

Defense supply chain collaboration: an exploratory study and empirical framework

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Abstract

Purpose – Considering the size and intricate nature of defense supply chains (DSC), there exists a need for a conceptual understanding regarding the precise dynamics of collaboration among the various participants engaged in these chains. This paper seeks to address the gap by investigating the practices that enable or inhibit collaborations and the development of new competencies to effectively employ a flexible response to temporary or more sustained surges in demand. Ultimately, the study aims to develop a theoretical framework relevant to the practical implementation and scholarly examination of contemporary military supply chains.

Design/methodology/approach – Semi-structured interviews were conducted with 51 DSC professionals in 7 embedded cases within an enterprise framework. The resulting transcripts were analyzed using constructs and concepts from a supply chain logistics (SC/L) literature analysis and synthesis relevant to our research purpose. Finally, the results were validated by an industry focus group with 12 participants representing the government, military, industry, and academia.

Findings – This research produced empirical generalizations that provide in-depth and systematic exploratory insights into collaboration's meaning and characteristics within the DSC context. This study culminates by introducing a conceptual model and definition of defense supply chain collaboration (DSCC) and concludes by proposing future research directions.

Originality/value – This study makes a novel and empirical contribution to the SC/L body of knowledge by investigating embedded cases through unique access to informants within an enterprise framework that focuses on the antecedent influencing factors of collaboration within the contextual domain of the DSC and positions a future research agenda.

Keywords Supply chain, Defense, Military, Case study, Collaboration

Paper type Research paper

1. Introduction

Collaborative relationships have been studied by academic researchers for decades, with the focal point of investigation and related key findings in gaining and sustaining competitive advantage within industrial settings (Hayes and Wheelright, 1984; Dyer and Ouchi, 1993; Stank *et al.*, 2001). The dynamics and supply chains of military operations introduce unique challenges that set them apart from typical product supply chains (Hellberg, 2023; Humphries and Wilding, 2001). While military supply chain partners have implemented supply chain



logistics (SC/L) collaborations to foster a shared understanding, strategic responsiveness and agility to address these challenges, the theoretical underpinnings which guide such efforts are understudied in this context (Shaffer and Snider, 2014).

The gap between theory and practice compared to common business settings is best illustrated by the paradoxical demands that modern militaries must meet. Namely, the stability and efficient cost-conscience readiness preparations in peacetime and adapting to sudden changes in product demand in response to conflict and war (Kovács and Tatham, 2009). The current research explores not only the special case for the defense supply chain (DSC) but aims at closing the loop and provide some insights as to how this bimodality holds relevance for industrial manufacturers, for example, transitioning from standard products to more personalized, customer-specific requirements as well (Van Hoek *et al.*, 2001).

High technological, financial barriers to new market entrants and historical mergers and acquisitions (M&A) have led the DSC to a near-economic monopoly (GAO, 2023; Humphries and Wilding, 2001). The failure of a supplier could pose significant risks to operational performance and responsiveness to demand. In DSC, SC/L collaborations have enhanced understanding and responsiveness, aligning with government requirements (DoD, 2016a; DoD, 2018a). The realization that such initiatives depend on principles of sharing and mutual gain prompts advancing research in collaboration (Hellberg, 2023). This paper seeks to review and synthesize existing literature on defense supply chain collaboration (DSCC) and provide an empirical framework through qualitative research to deepen our understanding of this distinctive supply chain context and its potential implications for industry as well.

1.1 Defense supply chain context

While commercial supply chains seek to optimize profit, delivering a product or service to a market, the DSC aims to deliver a military effect (NATO, 1997; MoD, 2015; JCS, 2019). This complicates the traditional product/market-based dualistic supply chain demand strategies (Basnet and Seuring, 2016; Fisher, 1997) and aids in defining the boundary conditions of our research context (Cornelissen *et al.*, 2021). The DSC involves the bi-directional flow of finances and “*materiel*,” similar to how a commercial after-market support supply chain operates (Farris *et al.*, 2005; Kim *et al.*, 2007). The DSC comprises a highly coordinated “federated” network, reflecting its “wholesale and retail” end-to-end nature (Gelderman *et al.*, 2008; Pathak *et al.*, 2007). The management of which shares operational and semantical synonymy between logistics and procurement as *acquisitions* (Lofgren, 2017). These unique characteristics provide a context to better understand collaboration, which, in turn, can inform business supply chains of potential mechanisms of applying collaborative strategies in their day-to-day operations (Ellram and Carr, 1994; Boyce *et al.*, 2016).

For perspective of scope, the U.S. Defense Industrial Base (DIB) is the “*Department of Defense, government, and private sector worldwide industrial complex with capabilities to perform research and development and design, produce and maintain military weapon systems, subsystems, components, or parts to meet military requirements*” (DoD, 2018b). The DIB currently consists of over 100,000 suppliers, 80,000+ daily requisitions, \$100BN inventory from 4.9M items, and annual budgets of \$63.6BN for supply and \$93.9B for maintenance. These suppliers support a vast asset base worth \$768.6B (Figure 1). The research problem of DSCC arises due to the unique characteristics of the military context, which require alignment across many aspects of business relationships.

“Collaboration” is defined here as “a relationship characterized by openness and trust where risks, rewards and costs are shared between parties” (Sandberg, 2007). Research on

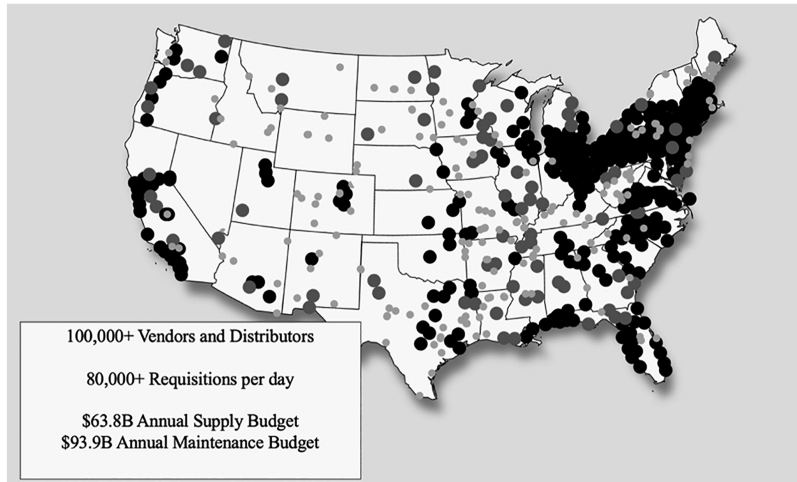


Figure 1.
US national-level
suppliers and
distributors

Source(s): Authors' own work; Adapted from DoD (2019), Reay (2000)

collaboration has shown significant value in improving collaboration and relationships (Soares Aharonovitz *et al.*, 2018; Panahifar *et al.*, 2018). However, past studies on collaboration have found that SC/L management (as it pertains to collaboration) has not yet achieved its full potential (Boyce *et al.*, 2016). SC “buyer-seller” relationships can range in complexity from those that are single transactions (unrepeated) to those that are vertically integrated, in which the buyer owns the supplier (Ellram, 1992). The formalization of buyer-seller interactions is underpinned by contractual purchasing arrangements to govern the high dependency between the two organizations (Sanders and Premus, 2005; Richey *et al.*, 2012). Such bureaucracy is critically important to the commitment to service within a military dual demand stream (Humphries and Wilding, 2004a; Humphries *et al.*, 2007). The high costs also must be recouped by the supplier, as much as it is a barrier to entry (Humphries and Wilding, 2004b; Sheu *et al.*, 2006). Some studies have tested long-term didactic relationships in defense procurement and a belief that such relationships achieve market growth (Humphries *et al.*, 2007). These pragmatic issues have dominated studies, and the research gap concerns a lack of a theoretical model that includes economic and strategic relationships, tangible assets and capabilities for SC/Ls and what practices enable or inhibit such collaborations in order to exploit them (Rutner *et al.*, 2012; Yoho *et al.*, 2013).

1.2 Theory building within the defense supply chain context

Exploratory case studies are the best way of addressing “how?” questions through the replication logic that treats each case as a discrete experiment, considering its replications, contrasts and extensions (Eisenhardt and Graebner, 2007; Yin, 1994). Eisenhardt (1989b) proposes that theory-building should be initiated with little reliance on preexisting theory.

Predominantly inductive, exploratory case studies were used in this study to continue the theory-building approach. The study focused on the nature of collaboration and how it works, with professionals providing answers to guided questions oriented by the following:

RQ1. How do different organizations and individuals within and throughout the defense supply chain collaborate to achieve performance outcomes?

RQ2. What variables influence the development of defense supply chain collaboration?

With these questions orienting our purpose, this research proceeds with a literature review to synthesize the relevant literature to build a questionnaire to explore our research focus in an embedded case analysis (Stake, 2010). The researchers considered the trade-off between the value of having an unstructured inductive approach with very little theoretic influence or a more structured approach based on previously existing theoretic constructs (Colquitt and Zapata-Phelan, 2007). A semi-structured approach with a more robust theoretical influence, rather than a succinct approach, was determined to be appropriate due to the maturity of the field of collaboration in order to establish a consistent predominance of theoretical views.

