

Systematic Review of Supply Chain Control Tower Critical Success Factors and Resilience Effects

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ABSTRACT

Supply chain control towers (SCCTs) are emerging as vital components of modern supply chain management (SCM). However, research on SCCTs is limited and disjointed. This paper explores critical success factors (CSFs) necessary for high-performing SCCTs and examines their impact on supply chain resilience (SCRES). Through a comprehensive systematic literature review, this research inductively identifies and classifies 14 CSFs into a framework consisting of organizational, process, and technological dimensions. We further map complex relationships among these CSFs, revealing how SCCT performance relies on CSFs interacting synergistically as dynamic capabilities. Moreover, this study extends the theory related to SCRES under dynamic and disruptive market conditions by discretely connecting SCCT outcomes to supply chain readiness, responsiveness, recovery, and renewal. By integrating both theoretical and practical perspectives, this study contributes to existing SCM knowledge by providing both a structured approach to identifying and implementing CSFs for SCCTs and explaining the role of SCCTs in advancing SCRES. This paper, therefore, serves as a valuable resource for both researchers and industry practitioners in understanding SCCT operations and outcomes in achieving efficient, robust, and resilient supply chains.

Keywords: control tower, critical success, logistics, resilience, supply chain factors

1. INTRODUCTION

As global supply chains continue to evolve, the deployment of supply chain control towers (SCCTs) is

increasingly necessary for maintaining firm competitiveness and resilience. SCCTs are centralized platforms that provide end-to-end visibility and control over the entire supply chain. Operating as central information and control hubs, SCCTs provide enhanced visibility, insight, and control across supply chain networks, offering a strategic risk mitigation solution (Bhosle *et al.*, 2011; Vlachos, 2021). SCCT capabilities, including supply and demand alignment, risk detection, information sharing, and advanced analytics, typically reach across traditional firm boundaries, empowering managerial engagement and collaboration with supply chain partners. This collaboration facilitates both tactical and strategic inter-firm decision-making, generating immediate benefits in addressing emergent and future aims (Smith, 2022; Trzuskawska-Grzezińska, 2017).

SCCTs are complex, multi-faceted entities that integrate vast amounts of data from numerous structures and interfaces; thus, achieving high levels of performance requires a deep understanding of technology's innovative advantages, as well as the specific deployment requirements and inter-firm organizational readiness for implementation (Patsavellas *et al.*, 2021; Vlachos, 2021). While technology is critical to unlocking SCCTs' full potential, it is insufficient if organizational structures and processes are not in place to ensure synchronization. Taken as a whole, these elements form a set of critical success factors (CSFs), representing key areas and capabilities that management must prioritize to achieve superior organizational performance (Denolf *et al.*, 2015; Koh *et al.*, 2011; Talib and Hamid, 2014). Rad *et al.* (2022) contend that neglecting the identification and development of CSFs can negatively influence

the performance of advanced technology within supply chains, ultimately hindering their ability to generate stakeholder value.

Despite their considerable potential, current SCCT research is fragmented and lacks consensus on specific CSFs and functions required for successful deployment, particularly in the context of supply chain resilience (SCRES) (Salah El Din *et al.*, 2023; Trzuskawska-Grzesińska, 2017; Vlachos, 2021; Wyciślak and Pourhejazy, 2023). Recent research indicates supply chains face unprecedented levels of uncertainty and volatility, with disruptions becoming more frequent and severe (Patsavellas *et al.*, 2021; Küffner *et al.*, 2022; Son, 2023). Given the increasing complexity and vulnerability of global supply chains, which are highly interconnected and exposed to disruptions ranging from natural disasters to geopolitical tensions (Ponomarov and Holcomb, 2009; Hohenstein *et al.*, 2015), studies examining organizational capabilities allowing firms to sense and respond as unified supply chains are notably relevant. Moreover, the limited and disjointed literature on SCCTs highlights their abilities to enhance supply chain management (SCM) and reduce the impacts of market volatility; however, the specific ways in which SCCTs contribute to SCRES have yet to be fully explored (Topan *et al.*, 2020; Patsavellas *et al.*, 2021; Vlachos, 2021; Küffner *et al.*, 2022).

This research aims to address these gaps by investigating the relationship between SCCTs and SCRES, focusing on how SCCT CSFs contribute to resilience through collaborative decision-making, real-time visibility, risk management, and rapid resource reconfiguration. Additionally, this study posits that SCCTs are not only operational tools but strategic enablers of SCRES, capable of transforming the way firms navigate and mitigate supply chain risks. Thus, to investigate these unexplored areas, this study proposes the following research questions (RQs):

1. *RQ1: What CSFs are imperative for effectively operating high-performing SCCTs?*
2. *RQ2: How do SCCTs contribute to the development of SCRES?*

2. CONCEPTUAL BACKGROUND

2.1 Defining Supply Chain Control Tower

Conceptually, SCCTs are rooted in the paradigm of modern-day air traffic control towers, which maintain visibility and operational control over airfields and airspace (Vlachos, 2021). Patsavellas *et al.* (2021) characterize SCCTs as integrated information platforms promoting business-to-business assimilation, ensuring end-to-end (E2E) visibility, and leveraging advanced analytics for digital twin simulations. Works by Ye *et al.* (2022) and Salah El Din *et al.* (2023) depict SCCTs as dashboards merging artificial intelligence (AI), machine learning, internet of things, and data from disparate sub-databases within a supply chain, culminating in a single, authoritative “source of truth”. Additionally, Bhosle *et al.* (2011), Sheffi (2015), and Maheshwari *et al.* (2023) describe SCCTs as central nodes harmonizing procedures, technology, and human resources to enhance oversight and decision-making within supply chains.

Beyond control and transparency, SCCTs possess extensive capabilities essential for maintaining a competitive

advantage, reducing costs, and optimizing supply chain operations (Küffner *et al.*, 2022; Oliveira and Handfield, 2022). Moreover, SCCTs promote collaboration and trust-building among partners by jointly addressing risks and ensuring secure data sharing through the implementation of big data technology (BDT) (Ye *et al.*, 2022). Within SCCTs, information technology facilitates big data (BD) exchange among stakeholders, which is distinguished by substantial volume (massive, complex, and real-time datasets), high velocity (rapid generation, collection, and analysis), diverse variety (comprising different forms and types of data), veracity (indicating data quality and accuracy), and value (reflecting the potential to extract meaningful insights) (Gupta and George, 2016; Patil *et al.*, 2023). As such, BD provides little utility unless it is processed into meaningful information. The application of sophisticated algorithms and knowledgeable analysts creates a BD analytics (BDA) capability (Chen *et al.*, 2015; Biedova and Mahdikhani, 2023). Rad *et al.* (2022) assert that SCCTs can provide the core infrastructure for BDT and are strategically designed to produce BDA (Oliveira and Handfield, 2022; Xu and Pero, 2023; Zhang *et al.*, 2020).

By way of BDA, SCCTs assimilate enterprise data to create predictive and prescriptive assessments (Cemberci *et al.*, 2024). This enhanced knowledge-creation process facilitates informed decision-making and is made achievable by uninterrupted connectivity between supply chain stakeholders (Rad *et al.*, 2022; Vlachos, 2021). Providing a bridge connecting both systems and organizations enhances situational awareness, and contributes to both 'sensing' and 'sense-making' by detecting supply chain demand signals and abnormal supply deviations that lead to actionable business intelligence (Sheffi, 2015; Cemberci *et al.*, 2024).

Synthesizing these insights from existing literature, we conceptualize SCCTs as *inter-organizational systems integrating processes and technology that enable end-to-end supply chain visibility and risk assessment for automated and informed decision-making.*

2.2 Defining Supply Chain Resilience

The onset of the COVID-19 pandemic in 2020 marked an unprecedented surge in supply chain disruptions, sparking a parallel increase in academic interest in SCRES (Spieske and Birkel, 2021). Despite extensive research examining SCRES, its definition remains ambiguous, with no consensus on what characterizes a resilient supply chain (Hohenstein *et al.*, 2015; Wieland and Wallenburg, 2013). Viewpoints vary among researchers, with some interpreting SCRES as the ability to recover following a disruption, and others considering SCRES as supply chains' initial capacity to withstand unexpected events.

