

# The influence of global value chain governance on supply network resilience

## Abstract

**Purpose:** Diversity – or having a range of different options – is an important part of being resilient. Yet research has not considered how diversity in terms of the governance relationship types that exist within a supply base or across a supply network relates to resilience. By drawing on a well-established Global Value Chain (GVC) governance framework, this paper investigates how different relationship governance types influence resilience at the dyadic and supply network level.

**Design/Methodology/Approach:** This research draws on 27 embedded cases of buyer-supplier relationships within a network, studied through 20 interviews in 11 organizations across four tiers of the Australian Defence Force supply network, including the end customer perspective, during and after a large-scale supply chain disruption. Analysis is conducted at the individual dyad and aggregated network levels.

**Findings:** At the dyadic buyer-supplier level, a variety of different resilience strategies and practices are used across the relationship governance types. Consequently, at the network level, relationships characterized by market and relational governance created more vulnerabilities during COVID-19 than hierarchical and modular governance relationships.

**Originality/value:** The GVC framework is extended to the supply chain domain, providing a deeper understanding of how GVC governance types in supply chain relationships relate to resilience strategies at the dyadic and network levels. Given that different governance relationships draw on different resilience strategies, diversity in governance relationships helps enhance overall resilience. Meanwhile, the findings show that resilience requires relational aspects to be considered alongside economic aspects of the GVC.

**Keywords:** Supply Network Resilience, Global Value Chain, Governance, Buyer-Supplier Relationships

## 1. Introduction

Global disruptions triggered by the COVID-19 pandemic, the escalation of conflict in Eastern Europe and the Middle East, and the China-US trade war have all had significant implications for well-established Global Value Chains (GVCs). As a consequence, many firms have realized the importance of diversification (i.e., the process of starting to include more different types or things) (Cambridge Dictionary), such as by adding geographically dispersed suppliers and manufacturing sites, and/or by introducing an expanded product portfolio (Cohen *et al.*, 2022; van Hoek, 2020), to spread risk and build greater supply network resilience (SNRes). Yet, an often-overlooked consideration when determining how to diversify is governance, i.e., considering how the range of institutional governance types across the supply network can be used to enhance its resilience. In this paper, we employ the highly influential GVC institutional framework (Gereffi *et al.*, 2005; Ashenbaum, 2018), often used to study the internal production networks of multi-national organizations (e.g., de Marchi *et al.*, 2014; Kano, 2018), to investigate how different relationship governance types influence resilience at the dyad and network levels of analysis.

The GVC framework and its central concept of governance are increasingly advocated as a powerful tool for supply chain (SC) management (Golini *et al.*, 2016; Gereffi *et al.*, 2022). Aitken and Harrison (2013) showed that the governance type employed influences how a reverse logistics system develops; and Choksy *et al.* (2022) found that the governance type affects whether suppliers rely on internally or externally-oriented resilience strategies. Yet, further research is needed that looks beyond the focal firm and into its upstream network. Supply disruptions often do not originate at a focal firm's facilities; rather they can originate at tier-one, tier-two, or even further upstream (e.g., Choi and Kim 2015). These upstream disruptions are often the result of lateral effects in the extended supply network. For example, the supply to Buyer X may be disrupted because it shares a common supplier with Buyer Y who is prioritized by the supplier in the event of a disruption to production capacity. Similarly, supply to Buyer X may be disrupted because its tier-one supplier is being held to ransom by a larger, more powerful tier-two supplier that is manipulating the market. Without visibility or an understanding of the extended supply network, focal firms run the risk of not being adequately prepared for a potential crisis.

At the same time, prior research on the GVC framework has been criticized for maintaining a focus on the strategic role of lead firms in shaping the governance of GVCs (Humphrey, 2020; Gereffi & Fernandez-Stark, 2016) and, consequently, for failing to consider how suppliers and other upstream network actors shape governance forms (Choksy *et al.*, 2022).

This literature largely frames direct suppliers as passive actors under the governance of a particular lead firm and it does not account for other upstream members of an extended network. This underrepresents the influence of suppliers and their capabilities (Humphrey, 2020) and overlooks the bigger picture beyond the focal firm, leaving it vulnerable to disruption (Gereffi et al., 2022). Accordingly, some scholars have highlighted the importance of future research that investigates how resilience relates to the range of governance forms evident across a network (Sako & Zylberberg, 2019; Choksy et al., 2022). Meanwhile, it has been advocated that a GVC perspective could help to understand how and where vulnerabilities develop in a supply network (Azadegan and Dooley, 2021; Ivanov and Dolgui, 2020), thereby elevating the analysis from a dyadic focus to the SC or network level (Gereffi and Lee, 2012; Pilbeam et al., 2012). Yet, the growing body of SC research is still predominantly focused on examining how the resilience of individual firms and dyads affects resilience (e.g., Kim et al., 2015; Azadegan & Dooley, 2021; Statsenko et al., 2023). Further research is therefore needed to understand how governance in upstream relationships and across a network affects resilience, informed by the GVC framework and insights from resilience research in the SC domain. Therefore, we ask:

*How does governance in buyer-supplier relationships influence the use of resilience strategies at the dyadic level and across the supply network?*

By extending the GVC framework and its macro-economic governance perspective to the SC management domain, we expand our understanding of what needs to be considered when building SNRes. To date, the link between governance and resilience has, to the best of our knowledge, only been studied at the micro level, where research investigates how relational or contractual governance aids in building resilience (e.g., Lee *et al.*, 2023; Wu *et al.*, 2023). Yet, the use and availability of different governance mechanisms depends on the governance type, which is derived from economic transactional factors captured in the GVC perspective (Ashenbaum, 2018).

This paper makes three important contributions by studying 27 buyer-supplier relationships in the Australian Defence Force supply network during and after COVID-19. First, we show how, at a dyadic level, resilience is built via internally-oriented buffering and externally-oriented bridging resilience strategies (Bode *et al.*, 2011) in different relationship governance types. We identify specific resilience practices and circumstances per governance type. The differences in resilience strategies per governance type at the dyadic level necessitate diversity in governance types within a supply base and across the supply network for an organization to

draw on a large variety of resilience strategies. This leads to our second contribution – identifying the need for diversification in buyer-supplier relationship governance types. As some governance types are inevitably more vulnerable than others depending on the context and situation, governance types need to be sought out and balanced when designing a supply base, SC, or supply network. This complements extant research, which has highlighted that resilience can be enhanced through diversifying the geographical spread of suppliers or production facilities (van Hoek, 2020), the portfolio of products (Urciuoli *et al.*, 2014), the modes of distribution (Pettit *et al.*, 2013), and the skillsets of employees (Poberschnigg *et al.*, 2020).

Our third contribution is in finding that economic variables alone will not allow for diversity. While the economic aspects captured in the GVC cannot be changed easily, and hence organizations only have a limited influence on the governance type with suppliers, they need to be aware of it and combine the governance type with different relational attributes. For example, a market governance relationship can be combined with a cooperative attitude to form a gracious relationship (see Kim and Choi, 2015), or, if this is not possible, firms need to plan their internal bridging resilience strategies accordingly. These insights, in turn, have important implications for practitioners concerned with building resilience across their networks.

## **2. Literature Review**

### **2.1 The Global Value Chain Framework**

Global value chains bring together internationally fragmented economic activities during the process of value creation (de March *et al.*, 2014). One of the most recognized institutional frameworks for studying GVCs was presented by Gereffi *et al.* (2005). The authors' framework allows for an "outside-in" or network-to-firm perspective on the role of organizations and the structure of their global operations (McWilliam *et al.*, 2020) by identifying specific economic transactional characteristics that prompt an organization to adopt a certain type of relationship governance, both upstream and downstream (Choksy *et al.*, 2022). While the framework helps to determine the nature of dyadic governance relationships, these can be aggregated to offer "a powerful perspective on the organization of economic activities beyond the single firm, looking at how the strategies and interaction of key actors – including lead firms, suppliers, buyers, platform leaders, and other non-firm actors – shape supply chains" (de Marchi *et al.*, 2020, p.1). Hence, the GVC framework, originally developed from an economic perspective at the macro-economic level to conceptualize the chain of value-adding activities from raw materials

to end-users in inter-firm networks, has since been shown to be a useful framework for understanding relational dynamics in supply networks (Golini et al., 2016; Mola et al., 2017).