2. Literature

2.1 SC/L collaboration

The understanding and effective management of DSC is uncertain and needs research; some have even noted the field is atheoretical (Shaffer and Snider, 2014). Additionally, there needs to be more well-established theoretical development regarding the most effective way to collaboratively operate a dual-demand supply chain that caters to buyers and suppliers (Farris *et al.*, 2005; Pathak *et al.*, 2007). Motivated by these issues, the authors reviewed existing literature that discusses collaboration in the supply chain and logistics (SC/L) (Daugherty, 2011; Soosay and Hyland, 2015; Nurmala *et al.*, 2017; Raltson *et al.*, 2017; Ho *et al.*, 2019) before proceeding to study collaboration specifically in the context of defense. DSC research is relatively scarce compared to commercial supply chain collaborations. The authors initiated their review to address this gap by systematically searching for and selecting key articles, seminal and contemporary, that combined empirical and conceptual studies related to SC/L collaboration within the defense context to synthesize and create a foundation for interpretive analysis (Cornelissen *et al.*, 2021). This process followed a structured and multi-staged approach outlined in Table 1 based on Tranfield *et al.*'s (2003, 2004) methodology.

The following phase of the literature review included a detailed search of two extensive databases (ABI/Inform, driven by ProQuest and Business Source Elite, hosted by EBSCO), including publications between 1995 (the first published references to “supply chain collaboration”) and 2021 using Boolean strings of keywords (Table 1). To improve the validity of the framing constructs, a review team of 3 academics with PhDs, with a minimum of 20 years of SC/L research, were selected, located in the United Kingdom and the United States.

Concepts	Keywords	Codes	Strings
Supply chain collaboration	Supply chain collaboration Buyer-supplier collaboration	(supply chain AND collaborat* OR Buyer-supplier AND collaborat*)	(supply chain NEAR/3 collaborat*) OR (Buyer-supplier NEAR/3 collaborat*)
Procurement	Purchasing Procurement Acquisition	(purchasing OR procurement OR acquisition)	(supply chain NEAR/3 collaborat*) AND (purchasing OR procurement OR acquisition)
Defense	Defense Military	(defense OR military)	(defense OR military) AND (supply chain NEAR/3 collaborat*) (defense OR military) AND (supply chain OR collaborat*)

Note(s): A Boolean operator was used to delimit each search string. N3 or N/3 was used for a “3 word” proximity of the term collaboration. Search strings for ABI/Inform used NEAR/3, whereas Business Source Elite used N3

Source(s): Authors’ own work

Table 1.
Keywords addressed in
the search

The initial search generated 10,564 articles, reduced by including only peer-reviewed journal articles from business journals listed in bibliographic databases. The second filtering review of titles and abstracts resulted in a population of 113 papers of sufficient quality and relevance to the study (Table 2). Each article was team-reviewed to record the data, theme, methodology employed and publication contributions to knowledge and the guiding research questions. The final quality review conducted by the review team determined whether the studies were applicable and appropriate for the research purposes of analyzing the field and developing a theoretically grounded interview questionnaire yielded 69 core papers directly impacting this study (Table 3).

2.2 Thematic and descriptive review analyses and synthesis

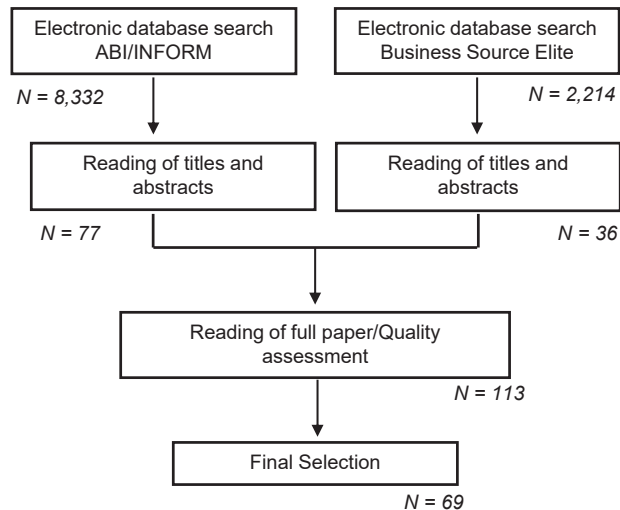
Descriptive and thematic reviews of each paper were conducted and subsequently plotted using a Venn diagram (Figure 2) (Seifert et al., 2018; Wankmüller and Reiner, 2020).

Table 2.
Results from each step
of search selection up
to final selection

Strings	Total primary search		First selection		Second selection	
	ABI/ INFORM	Business Source Elite	ABI/ INFORM	Business Source Elite	ABI/ INFORM	Business Source Elite
Search	4,743	972	151	23	29	8
String 1						
Search	3,129	164	73	2	32	4
String 2						
Search	460	1,078	14	26	16	24
String 3						
Totals	10,564		287		113	

Source(s): Authors' own work

Table 3.
Review process,
simplified



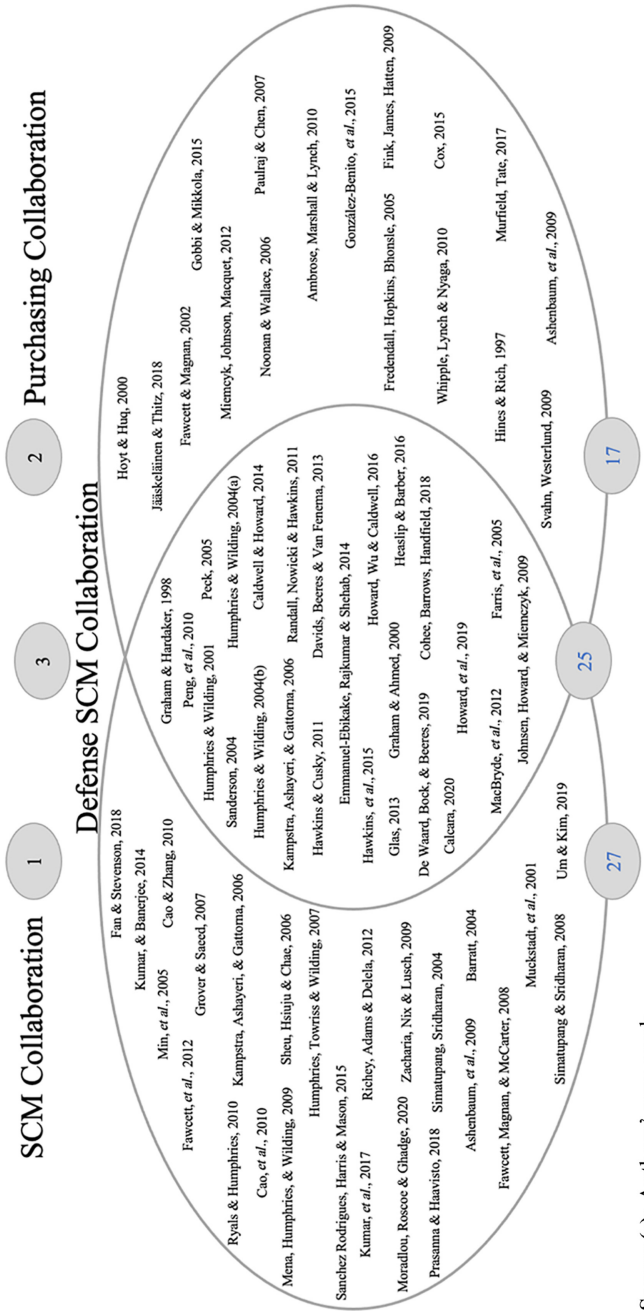


Figure 2. Venn diagram thematic document groups

Three themes emerged: SCM collaboration, purchasing collaboration and defense collaboration. Purchasing-specific collaboration was included due to the DSC's use of traditional acquisition and procurement methods (Larson, 2009). Thematic codes were constructed to describe the antecedents by which collaboration is enabled (*enablers*), inhibited (*inhibitors*) and key moderators, which neither definitively promote nor obstruct collaboration or have an ambiguous positive or negative interaction from the literature (*influencers*) to be further explored (Pereira et al., 2014; Raltson et al., 2017). Plotting research thematically in Figure 2 demonstrates a synthesis of prior theoretic work of existing research to re-purpose toward our research aims (Cornelissen et al., 2021). It is worth noting that seven of the 25 DSCC papers were atheoretical, five represented Transaction Cost Economic theory, three represented the resource-based strategic theory, and other theories were represented by two or fewer papers.

Analysis of academic definitional terms creates conceptual clarity of cause-and-effect relationships (Peck, 2005). Conceptualizing barriers and inhibitors also allowed an antonymic understanding of antecedents (Pereira et al., 2014). Quantitative content analysis using Atlas.ti v.22.1.0 qualitative software was conducted to compensate for the highly subjective nature of qualitative analyses and auto-coding was used to explore each paper's content (running titles, references and appendices were purposively excluded). The full list of coded constructs are displayed in a network analysis model (Figure 3). The network analysis model of Figure 3 is based on literature-derived concepts from which we develop the interview guide questionnaire in order to apply to our research framework (Figure 4).

Each paper was fully re-assessed to confirm that the coded sections were accurately represented and the occurrence of codes was analyzed. The papers were first organized by theme groups (from the Venn diagram in Figure 2), and then the relative frequency of the codes was normalized using the ATLAS.ti automated analysis toolset (Table 4) in order to assess the grounding of each concept from within the literature selection and to aid the analysis and synthesis and development of an interview questionnaire.