These varying perspectives align with Ponomarov and Holcomb's (2009) conception of SCRES as a multi-faceted capability encompassing three distinct phases: preparation for unforeseen events, response to disruptions, and recovery. In our study, we adopt Song *et al.*'s (2022) comprehensive framework, which builds upon Ponomarov and Holcomb's (2009) conceptualization of resilience by describing SCRES in four continuous, dynamic phases: (i) readiness, (ii) response, (iii) recovery, and (iv) renewal (please see **Figure 1**).

The readiness phase focuses on proactively establishing protocols and infrastructure to strengthen supply chains against potential disturbance (Sheffi, 2015). In this phase, strategic planning lays the groundwork for impact mitigation and expedited recovery, while ensuring supply chain continuity and fiscal stability (Ali and Gölgeci, 2019). Should a disruption occur, the response phase includes immediate post-disruption actions to stabilize supply chains and limit further adversity. Organizations should act swiftly and decisively, activating pre-defined strategies and mobilizing resources to address operational impacts (Ponomarov and Holcomb, 2009; Wieland and Wallenburg, 2012). In the subsequent recovery phase, firms focus on restoring operations to pre-disruption states (Spieske and Birkel, 2021). During this phase, supply chain performance steadily improves, to return to steady-state, normal operations (Song *et al.*, 2022). Finally, the renewal phase leverages learning during the disruption as an opportunity to codify improvements, fortify supply chains against similar future challenges, and transform adversity into an opportunity for growth (Hohenstein *et al.*, 2015).

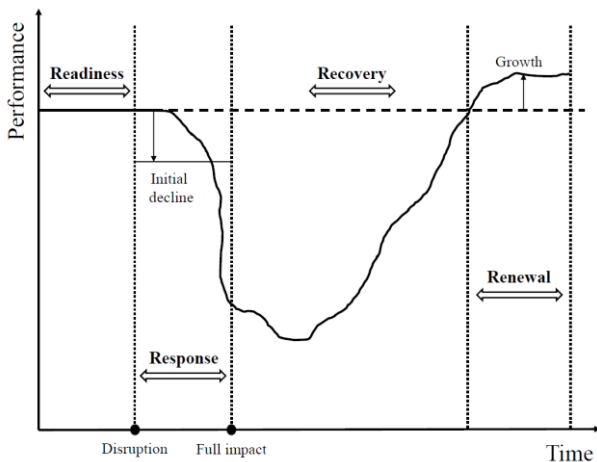


Figure 1 Phases of SCRES (adapted from Song *et al.*, 2022)

2.3 Theoretical Grounding

We use Dynamic Capabilities Theory (DCT) as the theoretical foundation underpinning our examination of SCCTs. DCT explains how organizations synthesize, cultivate, and recalibrate internal and external competencies to adapt to fast-paced environmental shifts (Eisenhardt and Martin, 2000; Teece *et al.*, 1997). SCCT effectiveness hinges on dynamic capabilities, resulting from CSFs, which are capable of adjusting supply chains in reaction to environmental changes. When confronted with disruption, the adaptability and responsiveness of SCCTs allow for an optimal reconfiguration of resources, thereby creating competitive advantages (Chen *et al.*, 2015; Weerabahu *et al.*, 2023). Moreover, Teece *et al.*'s (1997) framework on dynamic capabilities suggests competitive advantages in technology-intensive environments depend on technological, organizational, and managerial processes inside the firm. It is precisely this amalgamation of capabilities that SCCTs are extremely well-suited to execute both within and outside firm boundaries within the bounds of the supply chain. From this perspective, DCT provides a useful conceptual approach to pinpoint distinct capabilities for sustaining a competitive edge. It is in this vein, we conceptualize SCCT CSFs as

resources and capabilities that, when effectively combined, enable firms to adapt to dynamic market conditions.

3. METHODOLOGY

To address our research questions, we employed an evidence-informed, systematic literature review (SLR) methodology (Needleman, 2002). An SLR is a rigorous and structured approach to synthesizing findings across a body of literature in a reliable, unbiased, and comprehensive manner (Denyer and Tranfield, 2009). SLRs are particularly useful for gap analysis and delivering conclusions based on identified evidence and unknown assumptions. This systematic process outlays a repeatable approach to ensure impartiality and reliability in findings, as well as comprehensiveness in the review process (Tranfield *et al.*, 2003).

Our study employed the five-step SLR process described by Denyer and Tranfield (2009), as seen in **Figure 2**. Additionally, we executed a directed content analysis to formulate a theoretical framework of SCCT CSFs and clarify their roles in enhancing SCRES (Hsieh and Shannon, 2005). In combination, these two approaches strengthened methodological rigor while ensuring complete coverage of the relevant body of academic literature (Tranfield *et al.*, 2003).

3.1 Locating and Evaluating Studies

We developed key terms and search strings to maximize literature exposure and minimize risk of overlooking pertinent studies (Tranfield *et al.*, 2003). The search strings “control tower” AND “supply chain” were used in five databases recognized for their extensive coverage of peer-reviewed literature associated to our research questions: (i) ScienceDirect, (ii) Emerald Insight, (iii) Taylor & Francis Online, (iv) Wiley, and (v) EBSCOhost, yielding a total of 291 articles.

To further mitigate the risk of omitting relevant articles, we employed a snowball method to locate literature in less prominent sources (Greenhalgh and Peacock, 2005). Adhering to Jalali and Wohlin's (2012) snowballing guidelines, we identified additional articles through backward and forward tracking procedures. Backward tracking involves sourcing literature by examining article references, while forward tracking entails querying citation databases for research citing initially retrieved articles (Wohlin, 2014). These techniques contributed an additional 57 articles, as depicted in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram, adapted from Moher *et al.* (2009) (see **Figure 3**).

Despite the relative scarcity and fragmentation of research specifically on SCCT CSFs, extensive studies on CSFs associated with traditional BD initiatives provided a solid knowledge base, given SCCT's close association with BDT. Key findings from Kache and Seuring (2017), Rad *et al.* (2022), and Zhang *et al.* (2020) demonstrate SCCTs' reliance on BDT and BDA, leading us to explicitly consider BD, BDA, and BDT literature. These sources offered rich detail and explicit descriptions of CSFs applicable to SCCTs, and ultimately their role in developing SCRES.

After removing two duplicates, 289 articles obtained in our search were rigorously evaluated based on a set of defined selection criteria. We assessed titles, abstracts, and

keywords to determine relevance, removing articles unrelated to our research questions before adding articles sourced from snowballing. Our research team subsequently completed a detailed reading of each document to ensure alignment with the study's objectives. We retained articles whether they listed CSFs explicitly or implicitly suggested CSFs by pointing out barriers, challenges, and issues associated with SCCT performance. Finally, the remaining studies' overall quality and rigor were assessed by evaluating study design, data collection, and analysis, with the goal of retaining only high-quality research. While not an explicit selection criterion (owing to the scarcity of research in the field), studies published in A*, A, or B-rated journals from the Australian Business Deans Council's (ABDC) Journal Quality List 2023 were given positive evaluations (Al Humdan *et al.*, 2020). The ABDC journal ranking is a widely accepted standard used to assess quality within business and management research fields (Al Humdan *et al.*, 2020). When articles were not included in this list, a process of intercoder reliability (ICR) among the research team determined study quality. Following the approach recommended by Denyer and Tranfield (2009) for handling 'grey literature', the inclusion of these studies was important given the limited volume of SCCT research. These articles were often cited in subsequent A* and A-tier journal publications. After applying all inclusion and exclusion criteria, 47 articles were retained for inclusion and further analysis.