While the terms “GVC” and “supply network” are often used interchangeably (Ali *et al.*, 2022), the former provides a higher-level industry view of input-output processes, while the latter usually refers to how flows of goods and information are managed at the company level and with suppliers and customers (Golini et al., 2016). As such, the GVC literature avoids the limitations of the linear approaches often adopted in the SC literature (Gereffi and Lee, 2012; Kano *et al.*, 2020), which leads to better capability utilization in a relationship with varying degrees of mutual benefit (Gibbon and Ponte, 2008). Following Harland et al. (2001), we define a supply network as a set of interconnected buyer and supplier organizations operating within the same market, institutional, economic, and social environment. This is opposed to a supply chain, which consists of two or more organizations that are connected in a *linear fashion*.

## **2.2 Global Value Chain Governance**

The core tenet of the GVC framework is relationship governance. Governance describes an organizational construct or, in broader terms, an institutional framework that is supported by governance mechanisms (e.g., contracts, standards, or social norms) that specify the operating practices and required behaviour in buyer-supplier relationships in order to minimize exposure to opportunism (Hoetker and Mellewigt, 2009; Pilbeam *et al.*, 2012). In the SC literature, the main focus has been on contractual or relational mechanisms for governing relationships (see, e.g., Wu *et al.*, 2023; Cao and Lumineau, 2015) rather than on an institutional perspective.

In a GVC, the specific governance type, and hence power asymmetry and explicit coordination, is determined by: (1) the complexity of inter-firm transactions (e.g., detailed product specifications, special requirements, etc.), (2) the ability to standardize or codify these transactions, and (3) the capabilities in the supply base relative to the buyer (Ashenbaum, 2018; Gereffi et al., 2005; Golini et al., 2016) (see Table I). Accordingly, governance ranges from relatively simple, contractually-oriented *market governance* arrangements focused on price, particularly where there are many readily available suppliers due to little input requirements from buyers (i.e., specifications and information) (Mola et al., 2017), through to *hierarchical governance* arrangements, particularly in fully vertically integrated chains driven by high transaction complexity coupled with low codifiability and low supply base capabilities (Ashenbaum, 2018; Gereffi and Lee, 2012).

*Relational governance* is a hybrid structure that is positioned between these two extreme forms of governance (Aitken and Harrison, 2013). Complex information and knowledge-

intensive transactions that cannot be easily codified, for example in the form of engineering specifications, require a relational governance structure based on frequent interactions, knowledge sharing, trust, and mutual interdependence (Mola et al., 2017). Additionally, there are *modular* and *captive governance* relationships (Ashenbaum, 2018). In modular governance arrangements, highly capable suppliers operate in standardized environments where they can codify and manage complex transactional information (Aitken and Harrison, 2013). This allows for flexible buyer-supplier relationship structures that can be easily connected and disconnected because specifications are complex but relatively easy to codify (Mola et al., 2017). In contrast, buyer-supplier relationships are rigid in captive governance arrangements. Here, a powerful lead firm will coordinate and control suppliers with low capabilities to codify or manage the complex and often specific information requirements of the buyer (Gereffi and Lee, 2012). Consequently, suppliers are locked into the relationship and the buyer's competitors are prevented from gaining access to the resources that the buyer has invested in the vendor (Aitken and Harrison, 2013). Beyond these five governance relationship types, three others have been outlined in the literature including the developmental configuration type based on low transaction complexity (simple arrangements), high codifiability, and low supplier capabilities (Ashenbaum, 2018). According to Gereffi et al. (2005), developmental governance relationships are quite common but would be excluded from the supply base and/or value chain due to low supplier capabilities. The other two governance types are unlikely to be found in the real world due to the combination of low complexity of transactions with a low codifiability (Ashenbaum, 2018; Gereffi et al., 2005).

[Take in Table I]

### **2.3 Resilience**

Resilience in operations and SC management research context is generally defined as the adaptive capability (of an organization, SC, or network) to prepare for, respond to, and recover from disruptions in the most effective and efficient way (Ponomarov and Holcomb, 2009; Tukamuhabwa *et al.*, 2015) aiming to persist, adapt or transform operations (Wieland *et al.*, 2023). As such, resilience can provide an organization with a competitive advantage if it is *less vulnerable* to and better able to deal with disruptions than its competitors and their SC and network (Jüttner and Maklan, 2011; Kochan and Nowicki, 2018).

Less vulnerability and, hence, more resilience has been associated with flexibility, redundancy, agility, and collaboration capabilities (Speier *et al.*, 2011; Tukamuhabwa *et al.*, 2015). It is generally accepted that the more an organization, supply chain, or network focuses

on these strategies the more resilient it is (Dittfeld *et al.*, 2022; Scholten *et al.*, 2020). This becomes evident in internally-focused buffering and externally-focused bridging strategies in the design of the supply network (Bode *et al.*, 2011; Holgado and Niess, 2023). Buffering strategies act as safeguards and aim to minimize the impact of a disturbance for an organization (Zsidisin & Ellram, 2003; Kalaitzi *et al.*, 2019) through, e.g., implementing flexible processes (e.g., for transportation or in-house manufacturing) and maintaining redundant inventories or suppliers. As such, an organization is independent of the governance relationship type within its network and able to deal with disruptions (Manhart *et al.*, 2020). Meanwhile, bridging strategies aim to manage uncertainty by engaging in collaborative and boundary-spanning activities via alliances with partners, joint initiatives, and other forms of inter-organizational networks (Bode *et al.*, 2011; Mishra *et al.*, 2016).

It has been argued that there might be trade-offs and interdependencies between resilience strategies (Dube *et al.*, 2022), while their composition or emphasis might change depending on the context (e.g., Dittfeld *et al.*, 2022; Enz *et al.*, 2024). At the same time, SC theory inherently assumes that organizations decide how to build resilience, i.e., every organization can choose whether to deploy bridging and/or buffering strategies (e.g., Tukamuhabwa *et al.*, 2015). Yet, often at the dyadic level, the buyer-supplier relationship governance type determines the economic nature of relationships between two organizations and, hence, sets constraints on the bridging and/or buffering strategies available during a crisis (Choksy *et al.*, 2022). Furthermore, the extent to which an organization can employ resilience strategies through buffering and bridging might be determined by the properties of their supply network (Kim *et al.*, 2015; Wiedmer *et al.*, 2021). For example, structural properties provide the context in which firm-level strategies and state-level policies concerning global supply chains play out (Gereffi *et al.*, 2022). Therefore, depending on the GVC (i.e., the supply network), not every company may be able to implement the wanted or needed bridging or buffering strategies.

In line with the aims of this research, we focus on both the adaptive capability of resilience in dyadic relationships and the adaptive capability of resilience at the network level. In this study we draw on the GVC framework as a theoretical lens that provides insights into governance relationships (Gereffi *et al.*, 2005). While the GVC framework is often used from a 'lead firm' perspective, in reality organizations, have to look beyond their first-tier relationships into the upstream supply network to manage resilience. Therefore, lead firms get involved in the (governance) relationships of their second and third tier suppliers. The supply network view of resilience can be facilitated by the GVC perspective, as demonstrated by recent studies that link the two together (Gereffi *et al.*, 2022; Choksy *et al.*, 2022). While

previous studies provide insights into the dyadic level of resilience (e.g., Scholten and Schilder, 2015) or into linear relationships in a SC (e.g., de Sa et al., 2020), empirical insights into supply network resilience are still sparse (Choi and Kim, 2015; Statsenko *et al.*, 2018). Such as employing a network view of resilience, as opposed to a linear SC perspective, can help to understand and capture the complex dynamics and structures of buyer-supplier relationships within a confined network and the *aggregated* effect in terms of resilience at the network level (e.g., Choi *et al.*, 2001).

### **3. Methodology**

#### **3.1. Study Design and Case Selection**

Buyer-supplier relationships and their governance types are complex and require both consideration and an understanding of the context in which they operate (Scholten and Schilder, 2015). Therefore, we employed a multiple embedded case study design to investigate this complex phenomenon in its natural setting (Yin, 2009). More specifically, we studied multiple buyer-supplier relationships to derive conclusions at the dyadic level and then used these as embedded cases of a single network to derive conclusions at the network level. We focused on one network as we were granted access to several tiers across the network. This is still relatively unique in an operations and SC setting, where the literature has often struggled to extend empirical insights beyond the organizational or dyadic level of analysis (Scholten et al., 2020), with some exceptions at the SC (e.g., de Sa et al., 2020) and network level (Statsenko et al., 2018). As such, we present a revelatory case (i.e., access to a situation previously inaccessible to empirical study; Yin, 2018, p.50), which, according to Yin (2018), justifies a single case design because descriptive information alone will be revelatory. Hence, we study a single network.

