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Collaboration in the Supply Chain Control Towers: A Systematic Literature Review

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Abstract: Control Towers (CTs) and Supply Chain Collaboration (SCC) have emerged as critical components in improving the performance and resilience of modern supply chains. CTs enhance supply chain management by providing real-time visibility and enabling more accurate decision-making, while SCC involves the cooperation of independent partners to achieve shared goals. This article conducts a systematic literature review using Scopus and Web of Science databases and following the PRISMA protocol to explore the relationship between CTs and SCC. It seeks to investigate how CTs foster collaboration among supply chain partners and identify the challenges that inhibit their full potential. The research finds that CTs facilitate enhanced information sharing, decision synchronization, and resource optimization, while barriers such as power asymmetry, trust issues, and insufficient incentive alignment remain significant challenges. The study underscores the importance of governance frameworks and the potential of technologies to address these issues. By offering a comprehensive analysis of existing research, this study contributes to the understanding of how CTs and SCC together enhance supply chain efficiency, laying the foundation for future exploration in this area. Future research should focus on longitudinal studies to assess long-term impacts and develop metrics to quantify collaboration outcomes.

Keywords: Supply Chain; Control Tower; Collaboration; Literature Review.

1. Introduction

After COVID-19 pandemia, when disruptions had affected directly and indirectly the Supply Chain (SC) worldwide, end-to-end visibility has been required to reinforce the resilience (Hasbum *et al*., 2022). Patsavellas *et al*. (2021) argue that visibility is a key business enabler within an organization and its partners, being a capability that drives operational performance improvement.

Among the pool of technological tools of industry 4.0 that can support visibility, the control towers (CT) were gaining attention in the past decades. CTs are paving the way toward the development of large-scale digital platforms and new models that efficiently integrate resources to provide real-time visibility of the whole supply chain (Patsavellas *et al*., 2021; Wyciślak & Pourhejazy, 2023).

The concept of a control tower is to provide real-time information to everyone who needs it to make informed decisions in their roles (Handfield *et al.*, 2020), allowing smooth monitoring and adequate management of unplanned events. As a result, CTs foster a coordinated network to continuously handle complexity and achieve performance levels that would be difficult for humans to manage on their own (Liotine, 2019). Patsavellas *et al*. (2021) states that cost savings, increased efficiency, better consumer experience and improved organizational models are the four key benefits of CTs.

In fact, a CT results from the synergy of organizations (people), technology and process (Patsavellas *et al*., 2021). Its operation is based on the use of technologies (i.e. internet of things and cloud platforms) that integrate and process real-time data from various sources to enable a centralized planning and control (Wyciślak & Pourhejazy, 2023), ultimately allowing more accurate decision-making (Hasbum *et al*., 2022).

Another mainstream concept leading to supply chain performance improvement is Supply Chain Collaboration - SCC (Marty and Ruel, 2024). It refers to the capability of independent organizations to work effectively together, planning and executing supply chain operations toward common interests (Cao and Zhang, 2010). SCC's objective is to develop avenues for partners to collaborate effectively in developing and executing improved methods for problem-solving and delivering the expected value to customers (Fawcett *et al*., 2008a).

The relation between control towers and collaboration in the supply chain context is multifaceted. First, since CTs relies on the availability of data from supply chain partners (Liotine, 2019) to support its proper operation, collaboration among these organizations becomes a mandatory condition (Patsavellas *et al*., 2021). On another hand, there is a common understanding that enhanced visibility, provided by CTs, is also a catalyst of supply chain collaboration improvement among SC partners (Patsavellas *et al*., 2021; Hasbum *et al.*, 2022). Fawcett *et al*. (2008a) advises that although SCC is desirable, it has been proving to be difficult to implement in practice. Bringing this to the control tower context, Patsavellas *et al*. (2021) explain that this difficulty arises from concerns about asymmetric power dynamics in relationships and potential leaks of proprietary information. Liotine (2019) adds the lack of trust as another reason for hindering collaboration.

Providing empirical evidence of this difficulty, Wyciślak (2023) identified tensions and competition instead of collaboration in the integration of subcontractors, the platform owner, and the control tower due to power asymmetry in a company from the transportation industry.

