic decisions, Edcon underwent a major restructuring in 2019, and hoped to trade its way out of financial trouble, when COVID-19 struck South Africa in late March 2020.

During the initial, most stringent lockdown that followed, the South African government prohibited the sale of an extensive list of what it considered to be non-essential goods and services, including clothing and cosmetics, in a bid to limit movement and mixing of the population or congregation at shopping centres. While other retailers (e.g. grocery retailers) were able to innovate their sales channels to reach their customers through order-and-collect services or home deliveries, Edcon was not permitted to do the same, as the ban on non-essential goods applied to in-store and online sales alike (in any event, it seems doubtful that a beleaguered Edcon could have marshaled the skills and resources to rapidly pivot to online sales and home deliveries, however given the government regulations, this was a moot point).

Unable to transform their business model to allow them to continue to earn revenue, and unable to raise additional capital from current investors to see them through the lockdown, cash-strapped Edcon was forced to take drastic action in a last-ditch effort to prevent the imminent collapse of the business. In an emotional call to suppliers and other creditors, CEO Grant Patterson explained that with immediate effect, Edcon was not in a position to pay the money it owed them. Not long after, approximately twenty-two thousand permanent and contract staff, representing nearly the entire workforce, were served with retrenchment notices. Management hoped these measures would be enough to stave off liquidation long enough for them to attempt to sell the business.

Although they did not succeed in selling Edcon in its entirety, buyers were eventually found for the profitable Jet and Edgars stores, saving some 4800 and 5 200 jobs, respectively. However, Edcon's inability to transform key aspects of its business model in response to the pandemic still cost around 12 000 workers their livelihoods. For Edcon's financial backers and upstream supply chain partners, the impacts were equally severe. Despite the successful sale, creditors were hard hit, with even secured creditors – collectively owed R3.73 billion rand – expected to receive no more that nineteen cents in the rand. Many of Edcon's suppliers were small businesses, who could ill-afford the effects of non-payment on their cashflows. Even worse, for many, Edcon had for decades been their only customer.

Whereas this section has highlighted the potentially catastrophic consequences that can befall a business with an adversely affected business model when it fails to (or is unable to) transform compromised/misaligned elements of that business model, Section 1.1.6. uncovers the benefits of successful business model transformation in response to COVID-19.

1.1.6. Benefits of Successful Business Model Transformation in Response to COVID-19

As the following example demonstrates, successful business model transformation can help businesses avoid or reduce the consequences of epidemic-related disruptions, both for themselves and for their supply chains.

Brewster's Craft

While the majority of FMCG categories were designated as essential goods, and could therefore be legally sold throughout the pandemic, the local alcoholic beverages industry has been intermittently shuttered for extended periods after the South African government temporarily banned the production, transportation and sale of alcohol to prevent alcohol-related violence and limit infections caused by uninhibited and unsafe socializing, in order to reduce pressure on healthcare facilities.

Faced with the alarming prospect of no income for an unknown period of time, Brewster's Craft, South Africa's first 100% black-woman-owned brewery, innovated its established business model, and switched to producing and marketing non-alcoholic beers to enable it to continue to serve its existing core customers – beer drinkers. Meanwhile, the alcohol which was removed from the beer after brewing through a dealcoholizing process was used to make hand sanitizer for medical and personal hygiene uses, thereby opening up new markets to the company and securing an additional revenue stream to help make up for lost sales of their traditional alcoholic beer products.

When the nationwide ban on alcohol sales was first imposed in late March 2020, Brewster's Craft feared they may not survive, as without revenue, they would not be able to afford rent, pay their staff, or make upcoming loan repayments. In late December 2020, the Beer Association of South Africa estimated that the local beer industry had already shed 7400 jobs as a direct result of bans and restrictions on the sale of alcohol. Without urgent transformation of key aspects of their business model, Brewster's Craft may well have failed, adding further job losses to the already alarming industry tally, and further exacerbating SA's current unemployment crisis

In addition to lost jobs, whenever a business fails as a result of lockdown restrictions, the overstretched national fiscus loses out on a desperately needed future revenue stream. Most importantly for the purposes of this research, however, the collapse of the company could have had negative consequences and knock-on effects for other members of the supply chain, particularly Brewster's Craft's suppliers, who would have lost a potentially significant customer, which in turn could have had implications for their own financial performance and sustainability. It is thus clear that by engaging in business model innovation (BMI), Brewster's Craft did not only ensure its own survival, but also enhanced the transiliency of its supply chain, not just during the initial alcohol ban in early 2020, but also for subsequent bans.

1.2. Business and Theoretical Research Needs

These and countless similar stories provide anecdotal evidence of how businesses have been relying on business model transformations as a way of helping themselves and their supply chains better weather the COVID-19 storm. It was on the basis of such real-world observations that transformation of business models was included as one of the twin pillars of supply chain transiliency (Craighead et al., 2020). Since transiliency is a new concept, there is no existing body of literature dedicated to it, and furthermore, there are few studies in the related supply chain resilience literature examining the value of business model innovation for helping supply chains cope with disruption (Sabahi, & Parast, 2020). Instead, the supply chain resilience concept mainly emphasizes the capability to restore existing processes to their prior state as soon as possible (Ali, Mahfouz, & Arisha, 2017) following a disruption. Supply chain resilience corresponds to the second pillar of transiliency (Craighead et al., 2020).

Transiliency is thus distinct from resilience, and could potentially turn out to be a valuable tool to help supply chain practitioners cope with epidemic-related disruptions more effectively (Craighead et al., 2020). Owing to the lack of previous research into the concept, there is a strong theoretical need to further investigate and develop the concept of transiliency, especially as it relates to business model innovation, as it is this pillar that distinguishes transiliency from resilience. Future research is urgently required, not only to better understand how businesses are managing supply chain disruptions during COVID-19, but also to better equip supply chain practitioners to deal with similar disruptive events in future (Craighead et al., 2020). There is thus a clear and timely business need for the present study.

Furthermore, despite important differences between epidemics and other types of disruptive events, there appear to be few articles in the supply chain management literature focusing specifically on epidemic-related disruptions (Queiroz, Ivanov, Dolgui, & Wamba, 2020). This fact indicates a clear gap in knowledge, and hence there is a strong theoretical need to study both the impacts of epidemic-related disruptions as well as develop appropriate tools, such as transiliency, to manage them.

Since transiliency relates specifically to epidemics, the COVID-19 crisis presents an excellent setting in which to study it. Craighead et al. (2020) outline a range of gaps in knowledge around transiliency that require investigation with a view to theory-building around supply chain transiliency. Accepting this invitation, the proposed research will study the concept of supply chain transiliency in the context of COVID-19 in South Africa.

1.3. Summary of Research Problem

The advent of COVID-19 has caused massive disruptions to global supply chains. While considerable previous research has been devoted to helping supply chains resist, recover from and respond to supply chain disruptions, established supply chain resilience approaches have been found wanting in the face of the unique characteristics of disruptions triggered by disease epidemics (as described in Section… above). Many businesses around the world have been observed engaging in business model innovation to cope with the consequences of epidemic-related disruptions, rapidly transforming elements of their business models that are no longer aligned to the shifting

business environment in order to ensure their own sustainability and the sustainability of their supply chains.

Such observed practices, together with the apparent inadequacy of current supply chain resilience theory in the face of epidemic-related disruptions, have led scholars to call for new theoretical perspectives to address the perceived gap in the literature in respect of supply chain management under epideimic conditions (theoretical need), while equipping supply chain practitioners to better understand and respond to similar disruptions that may flow from future disease epidemics (business need). One such novel approach to enabling supply chains to more ably cope with epidemic-related disruptions is called supply chain transiliency (Craighead et al., 2020). By combining conventional supply chain resilience techniques with business model innovations which have been so frequently observed during COVID-19, supply chain transiliency argues that businesses should balance the restoration of certain business proceses against the transformation of other business processes to ensure sustainability of the wider supply chain during an epidemic.

Answering scholars' call, this research aims to address the gap in knowledge around supply chain management in the face of epidemic-related disruptions by studying the concept of transiliency, with an emphasis on business model innovations, in the context of different South African businesses and industries during COVID-19, thereby addressing both business and theoretical needs.

Chapter 2: Literature Review

2.1. Introduction

Chapter 2 reviews relevant academic literature pertaining to the concept of supply chain transiliency. The chapter is organised into three main sections (excluding the introduction and conclusion). It begins by discussing theory around underlying bodies of knowledge, namely supply chain resilience (Section 2.2.) and business model innovation (Section 2.3.), which form the twin pillars of supply chain transiliency.

It then links these bodies of knowledge with supply chain transiliency, thereby integrating existing academic theory with this novel concept in supply chain management (SCM) research (Section 2.4.). The proposed relationships between supply chain transiliency, supply chain resilience and business model innovation are presented diagrammatically in the form of a conceptual model of supply chain transiliency. The chapter concludes with a summary of the key literature and its implications for this research (Section 2.5.).

2.2. Supply Chain Resilience

2.2.1. Introduction

Section 2.2. reviews relevant literature related to the supply chain resilience concept, one of the twin pillars of supply chain transiliency. The section proceeds as follows.

First, the foundational concept of supply chain is defined and briefly discussed (Section 2.2.2.). Next, key characteristics of supply chains which render them vulnerable to risk are explored (Section 2.2.3.), followed by the potential consequences of breakdowns in the supply chain for its members (Section 2.2.4.), including the end-user (customer) of the product or service which a given supply chain normally delivers (Section 2.2.5.).

The concept of supply chain disruption is then formally introduced and defined (Section 2.2.6.), and discussed within the contexts of disease epidemics in general (Section 2.2.7.) and COVID-19 in particular (Section 2.2.8.), outlining the unique characteristics that distinguish epidemics from other types of supply chain disruptions.

Next, the supply chain resilience concept is introduced as a way of assisting supply chains to resist, respond to and recover from the impacts of supply chain disruptions (Section 2.2.9.). The relationship between supply chain resilience, and a closely related concept, organsational resilience, is explained (Section 2.2.10.). Supply chain resilience is then examined in the context of disease epidemics in general (Section 2.2.11.), and COVID-19 in particular (Section 2.2.12.), highlighting the deficiencies of existing theory for dealing with epidemic-induced supply chain disruptions, and in response, making the case for a new, expanded approach to supply chain resilience under epidemic conditions.

Section 2.2. concludes by concisely summarsing the key supply chain resilience concepts, noting the inadequacies in the supply chain resilience approach uncovered by COVID-19, describing how many businesses had to transform business models to better cope with the pandemic, and introducing the concept of Business Model Innovation, the subject of the following section (Section 2.2.13.)

2.2.2. Supply Chain Concept

Before discussing the concept of supply chain resilience, it is first necessary to define the concept of a supply chain. Although numerous definitions of supply chain exist, the definition proposed by Mentzer et al. (2001) is frequently cited in the literature. In their seminal article, the authors defined the supply chain as “a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer (Mentzer et al., 2001).” In other words, a supply chain may be thought of as consisting of all the organisations involved in the creation and delivery of a product or services to the end user. Between them, these organisations engage in a wide range of business activities, from procurement of the most basic primary inputs, to value-adding processes, to transportation, storage and final (last-mile) delivery.

It follows that Supply Chain Management is the process of managing the business's supply chain activities. According to the Council for Supply Chain Management Professionals (2021), Supply Chain Management "encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies (CSCMP, 2021)."

Supply chains exist within every industry, and also transcend the boundaries between industries. Some supply chains may be highly localized, confined to a small geographic area, such as single city. Others may operate on a country or regional level, while complex global supply chains form the backbone of international trade, with numerous members located in multiple regions. Whatever the scale, supply chains are typically designed to be as efficient as possible, as supply chain costs can represent a significant portion of a business's overall cost structure.

Unfortunately, the efficiency, length and geographic dispersion of modern supply chains also make them more vulnerable to disturbances triggered by events taking place either inside the supply chain itself, or else in the wider business environment (Revilla, & Saenz, 2017)

2.2.3. Supply Chain Vulnerabilities

Vulnerabilities may exist in a supply chain for numerous reasons. During COVID-19, the apparent preoccupation with so-called 'lean' supply chain practices, as well as the supposedly excessive length and interconnectedness of global supply chains, have both featured prominently in the popular press.

Lean principles, which advocate for minimal inventory levels and just-in-time delivery, have become established SCM doctrine (Katsaliaki, Galetsi, & Kumar, 2021). When procuring goods and services, many organizations employ single-sourcing, as purchasing from a single supplier instead of multiple suppliers often allows them to negotiate a lower price in return for placing large-volume orders (Gaur, Amini, & Rao, 2020).

However, lean principles can have a dark side, in that they tend to reduce the capacity of supply chains to cope with the negative consequences of unanticipated future events (Goldbeck, Angeloudis, & Ochieng, 2020; Katsaliaki, Galetsi, & Kumar, 2021). Therefore, when configuring their supply chains, businesses need to consider how best to manage the unavoidable trade-off that exists between minimizing supply chain costs under business-as-usual conditions and minimizing the harmful effects on the supply chain should it be disturbed by an unexpected internal or external event (Gaur, Amini, & Rao, 2020; Moussawi-Haidar, Daou, & Khalil, 2021). Like any highly-optimized system, lean supply chains are inherently vulnerable to destabilizing events, as they lack the layers of built-in redundancy which help less optimized systems withstand and recover from unexpected exogenous shocks. In the event of a supply chain disruption, just-in-time delivery and bare minimum inventory levels both increase the probability of stock-outs of either finished products, components or raw materials (as the case may be). Single-sourcing also increases an organisation's supply-side risk, as a problem occurring at the sole supplier could severely restrict or even cut off the flow of critical inputs to the organization entirely.

One way to resolve concerns over the apparent fragility of ultra-lean supply chains would be to make the system more redundant at critical points (Kamalahmadi, Shekarian, & Parast, 2021). However, deliberately building redundancy into a supply chain runs contrary to lean principles, undermining many of the efficiencies they aim to create and thereby raising supply chain costs. Understandably, many managers are reluctant to dampen the short-term financial performance of their businesses in order to limit the impacts of hypothetical future events which may never materialize (Snoeck, Udenio, Fransoo, 2019).

Globalisation has also created sources of vulnerability in supply chains. Offshoring of manufacturing and other business activities from developed nations to low-cost producers in developing countries like China has increased the length and interconnectedness of global supply chains. The increased interconnectedness brought about by globalization means that the impacts of a supply chain breakdown occurring in one country or region can have severe consequences for supply chain partners in the farthest reaches of the globe. High levels of global integration mean that the effects of the initial problem are able to spread beyond the immediate surrounding area, propagating downstream (through a phenomenon known as the ripple effect (Hosseini, & Ivanov, 2019)) as well as upstream (by way of the bullwhip effect (Pastore, Alfieri, Zotteri, 2019)).

Globalisation has also served to significantly lengthen supply chains, which had previously been confined to a local or regional geography, and comprised only a small number of entities. In terms of fundamental mathematical probability theory, a system having a greater number of nodes is more likely to experience a major disruption at least one of its nodes compared to a system consisting of a smaller number of nodes (all else being equal) (Bode, & Wagner, 2015).

During the normal course of business, common supply chain characteristics such as those discussed above are beneficial for the supply chain and its members. However, when faced a crisis, these strengths often turn into weaknesses. Failure to strike the right balance between day-to-day operational efficiency and appropriate preparedness for unexpected negative events can have serious consequences for the supply chain, as discussed in the following section.

2.2.4. Supply Chain Disruptions Consequences for Supply Chain Members

Supply chain problems may have serious deleterious effects on the functioning of the supply chain. The nature and extent of the damage caused to the supply chain is a function of the type, scope and duration of the disturbance, as well as the capacity of the supply chain to absorb, recover from and adapt to its effects.

Supply chain problems may also cause negative impacts for individual businesses which form part of the supply chain. These may include loss of production due to unavailability of inputs, lost sales and dissatisfied customers due to stock-outs, inability to store products due to a warehousing shortage, or an inability to deliver goods to market due to the failure of a key transport link. Such occurrences can have significant material consequences for the business, including reduced financial performance, damage to brand and reputation, or even closure. Hence, there is a very real incentive for supply chain members to seek ways to proactively reduce risks to the supply chain in the first place, and also mitigate their effects should they occur.

2.2.5. Supply Chain Disruptions and Risks

The above sections have focused on the characteristics of supply chains that make them vulnerable to risks, and the consequences of the realization of risks for supply chains and supply chain members. Before moving on to the concept of supply chain resilience, one last piece of the theoretical puzzle is needed – that is, an understanding of the types of risks against which supply chain resilience is meant to protect, which the next three sections will provide.

Supply chain risks may be subdivided into operational risks and disruption risks. Operational risks refer to relatively high-frequency but low-impact disturbances to the normal operation of the supply chain (El Baz, & Ruel, 2020). Operational risks are the result of endogenous factors (factors falling within the control of the organisations which make up the supply chain) such as those related to changes in patterns of demand, or changes in suppliers' lead times, for example (Giannakis, & Papadopoulos, 2016).

Meanwhile, a supply chain disruption may be defined as "an unexpected event that stops or slows the normal flow of material [through a supply chain] with potentially negative consequences to supply chain members (Scheibe, & Blackhurst, 2018)." In contrast to operational risks, disruption risks tend to be low-frequency, but high-impact events (El Baz, & Ruel, 2020), and stem from exogenous factors (factors arising as supply chain members engage with their external business environments) (Giannakis, & Papadopoulos, 2016).

For the sake of completeness, both types of supply chain risks have been defined above. However, at this juncture, it is necessary to clarify the scope of the study with respect to supply chain risks. As stated from the outset, this study is specifically concerned with supply chain risks arising from present and future disease epidemics. Since disease epidemics, including COVID-19, would clearly be exogenous risk factors in terms of the above definitions, they are classified as disruption risks. Hence, no further mention of operational risks is made in this report. Instead, the report only considers supply chain disruptions that are associated with epidemics in general, and COVID-19 in particular.

Supply chain disruptions can occur at any point along a supply chain, and may be triggered by any number of unexpected events, such as natural disasters, industrial accidents, logistics failures, labour disputes, the collapse of a key supply chain partner, or political strife (Dolgui, Ivanov & Sokolov, 2018; Jabbarzadeh, Fahimnia & Sabouhi, 2018). Although many types of disruption (e.g. factory fire) initially affect a single supply chain partner, if the extent of the disruption is large enough, or if the disruption occurs at

a critical node within the supply chain, there is a risk that the effects of the disruption may not be contained at the source, and that they may spread to other supply chain partners. In such cases, the disruption may 'propagate' downstream or 'ripple' upstream, potentially impacting both the buyers and suppliers of the supply chain member (or members) where the problem originated.