The network and embedded dyadic relationships we study relate to the Australian Defence Force (ADF) supply network. The network consists of specialist companies that manufacture components and possess capabilities for defence acquisition and sustainment projects. In this research, we drew the supply network boundaries by considering the Australian Government as the focal buyer and the set of companies procuring systems, equipment, and materials for major programs and projects. In this view, tier 1 and 2 suppliers perform engineering design and procurement for large-scale complex programs and projects for the Australian Government and are located both in Australia and overseas. These multinational companies have geographically diversified global SCs, including Australian and international suppliers. Tier 3 international and Australian suppliers are small and medium-sized enterprises that



manufacture, assemble, overhaul and service the equipment, sub-systems and components supplying to Tier 1 and Tier 2 companies, but not exclusively. Tier 3 suppliers source materials, components, and parts from Tier 4 suppliers, located both overseas and in Australia, and include a variety of companies, from small, local to large multinational original equipment manufacturers. As such, the embedded cases we study represented more than the ADF network *per se* as these suppliers also supply to other industries.

In identifying (embedded) relationship cases suitable for our study, we started with a Tier 1 buyer (A) leading major projects and programs at the time of the research in consultation with lead defence organization experts. From there on, we employed snowballing and purposeful selection to find companies with buyer-supplier relationships that would enable literal replication, i.e., similar governance types, and theoretical replication, i.e., different governance types. We drew on Ashenbaum (2018) to operationalize the underlying dimensions of the GVC framework (i.e., the complexity of inter-firm transactions, the ability to standardize or codify these transactions, the capabilities in the supply base relative to the buyer; see also Tables I) and to classify the relationships as a certain governance type (see Table II). We derived Table II based on the insights from the buyers on their suppliers.

[Take in Table II]

It emerged that the technological and knowledge-intensive nature of the defence sector is un conducive to captive governance. Hence, we were not able to include buyer-supplier relationships with captive governance, but rather investigated five market governance cases, four hierarchical, twelve modular, and six relational ones. These governance relationships were derived by engaging with ten buying organizations directly, comprising three second-tier and six third-tier buyers of which one also serves as a fourth-tier buyer adding up to a total of 27 buyer-supplier relationships in the ADF network from the buying company perspective. Organizations that we engaged with directly are referred to as A to J while organizations that were included indirectly as a supplier to a buyer are indicated by an asterisk. We drew the boundaries of the network we study in line with previous network level qualitative studies that “focused on key actors within each supply network .... These included first-, second-, and third-tier suppliers” (Harland *et al.*, 2001, p. 23). Figure 1 provides a depiction of the network studied; an overview of the cases and the governance types is also provided in Table III.

[Take in Table III and Figure 1]

### **3.2 Data Collection**

Firstly, we conducted 17 semi-structured interviews across the ten organizations (A to J). In each organization, we sought interviewees in strategic positions who could tell us about a specific relationship and inherent governance type and how SC disruptions were dealt with and affected the relationship. As such, participants were primarily SC, procurement, and operations managers, executives, and industry association representatives involved in strategic procurement and SC design decision-making. To gain insights from different perspectives, and for reasons of triangulation, we engaged with several employees within one company wherever possible. An interview guide was developed that drew on existing literature (Mishra *et al.*, 2022) and can be found in the Appendix A.

Additionally, we sought the network's end customer perspective to triangulate the findings. We interviewed three representatives of the ADF to gain insights into how they experienced the impact of a global disruption on the network. An overview of the interviewees is included in Table III. Data were collected between September 2020 and December 2021, including face-to-face, by telephone, and via video conferencing software. Interviews lasted between 60 and 90 minutes and were recorded, transcribed, and verified with the interviewees.

### **3.3 Data Analysis: Dyadic and Network Level**

Analysis began with reducing the interview data to excerpts relevant to the research question. The reduced data were then deductively coded into buffering and bridging strategies used in particular cases and more specific practices associated with each strategy (Manhart *et al.*, 2020). We juxtaposed the resilience strategies and practices with the governance types to derive insights into each governance type's resilience strategies and practices. We listed those strategies that were mentioned by respondents to help them deal with disruptions and, as such, made them less vulnerable and more resilient. This is depicted in Table IV.

Moving from a dyadic to a network level of analysis, we took the perspective of the final customer, the Australian Government that experiences the results of the interconnected dyads of supplier-buyer relationships across the network (see also Harland et al 2001, Choi & Hong 2002). We traced which dyadic relationships in the network were affected by disruption and what governance types and/or other reasons could be linked to this. Therefore, we mapped out connections between the end consumer and the relationship experiencing a disruption and used a *relative* comparison between these chains in the network to gauge vulnerability and hence the resilience of different parts of the network. As such, we could derive that market and relational governance relationships lead to more severe disruptions in the network than hierarchical and modular relationships. We continued to look for reasons behind this, as one

might have expected this result to be derived from market governance relationships but not from relational governance relationships. We subsequently found that economic indicators, i.e., the three underlying dimensions of the GVC framework, that are valid in business-as-usual times can change during crises where the capabilities of suppliers went from high to low. Furthermore, we saw that modular relationships were able to buffer against some of the impacts caused by market and relational relationships in the network that were also disrupted; they had more and other resilience options available. As such, we concluded that diversity of resilience options (possible by having diverse governance types) is important as situations are fluid. Therefore, to enable diversity in resilience options, we concluded that it is important to have diversity in governance relationships within a supply base or across the network.

In all of the methodological procedures we followed, well-accepted quality criteria for case study research were adopted (see Reuter et al., 2010, p. 49), as outlined throughout the manuscript and more specifically here in the methodology with the aim of making our choices and procedures transparent. Throughout the data analysis, the researchers discussed the evolving findings to ensure consistency in how the results were being interpreted and understood.

#### **4. Findings**

Australia is an island continent and relatively small in terms of market size, therefore *all* supply chain relationships experienced effects of border closures. However, we found that the consequences were different for dyads with different GVC governance types. The supply of critical components and materials, sourced locally, was disrupted due to forced factory shut-downs, interstate border closures, and the shift in focus from core business to manufacturing nation-critical goods, such as consumable healthcare products. There were also international border closures that disrupted material and component supplies. For example, standard commercial items and material inputs were often sourced from Australian distributors procuring products predominantly manufactured in Asian countries, such as China, India, Taiwan, and Malaysia (e.g., suppliers in relationships A\*\*, E\*, E\*\*, F\*, F\*\*, H\*). At the same time, some tier 3 and 4 suppliers experienced an increase in demand that could not be met via existing suppliers (e.g., suppliers in relationships E\*, E\*\*, F\*, F\*\*, H\*). Specialized defence supplies also became a challenge for tier 1 -3 suppliers since most critical equipment, sub-systems and components are sourced overseas from the United States and Europe (e.g., suppliers in relationships AB, AC, BC, BI, G\*). However, in these cases although the customers experienced increased lead-times, they were perceived not as a disruption *per se* but

rather as a schedule delay thereby providing evidence of effective preparation. Similarly, lead firms A, B, and C multinationals with globally diversified vertically integrated value chains reported exercising a high degree of control over their overseas suppliers (A\*, B\*\*, and C\*).

Our findings highlight that modular and hierarchical governance relationships were relatively resilient to the effects of COVID-19 when compared to market and relational governance relationships. By aggregating the findings from the various dyadic relationships across the different tiers to create a holistic picture at the network level, the data suggests that the resilience of a network is only as strong as its weakest link, i.e., market and relational governance relationships. We will begin by outlining the findings related to the influence of the individual governance types on SNRes (Table IV). This is followed by findings on the interactions between different governance types across the overall network and the effect on SNRes.