3.2 Analysis and Synthesis

After selection, our sample of literature was organized in a database for data extraction, in alignment with the approach described by Denyer and Tranfield (2009). The database cataloged article details, including title, author(s), source database, journal of publication, and publication date. After capturing this data, studies were individually analyzed to identify common themes, conclusions, and insights using a directed approach to content analysis, which is a structured method employed in qualitative research wherein specific theories or prior research guides coding and interpretation of textual data (Hsieh and Shannon, 2005). This theory-building approach was facilitated using MAXQDA 2023, following the three-step process outlined by Hina *et al.* (2022). This entailed: (i) initial coding of categories based on pre-existing research, (ii) development of axial codes through both inductive and deductive methods, and (ii) discussion and consensus among authors to confirm ICR and validity of axial codes. The culmination of this coding process led to the synthesis of coded segments, from which the most frequently discussed CSFs and their relationships were identified. After codifying our results, we further applied an abductive, theory extension approach using the lens of DCT to find explicit links between SCCT CSFs and SCRES.

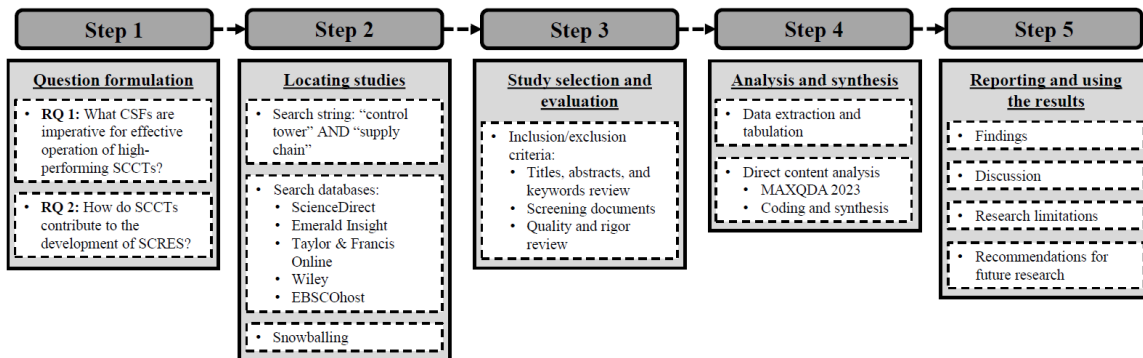


Figure 2 Systematic literature review methodology

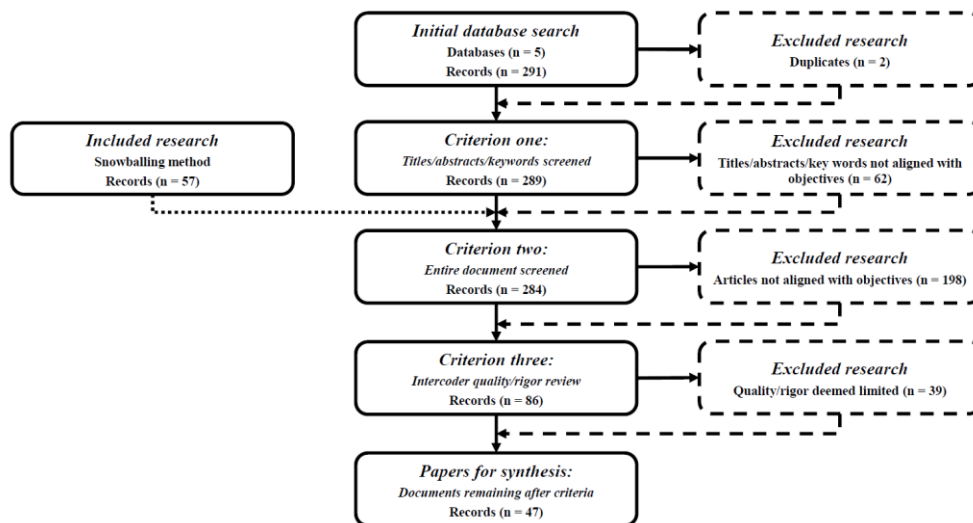


Figure 3 PRISMA diagram (search and selection process)

4. FINDINGS

4.1 Descriptive Analysis

Consistent with Tranfield *et al.* (2003), we provide a descriptive examination of our sample of literature. As depicted in **Figure 4**, the SLR’s timeframe spans from 2011 to 2023, with literature sourced from peer-reviewed journals, conference proceedings, a book, and consulting white paper. While no studies met our inclusion criteria prior to 2011, there was a noticeable uptick in volume of SCCT-related publications in 2018, underscoring growing academic and industry interest in SCCTs.

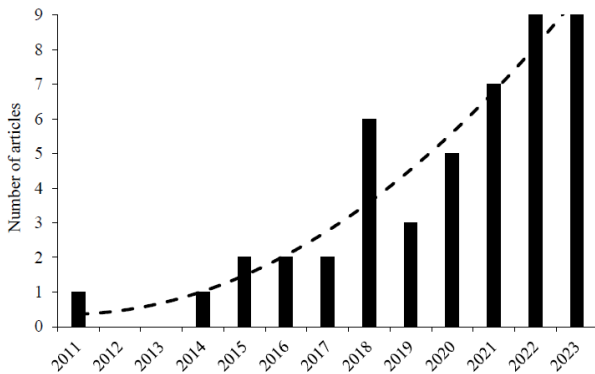


Figure 4 Distribution of selected studies

Academic articles constitute the majority of our sample (41, 87.2%), followed by conference papers (4, 8.5%), and a white paper and book chapter classified as “other” (2, 4.3%). A breakdown of journal articles reveals 35 appeared in ABDC-listed journals (74.5%), 6 of which were classified as ‘A*’ (12.8%), 25 as ‘A’ (53.2%), and 4 as ‘B’ (8.5%) (see **Figure 5**). Sample journals were cross-disciplinary, including articles in the fields of marketing, logistics, strategy, management, organizational behavior, business systems, and information systems. Journals with a notable number of contributions include *The International Journal of Logistics Management* (5, 10.6%), *International Journal of Physical Distribution and Logistics Management* (5, 10.6%), and *International Journal of Operations and Production Management* (3, 6.4%) (see **Table 1**).

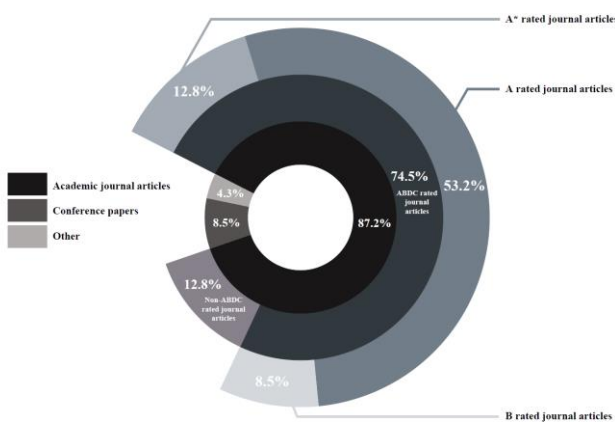


Figure 5 Distribution of literature

4.2 Supply Chain Control Tower Critical Success Factors

Firms garner a competitive edge by developing capabilities formed by way of integration and utilization of

various resources (Gupta and George, 2016). In the context of SCCTs, system capabilities and performance are contingent on CSFs alignment with supply chain strategy to maximize benefits (Xu and Pero, 2023). Rad *et al.* (2022) characterize CSFs as requisite conditions for value creation and threat mitigation, warning that insufficient attention can lead to problematic outcomes. Similarly, Denolf *et al.* (2015) emphasize system deployment requires presence, interactivity, and continuous management of CSFs. Furthermore, CSFs function as instruments improving competitive prowess and pinpointing pivotal issues in strategic evaluation (Talib and Hamid, 2014). Incorporating these perspectives, we define CSFs as *conditions that must be present, effectively implemented, and maintained to ensure successful organizational performance*. From the 47 articles shown in **Figure 3**, this SLR identifies 14 CSFs for high-performing SCCTs, as detailed in **Table 2**.