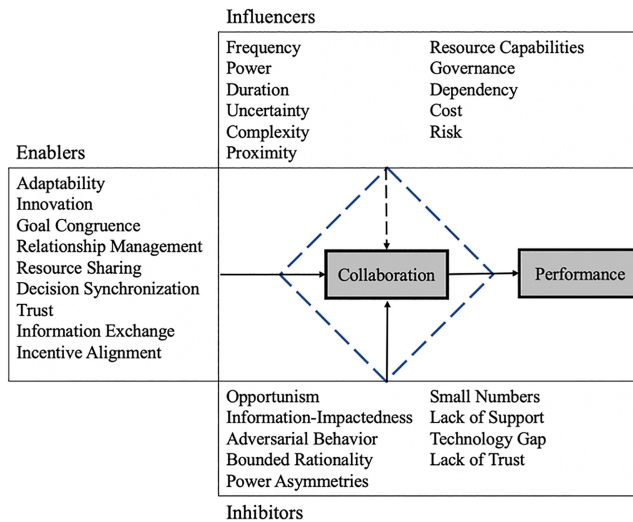
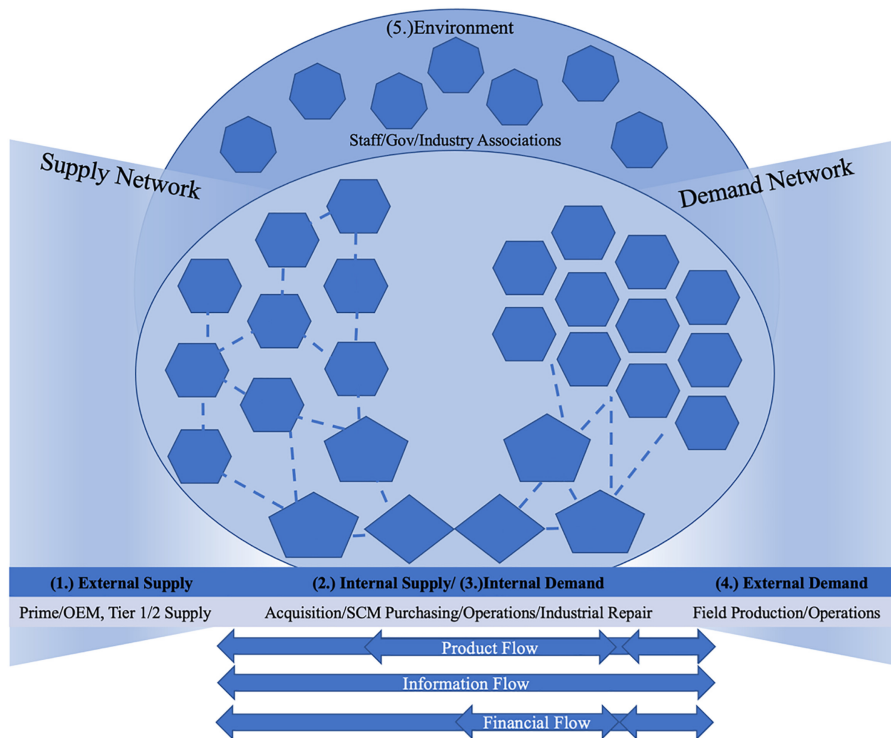


Figure 3.
Supply chain
collaboration network
analysis model based
on literature-derived
concepts

Source(s): Authors' own work



Source(s): Authors' own work

Figure 4.
Enterprise framework
of the study

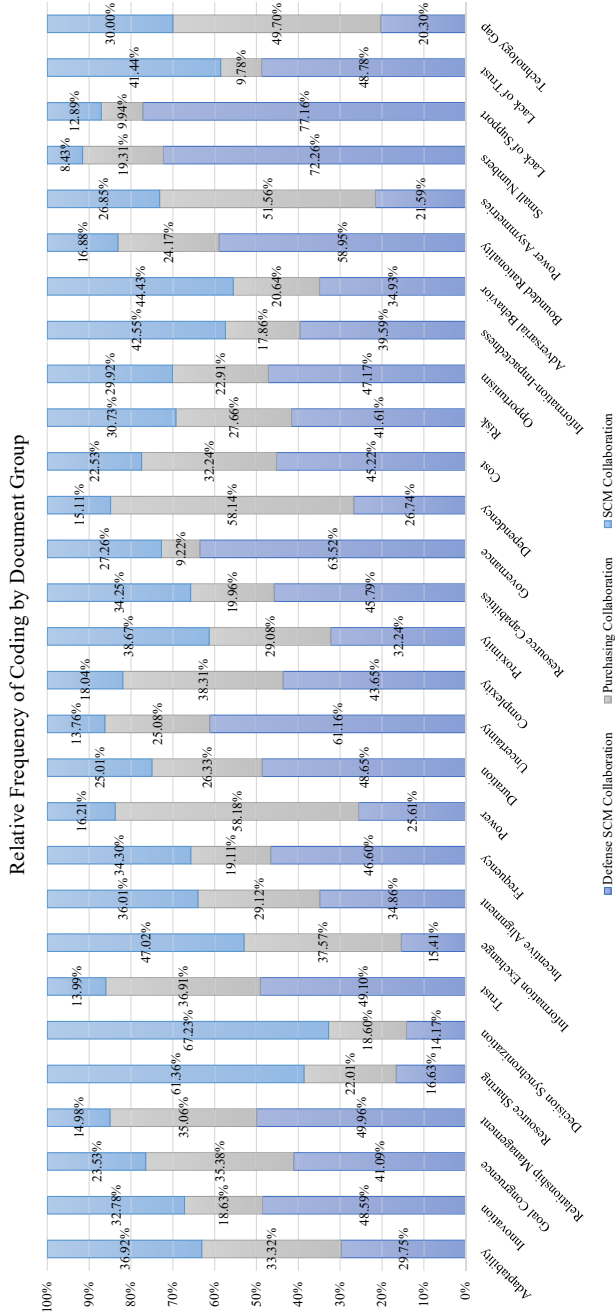
The final review stage identified the gaps, and the content analysis results will now be presented, exploring the *inter* and *intra*-organizational issues at the intersection of SC/L collaboration, purchasing and the DSC.

2.3 Complementary theories to SC/L collaboration

Strategic, economic and systematic theories were employed to contribute to a theoretical logic and conceptualization of supply chain collaboration and the inter-organizational relationships between the conceptual and empirical sources that enable or inhibit it (Halldórsson *et al.*, 2015; Perez-Franco *et al.*, 2016).

Strategic perspectives involve a formal strategy to direct the achievement of long-term goals based on a resource-based and market-based approach (Giachetti, 2010). Resource-based strategic theories emphasize the acquisition of internal resources for an advantage, whereas market-based theory focuses on identifying an external and exact market position to dominate (Giachetti, 2010). Porter (1985) suggests that transacting with a low-cost provider or ensuring a differentiated-value competitive strategy is critical for mutual corporate commitment and trust. Resource-based theories imply that enterprise ownership of resources and capabilities generates profits only when these resources are exploited effectively (Wernerfelt, 1984; Barney, 1991). Such resources may be tangible, including production facilities, raw materials, equipment and other readily identified objects, or they may be knowledge-based. Intangible resources are hard to emulate and include culture, reputation, brand name, organizational knowledge, patents or trademarks. Dyer and Singh

Table 4.
Relative frequency of codes within themed document groups normalized



Source(s): Authors' own work

(1998) claim that firms generate superior profitable positions through the joint contributions of specific alliance partners through relationships and synergistic combinations with other firms.

The economic perspectives of SC/L enterprises relate to organizational economics (Barney and Ouchi, 1986). The central concern of the organizational economics perspective is identifying actions that create efficiencies and minimize the costs of governance, maximizing performance (Combs and Ketchen, 1999). Transaction cost economics (TCE) is based on the seminal work of Williamson (1975, 1997) and involves market and hierarchy transactions. Market transactions support the coordination of buyers and sellers and involve firms conducting business with those companies that offer the most attractive terms, such as price (Boyce *et al.*, 2016). Hierarchy transactions support coordination within the firm and vertical integration of the supply chain through M&A. TCE modifies the firm's boundaries (i.e. full ownership), exchange in markets, or share with others (i.e. interfirm cooperation), or simply whether to "make, buy, or ally?" (Nooteboom, 1999; Combs and Ketchen, 1999). Agency Theory (derived from economic research) concerns decision-making and risk-sharing when cooperating parties have different attitudes toward risk, especially when cooperating parties have other goals (Alchain, 1972; Jensen and Meckling, 1976; Eisenhardt, 1989a). Unless induced to behave otherwise, self-interested agents (organizational decision-makers) will pursue their goals, so collaboration must involve mutual benefits.

Organizations and supply chains are systems (Bertalanffy, 1950, 1968) that evolve to maintain a fit with the environment within which they operate ("open" systems) that influence and interact with the external environment (Katz and Kahn, 1978) such that "*an enterprise is a complex, socio-technical system*" (Giachetti, 2010). Socio-technical systems interplay between the technically organized work units and individuals' social networking (Ketokivi and Choi, 2014). And complex adaptive systems theory extends this thinking of emergence behaviors and relationships (Choi *et al.*, 2001).