[Take in Table IV]

#### **4.1 Findings: SNRes by Governance Type**

##### *4.1.1 Market Governance Relationships and SNRes*

We found market governance arrangements across all tiers of the supply network related to standard equipment, materials, and components, including personal protective equipment, cables, and plastic extrusions (A\*\*, D\*, E\*\*, F\*\*, J\*). Often orchestrated by powerful global distributors, these relationships were the most vulnerable, and hence the least resilient to global COVID-19 disruptions. This is because these global distributors prioritized larger customers/markets over smaller Australian orders. As such, the suppliers' delivery capabilities went from high to low, creating a governance different from business-as-usual. More specifically, we found that supply was not as readily available during the disruption due to greater demand than supply globally, exacerbated by border closures, limited transportation routes, and increased lead times. The Commercial Director of J explained that "*now there's been massive price increases [due to a shortage of supply]. Early in April, a lot of our major suppliers advised that there would be a 10% price increase coming in on the first of May*" (Case J\*). Cases D\* and E\*\* also experienced a tenfold price rise and up to 20 times increase in delivery rates. Given this market situation combined with limited visibility beyond first-tier suppliers, buyers had to look internally for solutions to deal with the disruption.

We identified four leading buffering practices in the data that organizations engaged in. Firstly, as all cases faced shortages of critical and high-consumption components, they

attempted to increase their inventories. This included the supply of electronic and electrical equipment, such as components for printed circuit boards, relays, actuators, and switchboard frames (E\*\*, D\*), and of raw materials, including aluminum, steel, and titanium (E\*\*, F\*\*). The Account Manager of D tried to be as proactive as possible in this situation by "[extending] *orders on those companies* [components for printed circuit boards made in China] *to give them as much visibility as we could. So back in, end of January, we'd ordered everything we needed to July*" (Case D\*). That, however, led to over-ordering as the demand ultimately required turned out to be much lower. Yet, given the market governance situation, order commitments had been made and could not be adjusted later. However, low-consumption purchases were also affected. The General Manager of E explained that: "*We don't keep a lot of material in stock, just because each program for us has different material requirements, and we may go years without having to use that type and size material. But what we did, we increased our inventory [...]* Normally, we can get deliveries every two to three days and overnight, but now we're sort of experiencing about once a week. It takes a little bit longer, so we've had to increase our inventory" (Case E\*\*).

Secondly, linked to the low complexity and high codifiability of transactions, buyers could look for other sources of supply, either onshore or overseas. This was a common practice that the buyers of Cases A\*\*, D\*, E\*\* and F\*\* engaged in. Thirdly, linked to the steep price increases, case F\*\* started to include safeguards in their tendering procedures and contracts. The General Manager of F stated that "*for anything that was tendering basically through April and beyond, we have to ensure that we include any price escalation*" (Case F\*\*).

Finally, we found no examples of bridging practices in market governance relationships as this did not seem to be possible under COVID-19 due to limited opportunities to collaborate given the transactional nature of the relationship.

#### *4.1.2 Modular Governance Relationships and SNRes*

For modular governance relationships (AF, BD, BE, BF, BG, BJ, B\*, CH, DE, E\*, F\*, H\*, I\*\*), we found that a highly standardized environment, due to the high codifiability of transactions coupled with the availability of capable suppliers, created a setting in which it was possible to switch production capacities in response to shifting market demands with reasonable switching costs. Relationships with a modular governance arrangement thus appeared to be the most resilient, able to apply a variety of buffering practices and some operational bridging practices. Additionally, buyers in modular governance relationships benefited from the buffering strategies of their capable upstream suppliers.

More specifically, in terms of buffering we found that the complexity of transactions was offset by high standardization when alternative suppliers were readily available (AF, BD, BE, B\*, BG, BJ, CH, F\*). Cases AF, BF, B\*, CH, and H\* engaged in both proactive and reactive supply chain mapping. The Head of SC for A stated: "*...we were actively engaging with our suppliers both here and overseas to understand the impact that factory closures in China and other countries were having on their upstream supply chains. So, that very quickly gave us a picture of the likely impact on our programs*" (Case AF). Beyond an improved understanding, organizations also used supply chain mapping to re-design their supply network and make it less vulnerable to the global effects of COVID-19. For example, the CEO of H explained: "*We end up with [...] set of diagrams and the value stream specific to products through a mapping process we get where components are coming from. So the components from Japan, Taiwan, on the value stream these components might be – part of that might be manufacturing in China as well... And then we start mapping the alternatives...My agenda was bringing manufacturing 100% to Australia*" (Case H\*).

Furthermore, cases AF, BF, BG, DE, I\*\*, and H\* had sufficient stocks so "*we haven't had any [disruption] impact, mainly because from a sustainable point of view we have lots of stores [with stock]; we do a lot of remanufacturing here in Australia*" (Head of Procurement, Case I\*\*). Similarly, the Executive Manager of A (Case AF) stated that they keep stock in order to be ready for disruptions, such as those caused by COVID-19. Finally, we found that buyers in modular governance relationships also felt the effects of the buffering practices of their very capable suppliers. There was increased flexibility for buyers due to suppliers investing and upgrading their manufacturing process flexibility to quickly react to demand changes (AF, BF, F\*, H\*, I\*\*). Additionally, suppliers diversified product lines (BD, BE) or found alternative product niches (AF, BD, BE, CH), which in turn helped with avoiding bankruptcy and meant buyers maintained access to a large supply base. In the most striking example, Firm B was able to vertically integrate along the supply chain due to Firm D taking on more tasks, thereby reducing vulnerability: "*...we could do everything: plastic inject – plastic 3D printing. Relatively small parts. So, having in-house capabilities, we could quickly design and manufacture the tooling*" (General Manager Firm D, Case BD). At the same time, however, such supplier strategies also had negative consequences. For example, circuit board manufacturer E experienced disruption to the supply of the glue it used in assembly because overseas suppliers diverted their capacities to produce medication. The General Manager of E stated: "*They make the residue that goes over a tablet to make a tablet swallowable. I never thought that my glue could be affected by something like that.*" (Case E\*).

Bridging strategies were also used to counter the effects of COVID-19; however, our data pointed to a focus on operational informal practices linked to information and resource sharing (AF, DE, F\*, I\*\*) and to finding more effective arrangements for working together (AF, CH). Risk and cost sharing were mainly initiated by suppliers as they passed on additional costs to buyers and added clauses to contracts that protected them from penalties. The Head of SC at Firm A explained: *"maybe fly them [products] in 2 weeks beforehand and get them to quarantine. So that all comes at a cost to the company and also the customer as well. [...] any commercial arrangements we're getting into with our customers, we're making sure that we can include pandemic and force majeure clauses just to protect against the risk of time escalating"* (Case AF).

#### *4.1.3 Relational Governance Relationships and SNRes*

Relational governance arrangements developed based on the need for long-term and trust-based relationships, such as due to the low codifiability of transactions and high complexity of product requirements. Many cases had single sources of supply (AB, AC, AI, BC, BI, G\*). Buyers suffered from disruptions due to international and interstate border closures while being in a 'locked-in' position due to high dependency on partners' expertise, intellectual property, technology, and trained production staff. The capability of suppliers to deliver went from high to low.

In terms of buffering, we found that Firm G reviewed logistics channels and used inventory redundancy where *"we now make sure we place orders as early as possible and have a plan to create stock for the next half a year"* (Business Development Manager, G\*). Additionally, capacity and volume flexibility helped with responding to the effects of COVID-19 in cases AB, AC, and AI. The Executive Manager of Firm A stated: *"We created buffers in our production schedules to make up for increased lead times, ...but also ensure that workforce is available to commence work straight after the equipment arrives"* (Case AI). However, organizations could not easily switch suppliers, as was possible in modular governance arrangements, because of the complexity of transactions, which required a significant amount of tacit knowledge transfer, trust, and reputation-based links. The Head of Strategic Sourcing of B explained that *"...We have a history of working with them [supplier]... we work very closely together. So, from a relationship point of view, they can provide us with extra horsepower to the Australian projects, extra engineering capacity and capability... We would not lose a strategic partner just because there is a temporary challenge."* (Case BI).

Instead of switching the source of supply, relational governance cases heavily relied on bridging strategies in order to be resilient. For example, Firm G invested in strengthening existing relationships with their suppliers: *“We now think about ...which suppliers are the most critical for us and building strategic relationships”* (Business Development Manager, Case G\*). Lead companies A, B, and C focused on expanding the network of strategic alliances by ‘onshoring’ and ‘friendshoring’. The Executive Manager of A stated: *“We find a great willingness now...for [international] companies to look for a trusted partner or an Australian partner”* (Case AC). However, the Procurement Director of Land Programs for Firm C did explain that the firm is exploring alternative designs that would make switching and local supply easier: *“the level of dependency is too high, so we will initiate...an engineering design effort to look at alternatives. So that...we would come up with a design that could be produced by multiple suppliers, including suppliers in Australia”* (Case AC).