Bhosle *et al.* (2011) suggest SCCTs epitomize multi-tiered, multi-enterprise dynamic capabilities, merging people, processes, and technological elements enhancing supply chain transparency and oversight. Building on this notion, Gupta and George (2016) assert firms not only require CSFs to establish high-performing SCCTs but must regularly invest in CSF resources to adapt to changing requirements. Further, they emphasize integration of technological resources with organizational and process CSFs results in performance improvements. Without resource investment and integration, SCCTs will fail to reach their performance potential. Thus, in order to classify CSFs and to inform resource investment decisions, we group CSFs along organizational, process, and technological (OPT) dimensions (see **Figure 6**).

The OPT framework depicts SCCT performance as relying on balanced prioritization and synchronization of CSFs, and indicates focus on a singular dimension may result in suboptimal outcomes (Rad *et al.*, 2022; Vlachos, 2021). For example, if firms are equipped with advanced technology and data resources, they may still achieve suboptimal SCCT performance if they lack managerial support and analytical expertise (Gupta and George, 2016). Likewise, employing process CSFs singularly or independently is less efficient than with support from organizational and technological CSFs. The three-pillar diagram depicted in **Figure 6** expresses that weakening any single OPT pillar degrades a SCCT’s integrative capacity. Thus, organizations should identify opportunities and prioritize resources across OPT dimensions. The interconnected nature of the OPT framework emphasizes balance across all three dimensions to achieve superior SCCT performance.

4.3 Organizational Critical Success Factors

SCCT performance hinges considerably on top management commitment, which entails more than just tacit approval or resource allocation from an organizations’ highest echelons of leadership. Effective top management commitment involves active participation, calculated oversight, clear and consistent communication, and development of an organizational culture understanding and competently leveraging SCCT capabilities (Lamba and Singh, 2018; Maroufkhani *et al.*, 2020; Patil *et al.*, 2023; Sodero *et al.*, 2019). Senior leader support shapes firm

trajectory and readiness by articulating strategic objectives in preparation for organizational transformation and acceptance of SCCT technology (Salah El Din *et al.*, 2023; Sony and Naik, 2020; Weerabahu *et al.*, 2023). Additionally, top management involvement facilitates protocol standardization and provides guidance on the what, when, and how employees derive insight from data (Chen *et al.*, 2015).

4.3.1 Organizational Readiness

SCCT initiatives involve adopting new systems, strategies, and processes; thus, firms must demonstrate readiness to implement change (Maroufkhani *et al.*, 2020; Weerabahu *et al.*, 2023). Organizational readiness is the preparedness and ability to manage change in terms of physical infrastructure, culture, mindset, and practices, to fully take advantage SCCT capabilities (Lamba and Singh, 2018). Organizational readiness is often reflected in employees’ willingness to engage in transformational shifts involving these organizational attributes (Kache and Seuring, 2017; Patil *et al.*, 2023). New technologies often drive demand for new IT skills and critical thinking among staff, a shift potentially sparking employee resistance (Sony and Naik, 2020; Vlachos, 2021). Maroufkhani *et al.* (2020) and Richey *et al.* (2016) suggest fostering organizational allegiance and readiness towards SCCT acceptance, proficiency, and coherence can be achieved through training and education promoting SCCT acclimatization.

4.3.2 Human Capital

Insights captured from BDT are of limited value if supply chain decision-makers cannot interpret them; thus, making human capital development a priority (Lamba and Singh, 2018). Human capital comprises the collective pool of expertise, competencies, judgment, and experiential wisdom within individuals or groups (Weerabahu *et al.*, 2023; Xu and Pero, 2023). SCCTs are technologically and process-driven; however, their success ultimately depends on people who manage, operate, and interact with these systems. Thus, SCCT performance is closely tied to the workforce’s specialized knowledge, unique skills, and ongoing development (H. Gupta *et al.*, 2021; Richey *et al.*, 2016). Human capital is a fundamental element of SCCTs, touching all facets from routine operations to overarching

strategic vision. Chen *et al.* (2015) and Rad *et al.* (2022) reinforce the importance of staff proficient in advanced analytical techniques, noting that the lack of personnel adept at interpreting, assessing, and applying BDA for decision-making presents an obstacle when leveraging SCCTs for supply chain value enhancement.

4.3.3 Partner Trust

SCCTs primarily produce value by advancing collaboration, communication, and information sharing within supply chain networks, processes relying on mutual trust among partners (Oliveira and Handfield, 2022). Given the complexity and interconnectedness of modern supply chains, partner trust—the confidence firms have in supply chain counterparts to act dependably and transparently—emerges is an indispensable asset for SCCTs, especially considering the prevalence of data security and leakage of proprietary concerns (Kache and Seuring, 2017; Richey *et al.*, 2016). Insufficient trust can impede real-time data sharing, potentially resulting in gaps and introducing bias into BDA (Maheshwari *et al.*, 2023; Roßmann *et al.*, 2018). Prioritizing transparency and communication regarding privacy and data usage is critical for maintaining confidentiality, aligning partner actions with shared goals, and bolstering trust, all of which undergirds SCCT performance (Plasch *et al.*, 2021).

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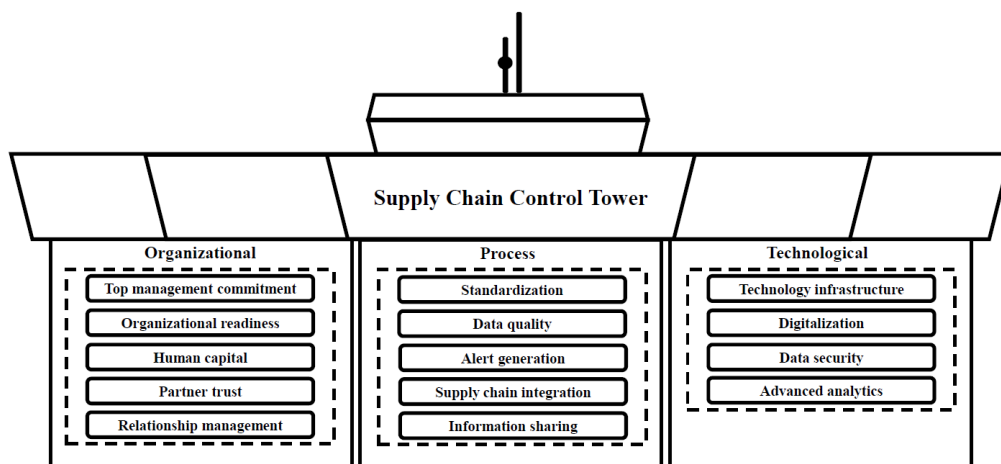