Having defined the concept of supply chain disruption, and discussed the risk of it spreading beyond its initial location to disrupt other members of the supply chain, the literature review now focuses in on the unique characteristics of supply chain disruption triggered by disease epidemics.

2.2.6. Supply Chain Disruptions during Disease Epidemics

Following the outbreak of COVID-19, scholars were quick to highlight the fundamental differences that exist between epidemics and all other categories of supply chain disruptions (Craighead et al., 2020; Ivanov, 2020). Disease epidemics differ from other types of disruptive events in at least four important ways. These have already been outlined in Chapter 1, but it is important to repeat them here as they are central to the purpose of the study, and also explain the reasons for the inadequacy of current supply chain resilience theory for dealing with epidemics, which is the primary justification of the need for this research. As stated in Chapter 1:

> *The defining characteristics of epidemics are that they cause disruption that i) is typically long-lived and which has the potential to directly affect large parts of supply chains located in diverse geographies, ii) progresses in time and space in a way that is notoriously difficult to model reliably, making it hard to anticipate the duration and full extent of the disruption, iii) propagates through the supply chain concurrently with the spread of the epidemic through the population, and iv) is characterised by concurrent shifts in supply, shifts in demand and destabilisation of logistics networks (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020).*

Despite the important differences between epidemics and other types of disruptive events, there is a dearth of supply chain management literature focusing specifically on epidemic-related disruptions (Queiroz, Ivanov, Dolgui, & Wamba, 2020), an untenable situation given the devastation wrought by COVID-19. Hence, this research forms part of early scholarly efforts to fill in this glaring gap in theoretical knowledge within SCM. By focusing specifically on disease epidemics as a unique class of supply chain disruption, it will also go some way towards providing guidance for business practitioners facing future epidemics.

To illustrate the unique characteristics of epidemics as disruptive events, the following section provides actual examples of the kinds of disruptions experienced by supply chains during COVID-19.

2.2.7. Supply Chain Resilience

Supply chain resilience refers to the capabilities of a supply chain to "anticipate, adapt, respond, recover and learn" from a disruptive event (Ali et al., 2017). There are numerous techniques available to practitioners seeking to build resilience into their supply chains. However, it is possible to group the various approaches into two broad categories: robustness and agility (Dubey, Altay, Gunasekaran, Blome, Papadopoulos, & Childe, 2018).

Robustness approaches are proactive, and focus on building a supply chain, ex ante, that will be able to absorb the impact of a disruption without experiencing a significant decline in its functioning. Common robustness approaches include investing in spare production capacity, maintaining higher inventory levels, and having relationships with multiple suppliers (Revilla, & Saenz, 2017).)

Although some of these robustness approaches may offer protection against more than one disruptive event, there is unfortunately no single, generic robustness approach that can render a supply chain impervious to all possible disruptions. This is because the impacts of different types of disruption vary widely, and hence defending the supply chain against each type of disruption requires a specific robustness measure (or combination of measures) to be taken. Furthermore, since supply chain members have finite resources (whether taken individually or collectively), it is also usually impossible for a supply chain to adopt and implement all appropriate robustness measures to guard against all possible threats of disruption that may exist in the business environment. In

light of these resource constraints, an implicit assumption of robustness approaches is that the members of the supply chain are able to anticipate the types of disruptive events that the supply chain is most likely to be subjected to in the future (even though they are unable to forecast if or when such disruptions might actually occur), and allocate the finite pool of resources available for resilience initiatives accordingly.

For common, periodic, small-scale disruptions that are short in duration and local in extent, this assumption may be reasonably valid, as it is relatively simple to devise contingency plans in the event of incapacity of one supplier, or the unavailability of one transportation provider, for example. In such instances, the cause of the initial disruption need not even be known, only the effects on the rest of the supply chain (e.g. at the factory of a supplier, the effects of a catastrophic fire will be roughly the same as a prolonged labour strike – both events result in a loss of production and reduced supply to other members of the supply chain).However, as COVID has demonstrated, it is impossible to predict the timing, location and progression of very large-scale disruptions such as disease epidemics, and therefore, very difficult to plan effectively for them in advance.

In contrast to robustness approaches, agility approaches aim to design the supply chain in such a way that it is able to respond adaptively to a disruption, recover rapidly from it, and restore normal functioning within a short space of time.

Agility approaches may appear reactive in the sense that they emphasize the ability to cope with disruption when it occurs, as opposed to creating invulnerability to disruption in advance. However, they are in fact no less proactive than robustness approaches, and require equal preparedness, as the capabilities required to cope effectively with disruption cannot be acquired when a disruptive event strikes, but must be nurtured beforehand.

Having defined supply chain resilience and discussed the two main groups of supply chain resilience approaches (robustness and agility), it is necessary to understand the mechanism through which supply chain resilience is actually achieved. In accordance with the definition presented in above, a supply chain is not a self-contained, standalone entity which exists independently of the supply chain members (which are typically organisations), nor does it have decision-making capacity of its own. Rather, it is the relationships between the individual supply chain members that gives rise to the concept of the supply chain, and so it is the actions taken by individual supply chain members to build their own organisational resilience that gives rise to supply chain members (which may or may not be coordinated) to build their own resilience which together give rise to supply chain resilience. The following section explores the relationship between the resilience of the supply chain and the resilience of its members.

2.2.8. Relationship between Supply Chain Resilience and Organisational Resilience

The concept of resilience applies at an organizational level as well as a supply chain level. Organisational resilience may be defined as “an organization’s ability to anticipate potential threats, to cope effectively with adverse events, and to adapt to changing conditions (Duchek, Raetze, & Scheuch, 2020).”

Since by definition a supply chain is merely a collection of interacting organisations, and does not exist independently of them, it is clear that any system-level attributes such as supply chain resilience cannot be inherent to the supply chain. Instead, supply chain resilience is an emergent property arising from complex interactions continuously taking place between the component organizations that collectively constitute the supply chain system (Tukamuhabwa, Stevenson, Busby & Zorzini, 2015). It follows that supply chain resilience is achieved through the implementation of initiatives designed to enhance resilience at the organizational level, where such initiatives may include changes to the organisation’s resource base, resource allocation, internal processes or capabilities (Kamalahmadi, & Parast, 2016; Scholten, Stevenson, & van Donk, 2019). Hence, when studying supply chain resilience, it is important to examine the actions that individual supply chain members take to build their own organisational resilience, as these give rise collectively to the resilience of the supply chain as a whole.

Now that supply chain resilience has been defined, and the relationship between supply chain resilience and organisational resilience has been clarified, the following section examines the operation of supply chain resilience in the context of disease epidemics.

2.2.9. Supply Chain Resilience during Disease Epidemics

Prior to the advent of COVID-19, most mentions of epidemics within the field of supply chain management were to be found in the humanitarian supply chain management literature. Humanitarian supply chain management is concerned with the establishment and management of supply chains tasked with providing relief to vulnerable populations in the immediate aftermath of a humanitarian disaster. While some articles described humanitarian supply chains set up to respond to past outbreaks of communicable diseases, none of the articles found treated epidemics as a class of disruptive events which can directly affect the proper functioning of supply chains, and against which supply chain resilience ought to be built. In other words, epidemic-related disruptions were not the focus of these studies, rather, epidemics were simply mentioned as one of many natural phenomena which have the potential to cause humanitarian disasters.

Similarly, in the supply chain resilience literature, little attention has been given to the operation of supply chain resilience in the face of epidemic-related disruptions. Most research has tended to focus on building resilience against other more frequently-encountered events. The fact that past epidemics like SARS have been fairly short-lived, confined to a small geographic area, and had relatively minor impacts on global supply chains may explain, at least in part, the lack of special attention epidemics have received in supply chain management research before now.

The relative dearth of literature on the subject of epidemics is concerning, particularly now, as there has been little in the way of past experience for supply chain practitioners to rely on when attempting to navigate the COVID-19 pandemic. In recognition of this glaring gap in knowledge, supply chain scholars have sounded the call for research dedicated to understanding the effects of epidemics as a unique class of disruptive event, in order to assist practitioners to equip supply chains to better prepare for, respond to and recover from future outbreaks. The justification for this research is aligned with that call. As stated in Chapter 1 above, this research recognizes the inadequacy of existing approaches to supply chain resilience when dealing with epidemics (which constitute a unique class of supply chain disruption) and therefore seeks to discover which alternative

approaches have actually been successful in helping supply chains cope with COVID-19 (van Hoek, 2020). The following section examines some common trends around supply chain resilience observed during COVID-19.

2.2.10. Supply Chain Resilience during COVID-19 Pandemic

While in the past epidemics may have been largely overlooked in the study of supply chain resilience, as well as supply chain management as a whole, COVID-19 has brought their potentially devastating consequences for supply chains sharply into focus. Many supply chains around the world were caught unprepared for the unique challenges posed by COVID-19, leading to significant drops in supply chain performance, and in the case of some supply chains, even collapse.

However, despite not having planned for the epidemic in advance, it has been observed that some supply chains were able to recover from COVID-19-related disruptions more quickly than others, which was attributable to their relatively greater degrees of agility. Experience from COVID-19 suggests that, of the traditional approaches to supply chain resilience, the agility approach appears to be most suited to tackling low-probability, high-impact disruptive events like epidemics. Due to the need to anticipate and plan for disruptive events in advance, robustness approaches appear to be best suited to protecting against high-probability, low-impact disruptive events (which is not to say that they will be of no value when dealing with epidemics).

However, despite the potentially serious consequences of disruptive events for businesses (as discussed above), and the myriad of tools at their disposal with which to combat disruptions, businesses are sometimes reluctant to embrace supply chain resilience. Investing in supply chain resilience initiatives adds cost and reduces business profitability, simply in order to protect the supply chain against hypothetical disruptions that might never materialise, so managers can be hard-pressed to justify the value of supply chain resilience to superiors and shareholders.

While this is not a new problem, it is likely to be especially pronounced in the wake of a supposed once-in-a-generation occurrence like COVID-19. After all, if decision-makers are already hesitant to back resilience efforts under normal circumstances, it seems probable that they may be even more reluctant to commit scarce resources to guard against epidemics, which have historically had return periods of a hundred years or more – far beyond the tenure of individual managers. Moreover, and despite calls to broaden performance measurement criteria, many businesses continue to measure managers solely on short-term financial outcomes, rather than long-term sustainability of the business. Such systems incentivize managers to reduce costs wherever possible in order to improve annual profits, further discouraging investment in resilience.

However, businesses that fail to recognize the dangers of epidemics do so at their own peril. Although COVID may appear to be a black-swan event, unlikely to be repeated in the lifetimes of people alive today, the risk of similar events has actually grown considerably over the past several decades. Due to population pressure and a growing demand for natural resources, humans are expanding ever deeper into wilderness areas, and coming into increasingly close and frequent contact with animals that may carry unknown pathogens, which are sometimes able to mutate sufficiently to jump the species barrier. In light of this, scientists warn that future outbreaks of novel diseases are almost inevitable. However, they cannot predict when or where the next pandemic will begin, or whether or not it will be similar to COVID-19.

2.2.11. Conclusion

The above section shows that supply chain resilience is an established concept in the supply chain management literature. Supply chain resilience enables supply chains to resist, respond to and recover from disruptions, and ultimately return to business-as-usual functioning within the shortest possible time, by employing a combination of robustness strategies and agility strategies.

Despite the successful application of supply chain resilience strategies to cope with past disruptions, scholars have questioned the adequacy of the existing supply chain resilience concept for dealing with events like COVID-19, due to the unique characteristics of pandemics (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020), which differ fundamentally from those of other types of disruptions. Given the extraordinary nature of the current pandemic, both in terms of magnitude and duration of the disruption, it is perhaps unsurprising that in addition to conventional

resilience-based approaches, businesses have resorted to additional actions to help themselves and their supply chains cope with the situation. In particular, an unprecedented number of organisations have responded to supply chain disruptions by 'pivoting', substantially altering the ways in which they do business, including switching product and service lines, finding alternative routes to market, or targeting new customer segments, among other measures. In the innovation literature, transformation of the components of a business model is known as business model innovation (BMI). BMI forms the second pillar of supply chain transiliency, and is explored in detail in the following section.

2.3. Business Model Innovation

2.3.1. Introduction

Section 2.3. reviews relevant literature related to the business model innovation concept, the second of the twin pillars of supply chain transiliency. The section proceeds as follows.

First, the foundational concept of business model is defined and briefly discussed (Section 2.3.2.). Next, the business model innovation concept is explained (Section 2.3.3.).

Business model innovation is then examined in the contexts of general crises (Section 2.3.4.), disease epidemics (Section 2.3.5.) and COVID-19 (Section 2.3.6.). The next section explores coopetition, a business model innovation that has been frequently adopted during COVID-19 (Section 2.3.7.).

2.3.2. Business Model

Before discussing business model innovation (BMI), it is first necessary to define what is meant by the term business model. The literature contains a large number of proposed definitions, but most definitions agree that at its core, “a business model articulates how a firm creates value for their customers and how it appropriates this value (Sorescu, 2017).”

In the literature, Osterwalder’s (2013) Business Model Canvas (BMC) is one of the most frequently cited conceptualizations of the business model construct. The BMC graphically depicts the elements of a business model, namely key partners, key activities, key resources, value propositions, channels, customer segments, customer relationships, cost structure, and revenue streams.

Distinguishing between product and process innovations and grouping them accordingly, it is possible reduce Osterwalder’s (2013) conceptualization to a much simpler definition. In a seminal article, McGrath (2010) asserts that at a fundamental level, a business model essentially consists of just two parts – the unit of business, which refers to the product or service being sold, and the ‘key metrics’, which encompass the operational processes which are required to sell a particular unit of business. This simplified definition is considered adequate for the purposes of this study, including the development of a conceptual model of supply chain transiliency, since the study is concerned with the relationship between the supply chain transiliency and business model innovation constructs, and not with the relationship between the different elements of business model innovation.

2.3.3. Business Model Innovation

Business model innovation (BMI) can be defined as “designed, novel, nontrivial changes to the key elements of a firm’s business model and/or the architecture linking these elements (Foss and Saebi, 2017).” Consistent with the above definition of the business model, to qualify as BMI, an innovation must bring about changes to the way in which an organization generates value, delivers value to the customer, and appropriates a portion of the value thus created for itself (Ghezzi, & Cavallo, 2020).

While proponents of BMI mostly emphasize its value as a means of creating and sustaining competitive advantage in the marketplace (Geissdoerfer, Vladimirova & Evans, 2018), research has also shown that businesses that possess the capability to continuously innovate their business models also display increased resilience to shifts taking place in their external business environment (Geissdoerfer et al., 2018). The latter finding is especially relevant for the current study, which is set in the context of a severe exogenous shock imposed by such an event taking place in the external business environment, leading to the contention that business model innovation is likely to play an important role in fostering resilience – and hence transilience – in supply chains subjected to epidemic-related disruptions. Indeed,

2.3.4. Business Model Innovation during Crises

In the crisis management literature, a crisis is defined as a situation of such significant impact on an organisation that it could threaten its very survival (Chowdhury & Quaddus, 2016). In the strategy literature, a crisis event is characterized by three dimenstions/criteria: importance (for survival), urgency/immediacy and uncertainty (Dutton, 1986). Crisis situations impose time constraints as well as cognitive pressures on managers when making decisions (Chowdhury & Quaddus, 2016), including decisions related to business model innovation.

Crises can trigger both necessity-driven and opportunity-driven entrepreneurial processes (Devece, Peris-Ortiz, & Rueda-Armengot, 2016). During a crisis, business model innovation is often driven more by a need to defend against a threat and ensure organisational survival, than a desire to create competitive advantage (Cucculelli & Peruzzi, 2020), which has been true for many businesses during the time of COVID-19.

Behavioural theory offers insights into why this may be so. Prospect theory asserts that in general, decision-makers exhibit a heightened propensity to accept risk when seeking to avoid a potential loss than they would when trying to secure a potential gain (Saebi, Lien & Foss, 2017; Kahneman, & Tversky, 1979). Thus, when faced with a threat to busines survival, such as is frequently present during a crisis, managers are expected to hold an increased business model change intention (Osiyevskyy & Dewald, 2018) compared to non-crisis situations. Evidence for prospect theory can be found in the way in which many businesses have engaged in radical, explorative business model innovations in response to threats imposed by COVID-19, despite the risks involved, which would ordinarily have discouraged experimentation in favour of the continued exploitation of safer, proven, existing business models.

However, a competing behavioural theory, threat-rigidity theory, argues the converse, predicting that when decision-makers perceive a situation as threatening, they are in fact more risk-averse, preferring to avoid new courses of action in favour of tried and tested methods (Saebi et al., 2017). According to threat-rigidity theory, managers are expected to display a reduced business model change intention in crisis situations (Osiyevskyy & Dewald, 2018). The study will shed light on which behavioural theory likely predominates and whether managers, on average, display an increased or decreased intention towards business model innovation during epidemics. Since business model innovation is a foundational construct of supply chain transiliency, the answer to this question has profound implications for the present study, as well as for the validity of the transiliency concept as proposed by Craighead and Ketchen (2020).

In terms of their effects on business models themselves, crises give rise to particularly severe exogenous shocks, which can cause some companies' existing business models to suddenly become obsolete or unworkable (Morgan, Anokhin, Ofstein, & Friske, 2020), forcing them pivot out of necessity into new or modified business models. Such pivots can include searching for new customers or markets and altering product or service offerings (Morgan, Anokhin, Ofstein, & Friske, 2020). In other cases, crises may herald new opportunities, which entrepreneurial mangers recognise and are driven to exploit by engaging in business model innovation.

Thus, it can be seen that, during a crisis, business model innovation takes on a renewed significance for businesses. For distressed businesses, the decision to seek out a new opportunity and pivot into a different business model in order to capture it may be driven by necessity (decline of the previous opportunity and/or the collapse of a previous business model), and may even mean the difference between survival and failure. For other businesses, the decision to pivot may be more discretionary, and may be taken in order to seize and exploit a new temporal or structural opportunity that may have emerged, rather than in response to disruption of a current opportunity and/or business model.

2.3.5. Business Model Innovation during Disease Epidemics

Epidemics appear not to have received particular attention in the business model innovation (BMI) literature. As in the case of the supply chain management literature, most references to epidemics tend to be context specific, occurring where a business model innovation is targeted at addressing a specific business problem within the healthcare sector. There appears to have been little research into how businesses in general might innovate elements of their business models in order to cope with and survive epidemic-related disruptions, or take advantage of new opportunities emanating from them. Once again, this lack of research may presumably be ascribed to the localised nature and short duration of earlier epidemics, which did not impose an imperative on large numbers of organisations to radically transform their business models. Thus, the need for such research was apparently not widely appreciated prior to the outbreak of COVID-19.