3. Methodology

3.1 Research strategy and methodology

Theory building from within military operational and manufacturing organizations is an interesting context that is generalizable to the new dualities of commercial supply chains (MoD, 2022). Moving from a steady state to a promotional stage of short-run products is a key competitive competence for most manufacturers (Basnet and Seuring, 2016; Fisher, 1997). A realist epistemology, using an inductive approach based on a cross-case comparative research strategy, was designed for this study (Golicic *et al.*, 2005; Seuring *et al.*, 2005). The study assesses differentiated performance outcomes related to these collaborative relationships from strategic, economic and systematic perspectives through business-to-business DSC relationships. The U.S. Air Force (USAF) provided the focus of the study due to its complex supply chains, technological dependence on weapon system product support, commitment to SC/L collaborations and ease of access to organizations as units of analysis. In-depth, exploratory case studies from the DSC supply chains were engaged following the development of a literature-derived conceptual framework to encapsulate why and how organizations within the DSC collaborate. The case study findings were then revalidated through triangulation by returning to the literature, individual academic peer review and group review by industry focus groups (Jick, 1979; Fink, 1998).

A single USAF case study was undertaken with multiple embedded organizations, which allowed for greater depth of discussion (Voss *et al.*, 2002) while meeting the threshold advocated for theory-building (Eisenhardt, 1989b) and a point where a sense of generality

could be detected (Ketokivi and Choi, 2014). Yin (1994) identifies four case study “ideal types” of which the multiple embedded types offered the greatest utility for theory-building.

The case inclusion framework for this study includes members of the Defense Industrial Base as an enterprise (Figure 4). An enterprise is “... a complex, socio-technical system that comprises interdependent resources of people, information, and technology that must interact with each other and their environment in support of a common mission” (Giachetti, 2010, p. 4).

The embedded cases were chosen by a theoretical sampling of “polar types” that present unique characteristics of interest (Eisenhardt, 1989b), including different forms of governance and technological and programmatic complexity, enabling cross-case analytical comparisons. Selecting such categorical dimensions and analyzing within-group similarities and intergroup differences reduces potential information processing biases (Eisenhardt, 1989b). Three jet engine supply chains were duly selected, representing three different OEMs and three different governance structures: government-operated/organic, performance-based logistics and public-private partnerships. The selection ensured the increased potential for unique characteristics and intergroup differences to be present by including “legacy” and “new” as well as large-body aircraft or “heavy” and fighter aircraft. The USAF average age of Air Force aircraft inventory is 29 years (Air Force Magazine, 2020), and “new” is defined as an aircraft inventory of 20 years and “legacy” as 20 years + on average. This framework created an overlap between types and ensured some key informants would report on multiple aircraft types within the enterprise framework (Table 5).

Unit of analysis	Designator	Description
Organic/Government owned operated engine	“a” or “E-O”	An aerospace manufacturer of aircraft engines and systems with >10 K < 50 K employees and ≈25% of its market portfolio dedicated to military engines, and roughly 35% by volume of engines
Performance-Based Logistic contract managed engine	“b” or “E-PBL”	An aerospace manufacturer of aircraft engines and systems with >10 K < 50 K employees, with most of its revenue from US sales and ≈15% of its market portfolio dedicated to military engines
Public Private Partnership managed engine	“c” or “E-PPP”	A manufacturer of aerospace and other industrial power systems with >50 K < 75 K employees and 55% military engines by volume of engines
Legacy Heavy/Large body aircraft	“d” or “A-HL”	An aerospace and defense manufacturer with >10 K < 50 K with most of its revenue from US sales and ≈45% of the company’s income from military
New Heavy/Large body aircraft	“e” or “A-HN”	An aerospace and defense manufacturer with >10 K < 50 K with most of its revenue from US sales and ≈45% of the company’s income from military
Legacy Fighter aircraft	“f” “A-FL”	An aerospace and defense manufacturer with >10 K < 50 K with most of its revenue from US sales and ≈45% of the company’s income from military
New Fighter aircraft	“g” or “A-FN”	An aerospace and defense manufacturer with >100 K employees with the preponderance of the company’s portfolio dedicated to the military and most of the company’s income coming from military sales, especially from the US

Table 5.
Description of selected units of analysis under study

Source(s): Authors’ own work

The study employed an enterprise framework capable of encompassing the dynamics of various supply chain types and levels. The use of an enterprise framework avoids overlooking perspectives from SC segments that do not neatly fit narrowly defined frameworks (like dyads) but ensures the explanatory capacity of the study and its generalizability and the interconnectedness between business units and strategy (Hofmann, 2010; Seuring *et al.*, 2005).

The study informants, with significant system insights due to their operational roles, provided a means of snowball introductions to other experts (Yin, 1994; Voss *et al.*, 2002; Gelderman and Van Weele, 2005; Easterby-Smith *et al.*, 2015). Using “theoretical sampling” of informants at different positions and organizations within the case enterprise enabled the collection of various perspectives via the interview process (Eisenhardt, 1989b; Meridith, 1998; Blackhurst *et al.*, 2011). Additionally, the number of categories was considered at the onset to provide a framework in which “*theoretical saturation*” could be reached (Easterby-Smith *et al.*, 2015). The DIB, specific to the support of the USAF, represents a unique case (Yin, 1994), and a single-case design was justifiable when using multiple embedded units of analysis (Eisenhardt, 1989b; Yin, 1994; Eisenhardt and Graebner, 2007). Although there is no exact number of cases to be included to reach this saturation, between 4 and 10 are considered ideal (Eisenhardt, 1989b). Initially, seven embedded types were engaged (Table 5).

Semi-structured interviews were designed to allow for context richness and insight into each case. The questions used were developed from the literature derived concepts (Figure 3). Questions were targeted on system relationships, performance and adaptability, and agility. The “surge” state was used to explore multiple contextual meanings of adaptability, flexibility and agility. Like the term *collaboration*, the term *surge* is used in multiple contexts within the literature, and dependent upon one’s position within the enterprise boundaries, it may also be used deferently. The research also set out to validate a definition of “defense supply chain collaboration” and openly explored participants’ examples of collaborative behavioral practices. The trade-off between the value of employing an unstructured inductive approach (with little theoretic influence) and a more structured approach based on existing concepts was resolved by using semi-structured questions in the interview guide (Easterby-Smith *et al.*, 2015). The concept of collaboration is mature enough to establish a consistent and predominant base of theoretical views, and these views would allow powerful exploratory and explanatory insight into the domain of defense logistics – a known knowledge gap (Ellram, 1996; Seuring *et al.*, 2005).

The selected methodology and framework limit the introduction of theoretic biases (Table 6) by framing questions to relate to the underlying *concepts* rather than the theoretical *constructs* themselves (Bacharach, 1989). The questionnaire (Appendix 1) concludes with additional open-ended questions regarding trends and future predictions for the DSC. To improve the validity of the questions, the questionnaire was reviewed by five respected supply chain academics, each with a minimum of 20 years of SC/L research located in the United Kingdom and the United States at four separate institutions.

3.2 Research protocol and informants

Analysis of the case study data involved breaking down each case and through separate stages, analyzing and synthesizing the data (Stake, 2010). Initial summary coding was used, discerning matching patterns and grouping similar codes before concluding with review by defining empirical generalizations that clarify how particular supply chain and logistics characteristics impact collaboration within the DSC following a process proposed by Miles and Huberman (1994). Manual coding was conducted in parallel with a Qualitative Data Analysis Software (QDAS) enabled process using Atlas.ti v.22.1.0. The computer software made the researcher’s analytical “sense-making” explicit (Dembkowski and Hanmer-Lloyd,

Questionnaire themes	Theoretic influence	Key literature	Constructs
Supply Chain Systematic Perspectives	General Systems Theory	Bertalanffy (1950, 1968), Forrester (1958), Sterman (2000)	Boundaries; Holism; Open/Closed Systems; Purposefulness, Feedback; Control, Complexity; Dynamic, Equifinality
	Socio-technical Systems Contingency Theory	Emery and Trist (1965), Cherns (1976, 1987) Fielder (1967), Lawrence and Lorsch (1967)	Structure; Technology; People; Tasks Decision Style; Leader Behavior; Situational Forces Environment; Strategy; Structure; Technology; Adaptability
	Complex Adaptive Systems Theory	Choi <i>et al.</i> (2001), Dopfer <i>et al.</i> (2004)	Adaptation; Complexity; Sustainability; Cooperation; Competition; Self Organization; Emergence; Innovation; Intractability
Collaboration Economic Perspectives	Transaction Cost Economics	Williamson (1975, 1979, 1985)	Information Exchange; Incentive Alignment; Decision Synchronization; Trust Goal Congruence; Frequency; Duration; Uncertainty; Risk; Proximity; Power; Dependency; Cost; Governance
	Agency Theory	Alchain (1972), Jensen and Meckling (1976), Eisenhardt (1989a)	Interests/Principle, Interests/Agent; Monitoring; Opportunism; Contract Formality; Dependence
Collaboration Strategic Perspectives	Resource-Based View	Wernerfelt (1984), Barney (1991)	Resource Capabilities; Resource Sharing; Human Capital Resources; Organizational Capital Resources; Physical Capital Resources; Competitive Advantage; Core Competencies; Market Influence
	Resource Sharing	Ostrom (1990)	Competitive; Cooperative; Common Pool Resources; Private/Public/Toll Goods; Governance
	Relational view	Dyer and Singh (1998)	Relationship Specific Assets; Knowledge Sharing Routines; Complimentary Resources and Capabilities
	Relationship Marketing	Webster (1992), Morgan and Hunt (1994)	Trust; Commitment; Loyalty; Relationship Quality; Satisfaction; Shared Values; Communication; Cooperation; Conflict; Reciprocity

Table 6. Theoretic perspectives utilized in questionnaire development

Source(s): Authors' own work

1995) and transparent (Bringer *et al.*, 2004), aiding the quality, validity and trustworthiness of the research (Catterall and Maclaran, 1998; Davidson and Skinner, 2010; Paulus *et al.*, 2017). The advice of Paulus *et al.* (2017) was taken that QDAS is a best practice knowledge generation process.