Strong collaborative links encouraged buyers and suppliers to share critical information that increased visibility and situational awareness while working together to expedite orders and reduce lead times by finding alternative delivery channels. The Procurement Director of B explained: *“We focused on ensuring that each of us had the most up-to-date information about potential upstream bottlenecks...”* (Case BC). Furthermore, resource sharing was common (Cases BI and G\*) during the pandemic, such as by swapping teams and people to maintain supply chain operations.

#### *4.1.4 Hierarchical Governance Relationships and SNRes*

We found hierarchical governance in the relationships of lead companies A, B, and C with their globally-diversified supply chains, but also in tiers two and three, such as in I\*. Hierarchical governance relationships are tightly knit and well-integrated. Due to the sensitive nature of defence-related information, these relationships often have low codifiable transactions and high investments in supplier capabilities from the buyer. As such, resilience mostly depended on the resources the buyer was prepared to invest to maintain a relationship. Accordingly, we found a great reliance on bridging strategies to deal with the effects of COVID-19; however, some buffering strategies were also used.

The buffering practices included increased inventory stocks and changes to locations, such as by using alternative warehouses in close proximity to head offices, rather than getting goods delivered to an interstate facility (Case A\*). The SC Manager of Firm B explained how the company makes the most of distribution centres to avoid being affected by state closures in Australia; *“we would like a bigger facility, we’ve also got an overflow warehouse down the*



road from where we are. And we also have a satellite branch that focusses on one particular product range, based out at [...]. Look we'd very much like to be all under one roof, from a logistical standpoint, service our whole product portfolio" (Case B\*\*). Internally, companies adopted advanced supplier solvency forecast strategies. For example, the Head of SC for Firm A stated: "we needed to assess the impact of COVID-19 on the solvency of our supply chain, and we couldn't do that through our – we couldn't do that effectively through our traditional data sources. We've added an additional layer of governance on supplier solvency, we use a tool that's provided by a company called [...]" (Case A\*).

Cases A\* and B\*\* also created time buffers in their production schedules if suppliers could not deliver on time. The Procurement Director of Firm B explained: "So, the way we manage our material flow is we allow a buffer between when the material is delivered and when it is required for the production and the maintenance activity... That buffer provided us with a level of protection" (Case B\*\*). In some cases, switching suppliers was the best option (Cases C\* and I\*): "If they cannot supply, there is always a second piece of equipment that you can go to; there is always a runner up. They are more than willing to supply it to you", often with cost implications as "in two months we were buying a one-cent item, for a dollar because we needed them" (Case C\*, Procurement Director).

Additionally, and similar to modular governance, we found indirect buffering practices that the suppliers employed to aid the resilience of the buying company. Here, however, buyers A, B, C, and I used bridging to enable buffering. More specifically, the lead companies assisted their suppliers in mapping out their SC with the aim of identifying bottlenecks and finding alternative sourcing and logistics options. The Head of SC for Firm A explained: "we have been working pretty closely along with our suppliers through this ... we see how they are going... obviously their supply chains impact on our ability to deliver for our customers. We haven't had any issue... with any of our supply chains, not being able to supply as a result of that" (Case A\*). The Procurement Director of Firm C added: "We worked with suppliers to expedite the order, the materials" (Case C\*), which could be as straightforward as switching transportation modes from ocean to air. Personal relationships and social capital were also critical, as explained by the Procurement Director of Firm B: "We have got very strong relationships with our supply chain. We were able to leverage the person relationships to get the key components shipped faster using air freight" (Case B\*\*).

## **4.2 Findings: Supply Network Level Resilience**

Despite the global implications of COVID-19 and some small-scale disruptions described above across dyadic relationships predominantly intermediary manufacturing goods, the overall effect on the supply network of the Australian Defence Force were quite limited.

While sectors, such as the hospitality, had suffered significant blows, the Defence industry was considered to be in a fortunate position. The government representative commented: *“One of the things that the pandemic really raised awareness of is that there are some critical areas that we don't necessarily control in their entirety.”*(Program Manager Joint Capabilities, ADF). The ADF was able to continue with ongoing projects, however with delays, rather than disruptions due to incapacity of the upstream supply network to deliver. *“We had some capability release milestone delays... we still delivered what was expected in the end’* (Materiel Logistic Services Specialist, ADF). This is for example evident in the fact, that while many other sectors were shedding workers, companies with Defence contracts were trying to hire employees to keep up with the work. By the end of March 2020, the Department of Defence and Capability Acquisition Support Group had also started to offer one-day turnaround on invoices to support local industry players. This cascaded upstream into the network – tier one lead companies were also quick to follow suit and offered 14-day payment terms to the higher-tier suppliers.

Furthermore, the limited effects can be explained by the ability of the lead companies, A, B, and C, to orchestrate the parts of their global upstream supply networks involved in hierarchical and modular governance relationships. As such, we found that the role of first and second tier suppliers was instrumental in mitigating and buffering the effects of the disruption for the end customer. More specifically, the efforts and resources invested in supply network visibility and collaboration by lead companies made hierarchical relationships resilient. For example, A, B, and C supported local suppliers by bringing orders and payments forward so that less powerful, local suppliers could sustain their business and gain extra time to apply buffering strategies without compromising on the fulfillment of major defence contracts. Consequently, the effects of market disruptions could be mitigated by minimizing the risk of late delivery as there was more time to find alternative sources of supply.

While companies with hierarchical governance relationships relied on the lead companies, modular governance relationships were resilient due to the presence of capable and resourceful suppliers. These firms created additional flexibility in manufacturing processes and internal operations, repurposed production facilities and manufacturing lines to produce some critical inputs, including personal protective equipment and sub-parts, and in some cases insourced critical capabilities or upgraded manufacturing facilities. In this way, shortages and disruptions

to intermediate manufactured goods (e.g., relays, actuators, switchboard frames, and lenses) and other small optical equipment sub-parts and materials produced at tier 3 (e.g., steel and plastic extrusions) could sometimes be mitigated, closing the gap for tier 1 and 2 suppliers (GVCs A-B-D-E-\*, A-F-\* and A-B-C-H-\*).

The ADF did however experience supply disruptions during and post COVID-19 when electronic and electrical equipment, specialized steel grades, and intermediary manufacturing goods were not available at tier 3 – and this was linked to market governance relationships (GVCs A-F-\*\*, A-B-D-E-\*\*, A-B-D-\*, A-B-J-\*, B-E-\*\*, A-\*\*). *”Electrical and electronics consumables - we’ve had supply issues in Australia... the other obvious area of impact that all companies in our supply network experienced has been metals and plastics”* Program Manager Joint Capabilities, ADF). As such, and somewhat counterintuitively, market governance relationships inherent to the most simplistic transactions between multiple vendors on the market caused the majority of disruptions for the end customer. This was often due to the fact that Australia is a relatively small market; hence, the volumes demanded were insufficient to gain a ‘preferred customer’ status during the global shortage.

Moreover, there were increased lead times and escalated prices for critical equipment and sub-systems delivered under relational governance arrangements in the GVCs of A-I-\* and A-B-G-\*. These chains, representing the most complex and customized products (such as customized sub-systems and components, complex electronics, and power systems), experienced the most delays. The relational nature of exchanges did, however, provide some advantages, such as when buyers used well-developed supply chain risk management strategies to support and work with suppliers to solve problems. *“Their ( A’s) European partner has always provided this particular equipment. This equipment is critical for the work we do. There was a delay, but they (A) were prepared and knew how to manage it.”* (Defence SC Advisor, ADF). As such, due to a willingness on the part of both parties to solve problems and overcome the effects of disruption as soon as possible, we found that relational governance exchanges, while experiencing problems, were still more resilient than market relationships.

Meanwhile, we also found that a modular relationship in a lower tier below a market or relational governance relationship could offset, to some degree, the missing resilience of market governance relationships (GVCs B-D-\*, B/D-E-\*\*, B-J-\*) or the shortcomings of relational governance (GVC B-G-\*). Through having advanced manufacturing capabilities, companies supplying products under modular governance were proactive and innovative in tackling disruptions and orchestrating their upstream supply chains, finding alternative ways to satisfy their customers. For example, Firm J invested in building new capabilities and

successfully performed value stream optimization, anticipating issues and reviewing upstream market channels before bringing critical inputs onshore. As such, besides being quite resilient themselves, modular governance relationships were also able to ‘buffer’ against the impacts of disruptions introduced by market and relational governance types upstream. This indicates that, in addition to the type of governance arrangement, the position of the governance arrangement within the network also matters.