2.3.6. Business Model Innovation during COVID-19 Pandemic

Although the impacts of COVID-19 have been felt across the world, different businesses have been affected in different ways, and have managed their business models accordingly. Ritter & Pedersen (2020) proposed a framework for classifying business models according to how each type had been impacted by COVID-19, which identifies six business models types. Four of these business model types – antifragile, robust, adaptive and suspended – are classified as resilient business models (Ritter & Pedersen, 2020). Two business model types – aided and retired – are classified as vulnerable business models (Ritter & Pedersen, 2020).

An aided business model relies on external support, without which it would not survive the crisis (Ritter & Pedersen, 2020). This support comes in the form of funding, either from government entities, commercial banks or cash injections from the business's investors (Ritter & Pedersen, 2020). Retired business models are business models which either cannot be sustained financially until the crisis has passed, or else where it is determined that the longer-term advantages do not justify commitment of the resources that would be required to support the business model in the interim (Ritter & Pedersen, 2020). Therefore, the decision is made to terminate the business model while still in the midst of the crisis (Ritter & Pedersen, 2020).

Instead of being adversely affected, antifragile business models benefit from a crisis and actually perform even better than they did before the crisis (Ritter & Pedersen, 2020). A suspended business model is essentially mothballed during the crisis, (Ritter & Pedersen, 2020), but revived and redeployed largely unchanged once the crisis is over (or perhaps sooner if conditions in the business environment permit) (Ritter & Pedersen, 2020). A robust business model is able to withstand the impacts of the crisis and continue to function effectively, even though the business may experience changes in the volume of sales (Ritter & Pedersen, 2020). In order to remain relevant during a crisis, adaptive business models undergo one or more changes, which can be as dramatic as pivoting into an entirely new product or service line, or as subtle as minor process innovations related to the delivery of an existing product or service (Ritter & Pedersen, 2020). In Ritter & Pedersen's (2020) framework, only the adaptive business model category coincides with the above definition of business model innovation. Therefore, the other business model types will not be considered further in this research report.

During COVID-19, the word 'pivot' has been bandied about enthusiastically by the popular press, however, business model pivoting should not be considered a generic, one-size-fits-all solution for all businesses, regardless of the circumstances (Morgan, Anokhin, Ofstein, & Friske, 2020). Business model pivoting has "bright and dark sides," so it is essential to understand the context (Morgan, Anokhin, Ofstein, & Friske, 2020). In some instances, pivoting could help businesses overcome the challenges created by COVID-19, but in other cases, pivoting may be ineffective, impracticable, or even damaging to the business (Morgan, Anokhin, Ofstein, & Friske, 2020). Importantly, even before evaluating the potential costs and benefits of a pivot, the expected duration of the crisis should be estimated. Businesses should ensure that they only pivot in response to structural or long-lived threats or opportunities. Pivoting to avoid short-term threats or seize temporal opportunities is not feasible, and these should instead be managed in other ways.

2.3.7. Conclusion

The above section shows how business model innovation has been a common method used by businesses to help themselves, their supply chain partners, even their competitors cope with the abnormally severe, widespread and long-lived supply chain disruptions triggered by COVID-19. Although business model innovation under crises has been studied previously (e.g. Osiyevskyy, & Dewald, 2018), epidemics appear to be under-researched in the literature. In light of the unique characteristics of supply chain disruptions caused by epidemics (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020), there is a clear need for dedicated research aimed at understanding how supply chains are impacted during epidemics, and developing a tailored approach for preventing, mitigating and recovering from these impacts.

Therefore, in response to observed coping strategies involving business model innovations, as well as perceived gaps in current supply chain resilience theory for dealing with disruptions caused by pandemics, several augmented / extended theoretical approaches to achieving supply chain resilience have been proposed. The following section introduces and explores the novel concept of supply chain 'transiliency' (Craighead, & Ketchen, 2020).

2.4. Supply Chain Transiliency

2.4.1. Introduction

Section 2.4. reviews relevant literature related to the supply chain transiliency concept. The section proceeds as follows.

First, the supply chain transiliency is defined (Section 2.4.2.). Next, supply chain transiliency and its twin pillars, supply chain resilience and business model innovation, are integrated (Section 2.4.3.), leading to the presentation of a conceptual model of supply chain transiliency (Section 2.4.4.)

2.4.2. Definition of Supply Chain Transiliency

Supply chain transiliency is defined as "the ability to simultaneously restore some processes and change – often radically – others (Craighead et al., 2020)," in response

to disruptions brought about by a disease pandemic. In other words, “the concept of transiliency melds the concepts of resiliency [sic] and transformability (Craighead et al., 2020).”

Supply chain transiliency mirrors the observed behaviour of real businesses around the world by promoting the deployment of existing supply chain resilience techniques while simultaneously transforming one or more aspects of the business model.

2.4.3. Integration of Supply Chain Resilience, Business Model Innovation, and Supply Chain Transiliency

Linking the two explanations together, it is evident that restoration of a disrupted supply chain process correlates with the concept of supply chain resilience (Ali et al., 2017; Craighead et al., 2020), while transformation of an organizational process in fact represents a business model innovation (Craighead et al., 2020; McGrath, 2010), as organizational processes (or ‘key metrics’) are one of the two elements which define a business model (McGrath, 2010).

Although Craighead et al.’s (2020) phrasing appears to confine the definition of transiliency to transformations involving process innovations only, several of the examples of transiliency they provide clearly describe innovations in respect of the unit of business itself. For instance, they mention how General Motors factories switched from making cars to manufacturing ventilators, and how Louis Vuitton produced hand sanitizer, face masks and other essential items (Craighead et al., 2020). Thus, it appears that the writers did not intend to exclude changes to the unit of business from the transiliency concept, and therefore the implied expanded definition of transiliency will be adopted to include unit of business innovations, which is strongly suggested by these examples.

From the above discussion, it is clear that BMI takes place at an organisational level, rather than at a supply chain level. However, as explained above, system level properties emerge through the interplay of the actions taken by the system’s component entities (Tukamuhabwa et al., 2015), thus successful BMI responses to the challenges facing individual businesses are expected to collectively contribute to the transiliency of the supply chain as a whole.

2.4.4. Conclusion: Conceptual Model of SCT

The final integration of business model innovation and supply chain resilience with transiliency is represented graphically in Fig. 1.

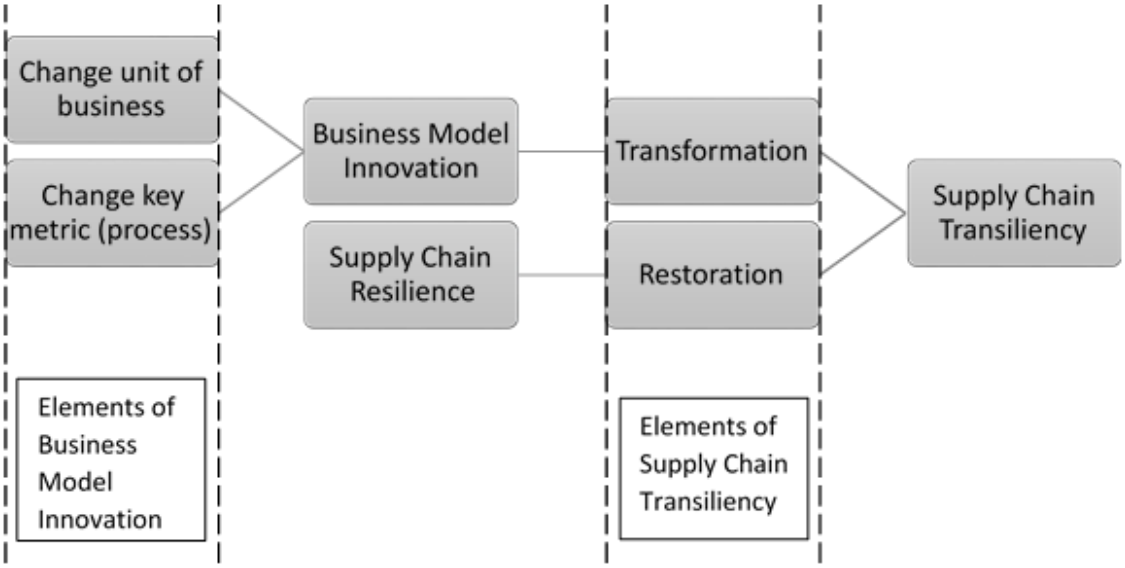

Figure 1: Conceptual Model of Supply Chain Transiliency

Chapter 3: Research Questions

3.1. Purpose Statement

The purpose of the study is to investigate how South African businesses have harnessed the concept of supply chain transiliency to help themselves and their supply chains withstand, respond to and recover from the disruptions caused by COVID-19.

In particular, the research will focus primarily on the transformability or business model innovation pillar of the transiliency concept, as this pillar encapsulates the point of departure from the existing concept of resilience, and hence a gap in knowledge requiring special attention.

3.2. Research Questions

Key research questions:

1. What are the most important characteristics of epidemic-related disruptions that have led businesses to transform key elements of their business models during COVID-19?
2. A) Which key elements of business models have been transformed in order to help businesses to avoid or cope with the consequences of epidemic-related disruptions during COVID-19, b) how have these business model innovations helped businesses to avoid or cope with the consequences of epidemic-related disruptions during COVID-19, and c) how have these business model innovations helped businesses' supply chains to avoid or cope with the consequences of epidemic-related disruptions during COVID-19?
3. How have conventional supply chain resilience methods helped businesses to avoid or cope with the consequences of epidemic-related disruptions during COVID-19?

3.3. Contributions

Answering the research questions will contribute in two ways. From a business perspective, the research will make a contribution to the study of supply chain transiliency by providing early insights into this nascent field, with the aim of assisting businesses to more successfully adapt to the current challenges posed by the COVID-19 business environment. Meanwhile, from an academic perspective, it will help to explore an emerging concept that has only recently been defined (Craighead et al., 2020), and is yet to be properly investigated. In so doing, it will start to lay the foundations for theory-building, with the ultimate goal of helping supply chain management practitioners to better manage similar disruptive events in the future.

Chapter 4: Research Methodology

As supply chain transiliency was a new and under-studied concept, there were no previous similar studies on the concept to guide the choice of methodology for this research. Therefore, the chosen methodology was informed by methodologies used in studies in closely related fields, especially supply chain resilience, as well as general literature on methodology in business research.

4.1. Choice of methodology

4.1.1. Philosophy

The study adopted an interpretivist research philosophy. While positivism has long been the most common philosophy employed in supply chain management research (Hardy, Bhakoo & Maguire, 2020), scholars are increasingly emphasising the merits of adopting an interpretivist outlook (Houe & Murphy, 2017). In general, qualitative research, such as this study, is typically associated with an interpretivist (rather than positivist) approach (Saunders & Lewis, 2018; Golicic & Davis, 2012).

Furthermore, an interpretivist philosophy is most aligned with the purpose and methodology of the research, that is, to provide insight into a poorly understood new phenomenon by collecting and analysing the views, opinions and experiences of the participants (Houe & Murphy, 2017).

4.1.2. Approach

As the literature review shows, supply chain transiliency has only recently been defined, and when this study began, no other studies on supply chain transiliency could be found, and no theory had been developed around the concept (Craighead et al., 2020). Therefore, the purpose of the research is to make a modest contribution towards theory-building by answering the research questions using the primary data collected during the study. Given the unknown nature of the phenomenon, the lack of existing theory and the goal of building new theory from data (as opposed to testing existing theory using data) the most suitable approach to theory development was inductive (Eisenhardt, Graebner & Sonenshein, 2016).

4.1.3. Methodological choices

The research is a mono-method qualitative study. A purely qualitative study is appropriate for exploratory research, as the purpose is to gain an initial appreciation of the nature of the phenomenon (Saunders & Lewis, 2018), not to quantify or measure it. Furthermore, a mono-method study was considered to be sufficient to provide such an initial appreciation of the as yet unstudied concept, while multiple and mixed methods were considered unnecessary until early explorations had been conducted.

4.1.4. Purpose of research design

The purpose of the research design is explorative. Explorative studies are appropriate when little is known about a topic, and indeed must necessarily precede deductive and explanatory studies in order to obtain a basic understanding of the problem and define possible areas for further research (Jebb, Parrigon & Woo, 2017). Hence, what was required was an initial “fact-finding mission,” while focused and detailed studies (by others) could follow once more was known about the topic (Saunders & Lewis, 2020).

4.1.5. Strategy

The research strategy took the form of a survey by way of interviews. A survey is the research strategy that is most closely aligned with the need to collect a large amount of data from many participants in as many different contexts (e.g. industry, business size, product or service business, etc.) as possible (Saunders & Lewis, 2018).

4.1.6. Time horizon

The research took the form of a cross-sectional study. A cross-sectional study is suitable for an exploratory study, where the aim is to obtain a snap-shot of a phenomenon at a moment in time (Saunders & Lewis, 2018), in this case with a view to generating early insights to guide and inform more focused and in-depth future research efforts.

4.1.7. Techniques and procedures

The research employed semi-structured interviews. Interviews allow for the collection of data with greater depth and detail than questionnaires (Saunders & Lewis, 2018). Because they make use of an interview guide with pre-formulated questions, semi-structured interviews ensure that the interviewer adequately covers the topics that are initially believed to be important, but still allow the interviewer to dig deeper when necessary (Saunders & Lewis, 2018), or even depart from the script in order to pursue other lines of questioning should the interviewee provide interesting and unexpected insights.

4.2. Proposed research methodology and design

4.2.1. Population

The population was defined as all South African businesses that had already adapted or who were in the process of adapting their business models in response to COVID-19 in ways which either created or enhanced their supply chain's transiliency, as defined by Craighead et al. (2020). Because the concept of supply chain transiliency was so new and therefore not well understood, and thus lent itself to exploratory study (Saunders & Lewis, 2018), it was not considered necessary to limit the population to a narrower group (e.g. based on size, sector, industry or whether they sell products or services). Instead, it seemed prudent to cast the net wide so as to obtain the broadest possible insights into the phenomenon.

4.2.2. Unit of analysis

The unit of analysis is the individual business which forms part of the population as defined above. Although Craighead et al. (2020) do not discuss units of analysis for the study of supply chain transiliency, it has been argued in the supply chain resilience literature that the preferred unit of analysis should be the entire supply chain (Tukamuhabwa et al., 2015), since resilience arises at system level through the complex interaction of entities internal and external to the supply chain. The researcher is inclined to agree that in the context of a maturing body of theory, a switch from organisation level to system level analysis may indeed be warranted, notwithstanding the added complexities this would involve in terms of data collection and analysis. However, in the case of a nascent field, it seemed premature to concentrate on the system as a whole without first understanding how the phenomenon affects its component parts. Thus, the individual business was deemed an appropriate and correct unit of analysis for an early exploratory study such as this.

4.2.3. Sampling method and size

Heterogeneous purposive sampling was used to obtain a non-probability sample from the population. Purposive sampling is well-suited to a qualitative, inductive, exploratory study, as it enables the researcher to select those members of the population that are most likely to provide useful insights that will assist in answering the research questions (Saunders & Lewis, 2018). More specifically, heterogeneous purposive sampling allows the researcher to construct the sample so as to observe the phenomenon being studied in wide-ranging contexts (Saunders & Lewis, 2018), thereby obtaining a comprehensive overview of the problem. This was considered critical because a) the phenomenon under study was not yet well-understood, and b) it was anticipated that there would be important differences between how the phenomenon manifested in the different contexts.

Sampling continued until data saturation was reached (i.e. no new themes were emerging with each successive interview), which, for a heterogeneous sample usually occurs somewhere between 12 and 30 interviews (Saunders & Lewis, 2020).

4.2.4. Measurement instrument

When conducting the interviews, the interviewer made use of a standard interview guide consisting of a set of topics and questions prepared ahead of the first interview. While interviewees were encouraged to share any other information which they felt was relevant, the interview guide assisted the interviewer to stay on track and to ensure that the topics which were expected to be of greatest importance to answering the research questions were properly ventilated (Saunders & Lewis, 2018). Of course, as the interviews progressed, interviewees revealed other areas of interest which had not been thought of in advance by the researcher, which were worth asking other participants about (Saunders & Lewis, 2018). In this case, the interview guide was revised accordingly prior to the next interview.

4.2.5. Data gathering process

As non-probability, purposive sampling was to be used, prospective research participants were approached individually, leveraging access to the researcher's personal network. Prospective participants were identified based on predetermined selection criteria. Since a heterogeneous purposive sample was desired, prospective participants were drawn from across the South African business community. They included large and small businesses in diverse industries. To ensure relevance to the study, the researcher first established that each prospective participant's business had, during COVID-19, made changes to their business models that fell within the definition of business model innovation, and that these changes had benefited their supply chains as well as themselves in terms of coping with the negative effects of disruptions triggered by the pandemic. Next, the researcher ensured that each prospective participant had the requisite knowledge of supply chain-related aspects of their business, so that they would be able to provide relevant and useful insights during their respective interviews.

A letter and supporting documents from the university (including the Informed Consent Letter) were then sent to each confirmed participant via email to provide further information about research project, and explain confidentiality arrangements.

Next, the participants were contacted again to make arrangements to interview them individually. In light of the ongoing COVID-19 risk, as well as to ensure standardisation and simplify logistical arrangements, all interviews were conducted over Zoom. Zoom had the added benefit of allowing interviews to be recorded (with prior permission from the interviewee) for easy transcription later. All interviews made use of a standard interview guide. Interviews continued until saturation was reached (i.e. no new themes were emerging with each successive interview). The final step in the data gathering process was to transcribe the recorded interviews into text format in preparation for subsequent analysis.

4.2.6. Analysis approach

Data was analysed using qualitative analysis software (Atlas TI). Data was coded and grouped into themes in order to reveal patterns (Jebb, Parrigon & Woo, 2017) which could help to answer the research questions.

4.2.7. Quality controls

In order to enhance the quality of the data and ensure it spoke to the research questions, the interview guide was trialled in a pilot study before being rolled out to the entire sample in order to uncover any problems that may compromise the quality and usefulness of the data (Saunders & Lewis, 2018). A small number of participants were interviewed using the draft interview guide, and asked to provide feedback on the interview, such as pointing out questions which were vague or confusing or suggesting other topics or questions for inclusion in the interview guide.

A major benefit of conducting the interviews sequentially with a single interviewer (rather than concurrently with many interviewers) was that the quality of the data could be further improved as the interviews progressed and new topics of interest emerged, simply by including additional questions in the interview guide for subsequent interviews (Saunders & Lewis, 2018). Using a single interviewer also aided in the pursuit of internal reliability, as it reduced the risk of observer error (e.g. different interviewers are more likely to ask questions in different ways, which could cause bias in the results) (Saunders & Lewis, 2018) as does using a standard interview guide (by ensuring that the single interviewer covers the same basic set of questions with each participant). Recording the interviews can also help to reduce observer bias (König, Caldwell & Ghadge, 2019) and facilitate

accurate transcription after the interview, as the interviewer does not have to rely on sparse notes and memory.