Table 7 organizes the informant framework included in Appendix 2, of which 51 informants engaged with the study.

The first-level coding included two researchers who evaluated the initial “start list” of codes (from those included in Figure 3). The coding process began by selecting a sample of 5 transcripts to test the adequacy of the “start list” within a sample rather than proceeding by coding all 51 transcripts at once. The sample transcripts were selected, one from each level of analysis. The primary researcher then read each transcript, afterward utilizing the “text search” function of Atlas.ti to search all transcripts by coded construct to find sentences that contained each word or compound, including all inflected forms of the word and English synonyms and any literature-derived associated concepts (Figure 5).

After concluding the text search analysis, each transcript was reviewed in its entirety and coded, and each code was reviewed for accuracy. Reflecting on the merits of the “text search” functionality, it was helpful to consider each transcript through its applicability to each coded construct, which required a rigorous number of reviews of each transcript. In doing so, the primary researcher continuously found applicable context not only for the codes included in

Unit of Analysis	Level of Analysis					Combined Total
	1. External Supply Network	2. Internal Supply/Demand Network	3. Internal Demand/Supply Network	4. External Demand Network	5. Environment	
(a) Organic/Gov owned operated	3	1	1	1	1	
(b) PBL	1	1	1	1	1	
(c) PPP	1	1	1	2	1	
(d) Legacy Heavy/Large body	1	2	2	1	5	
(e) New Heavy/Large body	1	1	1	1	1	
(f) Legacy Fighter	1	1	1	1	1	
(g) New Fighter	2	2	1	1	1	
Total	11	15	11	9	5	51

Source(s): Authors’ own work

Table 7. Completed key informant framework

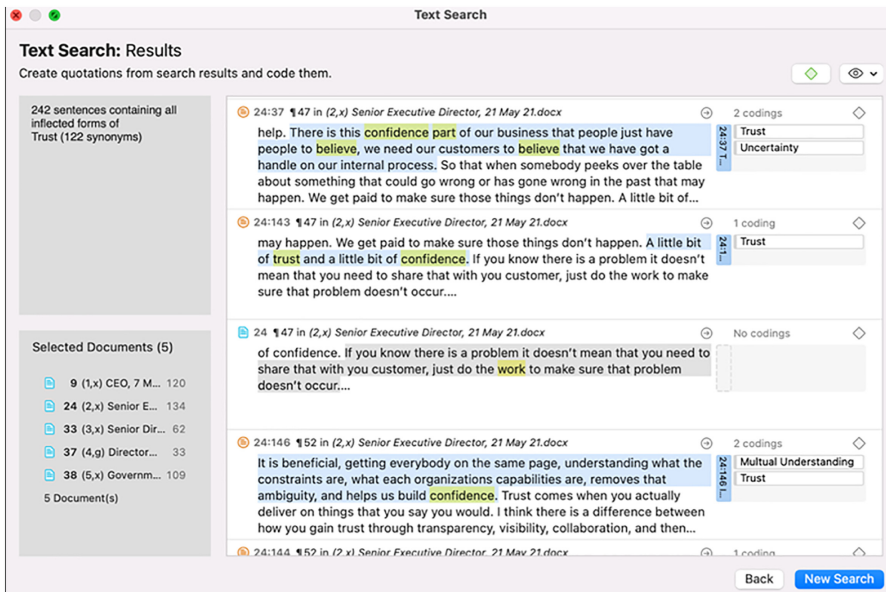


Figure 5. Screenshot of Atlas.ti text search function

Source(s): Authors’ own work

the search, but for other concepts as well. Searching the transcript by paragraph rather than sentence sometimes seemed too wide of an aperture to capture the meaning of each statement upon which to apply a code. Searching by sentence sometimes resulted in a clutter or disarray of codes, requiring consolidation upon the final review. Including all inflected forms and synonyms within the search created a sometimes-daunting number of references to review. Still, it was proven necessary to capture each instance of applicability of the coded construct in each context. The Atlas.ti project file was then reviewed by the second researcher who coded each transcript following the same methodology and reviewed each previous code for applicability. The disagreements were documented and reviewed through the use of the “intercoder agreement” functionality of the software. Each disagreement was discussed until the researchers met a consensus on the codes and the coding.

Our literature based first-level codes proved useful in exploring and describing the case data. Next level coding, or “pattern codes” (PC) were then necessary to progress in building theory. A table reflecting the code-transcript occurrence is included in [Appendix 3](#). “Pattern codes are explanatory or inferential codes, ones that identify an emergent theme, configuration, or explanation” or repeatable regularities (Miles and Huberman, 1994 pg. 69). This is done to reduce large amounts of data into small units, allows the researcher to focus the analysis, build a cognitive map and lay the groundwork for cross-case analysis in multi-case research (Miles and Huberman, 1994).

The inclusion of codes alongside their corresponding transcripts can be found in [Appendix 3](#) to maintain the accuracy of the source material, as well as aid in the development of the coding process and understanding the origin of each code. Additionally, the co-occurrence of codes is used to demonstrate the strength of relationships and provide a more accurate representation of the data [Appendix 4](#). Miles and Huberman (1994) suggest mapping the codes visually in a network display to see how the components interconnect. “The mapping is a new take on your conceptual framework” (Miles and Huberman, 1994 p. 70). Therefore, the codes and transcripts were reviewed, and relationships between coded factors were determined to be either enabling, inhibiting, or influencing based on the transcripts. An example network diagram for the first empirical generalization is included below in [Figure 6](#). The influence of coded factors and the relationship between factors was therefore considered

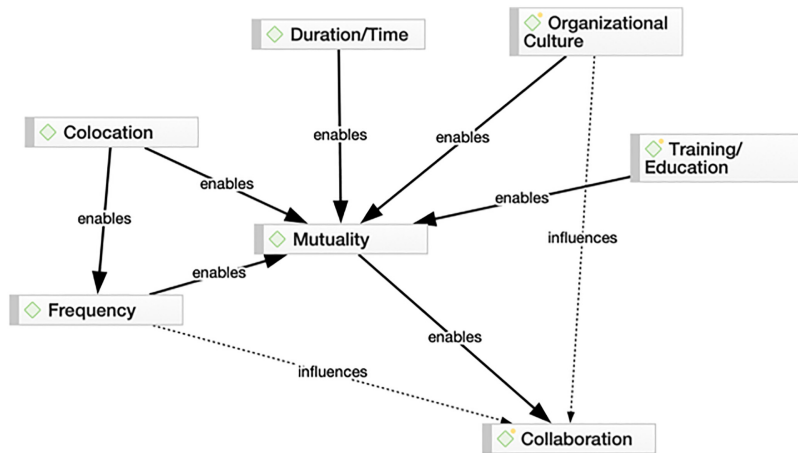


Figure 6.
Empirical
generalization 1

Source(s): Authors’ own work

in developing the empirical generalizations of the final phase of this case study research (Miles and Huberman, 1994).

The analysis yielded seven empirical generalizations based on either a positive (enabling) or negative (inhibiting) influence concerning collaboration in our research context. The occurrence of coded constructs with others (“code co-occurrence”) and construct influence on other factors was conducted to determine the strength of the influence of coded concepts on others in different contexts according to differing opinions posed by our informants. Though each construct can be considered interesting on its own, empirical generalizations were strong, offering a deeper understanding by yielding “larger meanings and their constitutive characteristics” (Miles and Huberman, 1994). A qualitative inquiry into the context was conducted before returning to the literature to confirm any proposed relationships (Blackhurst *et al.*, 2011; Eisenhardt, 1989b).

Empirical generalizations were then validated by conducting an industry focus group. The group included 12 participants from government and industry, two of whom held PhDs, with experience in each military logistics functional area (NATO, 1997; MoD, 2015; JCS, 2019).