Figure 6 OPT framework for CSFs in high-performing SCCTs

Table 1 Distribution of research articles by field of research

	Field of research:	Journal/source:	ABDC rating:	No. of articles:	%:
1	Marketing/tourism/logistics	<i>The International Journal of Logistics Management</i>	A	5	10.6%
2		<i>International Journal of Physical Distribution & Logistics Management</i>	A	5	10.6%
3		<i>Industrial Marketing Management</i>	A*	1	2.1%
4		<i>Journal of Business Logistics</i>	A	1	2.1%
5		<i>Supply Chain Management: An International Journal</i>	A	1	2.1%
6		<i>International Journal of Logistics: research and applications</i>	B	1	2.1%
8		<i>GeoForum</i>	--	1	2.1%
9		<i>International Conference on Industrial Engineering and Operations Management</i>	--	1	2.1%
10		<i>Sustainable Marketing, Branding, and Reputation Management</i>	--	1	2.1%
11		<i>Capgemini consulting white paper</i>	--	1	2.1%
Total:					18
12	Strategy, management, and organizational behavior	<i>International Journal of Operations & Production Management</i>	A	3	6.4%
13		<i>European Journal of Operational Research</i>	A*	2	4.3%
14		<i>Production Planning and Control</i>	A	2	4.3%
15		<i>International Journal of Production Economics</i>	A	1	2.1%
16		<i>Journal of Cleaner Production</i>	A	1	2.1%
17		<i>MIT Sloan Management Review</i>	A	1	2.1%
18		<i>Benchmarking: An International Journal</i>	B	2	4.3%
19		<i>Journal of Economics and Management</i>	--	1	2.1%
20		<i>Sustainable Manufacturing and Service Economics</i>	--	1	2.1%
21		<i>International Conference on Decision Support System Technology</i>	--	1	2.1%
Total:				15	31.9%
22	Business systems in context	<i>Technological Forecasting and Social Change</i>	A	2	4.3%
23		<i>Computers & Industrial Engineering</i>	A	1	2.1%
24		<i>International Journal of Project Management</i>	A	1	2.1%
25		<i>The Milbank Quarterly</i>	B	1	2.1%
26		<i>IET Collaborative Intelligent Manufacturing</i>	--	1	2.1%
27		<i>Journal of Business Forecasting</i>	--	1	2.1%
28		<i>Frontiers in Energy Research</i>	--	1	2.1%
Total:				8	10.6%
29	Information systems	<i>Information & Management</i>	A*	1	2.1%
30		<i>Journal of Management Information Systems</i>	A*	1	2.1%
31		<i>International Journal of Information Management</i>	A*	1	2.1%
32		<i>Industrial Management & Data Systems</i>	A	1	2.1%
34		<i>International Conference on Computing, Power and Communication Technologies</i>	--	1	2.1%
35		<i>International Conference on Computers in Management and Business</i>	--	1	2.1%
Total:				6	6.4%
Sum total:				47	100%

Notes: "--" delineates research not published in an ABDC rated journal

Table 2 List of CSFs for high-performing SCCTs derived from the literature review

Critical success factor:	Article																							
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]
Advanced analytics	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Alert generation	X	X	X					X							X			X		X	X		X	X
Data quality	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Data security						X	X	X				X	X	X	X			X	X			X	X	X
Digitalization								X				X	X											
Human capital	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X
Information sharing	X	X	X	X	X	X	X	X	X	X	X	X	X			X		X		X	X	X	X	X
Organizational readiness	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
Relationship management	X	X	X	X	X	X	X	X	X	X	X	X	X			X								
Supply chain integration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		
Partner trust						X	X					X						X	X					
Standardization	X	X	X		X	X	X	X			X		X	X				X						X
Technology infrastructure	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Top management commitment	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X					

Sources: 1. Bhosle *et al.* (2011), 2. Braglia and Frosolini (2014), 3. Chen *et al.* (2015), 4. Sheffi (2015), 5. Gupta and George (2016), 6. Richey *et al.* (2016), 7. Kache and Seuring (2017), 8. Trzuskawska-Grzesińska (2017), 9. Brinch (2018), 10. Brinch *et al.* (2018), 11. Lai *et al.* (2018), 12. Lamba and Singh (2018), 13. Roßmann *et al.* (2018), 14. Sony and Naik (2018), 15. Folkers and Stenmanns (2019), 16. Handfield *et al.* (2019), 17. Sodero *et al.* (2019), 18. Handfield *et al.* (2020), 19. Maroufkhani *et al.* (2020), 20. Topan *et al.* (2020), 21. Verma *et al.* (2020), 22. Zhang *et al.* (2020), 23. Fearne *et al.* (2021), 24. Finkenstadt and Handfield (2021)

Table 3 (Continued) List of CSFs for high-performing SCCTs derived from the literature review

Critical success factor:	Article																							
	[25]	[26]	[27]	[28]	[29]	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]	[40]	[41]	[42]	[43]	[44]	[45]	[46]	[47]	
Advanced analytics	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	
Alert generation		X	X		X	X	X	X				X	X	X	X		X		X					
Data quality	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Data security	X		X		X		X		X			X			X		X	X		X				
Digitalization	X		X	X	X				X	X	X	X		X	X		X	X		X		X	X	
Human capital	X		X		X	X	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	
Information sharing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Organizational readiness	X		X		X		X	X		X							X	X	X				X	
Relationship management	X	X		X	X		X	X	X	X						X	X	X	X			X	X	
Supply chain integration	X	X	X	X	X				X	X	X	X	X		X		X	X	X	X	X	X	X	
Partner trust	X		X	X	X		X	X				X					X							
Standardization				X	X		X		X			X					X	X	X	X			X	
Technology infrastructure	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Top management commitment	X	X	X		X		X	X	X				X			X	X	X	X	X	X	X	X	

Sources: 25. Gupta *et al.* (2021), 26. Ivanov and Dolgui (2021), 27. Patsavellas *et al.* (2021), 28. Plasch *et al.* (2021), 29. Vlachos (2021), 30. Gerrits *et al.* (2022), 31. Küffner *et al.* (2022), 32. Oliveira and Handfield (2022), 33. Rad *et al.* (2022), 34. Smith (2022), 35. Syahchari *et al.* (2022), 36. Tan *et al.* (2022), 37. Vlachos (2022), 38. Ye *et al.* (2022), 39. Dey (2023), 40. Ma *et al.* (2023), 41. Maheshwari *et al.* (2023), 42. Patil *et al.* (2023), 43. Salah El Din *et al.* (2023), 44. Weerabahu *et al.* (2023), 45. Wyciąsłak and Pourhejazy (2023), 46. Xu *et al.* (2023), 47. Xu and Pero (2023)

4.3.4 Relationship Management

Aligning supply chain decisions involving actors with diverse perspectives is challenging, making relationship management imperative for SCCT's success. Relationship management involves deliberate assessment, oversight, and fostering of interactions among the involved supply chain entities (Handfield *et al.*, 2019; Weerabahu *et al.*, 2023). This practice, further detailed by Kache and Seuring (2017), Küffner *et al.* (2022), and Rad *et al.* (2022), is abetted by selecting partners whose business objectives, cultural values, technological vision, strategies, and operational activities are closely aligned and compatible. Beyond selecting partners, effective relationship management enables SCCTs to leverage the collective capabilities of all parties involved, facilitating the achievement of shared goals and the collaborative resolution of shared risks

4.4 Process Critical Success Factors

Within the SCCT framework, optimal planning and execution require partners conforming to predefined standards to bolster information-sharing and data analysis (Vlachos, 2021; Xu *et al.*, 2023). Standardization refers to fashioning and executing consistent practices, procedures, and protocols throughout the supply chain (Bhosle *et al.*, 2011; Brinch, 2018). Standardized processes promote heightened compatibility and increase inclination towards greater supply chain cooperation (Richey *et al.*, 2016). The principal goal of standardization is to instill uniformity, reduce variability, and boost SCCT production. Adherence to standards, particularly in the technological domain, expedites information aggregation in SCCTs, yielding informed decision-making (Lamba and Singh, 2018; Trzuskawska-Grzesińska, 2017).

4.4.1 Data Quality

SCCT performance is predicated upon intelligent use of quality data, characterized by accuracy, validity, relevance, and real-time collection from various sources (Kache and Seuring, 2017; Lamba and Singh, 2018; Maheshwari *et al.*, 2023; Roßmann *et al.*, 2018). Sub-functions within SCCTs, including predictive analytics, status monitoring, and alert dissemination, rely heavily on high-quality data (Finkenstadt and Handfield, 2021; Gerrits *et al.*, 2022). Moreover, real-time data promotes SCCT effectiveness by empowering managerial agility in decision-making, risk mitigation, and averting unnecessary costs (Dey, 2023; Patil *et al.*, 2023). Conversely, absence of reliable and timely data can lead to miscalculations and proliferation of faulty or outdated information throughout supply chain networks. Such a scenario preempts flawed managerial decisions, often detrimentally impacting system performance and producing lasting repercussions (Oliveira and Handfield, 2022; Richey *et al.*, 2016; Vlachos, 2021). Despite the challenges of ensuring the velocity, veracity, volume of BD, high data quality is feasible by enforcing rigorous standards, stringent data security, and investment in BDT (Handfield *et al.*, 2019; Küffner *et al.*, 2022).