4.2.8. Limitations

The study is limited by the cross-sectional nature of the research. By nature, supply chain disruptions are uncertain, dynamic and evolving disturbances to which supply chains continuously adapt and respond over a period of time (Tukamuhabwa et al., 2015). This has certainly been true of COVID-19, an unpredictable phenomenon which was still unfolding even as the data was being gathered. As a cross-sectional study captures a "snapshot" at a moment in time, it was not able to account for variations in supply chain transiliency over time.

Another possible limitation may be the fact that the study was carried out in a developing economy, and therefore may not be transferrable to a developed economy setting. In the supply chain resilience literature, it has been argued that a country's stage of economic development may affect the supply chain resilience of its resident industries (Tukamuhabwa et al., 2015). It therefore stands to reason that material differences may also exist between the operation of supply chain transiliency in developing and developed economies.

Chapter 5: Results

3.1. Introduction

Chapter Five presents the results obtained from the twelve semi-structured interviews conducted with representatives of businesses participating in the research. The chapter begins with a description of the sample, including the designation of each participant and their roles and responsibilities within their respective businesses. Thereafter, the results are presented, grouped according to the specific research question they address.

3.2. Description of Sample

The twelve participants were selected based on three key criteria. First, in line with the population as defined in Chapter 4, they needed to have changed or be in the process of changing at least one business model element in response to COVID-19. Second, in accordance with the heterogeneous sampling technique prescribed in Chapter 4, to ensure maximum diversity of the sample, participants were selected from as wide a range of business types, sizes, sectors and industries as practically possible. Finally, in order to ensure that the data gathered from the semi-structured interviews would be of value for shedding light on the recently-defined and scarcely researched concept of Supply Chain Transiliency, it was essential that each participant have in-depth knowledge of their respective businesses' supply chain function. For this reason, all participants were either senior executives or supply chain specialists, as shown in Table 1 below.

By location within the supply chain, five business are B2C businesses, and are thus located just before the end user (consumer) of the product or service delivered by their supply chains. They include three retailers, one restaurant group, and one healthcare service provider. The remaining seven businesses are B2B businesses. These businesses are located at various tiers of the supply chain. They include three wholesalers and distributors, three manufacturers, and one miner.

Table 1: Details of Participants and Participating Businesses

Participant No.	Business Type	Participant Designation	Overview of Business Model and Supply Chain
1	Restaurant Group	Chief Executive Officer	The business sells prepared meals to consumers through its chain of casual dining restaurants located in upmarket shopping centres. Sit-down dining accounts for the majority of its revenue, with takeaways contributing a relatively small share of sales. Meal ingredients and most other supplies are sourced locally.
2	Book Retailer	Chief Executive Officer	The business sells new books through it chain of physical stores located in upmarket shopping centres. The majority of its books are sourced from publishing houses in the UK and US, and transported to South Africa using commercial air freight services.
3	T-shirt Wholesaler	Managing Director	The business sells plain T-shirts to the T-shirt printing industry. Its T-shirts are sourced from a garment manufacturer located in Bangladesh, and transported to South Africa using commercial sea freight services.
4	Occupational Health and Safety (OHS) Sensors Distributor	Managing Director	The business sells occupational health and safety (OHS) sensors to the mining industry. Products are sourced locally and internationally from contract

			manufacturers. Imported products are transported to South Africa, primarily using commercial air freight services.
5	Sporting Equipment and Apparel Retailer	Chief Executive Officer	The business sells sporting equipment and sporting apparel to consumers through its chain of physical stores. Its products are sourced locally and internationally.
6	Diversified Miner	Head of Supply: Technical Initiatives	The business sells a wide variety of metals and other mineral commodities, which it mines globally, but with a large proportion of its operations situated in South Africa.
7	Locomotive Control Systems Manufacturer	Managing Member	The business sells locomotive control systems and related electronic equipment to the mining industry, which it manufactures locally. Components are sourced mainly from Europe and Asia where they are manufactured. Components are or imported directly by the business or purchased from local distributors. Components are transported to South Africa using commercial air freight services.
8	Private Healthcare Provider	Managing Director: Innovative Healthcare Solutions	The business owns and operates private hospitals, clinics and medical practices. Supplies are sourced locally and internationally.

9	Branded Computer and Consumer Electronics Retailer	Managing Director	The business sells a single brand of electronics, mainly computers, printers and printer consumables to consumers through its chain of physical stores located in upmarket shopping centres. Products are purchased from local distributors, who source them internationally, mainly from Europe. Products are transported to South Africa using commercial air freight services.
10	Magnetic Separation Equipment Manufacturer	Managing Director	The business sells magnetic separation equipment to the bulk handling and minerals processing industries, which they manufacture. Laser-cut steel parts are sourced locally from contract manufacturers, while permanent magnets and other speciality components are sourced internationally, mainly from China. Imported components are transported to South Africa using commercial air freight services.
11	Specialist Chemicals Distributor	Industry Manager: Construction Chemicals	The business sells a wide range of specialist bulk chemicals to a variety of industries, including the food processing and construction materials manufacturing industries. Products are mainly sourced internationally from many different countries. Products are

			transported to South Africa using commercial sea freight services.
12	FMCG (Foods) Manufacturer	Category Manager: Dairy	The business sells a wide variety of food products, mainly to major food retailers, which it manufactures. Bulk raw materials are sourced locally and internationally. Imported bulk raw materials are sourced from many different countries, and are transported to South Africa using commercial sea freight services.

3.3. Results: Research Question 1

Research Question 1: What are the most important characteristics of epidemic-related disruptions that have led businesses to transform key elements of their business models during COVID-19?

The aim of this research question was to understand which characteristics of epidemic-related disruptions were most likely to trigger the transformation of elements of businesses' existing business models, either to counter negative impacts of these disruptions (necessity-driven business model innovations), or alternatively, to seize opportunities presented by these disruptions (opportunity-driven business model innovations).

As Craighead & Ketchen (2020) propose, epidemics can give rise to particularly severe and wide-spread supply chain disruptions, which cannot be effectively managed through Supply Chain Resilience tactics alone. To compensate for the supposed inadequacy of such tactics when responding to supply chain disruptions during epidemics, they propose a complementary approach of business model innovations, which, when combined with conventional resilience tactics, provides a superior approach, which they term Supply Chain Transiliency.

Hence, this research question also attempts to establish whether or not a link does indeed exist between the supposed unique characteristics of supply chain disruptions caused by disease epidemics and the propensity of businesses to respond to epidemic-related disruptions through the introduction of business model innovations, independently of or in concert with more conventional resilience measures.

3.3.1. Theme 1: The Human Element

Several participants referenced the human element of the pandemic, in line with the third unique characteristic of epidemic-related disruption, as presented in Chapter 2.

3.3.1.1. Category 1: Impact on Physical Wellbeing

Whereas the spread of disruptions such as production stoppages could be somewhat mitigated through supply chain resilience measures, the simultaneous spread of infection – the root cause of disruption – could not. As a result, one business, the diversified miner, underwent a significant business model transformation, adding a new key activity to its business model to ensure it could continue to operate during the pandemic. While most businesses simply sourced PPE and implemented social distancing and hygiene protocols, the miner went much further to protect the health and wellbeing of its workforce, by leveraging its global supply chain capabilities to roll out its own extensive COVID-19 testing infrastructure on a massive scale. Participant Six explained that they had to:

> *"implement a lot of health protocols in terms of testing and screening and etc., and we've done that, you know, by establishing 44 laboratories, medical laboratories across our operational footprint… with the requisite PCR test equipment or antibody testing, etc., and that was something that we don't typically do as a mining house… entering into this space and competing with governments, you know, right at the outset of the pandemic last year, March, February, March, to secure, you know, this medical equipment, that was a total paradigm shift for us… we've established a supply chain, a regular supply out of the US, Europe, China, of regular ongoing testing consumables… You know, that was a total business model innovation…"*

However, the miner's medical interventions went further than protecting its own staff. To ensure that it could continue to obtain the supplies it needed to sustain its operations, the business made its resources available to key supply partners. In this way, the business model transformation of its key activities business model element benefited not just the miner, but simultaneously enhanced the transiliency of the supply chain. Participant Six explained:

> *"…let's just open up our resource that we've established, this testing capability, this response to the pandemic. Let's open it up to partners, whether it's, you know, in this case, Transnet, key logistics supply partner... So many of those examples."*

3.3.1.2. Category 2: Impact on Psychological Wellbeing

Another feature of the pandemic highlighted by several participants was the psychological impact on their own staff, supply chain partners' staff, customers, and society as a whole general. Among employees, psychological impacts ranged from loneliness and feelings of social isolation when working from home, to grief following the death of a coworker or loved one. Among customers, concerns over safety caused them to stay at home and avoid visiting business premises, contributing away to a drop in sales for some businesses. As for the direct physical impacts arising from infection, psychological impacts of the virus, such as fear of infection, could not be mitigated using supply chain resilience, but could in many instances be overcome through business model transformations targeting various key business model elements.

The restaurant group transformed its key activities business model element to make sit-down restaurant patrons feel safe and comfortable in their restaurants. Constantly cleaning – and being seen to be doing so – which had previously been just a routine operational task performed quietly and unnoticed in the background, now became an important and highly visible key activity. Participant 1 explained that the COVID-19 pandemic:

> *"… highlighted hygiene, I think. Although COVID is just about sanitiser, I think that it also just made the volume of cleanliness in a restaurant a little bit louder, because although we know that you don't get COVID on food or dirty floor or whatever, the consumer's perception is dirt, COVID, illness, it's all stuck together."*

Meanwhile, the branded computer and consumer electronics retailer transformed both the channel element and the customer relationship element to serve their customers where they felt most comfortable and in a way that eased their anxiety and made them feel valued and cared for. Participant Nine explained that their focus was:

> *"… very much around dealing with the customer where they are. So if they want to be at home, great, if they want to come to store, great... You know, that whole kind of omnichannel idea. They want to buy online and fetch from the store, that's fine, if they want to buy online and have it delivered, that's fine. Like really trying to build an omnichannel business that essentially just treats the customer like a person and is empathetic to what they want, as opposed to here are our rules. I mean, when we've done that well, which we don't always do well, where we've done that well we've seen a lot of benefit from that as well, a lot of benefit."*

3.3.2. Theme 2: Market Turbulence

Consistent with the fourth unique characteristic of epidemic-related disruptions, as presented in Chapter 2, the interviews revealed considerable turbulence in market conditions in the markets in which the participating businesses operate. Several participants reported experiencing significant fluctuations in demand and/or supply for the finished goods or services they sell, and/or key inputs into those goods and services. Uniquely, these shifts in supply and demand often occurred concurrently. To overcome demand-side and supply-side issues, their businesses frequently resorted to business model transformations, as described in Sections 5.3.4.1. and 5.4.3.2., below.

3.3.2.1. Category 1: Demand-Side Issues

Several businesses experienced significant changes in demand for their products or services during the pandemic. Depending on their industry and other circumstances, COVID-19 brought either increases or decreases in demand, both of which presented different, but significant, challenges for the affected businesses. Frequently, the businesses transformed one or more key elements of their business models to help themselves cope better with the often severe demand fluctuations that characterised the COVID-19 pandemic.

Participant One, CEO of the restaurant group, saw a drop in overall demand for meals, while remaining demand swung in favour of takeaway meals:

> *"The change in the consumer demand and behaviour resulted in a shift of the proportion of sit-in versus takeout… I mean, our sales dropped. Obviously in the beginning they dropped to zero. Then they started climbing, and then Cyril locked us down in December and we went all the way down to the ground again."*

Meanwhile, the T-shirt wholesaler was hard-hit when a mandatory lockdowns, social distancing and lingering health concerns closed the events industry – a key customer base – for most of the pandemic period. Participant Three explained:

> *"There's less events and things like that, so the amount of stock we're carrying is less than what we normally would. We'd be able to turn stock much quicker… I think our sales dropped by eighty-five percent, just like that… from one month to the next…"*

The locomotive control systems manufacturer reported that although repairs and maintenance jobs remained steady, the industry did see a drop in demand for capital equipment, as its clients suspended operations during the hard lockdown, with demand still not back to normal a full year later. Participant Seven commented:

> *"We have, in some instances, given more favourable pricing to some of our customers, because I think there is a lot more competition, and people are desperate for work… a lot of people have cut their prices, because also the mines have cut their budgets quite substantially…"*

In stark contrast to the above examples, the health sector experienced a spike in demand for a wide range of drugs, PPE and other medical supplies needed to treat COVID-19 patients. Participant Eight, of the private healthcare provider, discussed several supplies which they struggled to obtain – or were forced to buy at exorbitant prices – due to demand outstripping the supply available in the market. Firstly, in respect of PPE, Participant Eight commented:

> *"So the cost of PPE went through the roof, and everybody was scurrying around just trying to get PPE so that they can keep their staff safe or their businesses open…"*

Secondly, in respect of oxygen, Participant Eight commented that before COVID-19, they:

> *"…didn't have that many patients on ventilators and high-flow oxygen. And as a result, the tanks that we had to fulfil the hospital needs weren't put under stress ever, ever, ever, ever…"*

However, during COVID-19:

> *"… the main oxygen suppliers in the country were under massive strain, and as a result, they were being pulled in all different directions. So quite often our CEO himself had to get involved with the CEO of [oxygen supplier] to make sure that we got enough oxygen… I think the oxygen guys, they just weren't prepared for it. They weren't prepared for this demand… At one point, we thought we had to shut down this one hospital because we didn't have oxygen, because they couldn't get oxygen to the hospital and the tank was about to just go under massive pressure."*

Thirdly, in respect of drugs, Participant Eight commented:

> *"Drugs was the other one. The treatment protocol for COVID changed every single month, depending on new studies… And as soon as a drug was listed as a miracle drug for COVID, the prices shot up and supply just went through the ground."*

Finally, in respect of PPE, Participant Eight described how demand for beds, and especially critical care (high care and ICU) beds, became a major challenge, as:

> *"… one in three patients were being admitted to ICU or High Care facilities of sorts. And normally what happens in a hospital, anywhere between 10 and 15 percent of the hospital bed are actually reserved for High Care and ICU, and the rest of it is General Ward. And the High Care and ICU used to get filled up first. So we needed to be able to create enough critical care capacity in our hospitals so that we can actually treat our patients. We ran out of capacity... In KZN in December, we ran out of capacity across the entire KZN. We just didn't have enough critical care beds."*

The branded computer and consumer electronics retailer also saw demand for its products skyrocket almost overnight. Participant Nine explained that:

> *"… structurally, there's been a huge increase in demand. So more people working from home, more kids learning from home. And it's driven excessive demand in the categories around the world, in really both categories where [manufacturer of computers, printers and accessories] plays, one is on the PC side… and then really interestingly enough, on the print side, print as a category… there was a massive structural surge in demand, which we're seeing to continue to this day, actually, the business is really busy."*

While the above businesses experienced either an increase or a decrease in demand for their products or services, the sporting equipment and apparel retailer experienced both increases and decreases in demand, depending on the product category. Participant Five explained:

> *"… the profile of demand in certain categories has changed fundamentally. So more, let's say, exercise, you know, home gym type product and less team sports products, so from a demand perspective, it's changed dramatically… there was overwhelming demand, global demand, in particular categories like cycling, like [home] gyms, like weights and those kinds of things…"*

3.3.2.2. Category 2: Supply-Side Issues

Several businesses had to contend with significant changes in supply of either finished goods which they sell, or key inputs into their business processes. As for demand, both large increases and decreases in supply were experienced, each presenting their own challenges. While lack of supply resulted in stock-outs and missed sales, oversupply in the market could also lead to financial losses as price collapses obliterated the realisable market value of any inventory on hand. Business model transformations were a powerful tool used by the participants' businesses to cope with supply-side disruptions triggered by COVID-19.

Lockdowns around the globe not only disrupted manufacturing, but also transportation, as Participant 4, Managing Director of the OHS sensors distributor, explained:

> *"there was this complete lockdown across the world, so for the first period, you couldn't get anything out of China - or anywhere else for that matter - and if you could get it, you couldn't bring it in here. So the world was stopped… after a while, we started getting stuff coming in slowly, and it sort of ramped up as the world opened up and started thinking that we were through this virus."*

Participant Nine, of the branded computer and consumer electronics retailer, experienced severe shortages of products, also due to a combination of supply constraints affecting the manufacturing output, as well reduced transportation capacity to deliver the products to SA. Participant Nine stated that:

> *"… from a supply chain point of view, really just massive, massive challenges around stock and availability. And again, really driven by two things. One was just not enough stock in the world of every component. So PC screens, chips, screens particularly, actually. Just total undersupply. And there's still backlog even to this day on those devices. And then on the print side, just not enough consumables created… And then really exacerbated… by the lack of transport infrastructure to get stuff into the country. At one stage, actually, [manufacturer of computers, printers and accessories] hired its own aeroplane, they flew in a [name of courier] plane full of stock, because they just couldn't get on other planes."*

Participant Seven, Managing Member of the locomotive control systems manufacturer, highlighted commodity and raw material shortages as a cause of the shortage of certain electronic components, saying:

> *"… the manufacture is a lot longer because the suppliers overseas are battling to get materials timeously… there seems to be a worldwide shortage of metals."*

3.3.2.3. Category 3: Transportation Issues

Consistent with the description of the unique characteristics of epidemic-induced supply chain disruptions, the disruption of critical transportation services was a recurrent complaint among the participants. Most, if not all supply chains rely heavily on logistics providers to move inputs as well as completed goods and services between supply chain members themselves, and between supply chain members and end users. COVID-19 impacted these transport links severely, leading to potential adverse consequences on participant's businesses and their supply chains. Most participants referenced the impacts of transport disruptions, affecting air freight, sea freight, and even overland freight, on their businesses and supply chains, so to avoid excessive repetition, only a few indicative quotations are provided below.