This complex interaction of CT and SCC evidenced in the literature demonstrates that more study is still needed in this field.
Hence, the main objective of this article is to investigate the relationship between control towers and collaboration in the supply chain context. Specifically, this study seeks to answer the following research questions: How do control towers enhance collaboration among supply chain partners? And what challenges inhibit their effectiveness? A Systematic Literature Review (SLR) of control towers and collaboration in the supply chain context was conducted to fulfill the study's objectives. The SLR was developed using Scopus and Web of Science databases and following the PRISMA protocol.
From this Introduction, this article is organized as follows. Section 2 reviews the existing literature on control towers and collaboration in the supply chain context. Section 3 presents the research design as well as the method employed in this research to reach its objectives. Section 4 presents the study findings. Section 5 presents the discussion about the relation between control towers and collaboration. Finally, section 6 summarizes the research questions, study limitations, contributions to the area, and propositions for future studies.

2. Theoretical Foundation

This section discusses the role of Control Towers in supply chain management, highlighting their ability to enhance visibility, decision-making, and collaboration through real-time data integration and advanced technologies. It also examines the challenges of CT implementation, including data integration and trust issues. Following this, the concept of Supply Chain Collaboration is explored, focusing on how joint efforts among supply chain partners can drive performance improvements, reduce costs, and foster innovation, with trust and communication as key enablers.

2.1. Control Tower in the Supply Chain Context

In modern supply chain management, Control Towers have emerged as a strategic tool to enhance visibility and control, supporting decision-making in complex supply networks. A CT functions as a centralized hub where real-time data from various supply chain stakeholders, such as suppliers, manufacturers, and logistics partners, are aggregated and jointly analyzed to provide actionable insights. This allows companies to respond proactively to supply chain disruptions, mitigate risks, and optimize operations efficiently (Liotine, 2019).
CTs can integrate different advanced technologies such as cloud computing, artificial intelligence, and the Internet of Things. Working together, these technologies enable CTs to provide an end-to-end view of the supply chain, offering visibility into every phase of the process, from raw material procurement to final delivery (Patsavellas *et al*., 2021; Wyciślak & Pourhejazy, 2023), through analytical dashboards and Key Performance Indicators (KPIs). In addition, the use of alert systems within CTs enables the stakeholders to be promptly informed about disruptions, such as delays in transportation or production issues, allowing for faster and more effective responses (Wyciślak & Pourhejazy, 2023).
This holistic view is essential for identifying potential bottlenecks and inefficiencies, as well as for improving companies' ability to respond to market fluctuations. In this context, one key capability of CTs is predictive analytics, which allows organizations to anticipate changes in demand and adjust their supply chain strategies accordingly (Liotine, 2019). By using historical

data and forecasting models, CTs help companies optimize inventory levels, reduce waste, and improve overall service performance (Sharabati *et al*., 2022).
However, besides the numerous benefits of its capabilities, the successful implementation of CTs often depends on overcoming some challenges. A key issue is data integration across different supply chain partners. In industries where proprietary information is sensitive, concerns about data security and the risk of intellectual property leaks can hinder effective data sharing (Liotine, 2019). Moreover, asymmetric power relationships within supply chains can complicate collaboration, as some partners may have more influence over data or decision-making processes than others (Patsavellas *et al*., 2021). This imbalance can lead to tensions and competition, rather than cooperation, particularly in supply chains with large multinational players and smaller subcontractors (Wyciślak , 2023).
On the other hand, despite these challenges, CTs can offer substantial benefits in enhancing collaboration across supply chains. By facilitating transparent data sharing and enabling joint decision-making, CTs help foster trust among supply chain partners (Alacam & Sencer, 2021). With greater transparency, organizations can better coordinate their activities, leading to improved resource utilization, reduced operational costs, and heightened responsiveness to market demands (Sharabati *et al*., 2022).
In conclusion, Control Towers represent a powerful technological tool for organizations aiming to enhance their supply chain operations. However, as much as CTs are a key enabler of operational efficiency, their true potential is unlocked when they are effectively integrated with collaborative supply chain practices. Collaboration among supply chain partners is not only a necessary foundation for successful CT operations but also is described as an outcome of enhanced visibility and synchronized decision-making. What makes CTs a crucial element in building strong, trust-based partnerships that drive supply chain performance.