4.4.2 Alert Generation

A fundamental feature built-in to SCCTs is the automatic generation of system alerts when predefined conditions, such as violation of performance thresholds or

potential supply chain disruptions, are detected (Gerrits *et al.*, 2022; Topan *et al.*, 2020). These alerts, which are based on pre-defined business rules, call for immediate action when shared data indicate inventory shortages or other anomalies, promoting agile decision-making and visibility across the supply chain (Braglia and Frosolini, 2014; Dey, 2023; Handfield *et al.*, 2019). In response to these alerts, SCCTs can programmatically manage minor issues or provide supply chain managers with calculated solutions for more complex challenges, including stock replenishment, distribution adjustments, or sourcing from alternative suppliers (Küffner *et al.*, 2022; Trzuskawska-Grzesińska, 2017; Vlachos, 2021). Additionally, SCCTs use alerts to improve stakeholder communication, enabling mass notifications supporting joint resolutions and continuous process optimization (Patsavellas *et al.*, 2021; Vlachos, 2022).

4.4.3 Supply Chain Process Integration

Synchronization of amassed data from diverse sources in SCCTs requires seamless union and communication between disparate IT systems (e.g., enterprise resource planning, transportation management, and warehouse management systems) (Tan *et al.*, 2022; Verma *et al.*, 2020). Harmonization is accomplished through supply chain integration, or the alignment and interlinking of actors, processes, systems, and information flows among entities within supply chains (Brinch, 2018; Syahchari *et al.*, 2022). Rad *et al.* (2022) stress the importance of data integration and interoperability of SCCTs to fully harness the power of BD. Data integration entails compiling large and dynamic datasets across the supply chain, enabling SCCTs to conduct and disseminate BDA (Chen *et al.*, 2015; Lamba and Singh, 2018; Oliveira and Handfield, 2022).

4.4.4 Information Sharing

SCCTs leverage shared information to continuously disseminate supply chain knowledge, alert stakeholders concerning potential risks, and mitigate bullwhip effects in the supply-demand continuum (Patsavellas *et al.*, 2021). Real-time information sharing enhances the efficacy of interaction with supply chain partners, considerably augmenting visibility, improving decision-making processes, and reinforcing collaboration within and across organizational boundaries (Dey, 2023; Ivanov and Dolgui, 2021; Sheffi, 2015; Verma *et al.*, 2020). Accordingly, each supply chain actor is encouraged to proactively share information with partners to improve data availability, evaluation, and application (Kache and Seuring, 2017; Lai *et al.*, 2018). When data security concerns and mistrust are addressed, firms are more likely to participate in cross-organizational information sharing, leading to more cooperative and transparent supply chain environments (Küffner *et al.*, 2022; Ye *et al.*, 2022).

4.5 Technological Critical Success Factors

Technological CSFs involve harnessing technological advancements to enhance supply chain performance. SCCTs require advanced technology for gathering, processing, securing, and analyzing data to ensure information connectively, reliability, and awareness (Rad *et al.*, 2022). The components for this dimension include *technology*

infrastructure, digitalization, data security, and advanced analytics (Fearne *et al.*, 2021; Xu and Pero, 2023).

4.5.1 Technology Infrastructure

SCCT performance is deeply anchored to IT ensuring unity between human resources and procedural methodologies (Küffner *et al.*, 2022). At the heart of this framework lies technology infrastructure, consisting of software and hardware systems executing data collection, storage, analysis, and circulation (Brinch, 2018). SCCTs integrate multitudes of emerging technologies to transform BD into intelligible information and grant end-to-end supply chain visibility (Küffner *et al.*, 2022). Without adequate technology infrastructure, BDA, data throughput, and data security become extremely challenging, posing risks to SCCT viability (Bhosle *et al.*, 2011; Patil *et al.*, 2023). Technology is the cornerstone of SCCTs, allowing near-instantaneous exchange and coherence of information between upstream and downstream entities (Vlachos, 2022).

4.5.2 Digitalization

Digitalization acts as a catalyst for unlocking SCCTs' full potential, facilitating data acquisition, analysis, and management activities (Sony and Naik, 2020). It entails transforming traditional supply chain operations into streamlined, technology-driven, and automated workflows (Dey, 2023; Vlachos, 2022). Digitalizing technology and processes provides SCCTs the intelligence to utilize data-driven insights and, as a result, markedly enhances the responsiveness, real-time communication, and transparency of supply chains (Vlachos, 2021). Digital encoding not only facilitates more efficient production processes, but also substantially increases supply chain adaptability in the face of changing market conditions and customer demands (Gupta *et al.*, 2021; Patil *et al.*, 2023). In an era of rapid technological advancement, digitalization is no longer optional but rather is a foundational requirement of SCCT success.

4.5.3 Data Security

SCCT integrity depends on secure management and manipulation of BD. Data security is the protocols and strategies enforced to protect data exchanged among supply chain entities from unauthorized access, corruption, or theft (Maroufkhani *et al.*, 2020; Richey *et al.*, 2016). Given SCCTs bridge numerous disparate stakeholders, they typically witness the flow of large amounts of sensitive and proprietary information (Kache and Seuring, 2017). Ensuring data security and privacy in collection, storage, and processing phases precipitate information exchange, collaboration, and trust amongst supply chain partners (Lamba and Singh, 2018; Vlachos, 2021). Due to the interdependent nature of SCCTs, partners should adhere to consensus-driven security standards, guaranteeing security of the entire network (Folkers and Stenmanns, 2019; Kache and Seuring, 2017; Sony and Naik, 2020).

4.5.4 Advanced Analytics

Advanced analytics are the intelligence converting data into strategic insights that ultimately drive the performance and competitive advantage derived from SCCTs (Maheshwari *et al.*, 2023). Analytics refer to sophisticated, technology-driven methods of analyzing data, including both

predictive and prescriptive techniques (Patsavellas *et al.*, 2021). SCCT analytical tools (i.e., BDA) are proficient at extracting and instantaneously processing real-time data from supply chain ecosystems into actionable insights (Brinch, 2018; Smith, 2022). This data transformation assists with problem-solving, anomaly detection, strength and vulnerability evaluation, and predictive supply chain event simulation (Dey, 2023; Patil *et al.*, 2023). Predictive analytics, exemplifying one of SCCT's most dynamic capabilities, empowers firms to monitor environmental impacts, anticipate potential disruptions, and strategize for operational efficiency and cost reduction (Oliveira and Handfield, 2022).

4.6 Supply Chain Control Towers and Supply Chain Resilience

Drawing on Song *et al.* (2022), we acknowledge four distinct phases of supply chain disruption and recovery with relevance to SCRES: readiness for unexpected events, response to disruption, recovery to a stable state, and renewal exceeding initial performance benchmarks. Studies by Ali and Gölgeci (2019), Hohenstein *et al.* (2015), Ponomarov and Holcomb (2009), Spieske and Birkel (2021), and Wieland and Wallenburg (2012) examine enablers of SCRES within each of the core phases of disruption. From these studies, we identify four key enablers of SCRES in the various phases of disruption: *collaboration, risk management, agility and flexibility, and visibility*. These enablers play distinct, yet interconnected, functions foundational to developing resilient supply chains before, during, and after disruption.

Through the lens of DCT, firms looking to reinforce SCRES must develop dynamic capabilities harnessing and integrating resources to stave off deleterious effects of disruption and quickly recover. Functionally, SCCTs perform this integrating function for the supply chain. They do not directly generate SCRES; rather, they enforce specific SCRES enablers through collective efforts of the previously identified CSFs (Dey, 2023; Küffner *et al.*, 2022; Salah El Din *et al.*, 2023). Thus, for SCCTs to contribute to a firm or group of firms' SCRES, they must demonstrate the ability to execute core functions leading to greater *collaboration, risk management, agility and flexibility, and visibility*.