On the topic of air freight services, Participant Two, CEO of the book retailers, commented:

> *"… the other thing, of course, it's called reduced flights into South Africa during COVID. The airlines, as you're well aware, just cancel flights, you know, you've got no passengers coming to South Africa, no need to repatriate people out of South Africa, it's just there's no flights. Emirates stops flying, United Airlines stops flying, KLM stops flying, British Airways stops flying, Virgin. All those normal transporters stop flying. So now you're competing with every Tom, Dick and Harry for space on a very limited supply chain…"*

Participant Seven, Managing Member of the locomotive control systems manufacturer experienced similar problems, commenting that:

> *"... prior to COVID... we could get components in relatively quickly with quick air freight turnarounds and what have you, but now definitely the air freight turnarounds are a lot longer... "*

Some participants were forced to consider drastic alternatives to commercial air freight services. Participant Eight, of the private healthcare provider, explained that:

> *"... at one stage we were going to try and charter a plane ourselves to get PPE into the country."*

Participant Nine, Managing Director of the branded computer and consumer electronics retailer remarked that:

> *"At one stage, actually, [manufacturer of computers, printers and accessories] hired its own aeroplane, they flew in a DHL plane full of stock, because they just couldn't get on other planes. They literally hired an aeroplane to fly here with stock... We've never seen anything like it previously, ever... you could always get on a plane. Like always.... there was always some plane that had space... Literally, there was no way. I could not find a way. There were no planes... And, as I say, [manufacturer of computers, printers and accessories] has - certainly in my knowledge - never hired a plane to come to South Africa before. They've never needed to..."*

Where flights were available, the supply and demand imbalance caused other problems, with Particpant Three, Managing Director of the T-shirt wholesaler, noting that:

> *"... the price of air freight went through the roof."*

COVID-19 impacted not only the airlines, but in some cases, airports as well, as Participant Three, Managing Director of the T-shirt wholesaler, explained:

> *"The airport in China shut down because people were delivering [so much] stuff...They had to shut the airport down to organize all the stuff that was going into it."*

Like airfreight services, transoceanic shipping was heavily impacted globally by the COVID-19 pandemic. Participant Five, CEO of the sporting equipment and sporting apparel retailer, described their experiences:

> *"... the third impact was the shipping lines themselves, for whatever reason. Either it's because the shipping lines took ships out of commission or mothballed or kind of like, you know, had less ships on the water. That significantly impacted shipping times and significantly impacted the cost of shipping... the prices can go up and down sort of quite radically."*

Similarly, Participant Eleven, Industry Manager (Construction Chemicals) of the Specialty Chemicals Distributor, commented that the business has had to contend with:

> *"... increased shipping times… as well as increased shipping rates. In fact, shipping rates this year from the east have almost doubled from last year.... getting sea freight out of the US has [also] been a major problem... "*

Disruption of port operations also posed a challenge for importers. Participant Two, CEO of the book retailer that:

> *"… the congestion at the ports and the inefficiency at the ports also had a catastrophic impact on efficiencies and logistics. The boats were supposed to come to Durban and, you know, Durban's blocked so they'd head around then maybe to PE and PE's got congestion, so they head off to Cape Town. Now your business is in Durban, your container is now in Cape Town. I mean, like, that's not really where I want the stock."*

Participant Five, CEO of the sporting equipment and sporting apparel retailer, experienced similar challenges:

> *And then there was... issues at the Cape Town port, both with COVID-related cases, and that impacted maintenance of equipment and attendance, and the shipping lines weren't interested in waiting outside Cape Town harbour, they just simply bypassed it."*

3.4. Results: Research Question 2

Research Question 2a: Which key elements of business models have been transformed in order to help businesses to avoid or cope with the consequences of epidemic-related disruptions during COVID-19?

Research Question 2b: How have these business model innovations helped businesses to avoid or cope with the consequences of epidemic-related disruptions during COVID-19?

Research Question 2c: How have these business model innovations helped businesses' supply chains to avoid or cope with the consequences of epidemic-related disruptions during COVID-19?

Research Question 2a attempts to establish which elements of businesses' existing business models have undergone transformations as part of businesses' efforts to mitigate the impacts of supply chain disruptions caused by the current COVID-19 pandemic, as this may provide early indications as to which elements should be prioritized for business model innovations in the event of future disease epidemics. It may also help to illuminate the circumstances under which the transformation of specific business model elements may be effective. For example, should different business model elements be targeted depending on the business type or industry context, and what way should the targeted element or elements be transformed in a given setting? What role do the characteristics of the disruption itself play in the selection of business model elements to target, and the changes that are made to the targeted elements?

Research Question 2b examines how the business model innovations uncovered by Research Question 2a have benefitted the individual businesses in terms of enhancing their ability to cope with the negative impacts of COVID-19. Although this research is situated within the field of supply chain, the benefits to the individual businesses making up a supply chain are highly relevant to the study, for three reasons. First, a supply chain, as defined in Chapter 2, is not a single entity, but is a system of interacting individual and organizational actors. Adopting a systems view, the properties of the system emerge through the interplay of the actions of the various actors which comprise it. Hence, the degree of transiliency of the supply chain as a whole is dictated by the business model transformations undertaken by the individual businesses of which it is comprised. This relationship between the degree of transiliency observed at a supply chain level and

business model transformations taking place at an organizational level is unsurprising, since a similar, well-documented relationship exists between supply chain resilience (the second pillar of supply chain transiliency) and organizational resilience, as described in Chapter 2.

Research Question 2c goes to the heart of the argument made by Craighead & Ketchen (2020) when setting out the apparent need for their novel Supply Chain Transiliency concept. In summary, they claim that the characteristics of epidemic-related disruptions are so unique and so challenging, that the existing approach to dealing with them, called Supply Chain Resilience, is not adequate by itself. Hence, they argue, it is essential that businesses also develop and implement appropriate business model transformations, to supplement any resilience tactics they may employ. This research question seeks to test this last assertion, by examining the effectiveness of the business model transformations implemented by the twelve businesses surveyed for avoiding or mitigating the consequences for the supply chain of disruptions brought about by COVID-19. If business model transformations have indeed played a significant role in these businesses' successful management of supply chain risks during COVID-19, it would lend credence to Craighead and Ketchen's (2020) theory, and demonstrate the practical value of Supply Chain Transiliency as an effective tool for countering epidemic-related supply chain disruptions.

3.4.1. Introduction to themes

From the analysis, it emerged that all nine of Osterwalder's (2013) key business model elements had been transformed by at least one of the participants' businesses, although some business model elements were more frequently targeted for transformation than others. Examining the similarities between the business model transformation discovered, three main themes emerged. The first two themes are consistent with McGrath's (2010) definition of the business model concept, provided in Chapter 2, whereby participants' businesses were found to have made changes to their unit(s) of business and/ or one or more business processes. In other cases, the transformation targeted neither the unit of business nor routine business processes, but rather sought to modify the fundamental financial model underlying the business model, giving rise to the third theme.

3.4.2. Theme 1: Unit of Business BMI

3.4.2.1. Category 1: Value Proposition

Only the locomotive control systems manufacturer undertook a transformation of the value proposition element of an existing business model . The business tweaked an existing value proposition to better meet the evolving needs of a client by integrating additional features into one of its existing products to help the client manage the impact of COVID-19 on its workforce and operations. Participant Seven explained:

> *"... one of the spinoffs we've had, possibly from [COVID], is that the mines are wanting a PDS, which is a Personal Detection System, which will not only help with the contact tracing with COVID, but it's mainly for safety... they're adding on the feature of contact tracing as well. So that has been one positive spinoff, I guess, from the pandemic."*

3.4.3. Theme 2: Business Process BMI

3.4.3.1. Category 1: Customer Segments

Only two of the participants' businesses have engaged in business model transformations in respect of the customer segments they serve: the branded computer and consumer electronics retailer, and the private healthcare group.

The branded computer and consumer electronics retailer shifted its product mix towards higher-end laptops, thereby targeting more affluent customers. Participant Nine explained:

> *"…we've actually kind of seen an increase in our AUP [Average Unit Price], because actually you just can't get the cheap stuff, like, they're just not manufacturing it, they'd rather use that stock for more expensive products. So that's been a big change, kind of our selling price and our focus around maybe moving up the value chain a little bit from really, really, really entry level stuff to more higher end things. "*

While the retailer may have been driven to shift into higher customer segments due to unavailability of product in the lower categories, as outlined above, it is interesting to note that these changes to the customer segments element were not entirely necessity-driven, but also opportunity-driven at the same time (Devece, Peris-Ortiz, & Rueda-Armengot, 2016; Cucculelli & Peruzzi, 2020). From the opportunity perspective, Participant Nine explained:

> *"I think there has been structural change in the demand for our products… the universities are saying to students, you need a computer to come to university. Schools are saying to their kids, you've got to have a computer. So I think there is structural change, without question, and that's been very good for us and very opportunistic."*

The private healthcare group, meanwhile, underwent a purely necessity-driven transformation of its customer segments business model element (Devece, Peris-Ortiz, & Rueda-Armengot, 2016; Cucculelli & Peruzzi, 2020), as it rapidly expanded its critical care capacity across its hospital network by converting general ward beds into high care and ICU beds. Although it did not exit the lower categories (general ward beds), like the computer and consumer electronics retailer, it did have to shift its focus towards serving a larger proportion of more demanding customers with greater requirements in terms of the product or service (in this case, level of care) provided.

> *"COVID meant that a lot of patients, one in three patients [i.e. 33 percent] were being admitted to ICU or High Care facilities of sorts. And normally what happens in a hospital, anywhere between 10 and 15 percent of the hospital bed are actually reserved for High Care and ICU, and the rest of it is General Ward… So we needed to be able to create enough critical care capacity in our hospitals so that we can actually treat our patients."*

3.4.3.2. Category 2: Customer Relationships

Several participants stressed the paramount importance of managing customer relationships, especially in a time of upheaval and uncertainty which typically accompany major crises (Dutton, 1986), including disease epidemics such as COVID-19. A common focus was on continuing to meet the needs of the customer through a constantly evolving business environment, while treating them with compassion and ensuring they felt safe and protected.

In the case of the computer and consumer electronics retailer, the need to change nature of customer relationships has coincided with and complemented the need to rapidly expand their nascent online sales channel, as described in Section 5.4.3.1. Participant Nine stated that:

> *"…from a customer point of view, very much around dealing with the customer where they are.. Like really trying to build an omnichannel business that essentially just treats the customer like a person and is empathetic to what they want, as opposed to here are our rules. I mean, when we've done that well, which we don't always do well, where we've done that well we've seen a lot of benefit from that as well, a lot of benefit."*

3.4.3.3. Category 3: Channels

Among the sample, changes to the business's traditional sales channels was a particularly common business model transformation, with four out of twelve participants' businesses either switching to a different channel or adding an additional channel to their existing channel(s). In particular, the rapid changeover to e-commerce or omnichannel models was featured prominently in the sample, especially among B2C businesses such as the three retailers, who rapidly built or scaled up their exisitng click-and-collect and click-and-deliver offerings, as well as the restaurant group, who relied on takeaway orders delivered to their customers through third-party meal-delivery services. Illustrating the unprecedented importance of online sales to retailers, Participant Nine, Managing Director of the branded computer and consumer electronics retailer, remarked that:

> *"… locally, there's been a huge shift from people not wanting to go to malls. I mean, again, you've heard, you know, they say this has accelerated e-commerce a decade in South Africa in a year, because suddenly people are buying online."*

Among B2B businesses, channel innovations were hardly encountered, with most participants perceiving no need to deviate from their existing channel(s) under epidemic conditions. Only the manufacturer of magnetic separation equipment reporting a change from their usual channel of regular sales visits to client organisations' office to online sales calls and email marketing. Participant Ten commented:

> *"... how we used to deal with those people is really face to face... As I say, face to face personal relationships, knowing the project managers, phoning them occasionally, dropping by... to offer something new, whether it be a once a month presentation... our value-add, was to be 'informationary,' leaders... That has changed... companies that we would deal with quite often don't allow anyone there yet... So it's now forced us to re-evaluate, like many things, the future of how we will do business. Based on that, we are now working on a new website, and we will undertake a comprehensive digital marketing campaign, specifically email campaigns... we need to somehow still stay engaged with them, and phone calls aren't really going to do it. The next best thing, unfortunately, at the moment, until we come up with some revolutionary method, will unfortunately just be staying in their face via email..."*

3.4.3.4. Category 4: Key Activities

While supply chain management as a whole had always been a key activity, it undoubtedly took on a renewed importance during COVID-19, owing to heightened supply chain risks as well as the need to rapidly introduce health initiatives to protect its people.

> For the diversified miner, ensuring the well-being of its staff, contractors and host communities (i.e. communities located near to mining operations) was first priority in their response to the pandemic. Hence, the business's extensive global supply network was leveraged to ensure the provision of comprehensive healthcare services, which constituted a new key activity of critical strategic importance for the business. Participant Six explained how they had had to:
>
> *"... implement a lot of health protocols in terms of testing and screening and etc., and we've done that, you know, by establishing 44 laboratories, medical laboratories across our operational footprint... what that meant for us as a mining company, specifically in terms of supply chain, was that, you know, we had to very rapidly establish this laboratory, you know, footprint with the requisite PCR test equipment or antibody testing, etc., and that was something that we don't*

typically do as a mining house. You know, we're used to procuring fuel on a large scale, we're used to procuring, you know, mining equipment and processing plants and all kinds of, you know, commodities, chemicals, etc., but certainly entering into this space and competing with governments, you know, right at the outset of the pandemic last year, March, February, March, to secure, you know, this medical equipment, that was a total paradigm shift for us, and we responded in a very agile manner by shifting resources around de-prioritizing certain activities. And we've successfully established, you know, this laboratory footprint and we've established a supply chain, a regular supply out of the US, Europe, China, of regular ongoing testing consumables... You know, that was a total business model innovation..."

To reduce its reliance on external partners, the diversified miner pursued a vertical integration strategy, integrating upstream, especially into the transport and logistics function. In so doing, the miner enhanced its control over its supply chain, which gave it greater agility to respond more rapidly to emerging supply risks, ensure security of supply , and ensure its mines could continue to operate, despite widespread disruptions caused by COVID-19. Management of the newly acquired in-house transport and logistics function hence became a new key activity for the business. Participant Six explained that:

"... when it comes to bulk chemicals, we had to take a totally different approach, you know, invest in capital equipment, logistics infrastructure so that we could, you know, vertically integrate the supply chain and become much more agile and less reliant on certain, you know, supply capability in the market... If we didn't vertically integrate, we would have had severe production impact, supply constraints, production impact, loss of revenue. So that would have impacted our bottom line directly, and the health of the business directly."

3.4.4. Theme 3: Financial Model BMI

3.4.4.1. Category 1: Revenue Streams

Participant Four explained:

> *"It was April and May. We had two record months, and it was almost exclusively scanners [handheld infrared thermometers]. And as quickly as that wave rose up so quickly, it disappeared. And yeah, but it certainly kept our company going at a time when there was no other business coming in."*

The T-shirt wholesaler had a similar experience when the initial lockdown came into effect. After suffering a massive decline in normal monthly revenues from March to April 2020, they also turned to selling PPE, in order to generate much-needed revenue to keep the business afloat. Participant Three explained:

> *"So we played around with PPE stuff…That was a very short term thing to help get some sort of a turnover going because your sales literally dropped by, I think our sales dropped by eighty-five percent, just like that. So we had to figure out how do you get some sort of cash flow going when you just hit this. Huge demand for PPE stuff, got involved in it, from thermometers to masks to hand sanitizer to radars to all sorts of stuff… So with regards to revenue streams, we changed products very quickly to look at things like that, using our same customer base."*

3.4.4.2. Category 2: Cost Structure

For the retailers, a major component of their cost structures which was essential to reduce during the pandemic was rental expense. As Participant One, the CEO of the restaurant group, commented:

"…what COVID did, first of all, is kicked the landlords in the butt, because the property industry, landlords, have been very slow to innovate. Their mindset is still 'OK, that's the rent, take it or leave it… it's forced more cooperation… the conversations are shifting from 'oh I want this and eight percent and this and this' to 'this is our business,' so we're playing open cards now."

Participant Nine, Managing Director of the branded computer and consumer electronics retailer echoed these sentiments, saying:

> *"... there's really been a shift in power, from the landlords being incredibly... You know the reputation landlord, very dictatorial, very autocratic, to where landlords had to work with their retailers, or if they didn't, you know, the retailers kind of just left… you can look at the listeds. It's just a complete death to some of those business models, which were just predicated on landlords being, you know, here's the thing, it's an eight percent increase, it's whatever, a thousand rand a square metre, take it or leave it, to a much more collaborative approach."*

Participant Nine added:

> *"In some centres our rents are down 50, 60 per cent, or we were going to close the stores."*

Apart from negotiating reduced rentals for its remaining stores, the branded computer and consumer electronics retailer did take further steps to reduce its leasing costs and truly innovate the cost structure element of its business model. According to Participant Nine, there had been :

> *"… a real focus around online, around digital channels. We reduced some of our stores, so either closed or reduced the size of some of our stores... digital will grow faster than stores. And so we will invest more money and effort and resources and time into digital."*

However, the reduction of total Gross Lettable Area (GLA) they occupied was only one part of a wider programme of cuts aimed at completely transforming the cost structure. Particpant Nine explained:

> *"… we've taken a lot of cost out of the business. We went through a restructuring. We reduced the size of head office. We renegotiated our leases. … We're a better business this year than we were last year, there's no question for me."*

The effects of these initiatives on the cost structure element of the business model have been dramatic. Participant Nine said:

> *"Our overheads are down 30 odd percent from a year ago, in the same size business."*

Of the B2B businesses, only the magnetic separation equipment manufacturer made significant changes to their cost structure, with the pandemic serving to accelerate a strategic initiative that was already underway. Participant Ten explained:

> *"Some items we will fabricate in-house, but you could say 70 to 80 percent of our business, even before lockdown and COVID, was leaning towards outsourced fabrication... From a manufacturing point of view, there has been a fundamental change and shift. We were, as I mentioned earlier, we were leaning that way anyway pre-COVID, but we certainly made the commitment, decision to go almost full subcontracted fabrication. You know, like we said, just stick to what you're good at... We have found ourselves a very nice subcontractor who is able to produce, truthfully, the work and machinery quicker than we can. We will just become a final assembly shop. I mean, they do all the welding and the prep and the tacking together and the data books and all the quality control and everything, and they hand us a semi-finished product and they hand us a data book and a file, and we put the rest together and then consolidate a few other documents for that file, and then we're essentially done. It comes at a premium, obviously, from a cost point of view... we're willing to sacrifice a large percentage of margin for the luxury of having someone else have the labour problems and have the supply problems and all the problems that come with fabrication and producing finished products made out of steel."*

3.5. Results: Research Question 3

Research Question 3: How have conventional supply chain resilience methods helped businesses to avoid or cope with the consequences of epidemic-related disruptions during COVID-19?

The aim of this question was to gain understand how conventional supply chain resilience tactics have been employed to enable businesses to respond to supply chain disruptions in the midst of the COVID-19 pandemic, either separate from or in conjunction with business model innovations.

Together, supply chain resilience and business model innovations comprise the twin pillars of the Supply Chain Transiliency concept. While this research places somewhat greater focus on the business model innovation concept, as it is the addition of this concept that distinguishes transiliency from conventional resilience, it is essential to investigate both the operation of concepts during epidemic conditions, as well to assess the relative importance of each for effectively responding to epidemic-induced supply chain disruptions.