4. Study results

4.1 Conceptual model

From the preceding logic and argument, a conceptual framework of the antecedents and potential outcomes of collaboration was developed for the DSC operating environment (Figure 7). In the conceptual model (Figure 7), the literature-derived concepts (Figure 3 of section 2.2.) later developed through our case study, were built within an economic, strategic and systematic structure based on relevant theory (Table 6 of section 3.1), and the socio-technical enterprise framework of our study (Figure 4 of section 3.1.). For example, strategic

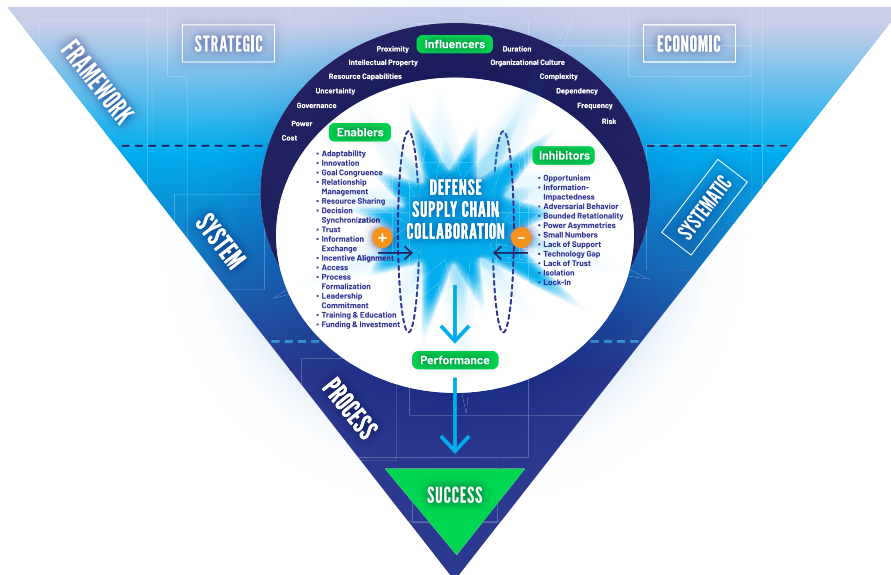


Figure 7.
Summarized
conceptual model of
defense supply chain
collaboration

Source(s): Authors’ own work

factors included leadership and trust (Webster, 1992; Morgan and Hunt, 1994) and the resource capabilities provided through education and knowledge (Dyer and Singh, 1998). Also included were the financial, organizational and physical resources (Barney, 1991; Wernerfelt, 1984), which influence and interact with each other (Combs and Ketchen, 1999; Pagell *et al.*, 2010) having moderating effects within a system (Blackhurst *et al.*, 2011; Mena *et al.*, 2013). These resource factors interact with distinctively economic factors such as information exchange (Fawcett *et al.*, 2012; Raltson *et al.*, 2017) and decision synchronization (Barratt, 2004; Simatupang and Sridharan, 2008). Additionally impactful are factors that inhibit collaborative performance, such as information impactedness and bounded rationality (Williamson, 1975, 1985).

4.2 Empirical generalizations

Following the iterative methodology discussed in Ch. 3, Section 2, the following factors had a pronounced effect on collaboration, whether in isolation or combination with others: *mutuality, incentive alignment, bounded rationality, leadership commitment, access (to resources), investment funding and adaptability.*

4.2.1 *Generalization 1: Mutuality.* A shared sense, feeling, understanding or relationship, knowledge or skill with other members involved in SC/L-related activities was highly cited by informants as a factor that increases collaboration based on a mutual understanding of the needs of dependent organizations, which supports Cao and Zhang's (2010) findings. Relation-specific training of SC/L managers can potentially ensure mutuality and avoid opportunism (De Almeida *et al.*, 2015). "That is what I see when collaboration works . . . we are trying to put ourselves in the other person's shoes" ((1,a) Program Director) and such an empathetic approach has been detected in other high-performance supply chains (Rose-Anderssen *et al.*, 2011; Hofer *et al.*, 2014). Perpetual formal training was also cited as essential to managing legacy and new weapons systems, especially when working with multiple agencies to reinforce mutuality and "To train folks at how to understand us, and we need training on how to understand them" ((2,x) Planning and Support Manager). The study finds that the stability of personnel and experiences gained with suppliers positively affect mutuality, and the lack of such stability was cited as inhibiting meaningful progress and mutuality. As one informant stated, "The flow of people in and out is very disruptive, and that is just the nature of the government" ((3,b) Managing Director). Hence, there is need for perpetual training to bridge knowledge gaps as staff change. However, a stark warning was issued: "The training level, and knowledge within the system, the level of experience, is not where it needs to be." "Especially in the supply chain, they get moved around every year. So, their actual experience, knowing what parts we need to surge, people lack that knowledge because they move in a short time. They don't spend enough time in their current job. Then they move to a section that is new that is not even related to what they were previously working" ((4 d) Production Superintendent).

Co-location (Lawson *et al.*, 2009) has a positive relationship on collaboration but can equally blur organizational lines between the commercial industry and the military (Caldwell and Howard, 2014). Co-location also increases the frequency of formal and informal interaction (Heide and Miner, 1992; Simatupang, 2004; Randall *et al.*, 2011). Informant (1,b) Program Manager cited a contractual co-location requirement and believed "Co-locating people for collaboration is key." Furthermore, "If you really want to foster collaboration, you must make investments where people work alongside part of a team and are responsible for those aspects. If you want them to work together, make them work together" ((4,f) Managing Director). Informants from each level of analysis within the enterprise framework correlated physical shared spaces as promoting mutuality and collaboration. The findings support Johnsen *et al.* (2009), who argue mutuality is a strategic shift in defense supply relationships in the MoD context, which enhances performance and reduces risk. Establishing mutual

understanding (in advance) for embedded SC/L partner relations also has greater importance as roles reverse with the flow of material, information and finances (a specific military supply chain dynamic).

The discussion leads to Generalization 1 that *Mutuality* is positively related to *Collaboration*.

- (1) Generalization 1a: *Training and Education* are positively related to *Mutuality*
- (2) Generalization 1b: *Duration* and *Organizational Culture* positively relate to *Mutuality*
- (3) Generalization 1c: *Co-location* and *Frequency* of interaction positively relate to *Mutuality*

4.2.2 Generalization 2: Incentive Alignment. The sharing of costs, risks, rewards and benefits creates a mutual incentive alignment structure within the SC (Whipple *et al.*, 2010; Cao and Zhang, 2011); it reinforces shared goals (Simatupang, 2004) and creates win-win outcomes (Hoyt and Huq, 2000). Aligning incentives is challenging in a DSC context (Wilding and Humphries, 2006) as organizations around a single product may contain a broad spectrum of governance structures, complicating the traditional options available to civilian commercial organizations (Nooteboom, 1999; Combs and Ketchen, 1999). The DSC, in essence, contains a multitude of differing governance structures within the same chain, and as an organization, must manage them in concert within a specific supply network topology, where the roles between supplier and buyer can be reversed (Pathak *et al.*, 2007) and power relationships can alter over time (Howard *et al.*, 2016). Simple “one-size fits all” heuristics cannot work under such conditions and are heavily influenced by the “small numbers” (demand profiles) of the defense environment (Humphries *et al.*, 2007). The Aerospace and Defense industry is highly capital-intensive, has high barriers to entry and is competitive with frequent M&A creating new oligopolies, increased complexity and new risks (Graham and Hardaker, 1998). The economics of such structures and incentives were captured in the statements:

- (1) “*There aren’t many companies that want to go out on risk without some guarantee. Firm-fixed price is about as good as it gets. With the volatility of the market, with commercial economy, people aren’t willing to take on work without a decent return.*” ((1,g) Senior Executive Director)
- (2) “*I think there is a shock coming to the primes (prime contractors). And they are going to realize, hey, we are all a bunch of starving dogs fighting over the same bone. Kind of a zero-sum game. So, I think that fewer suppliers, vying for fewer dollars sustaining older systems (would be predicted).*” ((1,x) CEO)

Risk exposure, combined with the complexity and value of multi-dimensional Intellectual Property (IP), creates dependencies between buyers, suppliers and other SC members (Kumar and Banerjee, 2014; Prassana and Haavisto, 2018) and can result in a condition of sole-source procurement and “lock-in” contracts, especially for “legacy” weapon systems (increased SC/L rigidities). The sentiments expressed included:

- (1) “*Everyone wants to protect their proprietary data, and everyone wants to keep their share of the bargain, and more in this very competitive environment.*” ((1,g) Supply Chain Director)
- (2) “*I see anecdotally platforms nearing the end of their life expectancy or past it. I think that in both cases, the ability of the infrastructure to surge is limited by contracts that have expired or existed at the beginning of its lifespan. I think for these older systems, there is no immediate ability to surge without the creation and investment in these parts and the system to spool up parts capability. Nothing is impossible, and with enough time and money, anything is possible, but for many of these parts, there is little or no ability to surge. That is largely a result of programmatic designs made early in the system’s lifecycle.*” ((4,f) Managing Director)

- (3) *“I think the trend is, supply chain as a whole, I think collaboration is going to be mandated. I don’t see defense budgets growing. Requirements are going to need to be dialed in. I see DLA taking on a bigger role. I see more integration of industry partners. I see a lot more vendor-managed workload.”* ((2,x) Planning and Support Manager)

The findings lead to Generalization 2: *Incentive Alignment* is positively related to *Collaboration and yields*:

- (1) Generalization 2a: *Small Numbers* positively relates to *Complexity, Risk and Dependency*
- (2) Generalization 2b: *Intellectual Property* positively relates to *Dependency*
- (3) Generalization 2c: *Dependency* positively relates to *Lock-in*
- (4) Generalization 2d: *Lock-in* positively relates to *Risk* and is negatively related to *Incentive Alignment*
- (5) Generalization 2e: *Complexity* positively relates to *Risk*