## 5. Discussion

In this paper, we have investigated how the governance of relationships at the dyadic level and across a supply network influences resilience by extending the well-established GVC framework (Gereffi et al., 2005) to the operations and SC management domain. This has provided new insights and a more nuanced picture of the differences between resilience at different levels of analysis. Importantly, the findings at the individual dyadic level add up to a different view at the network level.

Resilience, at any level, is often associated with diversification; for example, research has shown that diversification in terms of the geographical location of suppliers or production facilities (van Hoek, 2020), product portfolio (Urciuoli *et al.*, 2014), distribution channels (Pettit *et al.*, 2013), or skills of employees (Poberschnigg *et al.*, 2020) enables flexibility, which in turn enables resilience. This study extends this literature by highlighting that diversification of governance relationships is also important. Our findings have shown that when an organization is tied to one specific governance relationship type, it is much more difficult to problem-solve in response to a disruption. As expected, we found that different governance relationship types adopt different strategies for building resilience, ranging from mainly buffering strategies in market and modular governance relationships to mainly bridging strategies in hierarchical and relational governance relationships. Depending on the situation caused by a disruption, one strategy or resilience practice may be more advantageous than another, while resilience is also context-dependent meaning what works for one disruption may not work for another (Scholten *et al.*, 2020). Therefore, a variety of relationship types provides access to a range of resilience strategies that can be configured to reflect a given situation. This leads to the following proposition:

- P1.** *Diversification of governance types across the supply base and supply network supports organizational and network level resilience.*

While diversification in relationship governance types is needed, there will be situations where an organization in a network will have no choice but to enter into a one-to-one

relationship (e.g., for energy) under a given governance type or enter into several relationships simultaneously but with a common governance type. On the one hand, this might be a disadvantage, i.e. in the case of market or relational relationships, as we found that these governance types tend to be vulnerable to changing supplier capabilities in times of crisis. On the other hand, this might be advantageous, i.e., in the case of modular relationships, as we found that suppliers in modular relationships were the most resilient actors due to flexibility in the production process, enabled by their advanced manufacturing capabilities. This allowed them to buffer against disruptions not only internally but also further upstream in their SC, thus increasing the resilience of the network. Hence, when performing mapping exercises to identify weak points in the network, it is important to ensure that market and relational governance relationships are followed by modular governance relationships, to build SNRes. This leads to our second proposition:

**P2.** *In resilient supply networks, market and relational governance relationships are ideally followed downstream by a modular governance relationship.*

At the same time, and because an organization might not have a choice to engage in several different governance types, organizations that aim to be resilient should question whether managing a global value chain based on transactional considerations alone, such as the three underlying factors suggested by the GVC framework, is appropriate. As Kim and Choi (2015) showed in their framework on buyer-supplier relationships, economic indicators (i.e., relational intensity) need to be considered alongside relational attributes (i.e., relational posture). The importance of relational attributes has also been indicated by recent studies on SNRes (e.g., Enz *et al.*, 2023, Statsenko 2023). As such, while transactional variables determine a governance type, this does not have to be the case for the overall approach towards a relationship. For example, while market governance would call for mainly buffering strategies to be deployed to protect against exchange relationships with (mainly) lower tiers, developmental governance, arising from less capable market governance suppliers, in our examples due to COVID-19, would require bridging strategies and closer interactions. Hence, to deal with dynamic situations, organizations need to consider how to combine the economic perspective of the GVC with more relational aspects, such as by creating buffering strategies and a *cooperative posture* (i.e., how two firms regard each other) in market governance relationships, reminiscent of a gracious relationship (Kim and Choi, 2015).

While, in the short-term, applying bridging strategies and investing resources into market governance relationships might not appear to be efficient, this effort might pay off if a preferred

customer status can be obtained. This is in line with the idea that purchasing, as the foundation of an exchange relationship, is not simply about buying at the lowest price, but also about value creation (e.g., resilience) (Murfield *et al.*, 2021). Consequently, the GVC framework can inform organizations about the economic boundary conditions of an exchange relationship, but this should not be taken as the sole basis for deciding on the posture of an exchange relationship. This leads to the following proposition:

**P3.** *Relational posture between a buyer and supplier plays a critical role alongside economic variables in creating supply network resilience in dynamic situations.*

Relationships and resilience strategies are typically developed in business-as-usual times based on the buying organization's deliberate design decisions, e.g., to set up a relationship under certain boundary conditions (Kraljic, 1983; Kim and Choi, 2015; Gereffi *et al.*, 2005). Recent research has acknowledged that this view is relatively static, and that such decisions must be reviewed regularly (e.g., Formentini *et al.*, 2019). This study adds to this discussion by identifying that the transactional parameters of governance can change in times of crisis when capable suppliers (i.e., market and relational suppliers) can no longer deliver. Market and relational governance relationships in the network we studied caused the most vulnerabilities when suppliers' capabilities went from high to low. As a result, during the disruption, these relationships could be considered as different governance types than during business-as-usual times. More specifically, market governance relationships changed to 'developmental' governance (Ashenbaum, 2018) and relational governance relationships to hierarchical governance (Gereffi *et al.*, 2005). This indicates that even though an organization might have little control or possibility of choosing the governance type they engage in, awareness from the outset of how this might change under disruption is needed. For example, it might be helpful to think in advance about options to vertically integrate all or part of the operation and buy simultaneously (i.e., parallel production, see e.g., Nordigården *et al.*, 2014). This might be particularly important for bottleneck or strategic items (Kraljic, 1983).

Accordingly, we found that lead companies A, B, and C planned to be more vertically integrated and less dependent on overseas suppliers. Inherently, the lead organizations chose to change the resilience strategy from bridging to buffering to have more (internal) control over the situation. This is somewhat surprising as one would expect collaborative relationships and bridging strategies to be quite resilient (Scholten and Schilder, 2015). It appears, however, that beyond the strength of collaboration, the ability of a supplier to complete a transaction affects the resilience of a relationship. This leads to our final proposition:

**P4.** *Resilience requires the dynamic management of buyer-supplier relationships as governance types and available buffering and bridging strategies can change over time under shifting environmental conditions.*

## **6. Conclusions**

This study contributes to the literature by providing insights into the interplay between relationship governance types and resilience strategies at the dyadic and network levels of analysis. We studied the Australian Defence Force supply network, which contains a variety of GVC governance relationships at different tiers. We found that market and modular relationship governance types tend to lean more towards buffering, while relational and hierarchical relationship governance types use more bridging resilience strategies.

Our findings clearly highlight the need to understand the different relationships beyond first tier suppliers when aggregated to the network level. Given that resilience is contextdependent (Scholten et al., 2020), different governance relationships can be more or less resilient in different situations. Therefore, a network should contain diverse governance relationships to be as resilient as possible. At the same time, it appeared that modular relationships, due to the high capabilities of suppliers, were most resilient and valuable in a network. Nevertheless, we also found that a governance type can change under disruption and create a new situation for which different resilience strategies may be more appropriate. As such, governance types are dynamic and need to be treated as such when preparing for disruptions. This might require a relationship to be approached differently than expected based on the GVC framework's economic perspective, e.g., by treating a market governance relationship more like a relational governance relationship.

### **6.1 Implications for Practice**

SC practitioners currently use management models based on a linear value chain view and supplier categorization (e.g., Kraljic, 1983). Although these models serve their purpose for procurement, they severely limit the ability to project upstream risks beyond the immediate tiers. SC practitioners should embrace a broader supply network view beyond the organization's immediate set of supply relationships, identify potential points of failure, and proactively analyze upstream supply chain relationships to be better prepared for unforeseen disruptions. This also includes increasing visibility and evolving risk management practices towards understanding how relationship governance might change under disruption and what

this would mean for current resilience strategies. At the same time, looking at relational or economic aspects of relationships in isolation is not sufficient. Both need to be considered for resilience, including changes to situations and how that might affect a relationship's aims. Furthermore, aiming to understand the extended supply network allows for building necessary redundancy outside the organization, for instance, by determining the supply 'bottlenecks' in the upstream tiers of the supply network to inform where stocks of critical components and intermediary goods could best be located to ensure resilience at the network level.

From the policy makers' perspective, it may be necessary to draw on the market powers of the lead firms with mature supply chains overseas, who may have resources to support the local supply network in times of crisis. Local industry regulators should incentivize lead firms to work collaboratively with local upper-tier suppliers to ensure a resilient supply network that is diversified in terms of governance types. This might also mean building close relationships with market-type governance suppliers to ensure that buffering and bridging strategies are available during a disruption.