For instance, if it emerged that the majority of businesses have relied predominantly on supply chain resilience tactics, with little or no accompanying business model transformations, this would suggest that the existing supply chain resilience approach is in fact suitable and sufficient when it comes to dealing with epidemic-induced disruptions, and hence, suggest that the importance of business model transformations, which led to the proposal of Supply Chain Transiliency, may have been overstated (although it would be premature to reach a definitive conclusion on the basis of a single exploratory study).

3.5.1. Theme 1: Stock-related measures

3.5.1.1. Category 1: Inventory buffers

Of the supply chain resilience tactics employed by the participants' businesses to mitigate the impacts of supply chain risks triggered by COVID-19, increasing inventory levels to prevent stock-out of critical items was one of the most frequently encountered. Participant Seven, Managing Member of the locomotive control systems manufacturer, commented:

> *"… now that we know there's a huge shortage of components and long lead times, we're trying our best now to keep stock, especially of the long lead time components…"*

Participant Eight, of the private healthcare provider, described how their business stockpiled PPE:

> *"We increased inventory, so we bought enough inventory. At one stage, we had enough masks to last us for two hundred and fifty-three days. So we actually just spent money and increased inventory so we don't get caught with our pants down."*

Participant Six, of the diversified miner, explained:

> *"There's a couple of commodities where we had to do that, obviously some of that information is commercially sensitive, but we had to…. increase inventories…"*

However, several participants expressed mixed feelings on this tactic. While they did increase stock levels to some extent to help guard against stock-outs and lost sales, their ability to build large inventory buffers was in many instances constrained by the need to conserve available cash to fund their operations through the pandemic. Participant Seven, Managing Member of the locomotive control systems manufacturer commented:

> *"You've now got to think, let's plan ahead and make more stock, and that means it sits on a shelf... You know, it's a tricky one, because you don't want to run into cashflow issues either."*

Participant Six, of the diversified miner, expressed similar concerns, saying that:

> *"…although working capital optimization is a big focus for us, unfortunately, we had to due to the context, we had to increase inventories, you know, in some areas."*

However, in the case of temporal opportunities, such as PPE, holding excessive volumes of inventory could be extremely risky. The PPE market was highly dynamcic, changing from one day to the next as supply flooded into the country. Eventually, supply caught up with – and ultimately overshot – demand. Participant Four described their experience with leftover PPE once the market was saturated:

> *"We were left with half a million rands worth of stock… we were just fortunate to be able to find somebody who could use it that we could donate it to. So we got the full value of it [in BEE points]. But other than that, we would have been stuck with half a million rands' stock that was worth nothing. We could probably have sold it Dischem... I think Dischem are probably the ones who are selling scanners [handheld infrared thermometers] now, and we could probably have sold them for about a tenth of their value, if we were lucky, to Dischem or somebody like that, to get rid of them."*

Although not related to their own business, Participant Three, Managing Director of the T-shirt wholesaler, relayed a similar problem of leftover stock that had fallen in value, as experienced by a business associate:

> *"I've got one guy who is still trying to sell seven hundred and fifty thousand three-ply masks. No customers. The stock, the money that that's taking up, the space in his warehouse that its taking up. No one's buying masks like they were when it was this rush."*

Meanwhile, some businesses were simply unable to build the desired inventory levels due to upstream disruptions at multiple tiers of the supply chain. Participant Nine, Managing Director of the branded computer and consumer electronics retailer, explained how they had experienced:

"… from a supply chain point of view, really just massive, massive challenges around stock and availability… in retail, to not have stock is just death. I mean, in December, we literally ran out of laptops, we didn't have laptops in our stores, and so, you know, you can't sell what you don't have. And for us, it was particularly challenging. As a mono-brand business, in other words, we only sell [manufacturer of computers, printers and accessories]. It was really complicated, because [name of competitor store] , one of our competitors, they could sell, well, they couldn't get [manufacturer of computers, printers and accessories], but they'd get you [list of competitor laptop brands], whatever it is. We couldn't do that."

3.5.1.2. Category 2: Multi-sourcing

Another common supply chain resilience tactic that emerged from the data is multi-sourcing. Due to widespread disruption of global supply chains, several participants' businesses, and especially those reliant on imported items, used more than one supplier to source critical items. For some businesses, this was already established practice which was intended to protect them against common supply risks. Other businesses, meanwhile, actively expanded their supplier bases during COVID-19 to mitigate the risk of that epidemic-induced supply chain disruptions posed to their businesses. Participant Four, Managing Director of the OHS sensors distributor, described the steps they took:

"… we've looked at alternative supply routes and manufacturers in different countries and even in the same countries where we were getting them from, just to widen our net. In the event that one of our suppliers, for example, went out of business, we knew that we had to have somebody in the wings to take over if we lost a supplier as a result of closure from COVID-related matters… we will have a wider supplier base - that's permanent."

Unlike Participant Four's business, the branded computer and consumer electronics retailer was is not permitted to other manufacturers' products, however, they were still able to implement multi-sourcing measures to widen their supply base. Participant Nine explained that since COVID-19 struck, they had begun:

"… working actually a bit more with multiple distributors. We were really strategic with one of our distributors, and we've grown that now to two distributors, because they have their own challenges. So they've got to, you know... We just want, I suppose we want redundancy in our distribution. So, you know, whatever, they don't have the orders in time or they don't have the cash to pay for the orders or

they're not filling containers, so they wait to fill the containers, whatever that reason is, we've increased our number of suppliers quite dramatically, well, I mean, it's 100 percent, from one strategic to two, and that's made a big difference, and I don't think we would have done that were it not for the pandemic."

3.5.2. Theme 2: Information-related measures

3.5.2.1. Category 1: Visibility

The diversified miner committed considerable time, effort and resources to supply chain visibility initiatives, monitoring infection rates across their supply chains and collaborating closely with key supply chain partners in a bid to detect and resolve developing supply chain problems, before they could result in significant disruptions. Participant Six explained:

"... we had to, you know, open up regular, very focused dialogue with these supply partners to establish what's the infection rates in their business - the people that are on our operations - but also in their manufacturing facilities... so that we could translate that to potential supply risk of that particular commodity that we buy... so that we could preempt, you know, supply constraints in terms of manufacturing capacity... we established an ongoing, you know, risk radar for monitoring risk across all the commodities... looking at global freight and global ocean and air freight, etc., all the potential knock on effects... So it's a very focused, concerted effort across the global supply chain to monitor the market and respond rapidly in an agile manner... it put new demands in terms of how you jointly cope and communicate because, you know, we're reliant for critical supplies."

Particpant Six added that to facilitate the constant communication upon which their supply chain visibility efforts rely, they hold:

"... regular webinars with our key partners to whom we have a big exposure, you know, the key global tier one suppliers... what we wanted to secure out of those discussions was how are you coping as a business? What are you doing to mitigate your risks in terms of production, manufacturing capacity? Because at the end of the day, you know, that impacts us."

Commenting on the benefits of supply chain visibility for the business, Particpant Six said:

> *"... it's just given us the ability to see things in advance... and it's contributed to keeping our business sustainable... It gave us security of supply and mitigated supply risk...You know, every minute in terms of production, what we do is huge revenue... diligently keeping them on focus have allowed us to avoid, in advance, avoid potential trouble, supply risk, supply issues..."*

3.5.2.2. Category 2: Research

In its efforts to anticipate and pre-emptively/proactively mitigate supply chain risks at a global level, before they result in significant disruption, the diversified miner went a step further, utilising a sophisticated collection of business intelligence services. Through its subscriptions to industry research organisations, and even commissioning its own research projects, it ensured it stayed abreast of all supply chain developments unfolding in the its global business environment. Participant Six explained how the business had been:

> *"... leveraging the tools... the subscriptions that we have to, you know, research institutions, supply chain, you know, know-how out there in the global market in terms of supply risks, etc. You know, we've commissioned specific work in terms of looking at specific industries, you know, research, research groups, looking at specific industries so we could proactively pick up any, you know, any risks coming our way. So those were the, I would say, the, you know, the day-to-day, some of the day-to-day usual things with which we obviously just continued with, you know, but obviously added this layer over stuff in the business model innovation."*

3.5.3. Theme 3: Financial measures

3.5.3.1. Category 1: Pre-payment

The private healthcare group was able to pre-book supply of PPE before it became available by extending cashflow support to some of its smaller suppliers. Participant Eight explained:

> *"We reiterated the strategic relationship between partners, I mean, our suppliers and us, and we actually just helped them through some of their cashflow issues so that we can get first bite at the cherry when some of the other stuff comes through. So that helped a lot… pre-buying."*

3.5.3.2. Category 2: Improved payment terms

The diversified miner also extended financial support to some of its smaller suppliers, by paying more quickly for goods and services delivered by its smaller suppliers. Participant Six explained:

> *"…in the South African context, we're shifting more and more of our supply chain to host community vendors. That's a huge strategic focus for us to unbundle our supply chain and take it into our host communities, to incubate entrepreneurs, to really impact the well-being of our host community… we reviewed payment terms for the smaller host community [vendors], we reviewed payment terms. We brought in a lot of flexibility to ensure that we could pull that host community supply base, which we're very, very strategic about, which we're developing, which we've spent a lot of resource in over the years to develop, to bring them along through this because they've been impacted with lockdown regulations, etc., so there was a concerted effort to try and bring them along."*

Chapter 6: Discussion of Results

6.1. Introduction

In Chapter Six, the data presented in Chapter Five is analysed and discussed in an attempt to answer the three research questions set before the commencement of the data-gathering phase of the research project. The following sections highlight important patterns emerging from the experiences of the participating businesses, drawing links between real-world observations and theory contained in the literature review, and distilling key learnings which address the theoretical and business needs for the research as outlined in Chapter One.

Chapter Six proceeds as follows. Section 6.2. discusses evidence pertaining to the unique characteristics of epidemic-related disruptions, thereby answering Research Question 1. Section 6.3 analyses the data to discover what types of business model innovations were implemented by the participants' businesses, and how these businesses model innovations benefited the businesses and their supply chains, respectively, by helping them avoid or mitigate potential consequences of COVID-19 (or, in a few instances, seize opportunities presented by the pandemic), thereby answering Research Question 2. Section 6.4. examines what types of supply chain resilience measures were adopted by the participants' businesses, and how these resilience measures benefited the businesses and their supply chains, respectively, by helping them avoid or mitigate potential consequences of supply chain disruptions triggered by COVID-19, thereby answering Research Question 3. The chapter concludes with a concise summary of key findings in Section 6.5.

6.2. Discussion of Results: Research Question 1

Research Question 1: What are the most important characteristics of epidemic-related disruptions that have led businesses to transform key elements of their business models during COVID-19?

6.2.1.1. Introduction

As discussed in Chapter 2, but important to repeat here:

> *The defining characteristics of epidemics are that they cause disruption that i) is typically long-lived and which has the potential to directly affect large parts of supply chains located in diverse geographies, ii) progresses in time and space in*

a way that is notoriously difficult to model reliably, making it hard to anticipate the duration and full extent of the disruption, iii) propagates through the supply chain concurrently with the spread of the epidemic through the population, and iv) is characterised by concurrent shifts in supply, shifts in demand and destabilisation of logistics networks (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020).

The above definition draws on the perspectives contained in several early articles which published in first half of 2020, as the pandemic was still unfolding across the world. Interestingly, the results of this study, collected nearly a year later, reflect all of the unique characteristics of epidemic-related supply chain disruptions identified during the course of the literature review, though certain characteristics appear to have been more important than others for triggering business model innovations. In the following subsections, the key findings are discussed, grouped according to the unique characteristic of epidemic-related disruptions to which they relate, encapsulated by the same themes presented in Chapter Five.

6.2.2. Theme 1: Magnitude

While a number of businesses had experienced supply chain disruptions before, the results in Chapter Five show that several participants made reference to the unparalleled magnitude of the disruptions that the pandemic had brought. In their opinions, not only had they never experienced such severe disruptions as those brought about by COVID-19, but they could not recall a previous occasion on which such large parts of their supply chain, or even their entire supply chain, had been simultaneously struck by disruptions all flowing from a single, common disruptive event (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020).

Furthermore, several participants commented on the geographic distribution of COVID-19 as a disruptive event (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020). Although the effects of previous disruptions may have been felt by the business, the disruptive event itself had occurred in a particular country or region, with the worst effects concentrated in supply chain partners located nearby. In stark contrast, COVID-19-related disruptions had struck almost all of their supply chain partners simultaneously, regardless of where in the world they were located.

Finally, participants commented on the extended duration of the disruptions (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020), and how the business environment is still evolving and throwing up fresh supply chain challenges, more than a year since COVID-19 was first detected in China, and almost a year since it arrived in South Africa.

Among the four unique characteristics of epidemic-related disruptions, the unusual magnitude of the disruptions (in terms of severity, duration, geographic extent and the proportion of the supply chain that was affected (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020) appears to have been one of the two most important triggers of business model transformations among the study participants. For many businesses, the impacts of COVID-19 so severe and far-reaching that they completely undermined key elements of existing business models, leaving the participants with little option but to fundamentally reengineer their business models to realign them to the drastically altered and ever-evolving COVID-19 business environment.

6.2.3. Theme 2: Unpredictability

The second unique characteristic of epidemic-related disruptions, the unpredictability of the epidemic in terms of its progression through space and time (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020), also presented a significant challenge for participants' businesses. Unlike a typical disruption, which is relatively simple to understand and hence respond to, the participants' comments indicate that the complexity and dynamism of the epidemic made it incredibly difficult for management to grasp the full implications that COVID-19 would hold for their businesses, which made planning a coordinated response very difficult. The pandemic was in effect a 'moving target,' requiring businesses respond to a constantly shifting business environment with speed and agility.

6.2.4. Theme 3: The Human Element

The third unique characteristic of epidemic-related disruptions is the way in which disruption within supply chains and infection within human populations spread simultaneously (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020), with the former closely linked to and driven by the latter. While it is not uncommon for the effects of a disruption to propagate upstream and/or downstream of the source of the initial disruption to affect other members of the supply chain (Hosseini, & Ivanov, 2019; Pastore, Alfieri, Zotteri, 2019), the health dimension is unique to disruptions caused by disease epidemics. Participants explained how the need to slow down the spread of

infection had caused severe and widespread disruptions to large sections of their supply chains, causing major knock-on effects on their own businesses.

As laid out in Chapter Five, several participants repeatedly emphasised how addressing the human impact of COVID-19, in terms of assuring both physical and psychological well-being of staff, customers and supply chain partners, was key to mitigating the business impacts of the pandemic. Indeed, several of the business model transformations undertaken by the participants were motivated, on a physical level, by the need to protect staff, customers and supply chain partners against the risk of COVID-19 infection (e.g. COVID-19 testing became a key activity for the diversified miner), and on a psychological level, by the need to ensure that all stakeholders felt safe, comfortable and cared for in their interactions with the business (e.g. the transformation of customer relationships by the branded computer and consumer electronic retailer, which accompanied its channel innovation).

6.2.5. Theme 4: Market Turbulence

The fourth unique characteristic of epidemic-related disruptions is the significant and frequently simultaneous changes in both supply and demand, compounded by disruption of transportation networks, resulting in reduced capacity or unavailability of commercial freight (and passenger) transport services (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020). Several participants explained that when COVID-19 first hit, demand for their businesses' products and services dropped precipitously almost overnight (e.g. the T-shirt wholesaler and the book retailer), sometimes to zero (e.g. the OHS sensors distributor). For others, demand remained relatively stable, and in a few cases, even surged following the arrival of the pandemic (e.g. the branded computer and consumer electronics retailer and the sporting goods and sporting apparel retailer) .

Meanwhile, serving whatever demand remained become tremendously challenging for several participants, as their supply chains had been severely impacted and were no longer functioning normally. Upstream supply partners were unable to keep up with demand for variety of reasons, including reduced production capacity due to such factors as staff absenteeism due to COVID-19 infection (e.g. the diversified miner), reduced staff complements per shift as a result the need to observe social distancing protocols in the workplace (e.g. the T-shirt wholesalers), and severe shortages of components (e.g. the locomotive control systems manufacturer and the specialty chemicals distributor) which in turn were often attributable to global shortages of raw materials precipitated by the epidemic-related disruptions of COVID-19.

Compounding these supply chain challenges, many participants cited reduced global logistics capacity, which affected both sea freight and air freight, and served to increase lead times and freight prices. Finally, disruptions to seaport and airport operations further exacerbated the impacts of the reduced production capacity and reduced freight capacity on the participants' businesses.

The fourth unique characteristic of epidemic-related supply chain disruptions (supply shifts, demand shifts and logistics challenges) appears to have been responsible for a substantial number of business model innovations, based on the results presented in Chapter Five.

6.2.6. Conclusion

The data presented in Chapter Five shows that across the twelve businesses comprising the sample, all four unique characteristics of epidemic-related supply chain disruptions (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020) led to business model transformations in response to COVID-19. However, from the data, it appears that certain of these characteristics were more important drivers of business model transformation than others, in the sense that they led to more business model transformations across the sample than the other characteristics. They were unique characteristics one – the magnitude of epidemic-related disruptions in terms of number of supply chain members simultaneously impacted by the disruptions, the duration of the disruption, and the geographic extent of the disruption – and unique characteristic four – simultaneous shifts in supply and demand, coinciding with destabilisation of global logistics networks (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020).

Although this study is early, exploratory research, and furthermore, is based on a limited sample size, the results provide an early indication that whereas other classes of supply chain disruptions can typically be managed solely through supply chain management approaches, such as supply chain resilience (which aims to restore normal functioning of the disrupted supply chain in the shortest possible time (Ali, Mahfouz, & Arisha, 2017), effective responses to epidemic-related disruptions frequently require transformation of one or key elements of a business's existing business model, as postulated by Craighead & Ketchen (2020), leading them to assert the need for their novel concept of supply chain transiliency. The data further suggests that depending on the nature and magnitude of the epidemic-related disruptions impacting a business, the transformations undertaken

by businesses in pursuit of transiliency may take the form of either minor tweaks or radical, explorative innovations.

6.3. Discussion of Results: Research Question 2

Research Question 2a: Which key elements of business models have been transformed in order to help businesses to avoid or cope with the consequences of epidemic-related disruptions during COVID-19?

Research Question 2b: How have these business model innovations helped businesses to avoid or cope with the consequences of epidemic-related disruptions during COVID-19?

Research Question 2c: How have these business model innovations helped businesses' supply chains to avoid or cope with the consequences of epidemic-related disruptions during COVID-19?