4.2.3 Generalization 3: Bounded Rationality. “Bounded Rationality implies, that when faced with complex decision-making, supply chain professionals with ‘agency’ will seek satisfactory rather than optimized solutions (Simon, 1957; Williamson, 1997). The inability to optimize is also a function of *available information, time and capabilities* (Williamson, 1985; Flynn *et al.*, 2016). Informants observed that *individual or organizational isolation* drives poor decision-making and lack of creativity: *“I always tell my folks, don’t work in a stove pipe. Because internally we are our own worst enemy . . . we get into finger pointing when we should be looking for common solutions”* ((2,x). Chief of Planning and Support). Improved decision outcomes result from joint working (Simatupang and Sridharan, 2002), and this increases win-win outcomes (Dyer and Singh, 1998) when “silo thinking” is replaced by a process approach (Randall *et al.*, 2011). Breaking down silos is associated with both timely and more effective information exchange, decision-making and outcomes (Barratt, 2004). The sentiment is captured in this quote: *“Some people get stuck in ways. Sometimes you need to be creative. Sometimes, it’s a challenge for people. I don’t think it’s based on how many years; some people are just in their own ways. And it takes strong leaders and how to break some of that down. But it’s really being creative in this industry, how do we get things quicker, that is still safe and conforming. That is really it. Getting people to collaborate and be more transparent”* ((1,a) Program Manager).

Consolidation of competing firms through commercial M&A can lead to short-term gains for the buyers through long-term partnering and transactional cost gains and greater demand for suppliers (Koufteros *et al.*, 2007), but such integration increases isolation and dependency risks to opportunism in the presence of small numbers bargaining and asset specificity (Hingley, 2005a, b; Hoyt and Huq, 2000). Within the military supply chain, the negative dependencies of sole-source agreements are exacerbated by aging weapon systems technology and its resultant uncertainties.

- (1) *“I think sole source is really becoming more and more prevalent, and it’s becoming more and more of a problem, meaning that we have a hard time being able to get parts because of the aging aircraft if you ask us to surge.”* ((3,x) Senior Director)
- (2) *“I think we need to have divergent thinking; we really need to think differently. I think sometimes we get stuck in the old ways. Let’s use technology. Let’s really be serious about getting rid of legacy systems.”* ((3,x) Senior Director)

Organizational resiliency is also established in interpersonal relationships and is easily disrupted by staff rotations. The sentiment is captured in these statements: Journal of Defense
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- (1) *“It comes down to individual personalities. You certainly would have organizational culture. If you have the historic experiences, someone may judge how a relationship may go with a particular activity. If you try going into an environment with a positive attitude, you are probably not going to end up with a collaborative environment if the historical relationship is distrust.”* ((1,e) Senior Program Manager)
- (2) *“I don’t see a lot of collaborative decision-making between the department and its partners. It is largely a tug-of-war between two entities that may not have the same goals . . . I don’t necessarily see a lot of collaborative decision-making.”* ((5,x) Staff Director)

The logical conclusion leads to empirical generalization 3 that *Bounded Rationality* negatively relates to *Collaboration*:

- (1) Generalization 3a: *Isolation* positively relates to *Bounded Rationality* and negatively relates to *Collaboration*
- (2) Generalization 3b: *Leadership Commitment* negatively relates to *Bounded Rationality*
- (3) Generalization 3c: *Uncertainty* and *Complexity* positively relate to *Bounded Rationality*
- (4) Generalization 3d: *Opportunism* positively relates to *Bounded Rationality*
- (5) Generalization 3e: *Relationship Management* negatively relates to *Bounded Rationality*

4.2.4 Generalization 4: Leadership Commitment. While the manifestation of commitment is provided by team leader collaboration, engagement and trust building (Randall *et al.*, 2011; Fawcett *et al.*, 2012), a leadership role between organizations, governments, OEMs and suppliers is needed to manage risk, overall performance and improvement over time (Howard *et al.*, 2016). Leadership commitment reinforces common goals (Johnsen *et al.*, 2009; Hawkins and Cuskey, 2011) and system-level joint planning (Barratt, 2004). Many informants noted such a directional capability:

- (1) *“I think a lack of a clear vision of where we want to go. I think that has hurt the enterprise. I think it is poorly defined where we want to get what the end goal is. I think change of leadership turnover in the military, it’s a double-edged sword. You lose some corporate expertise and then move on. I know there have been some reorganization on both sides. And when you do that, you sometimes take a little stumble, and then you move forward.”* ((1,a) Program Director)

Leadership responsibility is exercised in areas of bureaucracy reduction, promoting adaptability and organizational/supply chain resiliency (Simatupang and Sridharan, 2008). Reduced interfirm bureaucracy and enhanced transparency improve responsiveness and economic efficiency (Lamming *et al.*, 2004). The informants were animated during these discussions and the contingent challenges it poses to SC/L, which can be summarized as:

- (1) *“The Air Force mentality is if it isn’t written in the FAR (Federal Acquisition Regulation), you can’t do it. I went to the Navy and ended up using them because theirs was a different mentality. They said, if it doesn’t say I can’t do it, in the FAR, I’m all in, I’ll do whatever you need. So that philosophy permeates to me the Air Force’s inability when it comes to their desire to do large-scale supply chain innovation.”* ((1,d) Senior Sales Manager)

In the absence of widespread reforms, leaders can reduce bureaucracy through the management of relationships and comprehensive interactions to improve processes

dyadically and through multi-tier supply chain relationships (Pala *et al.*, 2014; Zhang and Huo, 2013). Such change allows leaders to improve point and network performance by leveraging trust and commitment (Grudinschi *et al.*, 2014), which leads to the fourth generalization: *Leadership Commitment* positively relates to *Collaboration*

- (1) Generalization 4a: *Leadership Commitment* positively relates to *Goal Congruence*, *Governance*, and *Adaptability*
- (2) Generalization 4b: *Governance* negatively relates to *Adaptability*
- (3) Generalization 4c: *Relationship Management* positively relate to *Trust*, *Leadership Commitment*, and *Goal Congruence*

4.2.5 *Generalization 5: Access*. It is argued that organizational access to information intelligence and resources and information results in improved efficiency, coordination and performance (Peng *et al.*, 2010). Such access compresses time from decision to action and allows information exchanges to make more effective use of materiel flows (Sabath and Fontanella, 2002). Access is, therefore, the result of relationship management and mutual benefits (Koufteros *et al.*, 2007), including the leverage of information for performance gains (Cao and Zhang, 2010). Modern IT systems facilitate such access and aid decision-making (Fawcett and Clinton, 1997), whereas ineffective systems, in the DSC context, have been identified as sources of inefficiency (Humphries and Wilding, 2001) and “information blindness” (Haraburda, 2017). The ability to sense and exploit information impacts on all stages of the product life (Cohee *et al.*, 2019; Kollenscher *et al.*, 2014). The impact is critical when surge plans are executed and informational “noise” increases on an organizational and network scale (Kollenscher *et al.*, 2014; Heaslip and Barber, 2016). This sentiment is summarized by the following quotes:

- (1) “If the US government has one level of information and the OEM has another, it has one hand tied behind its back.... I think leveling the playing field on information is another thing that really helps collaboration.” ((1,a) Program Director)
- (2) “. . . a large investment in analytics (is needed), all of this information swirling all around us, and it is very hard to act upon it.” ((2,x) Senior Executive Director)

A responsive, timely and precise flow of informational resources across the SC/L facilitates the requisite operational coordination of physical assets for deployment (Levina and Vaast, 2008), which constitutes a critical capability for all trading partners (Tsanos *et al.*, 2014), and this leads to a further generalization. Generalization 5: *Access* is positively related to *Collaboration*

- (1) Generalization 5a: *Information Technology* positively relates to *Access*
- (2) Generalization 5b: *Access* and *Information Technology* negatively relate to *Information Impactedness*
- (3) Generalization 5c: *Access* is negatively related to *Isolation*
- (4) Generalization 5d: *Isolation* and *Information Impactedness* negatively relate to *Collaboration*

4.2.6 *Generalization 6: Funding and Investment*. Financial considerations determine performance outcomes, cash flow (Sokri, 2014) and profits (Larson, 2009). This is complicated as the DSC is both a supplier and customer of the network (Ekström *et al.*, 2020) and is subject to significant legislative conditions, regulations for specific provisions and states of readiness, which all are offered at the lowest possible overall cost. Cash flow is

also controlled by military budgetary processes and funding allocations which were captured by the following informant statement:

- (1) *“Resources is a big one. Your biggest thing is, hey, you need to do this . . . we need to ask for funding, and it’s going to take three years, so your biggest inhibitor is money since budgets change year to year, from president to president. Congressional hearing deciding business and saying ‘this isn’t important to us any more’. Congress can be an enabler, but they can also be a constraint as well trying to take care of their own State as well.”* ((2,g) Sustainment Director)