## **6.2 Limitations and Future Research**

Key insights derived from this study are based on the Australian Defence Force supply network and its responses to disruptions caused by COVID-19. The following boundary conditions of our findings need to be considered. Although the lead company (i.e., the Australian Government) is a powerful player in the overall global market, Australia is a relatively small market and so it may be important to conduct further research in other contexts with different market characteristics. COVID-19 created a set of specific global disruptions that interacted with local responses, e.g., the combination of supply and demand challenges coupled with border closures. Due to the geographic location of Australia, sea freight constraints and price escalations had a noticeable effect on its SCs. Different findings on the role of governance types for resilience may be drawn from other geographical contexts or types of disruptions. At the same time, the range of resilience strategies implemented in the ADF supply network during COVID-19 are similar to those identified in networks in other geographical contexts (United States, France and Poland) (Enz *et al.* 2023). This confirms that despite the geographical remoteness and isolation, Australian companies embedded in the global economic exchange experienced similar challenges, which were tackled by similar resilience strategies. Therefore, further research is required to distinguish which findings are idiosyncratic to the studied network and which can be transferred to other settings. Finally, while this is one of the first resilience studies from a network perspective, we had to make



choices and draw boundaries regarding which companies to include and exclude. Future studies might want to consider first-tier suppliers or seek out networks with a different spread of governance relationships to gain further insights into the dynamics of resilience across a supply network.

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## **APPENDIX A – INTERVIEW GUIDE**

### **Questions for supply network participants (Companies A – J)**

1. What are the core company's products and services?
2. What Defence projects has your company worked on over the past three years?
3. Which products and services (X,Y,Z) have been sold to Defence industry for the past three years?
4. How do value chains for products/services X,Y,Z look like?
5. What is the nature of relationships with the customer of products/services X,Y,Z?
6. Acknowledging the complexity of the product X,Y,Z value chains, what would you see as the key specific categories of inputs, e.g. equipment/sub-systems/components/raw materials (K,L,M,N) that need to be externally sourced vs produced in-house?
7. What percentage of product/service (X,Y,Z) input is sourced locally/from interstate/overseas?
8. What countries do you source inputs (K,L,M,N) from?
9. What is the nature of your relationships with the supplier of inputs (K,L,M,N) for the products/services (X,Y,Z)? (Refer to Table II for details)
10. Were there instances where the supply chains for products/services X,Y,Z was resilient/not resilient to the disruption, and specifically for inputs K,L,M,N? (e.g. component supply disruptions, shifts in demand, problems with inbound and outbound logistics, order cancellations, significantly increased lead-time and prices for critical components and equipment).
11. What strategies were implemented when a supplier of input (K,L,M,N) could not fulfil an order ?
12. What strategies were put in place by customers for products/services (X,Y,Z) when you, as a supplier experienced delays in your delivery schedule?

### **Questions for the End Customer (ADF)**

1. How did the major Defence projects (A,B,C) perform during the COVID-19 global supply chain disruption?
2. Were there instances where the supply chains for major Defence Projects/Programs (A,B,C) were resilient/not resilient to the disruption? How long would it take for disrupted supply chains to recover fully?
3. What policies and incentives were implemented by the Australian Government to enhance resilience of Defence supply chains during COVID-19 disruption?
4. What policies and incentives must be implemented by the Australian Government to avoid/mitigate similar supply chain effects in the future?
5. What is the role of Australian MNEs and SMEs in building sovereign resilient supply chains for the future?

**Table I: Global Value Chain Governance Types and Their Attributes**

<b>Governance Type</b>	<b>Governance Type Attributes (Aitken and Harrison, 2013; Ashenbaum, 2018)</b>		
	<i>Complexity of transactions:</i> the complexity of information and knowledge transfer required to support and sustain transactions.	<i>Codifiability of the transactions:</i> the ease with which complex information and knowledge can be codified for efficient transfer between parties without transaction-specific investments.	<i>Supplier capabilities:</i> the competence of suppliers (relative to the focal firm) in providing the item or service in accordance with the needs of the buyer.
<i>Market</i>	Low	High	High
<i>Modular</i>	High	High	High
<i>Relational</i>	High	Low	High
<i>Captive</i>	High	High	Low
<i>Hierarchy</i>	High	Low	Low

**Table II. Operationalization of the GVC Governance types**

Governance parameter	Operationalization (Ashenbaum, 2018)	Relational governance					
		AB	AC	AI	BC	BI	G*
Complexity of transactions	We exchange considerable information with our key suppliers (e.g., product design info or inventory and item movement info)	Agree	Agree	Agree	Agree	Agree	Agree
	We require more than a simple “price quote” to award business to a supplier	Agree	Agree	Agree	Agree	Agree	Agree
Codifiability of transactions	Technology is by and large the same across potential suppliers	Disagree	Disagree	Neither Agree nor Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree
	Our industry is characterized by well-known and accepted technical standards	Disagree	Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Neither Agree nor Disagree	Disagree
	Our key suppliers are “full service” outfits who can deliver a complete design with little input from us	Disagree	Disagree	Disagree	Disagree	Disagree	Neither Agree nor Disagree
Supplier Capability	We do not have to spend a lot of time monitoring our suppliers for quality or to make sure they are fulfilling their commitments	Agree	Agree	Neither Agree nor Disagree	Agree	Agree	Agree

Governance parameter	Operationalization (Ashenbaum 2018)	Market				Hierarchical		
		A**	A*	B**	C*	D*	G*	F**
Complexity of transactions	We exchange considerable information with our key suppliers (e.g., product design info or inventory and item movement info)	Disagree	Agree	Agree	Agree	Disagree	Neither agree nor disagree	Disagree
	We require more than a simple “price quote” to award business to a supplier	Disagree	Neither agree nor disagree	Agree	Neither agree nor disagree	Disagree	Disagree	Disagree
Codifiability of transactions	Technology is by and large the same across potential suppliers	Agree	Neither agree nor disagree	Disagree	Neither agree nor disagree	Agree	Agree	Neither agree nor disagree
	Our industry is characterized by well-known and accepted technical standards	Agree	Neither agree nor disagree	Disagree	Disagree	Agree	Agree	Agree
	Our key suppliers are “full service” outfits who can deliver a complete design with little input from us	Agree	Disagree	Disagree	Disagree	Agree	Agree	Neither agree nor disagree
Supplier Capability	We do not have to spend a lot of time monitoring our suppliers for quality or to make sure they are fulfilling their commitments	Agree	Neither agree nor disagree	Disagree	Disagree	Neither agree nor disagree	Agree	Agree

Governance parameter	Operationalization (Ashenbaum 2018)	Modular										
		AF	BD	BE	BF	BG	BJ	B*	CH	DE	H*	I**
Complexity of transactions	We exchange considerable information with our key suppliers (e.g., product design info or inventory and item movement info)	Neither agree nor disagree	Agree	Agree	Agree	Neither agree nor disagree	Agree	Agree	Neither agree nor disagree	Neither agree nor disagree	Disagree	Agree
	We require more than a simple “price quote” to award business to a supplier	Agree	Agree	Neither agree nor disagree	Agree	Agree	Neither agree nor disagree	Disagree	Agree	Agree	Agree	Agree
Codifiability of transactions	Technology is by and large the same across potential suppliers	Neither agree nor disagree	Agree	Agree	Neither agree nor disagree	Agree	Agree	Agree	Agree	Agree	Neither agree nor disagree	Agree
	Our industry is characterized by well-known and accepted technical standards	Agree	Agree	Agree	Agree	Agree	Neither agree nor disagree	Agree	Agree	Neither agree nor disagree	Agree	Agree
	Our key suppliers are “full service” outfits who can deliver a complete design with little input from us	Agree	Agree	Neither agree nor disagree	Agree	Agree	Agree	Agree	Disagree	Agree	Agree	Agree
Supplier Capability	We do not have to spend a lot of time monitoring our suppliers for quality or to make sure they are fulfilling their commitments	Neither agree nor disagree	Agree	Agree	Agree	Agree	Neither agree nor disagree	Agree	Agree	Neither agree nor disagree	Agree	Agree