Our proposed model (see **Figure 7**) depicts how SCCT CSFs contribute to the four key SCRES enablers during each phase of a supply chain disruption. This framework emphasizes a holistic approach, wherein SCCTs facilitate a seamless transition through the phases of SCRES—*readiness, response, recovery, and renewal*—thereby ensuring supply chains are not only resilient in the face of disruption, but are also positioned for sustainable growth and competitiveness. Based on our sample of literature, links between CSFs and SCRES enablers and phases are explicitly mapped in **Figure 8**, depicting their most salient relevance. The next section succinctly discusses the most important relationships illustrated below.

4.6.1 Collaboration

Regardless of whether operations are routine or abnormal, SCCTs consistently maintain an enhanced collaborative environment. *Collaboration* is the cooperative movement of supply chain stakeholders uniting to pursue

shared objectives and contributes to both the *respond* and *recovery* phases of disruption (Ali and Gölgeci, 2019; Spieske and Birkel, 2021; Wieland and Wallenburg, 2013). SCCTs empower stakeholder collaboration by facilitating better communication, information exchange, risk dispersal, and consolidation of resources and capabilities. In this vein, SCCTs facilitate coordinated and collective responses minimizing disruption impacts and development of unified approaches to recovery (Dey, 2023; Küffner *et al.*, 2022). Moreover, through more secure data transfer and greater partner trust, SCCTs alleviate data exposure concerns which further promote consensus-driven action when navigating disruptions (Patsavellas *et al.*, 2021; Plasch *et al.*, 2021; Roßmann *et al.*, 2018).

4.6.2 Risk Management

By harnessing BDA and predictive modeling, SCCTs ideally identify patterns and foresee potential risks

promoting proactive rather than reactive risk management strategies (Ivanov and Dolgui, 2021). In this context, *risk management* involves identification, evaluation, and mitigation of risks ensuring operational continuity and reliability across supply chains (Ye *et al.*, 2022). As a potential focal point of a supply chain’s *risk management* culture, SCCTs can be used to develop and execute risk mitigation strategies and strengthen the supply chain in the *readiness* and *renewal* phases of disruption (Vlachos, 2021). Serving as a central platform for risk intelligence and decision support, SCCTs advance risk management practices by equipping supply chain managers with the tools and information needed to anticipate and adapt to hazardous situations (Finkenstadt and Handfield, 2021; Küffner *et al.*, 2022).

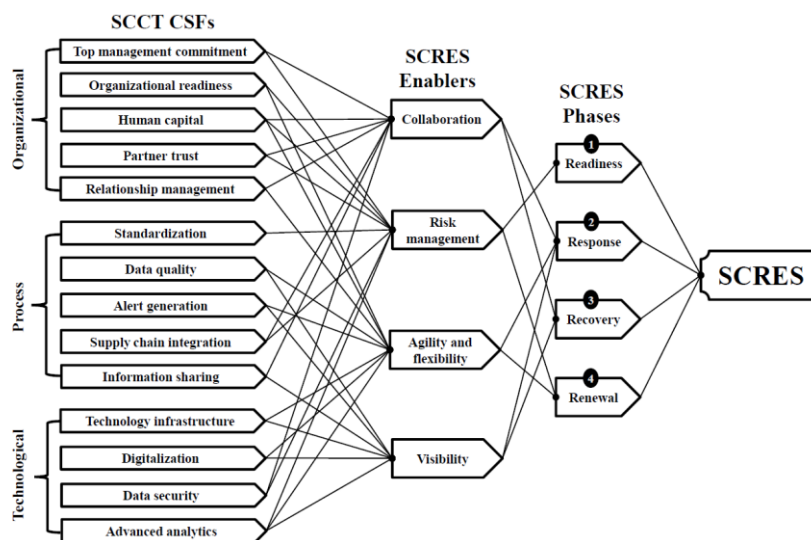


Figure 7 Depiction of SCCT CSFs activating SCRES enablers and phases

4.6.3 Agility and Flexibility

The integrated nature of SCCTs inherently improve an otherwise disjointed supply chain’s *agility and flexibility*, enabling more responsive and adaptable supply chain environments (Oliveira and Handfield, 2022). In line with DCT, rapid tactical adjustments and operational reconfigurations assist in navigating market shifts or unexpected disruptions (Bhosle *et al.*, 2011; Patsavellas *et al.*, 2021). This capability is important during the *response* and *renewal* phases of disruption. SCCTs provide the means for agile and flexible decision-making by way of real-time data integration, allowing managers to monitor and make sense of evolving supply chain conditions and rapidly revise logistics and routing (Salah El Din *et al.*, 2023). Synergy created by technology, data, and human analysts allow autonomous adjustments or swiftly implemented manual solutions, such as rerouting shipments or changing suppliers (Bhosle *et al.*, 2011; Vlachos, 2021). The ability to conduct predictive analytics in real-time both fortifies supply chain responsiveness in the face of unforeseen events (Maroufkhani *et al.*, 2020; Rad *et al.*, 2022; Trzuskaawska-Grzesińska, 2017) and supports learning allowing supply chains to robustly equip themselves to overcome in preparation for future complex events (Küffner *et al.*, 2022).

4.6.4 Visibility

A key capability of SCCTs is delivery of end-to-end supply chain *visibility* necessary for disruption *response* and *recovery* (Kache and Seuring, 2017). Supply chain *visibility* is a product of SCCT technological infrastructure and procedural execution granting near-instantaneous access to relevant information in every facet of the supply chain, from initial sourcing to final delivery (Küffner *et al.*, 2022; Plasch *et al.*, 2021; Trzuskaawska-Grzesińska, 2017; Vlachos, 2022). SCCTs generate *visibility* by aggregating supply chain stakeholder data and transforming it through BDA into insightful information, which is then shared between each stakeholder (Handfield *et al.*, 2019; Patsavellas *et al.*, 2021). Moreover, alert generation capabilities enhance visibility by spotlighting irregularities, such as logistical delays or inventory deficits, thereby prompting managers to initiate corrective measures (Finkenstadt and Handfield, 2021; Tan *et al.*, 2022). In this way, SCCTs enable transparency of physical product, information, and financial flows leading to better-informed decision-making and increased responsiveness (Plasch *et al.*, 2021).

5. DISCUSSION

Our study identifies CSFs necessary for high-performing SCCTs, as well as their relationship with SCRES

through the perspective of DCT. The SLR and content analysis emerged a portfolio of three distinctive OPT dimensions, and demonstrated how SCCTs can be the physical entities integrating collective bundles of resources, capabilities, and conditions that ultimately bolster SCRES. The following section discusses both the theoretical and practical implications of our results, detailing how examining SCCT CSFs significantly enriches SCM literature. Additionally, it establishes a solid foundation for future research by bridging the relational gaps between SCCT CSFs and enhanced supply chain performance.

5.1 Theoretical Contributions

Our review advances theoretical knowledge by offering two distinct contributions to SCM and SCCT research. First, we identify and analyze 14 distinct, yet interrelated, CSFs essential in high-performing SCCTs. These CSFs are categorized into one of three OPT dimensions: (i) organizational, (ii) process, and (iii) technological. Drawing from the SLR literature, we argue SCCTs cannot neglect CSFs in any single OPT dimension, as these dimensions work interdependently to achieve SCCT performance (Bhosle *et al.*, 2011; Gupta and George, 2016).

As such, our research findings indicate SCCT CSFs do not function in isolation; rather, they exhibit complex interactions and interconnections. To explore these dynamics, we conducted a content analysis examining relationships and mutual influences among the 14 CSFs. This analysis involved a detailed scrutiny of the literature to identify linkages between CSFs. For example, Vlachos' (2021) observation that "trust is paramount for information sharing and supplier involvement" highlights the link between *partner trust* and *information sharing*.