6.3.1.1. Introduction

The results presented in Chapter Five revealed that all of the participants' businesses transformed at least one element of their existing business models as part of their businesses' response to epidemic-related supply chain disruptions triggered by COVID-19. Most participants' businesses transformed a few elements of their business models, while no participant's business transformed all nine of Osterwalder's (2013) business model elements. The data revealed that some business model elements were targeted for transformation more frequently than others, however, across the sample, there was at least one occurrence of a business model transformation involving each of the nine business model elements.

Since the three parts of Research Question 2 are closely intertwined, and indeed difficult to separate, all three parts of Research Question 2 will be discussed together in each subsection below.

6.3.2. Theme 1: Unit of Business BMI

6.3.2.1. Category 1: Value Proposition

As described in Chapter Five, only the locomotive control systems manufacturer made a significant change to an existing value proposition, by incorporating contact tracing functionality into its personal detections system (PDS) to help the customer monitor and contain the spread of infection among its employees.

For the business, the main benefit of transforming its value proposition business model element in this way was that it generated additional revenue for the business. Although the business was classified as an essential service provider, and was therefore permitted to reopen sooner than most other businesses in the country, cashflow was nevertheless a major concern for Participant Seven, firstly, because they entered the COVID-19 period with limited cash reserves, and secondly, because many of their customers reduced their budgets for capital equipment, presumably in an effort to conserve cash as part of their own response to the pandemic. Reduced market demand for capital equipment, including locomotive control systems, led to intensified competition in the industry, with corresponding lowering of prices leading to pressure on margins. Thus, by transforming the value proposition element of its business model, the business was able to charge a higher price for its upgraded PDS system, generating additional revenue and helping to maintain a healthy cashflow.

From the results, there do not appear to have been significant benefits to the supply chain, other than the fact that by assisting customers with contact tracing for the purposes of slowing the spread of infection, the business contributed to their ability to continue operating safely. Thus, it can be argued that the resilience of the supply chain was enhanced, albeit to a limited extent.

6.3.3. Theme 2: Business Process BMI

6.3.3.1. Category 1: Customer Segments

As stated in Chapter Five, only two participants transformed the customer segments element of their business models, the branded computer and consumer electronics retailer and the T-short wholesaler. In the case of both businesses, the transformation of the customer segments business model element was driven primarily by the fourth unique characteristic of epidemic-related supply chain disruptions, namely, significant

and often simultaneous shifts in supply and demand, frequently exacerbated by destabilisation of transportation networks (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020).

While demand for laptops increased during COVID-19, the branded computer and branded electronic retailer faced a persistent lack of supply in certain product categories. From the quotations presented in Chapter Five, it is evident that Participant Nine, believes that the business had no option but to shift its focus towards the high-end of the laptop market, as global shortages of electronic components had caused the laptop manufacturer to cut back production of lower-end models in favour of building higher-margin products using the limited quantities of components they could obtain. In Participant Nine's view, failure to transform the customer segments element of their business model would have resulted in the loss of sales, especially to multi-brand competitors whose procurement options were not restricted like they were (as mono-brand retailer), and reduced profitability.

Participant Nine did not know of any material benefits to the supply chain arising from the business's transformation of its customer segments business model element. Rather, it was the actions of an upstream supply chain partner, specifically the laptop manufacturer, that caused Participant Nine's business to undertake this business model transformation. Hence, the branded computer and consumer electronics retailer's business model transformation around the customer segments element of its business model did not serve to materially increase the transiliency of its supply chain.

While the branded computer and electronic retailer transformed its customer segments business model element in response to supply-side challenges, the T-shirt wholesaler innovated due to lack of demand for their usual product range. The data for the T-shirt wholesaler laid out in Chapter Five reveals that the business almost ceased supplying its traditional customer segment of garment printers (sales fell to 15% of pre-COVID-19 levels), and began selling PPE to anyone who needed it.

Admittedly, it is questionable whether this action constitutes a change in customer segment in the strict sense, or whether the wholesaler simply entered an entirely new and unrelated market, with a distinct and separate business model. However, regardless of the interpretation of customer segment adopted, what is not in question is the fact the business made intentional changes to the types of customers it targeted, and that doing so constituted a business model innovation in a way that is consistent with the definitions of business model innovation presented in Chapter Two (Foss and Saebi, 2017; Ghezzi, & Cavallo, 2020). Therefore, for the purposes of this study, the actions of the T-short

wholesaler in changing from selling T-shirts to garment printers to selling PPE to a wide variety of customers is deemed to be a form of business model innovation around the customer segments element.

By rapidly pivoting to the sale of PPE, the T-shirt wholesaler was able to mitigate the consequences of a precipitous drop in demand in its traditional market. As covered in Chapter Five, in the view of Participant Three, if they had failed to transform their customer segments business model element in this way, the likely consequences would have included, in the first place, an 85% reduction in the business's total monthly revenues during the first few months of hard lockdown at the beginning of the pandemic. With such a drop-off in revenue, it is likely they the business would have to have either retrenched staff and/or reduced salaries, as many of the business's competitors in the industry were forced to do. Thus, for the business itself, the primary benefirts of the business model transformation of the ciustomer segments business model element was the generation of much-needed revenue, which offset the decline in T-shirt sales, allowing the business to continue to fund it operations and cover its expenses, including paying all staff their full salaries, without the need seek additional capital in the form of either loans or government economic relief schemes.

Participant Three was not aware of any significant benefits to their supply chain that could be attributed to the business's transformation of its customer segments business model element. The PPE supplier merely acquired another customer, but there was no evidence that the business's actions served to enhance the transiliency of PPE supply chains. The T-shirt supply chain was not affected by this particular business model transformation, so there was no effect on its overall transiliency either.

6.3.3.2. Category 2: Customer Relationships

Only the branded computer and consumer electronics retailer made deliberate, non-trivial changes (Foss and Saebi, 2017) to this business model element. Transforming the customer relationships element of its business model was a complementary innovation to its transformation of it channels element (discussed further in Section 6.3.3.3. below).

According to Participant Nine, during COVID-19, the business improved the ways in which it related to its customer, paying particular attention to catering to customers' needs, allaying their fears by ensuring they felt safe when shopping, be it online or in-store, and treating them empathetically, recognising that like many businesses and society as a whole, many customers were understandably feeling uncertain (Dutton, 1986) and anxious in the face of the COVID-19 crisis

By innovating the customer relationships element of its business model, the business helped to enhance the transiliency of its supply chain. After all, if customers did not feel safe and valued, it is likely that they would have purchased elsewhere, and if they had purchased elsewhere, the retailer would have experienced reduced inventory turnover and placed fewer orders with their suppliers, thereby negatively impacting on the sustainability of the entire upstream supply chain.

6.3.3.3. Category 3: Channels

The results presented in Chapter Five show that channel innovations were a common type of business model innovation, with four out of twelve participants' businesses transforming the channel elements of their respective business models. Channel innovations were particularly popular among the B2C businesses, with all three retailers, as well as the restaurant group, adding or accelerating the expansion of existing e-commerce capabilities.

For the three retailers and the restaurant group, the principle benefit of transforming the channels element of their business models from a predominantly in-store sales channel to an omnichannel model (i.e. a combination of physical and online retail) was that it allowed them to continue to sell to their existing client base throughout the pandemic (except during the initial hard lockdown, when the sale of non-essential items was prohibited by law). The addition or expansion of online shopping channels enabled the retailers to continue trading and earning much-needed revenue, even as ongoing concerns over safety meant that some customers were reluctant to visit their physical stores.

According to the participants, potential consequences of failing to transform or being unable to transform the channels element of their business models would have included revenue loss; inability or further inability to cover expenses (as it was, all four businesses saw fit to renegotiate the terms of store leases, while the bookseller also negotiated deferred payments with suppliers in order to conserve cash); reduction of staff (all four businesses retained their full staff complement, although the bookseller did implement temporary salary cuts for higher-paid employees); an inability to service debts as they fell due (insolvency); and in the worst case scenario, even business failure.

As well as benefitting the participants' own businesses, their successful transformation of their channels business model element created considerable benefits for their supply

chains. Adding or expanding their online channel also helped sustain the revenues of upstream supply chain partners located at multiple tiers of the supply chain. As the retailers sold to consumers, they continued to place order with their suppliers, who in turn placed orders with their own suppliers and service providers, thereby supporting and enhancing the transiliency of the entire supply chain.

For example, the bookseller was able to continue selling books to its customers through its online sales channel, so it continued ordering books from various publishing houses, helping to shore up their revenues. As the majority of the books the business purchases are sourced in either the US or the UK, and need to be transported to South Africa, the publishers in those countries engage commercial air freight services, who therefore also benefited and earned revenue from the bookseller's ability to continue to trade. Thus, the booksellers channel innovation enhanced the transiliency of the entire supply chain. Similarly, the branded computer and consumer electronics and sports equipment retailers were both able to continue purchasing trading stock, providing crucial revenue for their wholesalers and distributors, manufacturers, and transport providers, thereby enhancing the transiliency of their respective supply chains.

6.3.3.4. Category 4: Key Activities

The results presented in Chapter Five show that the diversified miner benefited considerably from the business model innovations it undertook in respect of its key activities business model element, specifically, vertical integration. Through the strategic backwards integration into supply chain activities such as transportation and logistics, which it did not previously perform in-house, the business was able to gain greater control over the performance of its supply chain. This in turn helped to ensure greater security of supply of critical inputs, as well as ensuring it could transport the commodities it mines to market.

Thus, the miner was able to avoid costly production stoppages at its mines, continue to earn revenue, and sustain profitability, despite the widespread supply chain disruptions affecting large parts of its global supply chain, which may otherwise have prevented procurement and delivery of many of the wide range of inputs a large mining company requires. Hence, it is clear that the miners' transformation of the key activities element of its business model contributed, directly and significantly, to enhancing the business's organisational transiliency against epidemic-related supply chain disruptions

Transforming the key activity of the business model in this way also enhanced the supply chain transiliency, giving the miner greater visibility of and control over its supply chain,

allowing it to bring its formidable supply chain management expertise to bear, thereby helping to reduce supply risks, avoid supply chain disruptions, and maintain the smooth flow of goods and services in the supply chain, to the benefit not only of itself, but its supply chain partners as well.

Another important key activity innovation for the miner during the pandemic revolved around keeping its staff and 'embedded' (i.e. on-site) suppliers and contractors healthy and protected against the virus. This new key activity centred around the establishment of a vast network off fourth-four separate medical laboratories, located across the length and breadth of its South African operations, for the purposes of COVID-19 testing. So critical was this key activity for the miner, that for much of the pandemic period, the miner's laboratory services far surpassed the public health system in terms of daily testing capacity and total coronavirus tests performed. A dedicated global supply chain for the procurement of testing consumables was set up to support the laboratories. At the time of the interview, the business was making preparations for the next phase of the fight against the virus, the vaccination of its staff, embedded suppliers and contractors, and even host community members.

The miner's medical interventions benefitted the business by ensuring maximum possible workforce availability, helping to maintain all-important production volumes, and sustaining revenue, which when combined with favourable commodity prices and a weak Rand, contributed to impressive financial results relative to many of the miner's industry peers, the pandemic notwithstanding.

The medical interventions enhanced supply chain transiliency, as the fully operational miner was able continue to procure supplies needed for production, thereby supporting upstream supply chain partners. Both upstream and downstream supply chain partners also benefitted from the miner's decision to make testing facilities available to its partners, helping them to detect and control infection rates in their own workforces so their businesses could also operate as normally as possible.

6.3.4. Theme 3: Financial Model BMI

6.3.4.1. Category 1: Revenue Streams

Only two businesses engaged in transformations of the revenue streams element of their business models, namely the OHS sensors distributor and the T-shirt wholesaler. By pivoting into selling PPE, as described in Chapter Five, both businesses secured a much-needed alternative source of revenue, which helped to sustain them through the first few

months of the pandemic, when hard lockdown measures effectively prevented them from selling their usual product lines.

Participant 4, the Managing Director of the OHS sensors distributor, stated that this additional revenue stream probably saved the business from failing, as without income, the business would have depleted its finite cash reserves within a few months. At the very least, the business would have had to consider retrenching some staff and reducing the salaries of others. Participant Three, Managing Director of the T-shirt wholesaler, made similar remarks regarding the potential consequences of not transforming the revenue streams element of their business model, which may also have included job losses and possible collapse of the business.

As these transformations of the revenue streams element of business models involved a separate PPE supply chain, these business model innovations did not have any effect on the level of supply chain transiliency of the businesses' existing supply chains (OHS sensors supply chain and T-shirt supply chain). The revenue stream innovations also appear to have had little impact on the upstream PPE supply chain, apart from the fact that the PPE suppliers acquired two new customers.

However, in the case of the OHS sensors distributor, the PPE revenue stream innovation may have slightly enhanced the transiliency of customer organisations, as the handheld infrared thermometers supplied by the business enabled customers to screen their staff for COVID-19, assisting them to continue to operate safely, and continue to support upstream supply chain partners. Thus, in a limited sense, it could be argued that the OHS sensors distributors revenue stream innovation did in fact contribute to increasing the transiliency of broader mining industry supply chains.

Although both businesses transformed the revenue streams element of their business models to enable them to seize a temporal opportunity arising from an overnight surge in demand for PPE products, both participants indicated that these were in fact purely necessity-driven innovations (Devece, Peris-Ortiz, & Rueda-Armengot, 2016) motivated by the need to compensate for lost revenue to enable their businesses to survive (Cucculelli & Peruzzi, 2020) the initial hard lockdown. Consequently, these business model innovations around their revenue streams, while critically important for business viability at the time, were extremely short-lived.

The remainder of the participants' businesses made no attempt to alter or add to their revenue streams. Some were able to continue earning revenue throughout the pandemic, with several even experiencing an increase in revenues due to heightened

demand for their products or services. Others saw big revenue falls, but had sufficient cash reserves to tide them over until revenue picked up again. Still others made use of business model innovations in respect of other business model elements to support and maintain existing revenue streams, without making changes to the revenue streams themselves.

6.3.4.2. Category 2: Cost Structure

For many businesses, the pressures of navigating the turbulent COVID-19 business environment also triggered or accelerated a reengineering of the other component of their financial models – their cost structures.

In the retail sector, a phenomenon that has received a lot of attention has been the recalibration of the power relationship between landlords and their tenants. When lockdown regulations forbade trading in so-called non-essential goods and services, retail tenants were not in a position to afford the high rental payments, and certainly unable to absorb further above-inflation annual increases, which had become customary in the property industry. Many landlords were compelled to support their tenants by temporarily suspending certain conditions in their lease agreements, or risk tenants leaving their premises and sitting with high vacancy rates.

While it is questionable whether the reset in rental rates in the retail property industry represents a deliberate, planned, non-trivial business model innovation (Fosse & Saebi, 2017) on the part of the tenant, as opposed to merely a shift in supply and demand, substantial reductions in the rates charged by landlords, as reported by Participant Nine, do have the effect of significantly altering the overall cost structure by reducing rental expenses – one of the largest components of the cost structure element of any brick-and-mortar retailer's business model.

6.3.5. Conclusion

Consistent with the discussion in Section 2.3.4., the data revealed evidence of both necessity-driven and opportunity-driven entrepreneurial behaviour (Devece, Peris-Ortiz, & Rueda-Armengot, 2016) manifested through business model transformations.

Of the businesses that did implement business model innovations, the majority did so with the intention of helping the business to cope with negative impacts of COVID-19, rather than the aim of creating competitive advantage (Cucculelli & Peruzzi, 2020). For many, these impacts were so severe that the participant believed that they threatened the sustainability of the business, and that save for the business model transformations they implemented, there is a high probability that the business would not have survived the pandemic. Thus, the decision to introduce business model innovations was driven by necessity, to avoid or reduce the potential consequences that failing to innovate may have had for the business, up to and including total collapse of the business.

The fact that a number of participants believe that their businesses could have failed as a result of disruptions it suffered as a result of COVID-19, and that to a large extent, they attribute their survival to the business model innovations they introduced in response to the pandemic, demonstrates the immense value that business model innovations can hold for businesses struck by the types of supply chain disruptions that accompany disease epidemics. Moreover, these findings can be interpreted as providing compelling support for the most fundamental premise underlying the novel supply chain transiliency concept – that business model innovations could be an effective, and even essential, tool for businesses responding to epidemics, to help avoid or at least mitigate the worst consequences of epidemic-related disruption for the business (Craighead, & Ketchen, 2020).

While none of the businesses surveyed were unaffected by COVID-19, a few businesses experienced primarily positive rather than negative impacts. In some instances, the pandemic triggered increased demand for a business's products or services, with the businesses transforming elements of its business model to enable it to efficiently and profitably meet heightened levels of demand. In other cases, COVID-19 created or increased demand for new products or services which the business did not previously sell, but which they were well-positioned to begin to supply through the rapid transformation of key business model elements. Such business model innovations were opportunity-driven as opposed to necessity-driven (Devece, Peris-Ortiz, & Rueda-Armengot, 2016).

Of the two competing cognitive theories described in Chapter 2, the results of the interviews suggest that prospect theory provides the best explanation for the increased business model change intention observed in some of the businesses (Osiyevskyy & Dewald, 2018)

No support for threat-rigidity theory (Saebi et al., 2017) as a driver of business model change intention was detected. There is no evidence that any business experienced a reduced business model change intention during the pandemic as compared to before the pandemic, as threat-rigidity theory predicts. It appears that the businesses which made no attempt to change their business models did not do so out of an aversion to the risks that might accompany such business model changes, as threat-rigidity theory predicts, but rather because they simply did not perceive COVID-19 to represent a crisis for their businesses, as one or more key elements of the crisis concept, as defined in Chapter 2 were absent from their particular circumstances. In particular, while they may have experienced negative impacts arising from the pandemic, these businesses did not perceive an immediate/imminent existential threat to the survival of the business (Chowdhury & Quaddus, 2016; Dutton, 1986), as a result of COVID-19.

There appear to be several reasons for this. Some of these businesses were simply less severely affected by the pandemic than businesses that did transform their business models. In other cases, management was comfortable that the business's cash reserves could sustain it through an extended period of disruption, perhaps with additional support from financial relief schemes offered by National Government, such as the Temporary Employee Relief Scheme (TERS), which helped employers avoid cuts to staff numbers and/or staff salaries. Others had extensive confirmed order books, so were not concerned about potential drop in demand. Finally, some businesses experienced significant positive impacts which offset, and in some cases, exceeded the negative impacts of the pandemic.

6.4. Discussion of Results: Research Question 3

Research Question 3: How have conventional supply chain resilience methods helped businesses to avoid or cope with the consequences of epidemic-related disruptions during COVID-19?