**Table III: Interviewee and Case Overview**

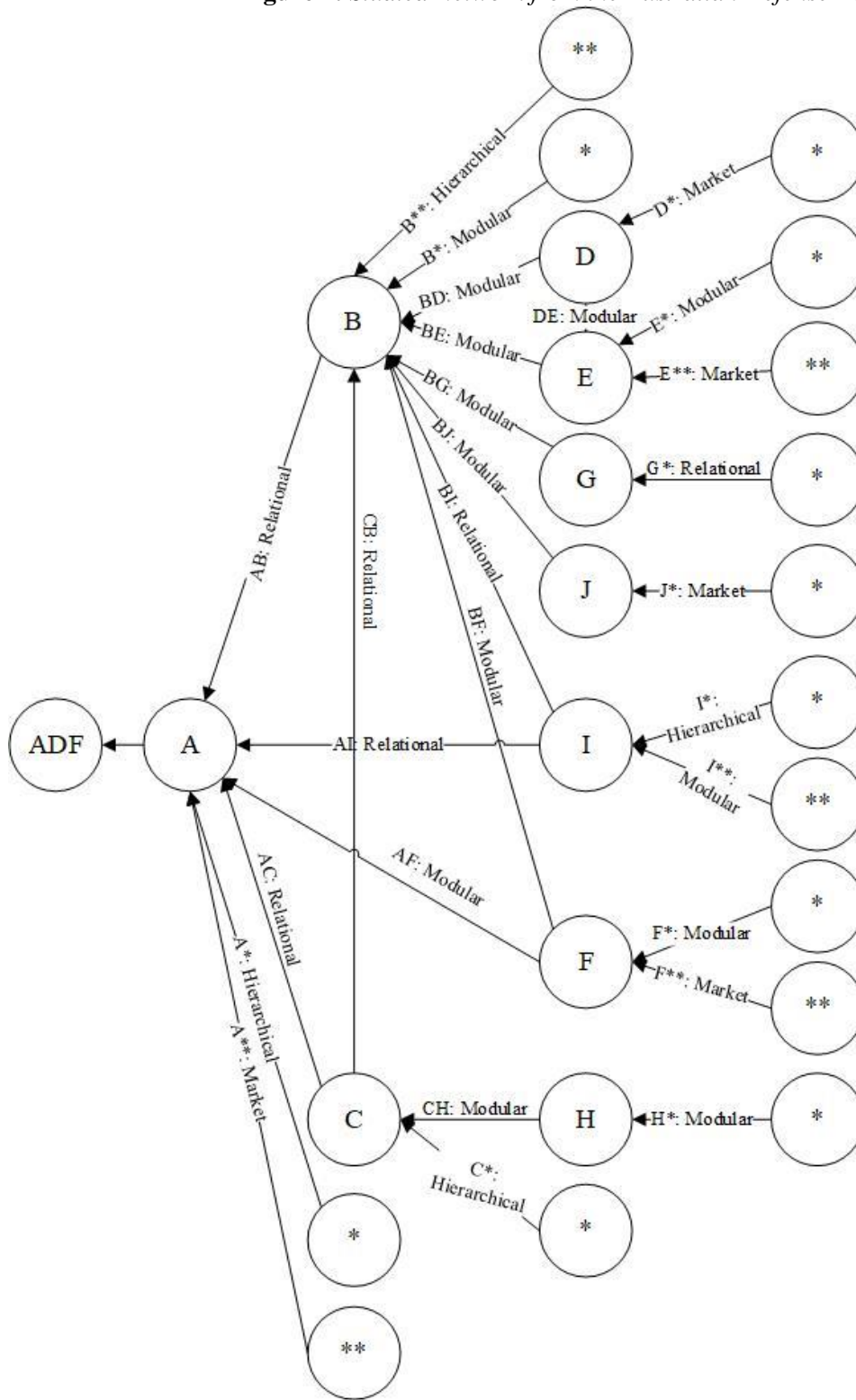
Firm	Interviewee	Case*	Product/ Service	Governance Type
ADF (End customer)	1. Program Manager Joint Capabilities (Centre for Defence Industry Capability) 2. Capability Acquisition and Sustainment Group Materiel Logistic Services Specialist (Centre for Defence Industry Capability) 3. Defence SC Advisor (Office of Defence Industry Support)		N/A	
A (Tier 1)	1. Head SC Australia 2. Exec. Mgr. Capability Development	AB	Submarine platform systems	Relational
		AC	Submarine design, acquisition, and maintenance	Relational
		AF	Electrical sub-systems	Modular
		AI	Ship Power Systems	Relational
		A*	Special platform gear & subparts	Hierarchical
		A**	Generic auxiliary gear & sub parts	Market
B (Tier 2)	3. Procurement Director 4. Head of Strategic Sourcing 5. Senior Program Mgr. 6. SC Mgr. Australian Defence	BC	Combat naval vessel design, manufacture and maintenance	Relational
		BI	Ship Power Systems	Relational
		BD	Electronic gear	Modular
		BE	Electronic gear	Modular
		BF	Electrical sub-systems	Modular
		BG	HVAC systems	Modular
		BJ	Hydraulic & Pneumatic gear	Modular
		B*	Generic auxiliary gear & sub parts	Modular
		B**	Special gear, sub-systems & parts	Hierarchical
C (Tier 2)	7. Procurement Director Land Programs	CH	Optical gear & switchboards	Modular
		C*	Special gear sub-systems & parts	Hierarchical
D (Tier 3)	8. Director Maritime SC 9. Account Mgr. Defence	DE	Customized parts	Modular
		D*	Sub-components printed circuit boards	Market
E (Tier 3/4)	10. General Mgr.	E*	Electronic equipment parts	Modular
		E**	Raw material (aluminum, titanium)	Market
F (Tier 2)	11. CEO 12. General Mgr.	F*	Electric control switchboard parts	Modular
		F**	Raw material (alloys)	Market
G (Tier 3)	13. Bus. Develop. Mgr.	G*	Cooling & refrigeration gear	Relational
H (Tier 3)	14. CEO	H*	Optical gear parts	Modular
I (Tier 3)	15. Industry Capability Mgr. Australia 16. Head of Procurement Defence	I*	Engine sub-systems and components	Hierarchical
		I**	Engine sub-parts	Modular
J (Tier 3)	17. Commercial Director	J*	Hydraulic & Pneumatic gear parts	Market

<sup>1</sup> First letter buyer firm, second letter supplier firm; \*/ \*\* supplier outside the scope of data collected

**Table IV: Overview of Resilience Strategies per Governance Type**

<b>SNRes Strategy</b>	<b>Market Governance</b>	<b>Modular Governance</b>	<b>Relational Governance</b>	<b>Hierarchical Governance</b>
<b>Buffering</b>	<ul style="list-style-type: none"> <li>- Increase inventory (A**, D*, E**)</li> <li>- Find alternative suppliers (A**, D*, E**, F**)</li> <li>- Order as early as possible (D*, F**, J*)</li> <li>- Have safeguards in contracts (F**)</li> </ul>	<ul style="list-style-type: none"> <li>- Have sufficient inventory (AF, BF, BG, DE, I**, H*)</li> <li>- Find alternative suppliers (AF, BD, BE, BG, BJ, CH, F*)</li> <li>- Map SC (AF, BD, BE, BF, CH, H*)</li> <li>- <i>Indirect</i>: Impacts from suppliers' buffering (AF, BD, BE, BF, CH, DE B*, E*, H*, I**)</li> </ul>	<ul style="list-style-type: none"> <li>- Have sufficient inventory (G*)</li> <li>- Have capacity and volume flexibility (AB, AC, AI)</li> <li>- Review logistics channels (G*)</li> </ul>	<ul style="list-style-type: none"> <li>- Have redundancy in production (all)</li> <li>- Change warehouse locations (B**)</li> <li>- Switch suppliers (B**, C*)</li> <li>- Review logistic channels (A*, B**, C*, I*)</li> </ul>
<b>Bridging</b>		<ul style="list-style-type: none"> <li>- Share information and resources in informal operational alliances (AF, DE, F*, I**) as well as work arrangements (AF, CH)</li> </ul>	<ul style="list-style-type: none"> <li>- Share information (all)</li> <li>- Find joint solutions (all)</li> <li>- Share resources (J*)</li> <li>- Invest in relationship (G*)</li> </ul>	<ul style="list-style-type: none"> <li>- Help suppliers with buffering through SC mapping and order expediting (all)</li> </ul>

**Figure 1:** Studied Network from the Australian Defense Force



ADF = Australian Defense Force