As we observed relationships between CSFs in the studies included in our SLR, we documented both the nature of these relationships and the directionality of any influence. We then summed the counts of these relationships to quantitatively assess the proportional degree these relationships appeared in our sample, which is represented in the causal loop diagram (see **Figure 8**). The diagram's directional arrows indicate either direct or reciprocal influences as identified in various studies, while different line styles specify the frequency and strength of these relationships in the literature.

All CSFs contribute significantly to SCCT performance; yet, our causal loop diagram offers deeper insight into how this happens and which CSF combinations are most effective. **Figure 8**, for example, illustrates how *top management commitment* influences *organizational readiness*, *human capital*, and *technology infrastructure* — all essential in executing *advanced analytics*. *Top management commitment* emerges as a pivotal CSF, influencing almost all others while being unaffected by them. Additionally, the number of CSFs influencing both *advanced analytics* and *information sharing* suggests that these two are the key, tangible outputs of SCCTs. Lastly, the strong links (solid arrows) between *technological infrastructure* and these outputs stress its role in transforming CSF interactions into actionable capabilities.

In essence, **Figure 8** captures how CSFs are intricately woven together, reinforcing the notion that collective integration across all OPT CSFs is fundamental for superior SCCT performance. This framework stresses the importance of a robust foundation built on leadership and innovative technology, which enables subsequent development of analytical tools and collaborative practices within SCCTs.

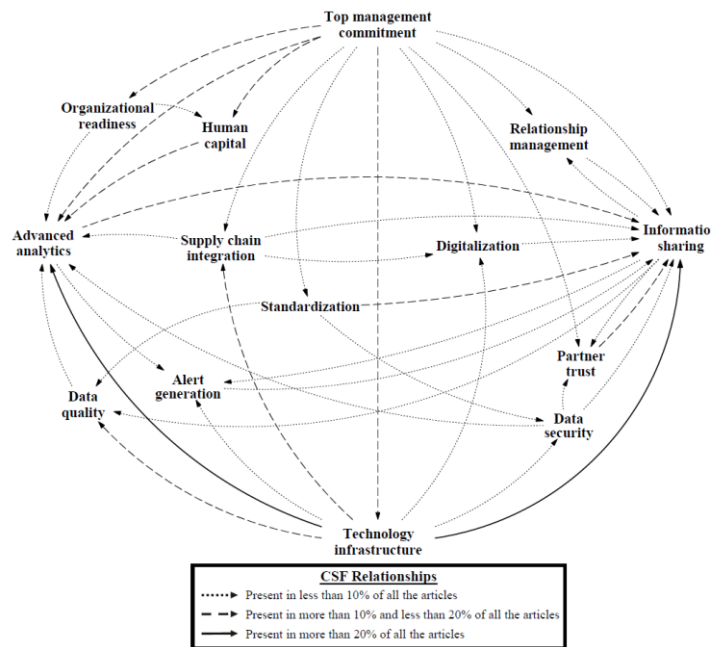


Figure 8 Relationships among SCCT CSFs

Second, this study offers novel insight into how SCCTs lead to the development of SCRES. Experts interviewed by Küffner *et al.* (2022) assert supply chain disruption intensifies the need to bolster SCRES by way of relationship, technology, and organizational integration. Accordingly, dynamic capabilities developed and executed through

SCCTs reinforce this integration across firm boundaries and support SCRES enablers, including *collaboration*, *risk management*, *agility and flexibility*, and *visibility*. Each of these enablers contribute to SCRES within the *readiness*, *response*, *recovery*, and *renewal* phases of supply chain disruption. In this context, our SLR complements existing

literature offering detail on how specific resources and capabilities should be identified, understood, and invested in to bolster SCRES. The framework we propose advocates an extensive approach to SCM, positioning SCCTs as a pivotal tool for advancing the field of research (Rad *et al.*, 2022).

5.2 Practitioner Implications

In addition to the theoretical contributions, our study provides actionable insights for supply chain practitioners. Beyond providing standard definitions and understanding of SCCTs found in literature, our framework highlights the collective investment areas in each OPT dimensions to amplify system performance. Using our framework, firms can identify areas of underinvestment, and thus avoid potential pitfalls related to an over- or under-concentration within a single OPT dimension. Moreover, utilization of this framework may direct practitioners towards complimentary CSFs that bolster an inherent SCCT weakness or further augment an area of strength.

It has been proposed that high-performing SCCTs can be tactically implemented to address specific industry challenges and enhance overall supply chain performance (Ma *et al.*, 2023; Salah El Din *et al.*, 2023). Practitioners can employ our framework as a blueprint to evaluate strengths, weaknesses, opportunities, and threats to the implementational success of SCCTs and align investment strategies with stakeholder interests (Rad *et al.*, 2022). For example, firms can proactively identify and address inherent weaknesses and threats in their supply chain, and then use this study's framework to build a high-performing SCCT that ultimately improves supply chain performance.

Our study additionally benefits practitioners by illustrating the role of SCCT CSFs in developing SCRES. SCCTs assist managers in rapidly reconfiguring resources and reducing dependency risks, promoting supply chain agility and flexibility (Handfield *et al.*, 2020; Ivanov and Dolgui, 2021). This study reveals CSFs enabling SCCTs to facilitate collaborative response, recovery, and renewal from emerging challenges (Küffner *et al.*, 2022).

Finally, we highlight how SCCT *technological infrastructure* and *alert generation* can assist firms in achieving end-to-end supply chain visibility and monitoring, an important aspect of early anomaly detection and proactive intervention (Handfield *et al.*, 2019; Patsavellas *et al.*, 2021). By combining experienced data analysts with powerful BDA, SCCTs allow practitioners to foresee demand fluctuation, supply shortages, and logistical challenges. With this knowledge, practitioners can engage in preemptive risk management and employ adaptive responses, fortifying supply chains pre-disruption and evolving to a higher post-recovery standard (Syahchari *et al.*, 2022). The explanation of links between SCCT CSFs and SCRES enablers affords practitioners a comprehensive approach when aiming to strengthen their supply chains against unforeseen risks.

5.3 Limitations and Directions for Future Research

While we offer implications for both SCM researchers and practitioners, we should acknowledge this study's limitations. First, we found a relatively limited set of literature examining SCCTs, necessitating augmentation of our SLR with studies on BD, BDA, and BDT. This limitation

could drive future case study research involving firms with established SCCTs to determine CSFs industry leaders deem most critical. Empirical investigations might refine our existing list of CSFs, leading to expansion, reduction, or prioritization of CSFs. Another avenue for exploration might involve interviewing organizations struggling to achieve expected SCCT performance, using our identified CSFs as a framework pinpointing specific deficit areas.

Secondly, we establish interdependencies and potential causal relationships among CSFs; however, our study does not examine at great length the specifics of how these causal relationships form. Addressing these gaps requires detailed analysis of initiation and relation between each CSF (i.e., how does *top management commitment* specifically generate *organizational readiness*, or how does *data security* lead to *partner trust*?). Moreover, while the generalizability of our SCCT framework is advantageous, a more context-specific application may more clearly define boundary conditions and limitations. In this vein, managers should critically consider unique and distinctive aspects of their firms when leveraging our findings.

6. CONCLUSION

Studies on CSFs for high-performing SCCTs have been limited, disjointed, and enjoyed little consensus. Yet, thoroughly understanding CSFs increases likelihood of achieving SCCT benefits. Our study's framework provides a foundational step towards that end, revealing a set of CSFs, mapping their interdependencies, and illustrating specific avenues in which SCCTs bolster SCRES. Our results reveal CSFs are interdependent, emphasizing a synergistic effect displayed through the integrative function of SCCTs. The combined dynamic capabilities of SCCTs work in harmony to bolster essential SCRES enablers tied to the *readiness*, *response*, *recovery*, and *renewal* phases of supply chain disruption. While not exhaustive, our framework offers a valuable foundation for both researchers and practitioners, representing an advancement towards a thorough understanding of the competencies, resources, and conditions required for high-performing SCCTs and their collective role in SCRES.

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