6.4.1.1. Introduction

As discussed in Section 6.3.5. above, participants whose businesses had sufficient cash reserves, forward order books, or sustained or increased demand for their products and services do not appear to have perceived COVID-19 as a true crisis (as defined in Chapter Two (Chowdhury & Quaddus, 2016; Dutton, 1986)) as it did not present an existential threat to their businesses, and thus they do not appear to have displayed an increased intention towards business model innovation. It follows that these businesses did not consider it necessary to make extensive changes to their business models during COVID-19. Those businesses that did make extensive changes to elements of their business models, despite the absence of an existential threat to their business, did so to seize an opportunity that arose in the COVID-19 business environment, and hence constituted opportunity-driven as opposed to necessity-driven entrepreneurial behaviours (Foss & Saebi, 2017) manifesting as business model innovations.

Regardless of whether or not they innovated their business models extensively, all participants' businesses employed one or more supply chain resilience measures to avoid or mitigate the negative impacts of supply chain disruptions emanating from COVID-19. Hence, even businesses that made relatively little use of business model innovations still fostered transiliency, primarily by leveraging the second pillar of transiliency (Craighead, & Ketchen, 2020), namely supply chain resilience, with the first pillar of busines model innovation playing a far less prominent role. In a few cases, participants' businesses made no changes to any of their business model elements, in which case they relied on resilience, rather than transiliency, since by definition, the latter requires the use of both resilience measures and business model innovations.

6.4.2. Theme 1: Stock-Related Measures

6.4.2.1. Category 1: Inventory Buffers

One of the most common supply chain resilience measures employed by the participants' businesses was increasing inventory levels to provide a buffer against shortages of key inputs provided by their suppliers and long lead times for certain items. In the case of several of the retailers, levels of trading stock were increased, while several of the industrial businesses, including manufacturing, distributing and mining business, sought to hold larger inventories of components and other key inputs into their businesses. The private healthcare provider stockpiled scarce PPE supplies as well as medications prescribed for the treatment of COVID-19 patients.

However, as several participants commented, while increasing inventories may have enhanced the resilience of their businesses and their supply chains, it came at the cost of increasing their working capital requirements. At a time when revenues were down, many businesses were trying hard to free up cash to cover expenses, and could not afford to add significantly to their inventories. Supply chain disruptions also frustrated some participants' efforts to build their inventory buffers to the desired levels.

6.4.2.2. Category 2: Multi-sourcing

Another supply chain resilience measure that was frequently encountered during the interviews was the practice of multi-sourcing, whereby participants utilised relationships with multiple suppliers to obtain key inputs for their businesses. Multi-sourcing imparts redundancy into a business's procurement process, increasing the likelihood of the business maintaining uninterrupted access to a regular supply of key inputs, including, in the case of the sample, trading stock and critical components, even when one supplier is experiencing supply problems.

While some participants were routinely practicing multi-sourcing prior to COVID-19, at least for critical supplies, others implemented multi-sourcing in as a means of mitigating the negative effects of supply chain disruptions arising during the pandemic. For example, the branded computer and consumer electronics retailer had previously operated on lean supply chain principles (Katsaliaki, Galetsi, & Kumar, 2021), as discussed in Chapter Two, strategically employing single-sourcing as a means of maximising the efficiency of procurement while minimising the costs associated with procurement (Gaur, Amini, & Rao, 2020; Moussawi-Haidar, Daou, & Khalil, 2021). However, when COVID-19 led to erratic availability of trading stock, a decision was made

to add a second supplier to increase the inherent redundancy of the procurement process and reduce the risk of stock-outs and resultant lost sales. By adding redundancy in this way, they increased the robustness of the system (Kamalahmadi, Shekarian, & Parast, 2021), and thereby enhanced the resilience, and hence transiliency, of their supply chain.

Unlike inventory buffers, multi-sourcing does not generally have working capital implications, so it was a viable resilience tactic even for businesses experiencing cashflow constraints in the midst of the pandemic.

6.4.3. Theme 2: Information-Related Measures

During COVID-19, a few participants' businesses made use of information-related supply chain resilience measures, although these were less commonly employed across the sample than inventory-related resilience measures. However, despite occurring infrequently, the data suggests that for those few businesses, information-related resilience measures proved crucial to their overall response to the pandemic, substantially increasing the resilience of their supply chains.

6.4.3.1. Category 1: Visibility

The diversified miner made extensive use of supply chain visibility measures, maintaining regular two-way communication with supply chain partners, especially with major top-tier suppliers, in an effort to understand how their businesses were being impacted by the pandemic on a day-by-day basis, and what the implications for the miner could be.

In this way, supply chain visibility initiatives helped the miner detect emerging supply risks early, so that it could respond timeously to avert or at least lessen the severity of potential supply chain disruptions. Organisational resilience was increased (Duchek, Raetze, & Scheuch, 2020), thereby contributing to the overall resilience, and hence transiliency, of the supply chain (Kamalahmadi, & Parast, 2016; Scholten, Stevenson, & van Donk, 2019). Furthermore, by sharing learnings and methods of dealing with COVID-19 business impacts, including surrounding infection control, the miner directly contributed to the resilience, and hence transiliency, of its partners, and this, the resilience and transiliency of the supply chain as a whole

6.4.3.2. Category 2: Research

The diversified miner utilised its subscriptions to various research output published by supply chain research organisations and industry bodies to monitor the global business environment in a bid to anticipate and proactively mitigate emerging supply chain risks before they could disrupt the minor's global supply network. It also commissioned its own research projects to obtain more detailed information on key supply chain risks which could not be found elsewhere.

Participant Six explained that anticipate and proactively mitigate emerging supply chain risks before they could significantly disrupt the miner's global supply network, thereby helping to avoid potential consequences of supply chain disruptions on its business. Hence, their strategic use of research output as part of a broader set of information-related supply chain resilience measures not only helped their supply chain partners avoid or mitigate the negative impacts of epidemic-related disruptions on their businesses, but also ensured that the miner could sustain production at its mines, preventing production stoppages and potentially huge revenue losses. Together with other information-related supply chain resilience measures, Paricipant Six cites the successful leveraging of these research resources as a significant factor contributing to the strong financial performance of the business in FY2020, despite the challenging operating environment created by COVID-19.

6.4.4. Theme 3: Financial Measures

Financial supply chain resilience measures were encountered relatively infrequently within the sample, occurring in just two businesses. However, the data suggests that these measures, though rare, did nevertheless substantially enhance the resilience of both businesses' supply chains, to the benefit of themselves and their suppliers, and that the consequences of failing to implement such measures could have been dire for both parties.

6.4.4.1. Category 1: Pre-payment

During the height of the pandemic, when PPE was in short supply, the private healthcare provider pre-paid for PPE, thereby providing a form of cashflow support to the small suppliers from whom it purchased. Advancing payment to these small businesses enabled them to fund the purchase of large volumes of PPE which they would not otherwise have been able to do due to insufficient working capital availability. As a result

of the financial support offered by the private healthcare provider, some of these small businesses were able to grow rapidly to become major players in the local PPE market.

Participant Eight explained that the supply chain resilience measure of pre-payment not only provided much-needed capital to small PPE suppliers to ensure their sustainability and facilitate their growth, but also ensured that the private hospital provider was able to secure in advance the large volumes of PPE required to protect frontline health workers in a market where any available supply was immediately snapped up. Without the implementation of the supply chain resilience measure of prepayment, the small businesses would have been unable to procure the volumes of PPE the private healthcare provider required, and would have lost significant sales from a large and important client. For its part, the private healthcare provider would have experienced much greater difficulty in sourcing critical PPE supplies, and may have run short, potentially leaving hospital staff unprotected against the risk of infection from COVID-19 while on duty. Hence, the supply chain resilience measure of pre-payment greatly enhanced the resilience, and hence transiliency, of the supply chain, benefiting both the private healthcare provider and its key supply chain partners.

6.4.4.2. Category 2: Improved Payment Terms

The diversified miner changed its payment terms to provide cashflow support to some of its suppliers, particularly small vendors from host communities (i.e. communities located nearby mining operations) which the miner has been developing over the last number of years. By bringing forward the payment of its accounts, the miner reduced pressure on the cashflows of these businesses, which because of their small size, were particularly vulnerable to the adverse economic impacts inflicted by the COVID-19 pandemic.

Participant Six opined that the financial supply chain resilience measure of improving payment terms to host community vendors likely averted the imminent collapse of these small but important suppliers, ensuring that the miner could continue to procure essential supplies required to sustain production at its mines, and enhancing the resilience, and hence transiliency, of the entire supply chain in the face of the severe macroeconomic shock triggered by COVID-19.

6.5. Conclusion / Summary

As predicted by Craighead & Ketchen (2020), supply chain resilience measures played an important role in enhancing the transiliency of the participants' businesses and their supply chains, complementing the business model innovations they also employed.

All businesses were found to have employed resilience measures, although some businesses placed greater emphasis on resilience than others. Businesses who did not perceive the pandemic as a true crisis (Foss, & Saebi, 2017), in that it did not pose an imminent existential threat to the business (Dutton, 1986), appear to have placed relatively greater reliance on resilience measures than business model innovations when it came to fostering transiliency.

The most frequently encountered supply chain resilience measures were stock-related measures, especially the increasing of stocks on hand to create inventory buffers for critical items, and multi-sourcing, to increase the odds of being able to find supply in a widely-disrupted business environment. Information-related and financial measures were much less common, but were used to great effect by a few business to enhance their supply chain resilience, and hence, supply chain transiliency.

Chapter 7: Conclusion

7.1. Principal Findings

7.1.1. Research Question 1

The research uncovered evidence confirming all four unique characteristics which distinguish epidemics form other types of supply chain disruptions, as stated in the literature review, namely that epidemics trigger disruptions that are i) severe in magnitude in terms of duration, geographic extant, and the number of supply chain partners that are affected, ii) spread through the supply chain in ways that are difficult to model, making it difficult to predict the duration and extent of the disruption in advance, iii) spread through the supply chain at the same time as the disease spreads through the population, and iv) lead to simultaneous changes in supply, changes in demand, and destabilisation of transportation services (Govindan, Mina, & Alavi, 2020; Ritter & Pedersen, 2020; Ivanov, 2020).

Although all four unique characteristics were alluded to by the participants, the first and fourth characteristics appear to have presented the greatest challenges to businesses grappling with the impacts of the epidemic, undermining most participants' business models, and consequently, spurring the majority of the business model innovations observed within the sample.

7.1.2. Research Question 2

7.1.2.1. Introduction

The results revealed that each of the twelve businesses surveyed had transformed at least one of the nine elements (Osterwalder, 2013) of their pre-COVID-19 business models as part of their response to the pandemic. However, the number of elements that had undergone transformation, and the degree to which business elements were transformed relative to before the pandemic varied widely.

When it came to necessity-driven innovation specifically, businesses whose management did not perceive the pandemic as a crisis, as they saw no immediate existential threat to the business appear to have made fewer and/or less significant transformations of their business model elements during the COVID-19 period than did businesses whose management teams believe the business may not have survived save for the business model innovations they implemented. These businesses were larger in size; possessed larger cash reserves at the start of the pandemic; were in industries or

economic sectors that were less severely impacted by COVID-19; were less specialised and more diversified in terms of products or services, number of customers, or industries to which they sell; experienced steady or even increased demand for their products or services during the pandemic period; had less difficulty obtaining the necessary supplies of key resources.

Conversely, businesses which did identify a serious threat to their survival, and hence perceived the pandemic as a crisis situation, made more changes and/or more significant changes to their business model elements, on average. These businesses were smaller in size; possessed limited cash reserves at the start of the pandemic; were in industries or economic sectors that were more severely impacted by COVID-19; were highly specialised and undiversified in terms of products or services, number of customers, or industries to which they sell; or experienced decreased demand for their products or services during the pandemic period; and had more difficulty obtaining or were unable to obtain the necessary supplies of key resources.

7.1.2.2. Research Question 2a

The data reveals numerous instances of business model transformations relating to the unit of business and business processes (McGrath, 2010). Although none of thee twelve businesses comprising the sample transformed every element of their business models, across the sample there is at least one instance of a transformation made to each of the nine business model elements (Osterwalder, 2013).

7.1.2.3. Research Question 2b

For the participating businesses themselves, the most frequently cited benefit of business model innovation during COVID-19 was that it helped businesses avoid or mitigate potentially severe consequences that they might otherwise have suffered as a result of the pandemic. Among other benefits, business model innovations enabled businesses to continue generating revenue; avoid retrenching staff or reducing their salaries; and ensure survival of the business.

7.1.2.4. Research Question 2c

For the participating businesses' supply chains, the most frequently cited benefit of business model innovation during COVID-19 was that it helped businesses avoid or mitigate potentially severe consequences that they might otherwise have suffered as a result of the pandemic. Among other benefits, business model innovations enabled supply chains partners to ensure the smooth(er) flow of materials throughout supply

chain, avoid stock-outs, mitigate transport disruptions, manage lead times, continue earning revenue, and in many instances, ensured their very survival, particularly in the case of smaller, vulnerable partners.

7.1.3. Research Question 3

The most frequently encountered supply chain resilience measures were inventory buffers and multi-sourcing. While popular among the participants, for many businesses, the ability to increase inventory levels to create a buffer against supply chain disruptions was severely constrained by the need to reduce working capital and preserve cash on hand to ensure they could fund the business through the pandemic. Having such a 'cash buffer' was often preferred, since it not possible to reliable forecasting cashflows during such an uncertain, crisis situation like COVID-19 . Multi-sourcing was not subject to the same trade-offs, as this measure does not directly impact on working capital requirements. However, multi-sourcing did, in some cases, lead to higher prices compared to strategic single-sourcing through an industry cost-leading supplier. Supply chain visibility initiatives focused on leveraging relationships with key supply chain partners, and involved close collaboration and constant communication, but does not appear to have affected procurement costs where it was employed.

Like business model innovations, supply chain resilience measures were shown to have a played an important role in helping businesses avoid or mitigate potentially severe consequences that COVID-19-related disruptions could have had for their businesses. By helping the businesses to anticipate emerging supply chain risks, secure an adequate, if sometimes erratic, flow of supply, and prevent inventory stock-outs, supply chain resilience measures enabled participants' businesses to continue generating revenue, retain all their staff (mostly on full pay), and in many cases, according to the participants themselves, helped make the difference between business survival and business failure.

For the supply chain

7.2. Implications for Management and Other Relevant Stakeholders

Whereas managers responsible for supply chain management may be more accustomed to using tried-and-tested supply chain resilience measures to counter the threat of disruptions within their supply chains, this research introduces the concept of supply chain transiliency as a more potent tool to respond to the unique

class of supply chain disruptions triggered by disease epidemic. Thus, this early exploratory research lays the groundwork for improved outcomes when managers respond to future disease epidemics.

7.3. Limitations of the Research

When conducting the interviews, it became apparent that while the business model of each participating business is differed from the business models of all the businesses in the sample in numerous respects, due to the careful selection of the heterogeneous purposive sample, there was some overlap between the industries or customer groups served by some of the businesses. Firstly, in the case of the three retailers and the restaurant group, all four businesses are B2C businesses, meaning that they sell directly to consumers, and more particularly, to consumers with enough disposable income to spend on luxuries such as books, high-end computers and electronics, sports and fitness equipment and apparel, and eating out. Thus, the heterogeneity of the sample may have been somewhat reduced, and not give as broad a reflection of South African businesses as first though, impacting generalisability when it comes to the population (Saunders, & Lewis, 2018).

Second, although they engage in different key activities (mining vs. manufacturing vs. distribution) and are located at different tiers of the supply chain, the locomotive control systems manufacturer, OHS sensors distributor, magnetic separation equipment distributor and diversified miner are all either directly involved in or else supply predominantly to the mining industry, or the closely related mineral processing industries. Once again, as a result of this fact, the sample may not in facet give as broad a reflection of South African businesses as first though, impacting generalisability when it comes to the population (Saunders, & Lewis, 2018).

Another limitation of this research arises from the fact that data on the supply chain impacts of the business model innovations and supply chain resilience measures implemented by the participating businesses was only gathered from representatives of the participating businesses themselves. Supply chain partners of the participating business were not surveyed, even though they would be better placed to provide valuable data on the benefits of the while the supply chain partners.

Though clearly not optimal, the sample was selected in this way for purely practical reasons. In the first instance, to interview both the twelve focus businesses and, say, one or two suppliers of each would have doubled or tripled the number of interviews to

be conducted, which was clearly impractical, given the short time available for MBA research. Conversely, maintaining a total sample size of twelve participants, while including one or two suppliers of each focus business was also considered unviable, as it would have resulted in a sample containing only six business-supplier dyads (pairs) or four business-supplier triads (groups of three), respectively. In this case, the unit of analysis would have effectively changed to business-supplier groups, not individual organisations, and the sample would have consisted of six or four units, instead of twelve. A sample size of six or four units could have been problematic from a validity perspective, as it is highly unlikely that saturation could have been achieved with such a small sample size (saturation typically occurs at between 12 and 30 interviews (Saunders, & Lewis, 2018)).

7.4. Suggestions for Future Research

This study constitutes early, exploratory research into a recently proposed and under-researched concept, and as such, aimed simply to provide initial insights into supply chain transiliency as a potential augmented approach for managers seeking to help their businesses and their supply chains better cope with the negative impacts of the unique class of supply chain disruptions that can be triggered by disease epidemics.

Hence, the research questions were purposefully formulated to be broad in scope, and did not address specific issues pertaining to supply chain transiliency. In answering the research questions, the study made a first attempt to investigate a) whether or not epidemic-related disruptions appear to be sufficiently dissimilar to disruptions triggered by other disruptive events that they may in fact warrant or necessitate a different approach to the conventional supply chain resilience concept, b) which business model elements have been commonly targeted for transformation, how they have been transformed, and how these transformations have benefited the businesses and enhanced the transiliency of their supply chains, and c) what the role of conventional supply chain resilience measures may be in complementing business model innovations in the attainment of supply chain transiliency.

Since the results of these early investigations appear to support the case for supply chain transiliency as a promising new approach for counteracting the impacts of disruptions during epidemics, and considering warnings from scientists about the heightened risk of future epidemics, there is a clear need for further research into the supply chain resilience concept. To this end, some specific research questions are proposed:

1. Have features of supply chain transiliency been observed in smaller past epidmeics, or does transiliency only hold significant value for businesses and their supply chains in the event of a large-scale, global epidemic?
2. What is the relative importance of the two pillars of supply chain transiliency, namely business model innovation and supply chain resilience, for reponding to epidemic-related supply chain disruptions?
3. Under what conditions should a business consider transforming an element(s) of its business model in response to epidemic-related supply chain disruptions, and under what conditions should it avoid doing so?
4. What are the long-term effects of transformations undertaken during epidemics on businesses and their supply chains?
5. Can supply chain transiliency developed during an epidemic assist businesses and their supply chains to cope better with other more common types of disruptive events in the future?
6. What role does the business environment during an epidemic play in encouraging business model innovations, and what role do the attitudes and mindsets of managers play?

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