Commercial organizations face significant financial and technological barriers to access large capital investments and mitigate associated risks (Humphries *et al.*, 2007). Defense acquisition schedule and cost growth lead to longer, increasingly complex and more expensive procurement processes (Hasik, 2014) and typically significant resource constraints, involving many “at risk” commercial decisions (Farris *et al.*, 2005; Heaslip and Barber, 2016) and operational plans (McKinzie and Barnes, 2004). Specific resource constraints can encourage inter-organizational cooperation (Simatupang and Sridharan, 2002; Simatupang, 2004) but typically results in managing surge constraints and a strategic/collective response to an operational deployment (Kollenscher *et al.*, 2014), with resource constraints usually inhibiting SC/L responsiveness (Tsou, 2013). Human resources and physical resource acquisition are dependent upon financial flows (Kovács and Tatham, 2009) to acquire and fund productivity which leads to:

Generalization 6: *Funding/Investment* is positively related to *Collaboration*

- (1) Generalization 6a: *Leadership Commitment* is positively related to *Funding/Investment*
- (2) Generalization 6 b: *Funding/Investment* is positively related to *Resource Capabilities*
- (3) Generalization 6c: *Resource Capabilities* is positively related to *Adaptability* and *Collaboration*

4.2.7 Generalization 7: Adaptability. Operational adaptability, flexibility and agility are critical to the DSC’s bi-modal operations of steady state and “surge” conditions (Barber and Parsons, 2009; MoD, 2022). Formalization of SC/L practices under the “steady” state is comparatively easier, whereas unpredictable and instant demand signals to surge deploy instantly inflates costs at the network scale, and such a switch has contingent impacts on types of suppliers. *“The definition of surge between operations and depot are completely different. I think when you say surge, you have to ask that question as to whether you are depot or are you an operational Wing”* ((3,x) Senior Director).

Formalizing operational processes reinforces competencies, supports the command chain and offers superior performance outcomes (TysseLand, 2009), especially when formalized collaborative processes support joint and transparent planning (Barratt, 2004; Kierpiec, 2006; Simatupang and Sridharan, 2008). However, hierarchical and contractual governance structures and mechanisms can act to limit decision-making, reduce operational flexibility and slow innovation (Rutner *et al.*, 2012; Kollenscher *et al.*, 2014) which is embodied in the following informant statements:

- (1) *“A few years ago, we set up a sales inventory team, a team to help with the planning, I think, to manage the materials across the OEM to make sure any big swings that we were having were clearly communicated across the supply chain. The introduction of that team introduced a lot of bureaucracy but also a lot of discipline as well. Without that team working through these issues, I don’t think we would have the discipline either.”* ((1,a) Department Head)

- (2) “What inhibits it is everything that comes with being in the military. It’s everything that requires standardized, repeatable processes, even when they inhibit flexibility and agility and create real-time solutions. All of the legal burdens by the FAR. But even past that, go pick up the defense transportation guidance, heck, try to file a travel voucher. What you get is 1000 pages telling you how not to spend three extra dollars on a hotel. And all of that burden, you know, the shipping, the packing, the burdensome requirements are not built around efficient and effective as much as they are predictable and repeatable. I think that is a barrier that needs to be worked through.” ((1,d) Senior Sales Manager)
- (3) “I am often frustrated by our ability to do work that we are capable of but are prohibited by regulation.” “We design things to eliminate risk and eliminate lawsuits and not to be operationally effective and efficient. Cutting that red tape is going to take time because there is a lot of institutional inertia. That will take another paradigm shift.” ((4,f) Managing Director)

The discussion provides generalization 7: *Adaptability* is positively related to *Collaboration* and *Performance*

- (1) Empirical Generalization 7a: *Governance* is positively related to *Process Formalization* and is negatively related to *Adaptability*
- (2) Empirical Generalization 7 b: *Process Formalization* is positively related to *Collaboration* and *Performance*
- (3) Empirical Generalization 7c: *Resource Capabilities* is positively related to *Adaptability*

5. Discussion

5.1 Definition and contributions

This study contributes to the exploratory body of knowledge on supply chain collaboration and responds to calls for research within the DSC context through unique and in-depth access (Yoho *et al.*, 2013; Rutner *et al.*, 2012; Zsidisin *et al.*, 2020). The study illuminates the challenges and opportunities of DSCC in relation to the research questions posed. It explores specific challenges and opportunities for various organizations and individuals involved in the defense supply chain to work together to achieve performance outcomes, which has significant implications for modern militaries and their extensive network of suppliers. The empirical framework presented in this paper explicates DSCC’s influencing variables which can serve as a guide for practitioners and researchers seeking to improve the effectiveness and efficiency of DSCC. The early exploratory research, embodied in generalizations and antecedent factors of collaboration in a DSC context, provides contingent meaning to collaborative management practices.

The DSC is becoming increasingly interdependent (Kidd, 2019). US alliances and Public Private Partnerships are increasingly being adopted to generate synergies from shared private and public resources (DoD, 2016b), which is common to other advanced economies such as the UK and Australia where mature collaborative alliances exist (Pint and Hart, 2000; Ziesing, 2008). The demand for resiliency and security of US supply chains (US Executive Order (EO) 14,017) resulted in the submission of a DoD action plan to address strategic vulnerabilities and to develop internal, interagency, international ally and industry partner collaboration (DoD, 2022). These actions regarding the supply chains of the DIB, are aimed to promote strategic flexibility and prioritize new and deeper collaborations, which have been included in this study’s framework. The highly dependent and integrated nature of DSC relationships (Humphries and Wilding, 2001; Sanderson, 2004; Howard *et al.*, 2019) represent relationships that go well beyond voluntary involvement of commercial buyer-seller engagements (Bowersox

et al., 2003). The explicit causality of the proposed new definition was easier to conceptualize as an *extent* or *degree* within a constant state rather than a choice or a progression away from transactional relationships (Hoyt and Huq, 2000). This collaboration mandate could be anticipated in non-commercial, vertically integrated, hierarchical, or allied chains. The integrative nature of the DIB capabilities and organizational and governance structure means a definition must be broad enough to encompass both government and commercial entities and each functional area of military logistics (NATO, 1997; MoD, 2015; JCS, 2019). The distinctive military context means inter-organizational collaboration must “fit” by aligning strategically with the defense of a nation, its allies and the interests of national democratically elected leaders. Our operational research definition of DSCC was developed during and validated through the case study interviews and focus group:

“The extent to which individuals and organizations within the military and throughout the defense industrial base enter into, participate in, and develop joint and mutual logistics activities, trusting relationships, planning, and coordination to maintain and achieve performance objectives toward responding to the defense of a nation its interests and allies.”

SC/L mutuality and reciprocity relationship concepts have significant managerial and performance implications, and the bi-modal nature of the DSC demands that these relationships are embedded well before “surge” demand activation so that adaptive competencies are available and rehearsed, because “*you can’t surge trust.*” The dependent nature and frequency of DIB partner exchanges demonstrate prime importance in aligning demand signals and require ease of access to data and interpretative capacity (Tatham, 2013). The military response will inevitably be dependent upon financial resource availability to, through governance systems, invest in human and material resources to accommodate a demand uplift. This process depends on strategic prioritization processes, leadership influence and funding allocation to support the deployment strategy (Sysoiev, 2013).

Over the longer term, demand duality will require a new operating model “fit” for all organizations and an expansion to the closed and highly dependent DIB supply chain as innovation strategies prioritize new collaborations with new entrants to the DIB network and technologies that can accommodate stable and surge conditions profitably and without significant disruption to cashflow. The latter condition can only be achieved when barriers to DIB membership allow such expansion (Johnsen *et al.*, 2009; Zsidisin *et al.*, 2020). Such innovative leadership and collaboration through aligned governance structures allow the exploitation of data-driven analyses and the material flows to maintain a combat advantage (Wilding and Humphries, 2006; Rutner *et al.*, 2012).

5.2 Study limitations and future research

Exploring and testing the empirical generalizations would be desirable but significantly complex to execute, so practical progress is likely to be made in further exploration of the meaning and strengths of relationships between the interconnected elements of the new framework. For instance, intuition suggests disruption, crisis and conflict could stimulate collaboration but may promote inertia due to a lack of scenario rehearsals and poor corporate investments. It is plausible that the surge may strain collaborative relationships (in its initial stages at least). The role of inter-organizational relationships under conflict and surge conditions and different governance structures is underdeveloped (Pacheco, 2021). Further, supply chain design theory, which categorizes chains as either physically efficient or market-responsive based on product characteristics, inadequately addresses the bi-modal surge performance requirements of the MSC’s contingent environment (Basnet and Seuring, 2016; Fisher, 1997). In the same non-intuitive vein, governance structures are necessary to create a design framework for operational performance and ensure the needs of stakeholders (i.e. the

public) are met but discourage and prevent optimized performance. Given the unique context of the DSC with its non-linear, bi-directional financial and material flows, it is interesting that research on *mutuality* consists of just one paper exploring the constructs (Johnsen *et al.*, 2009). Further, this study holds relevance to resetting the boundaries of modern TCE theory, including significant implications for *bounded rationality*, *information impactedness* and *incentive alignment* and how new forms of collaborative economics will reshape governance structures, sourcing decisions and organizational designs through collaboration and the longitudinal adaptation of businesses within the DIB (Pint and Baldwin, 1997; Melese *et al.*, 2007). More studies of these foundational influencing relationships would contribute to the understanding of promoting win-win collaboration for supply chain performance and organizational changes in this domain of supply chains.

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Appendices

The Supplementary Material for this article can be found online

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