2.2. Supply Chain Collaboration

Supply Chain Collaboration refers to a partnership process where several independent firms work closely to plan and execute SC operations to achieve shared goals and collective benefits (Cao and Zhang, 2010). This definition serves as a building block for the research in SCC, although other relevant perspectives were also added by other authors (Marty and Ruel, 2024), such as the value added through collaboration (Fawcett *et al*., 2008a,b) and the resulting competitive advantage (Simatupang and Sridharan, 2005).
It entails the joint utilization of resources such as information, personnel, and technology among supply chain partners to generate synergies and gain a competitive advantage (Fawcett *et al*., 2008a). However, it has been proving to be difficult to implement (Barrat, 2004). Internal and external turf protection, poor collaboration among chain partners, and lack of partner trust are some of the barriers to its effectiveness achievement (Fawcett *et al*., 2008b).
As a result, the benefits of SCC will be fully realized solely when every participant in the supply chain, from suppliers to customers, actively cooperates (Cao and Zhang, 2010) because collaboration extends beyond merely handling transactions for efficiency; it involves cultivating relationships that drive continuous improvement (Fawcett *et al*., 2008a).
These benefits are described by Fawcett *et al*. (2008b) as reduced purchasing costs, better asset utilization, ability to handle unexpected events, reduced inventory costs, firm productivity, and reduced overall product cost. Cao and Zhang (2010) add that SCC can assist the organization

in preventing the expensive bullwhip effect, enhancing business synergy and quality, offering greater flexibility, and fostering collaborative innovation.
In this context, trust is nearly always a foundational element in successful collaborative supply chain relationships (Fawcett *et al*., 2008a). Communication and understanding (to foster information sharing and mutual understanding creation), as well as openness and honesty (to foster trust) should be ensured to allow SCC (Barret, 2004).

The seven interconnect dimensions of SCC described by Cao & Zhang (2010) are presented in Table 1. This framework improved a previous one named Collaboration Index (Simatupang and Sridharan, 2005), which was restricted to information sharing, decision synchronization, and incentive alignment perspectives.

Table 1 – Supply Chain Collaboration' dimensions definition

Dimension	Definition
Information sharing	The extent to which a firm shares a variety of relevant, accurate, complete and confidential ideas, plans, and procedures with its supply chain partners in a timely manner.
Goal congruence	The extent to which supply chain partners perceive their own objectives are satisfied by accomplishing the supply chain objectives.
Decision synchronization	The process where supply chain partners orchestrate decisions in supply chain planning and operations that optimize supply chain benefits.
Incentive alignment	The process of sharing costs, risks, and benefits among supply chain partners.
Resource sharing	The process of leveraging capabilities and assets and investing in capabilities and assets with supply chain partners.
Collaborative communication	The contact and message transmission process among supply chain partners in terms of frequency, direction, mode, and influence strategy.
Joint knowledge creation	The extent to which supply chain partners develop a better understanding of and response to the market and competitive environment by working together.

Source: Cao & Zhang (2010, p. 6617-6618)

3. Research Methodology

The systematic literature review had involved a comprehensive and systematic search to locate relevant published work that addresses the research questions. To ensure a high-quality range of peer-reviewed journals, only published articles in the Scopus and Web of Science databases were included within the research scope, as detailed in Table 2. Therefore, proceeding papers, early access papers, books, book chapters, and conference papers were not considered, which reduced the search result from 51 to 29.

Table 2. Description of the search in databases.

Criterion	Description
Topic	(digital* OR logistic* OR "Supply Chain" OR "Supply Chains" OR service* OR transport*) AND ("Control Tower" OR "Control Towers") AND (collabor* OR cooper* OR coordinat*) AND NOT "Air traffic"
Database	Scopus and Web of Science (all areas)
Times	All years
Search Date	May 6, 2024, at 4:06 p.m.

The keywords used resulted from previous research looking for possible keywords that may relate to the subject, control towers and collaboration in the supply chain context. Moreover,

the search for the SLR had found a huge number of articles from the aviation industry (as traffic control), which are not related to the sake of this research. It is explained by the fact that the concept of a CT is derived from the aviation industry. Consequently, an exclusion keyword (AND NOT "Air traffic") was added to solve this issue. Lastly, no publication date interval was adopted due to the reduced number of results.

Through the PRISMA protocol guidelines, other exclusion criteria were applied to the 29 selected articles. First, duplicated articles were excluded by manual detection. Then, the abstracts were read to find the most suitable articles for the research objective. In sequence, the eligibility was determined by reading each of the 10 articles chosen for assessment. Finally, the researcher selected 8 articles from 29 papers that were found in the databases. Figure 1 displays the PRISMA that illustrates the review process following the methodology of Rethlefsen *et al.* (2021).

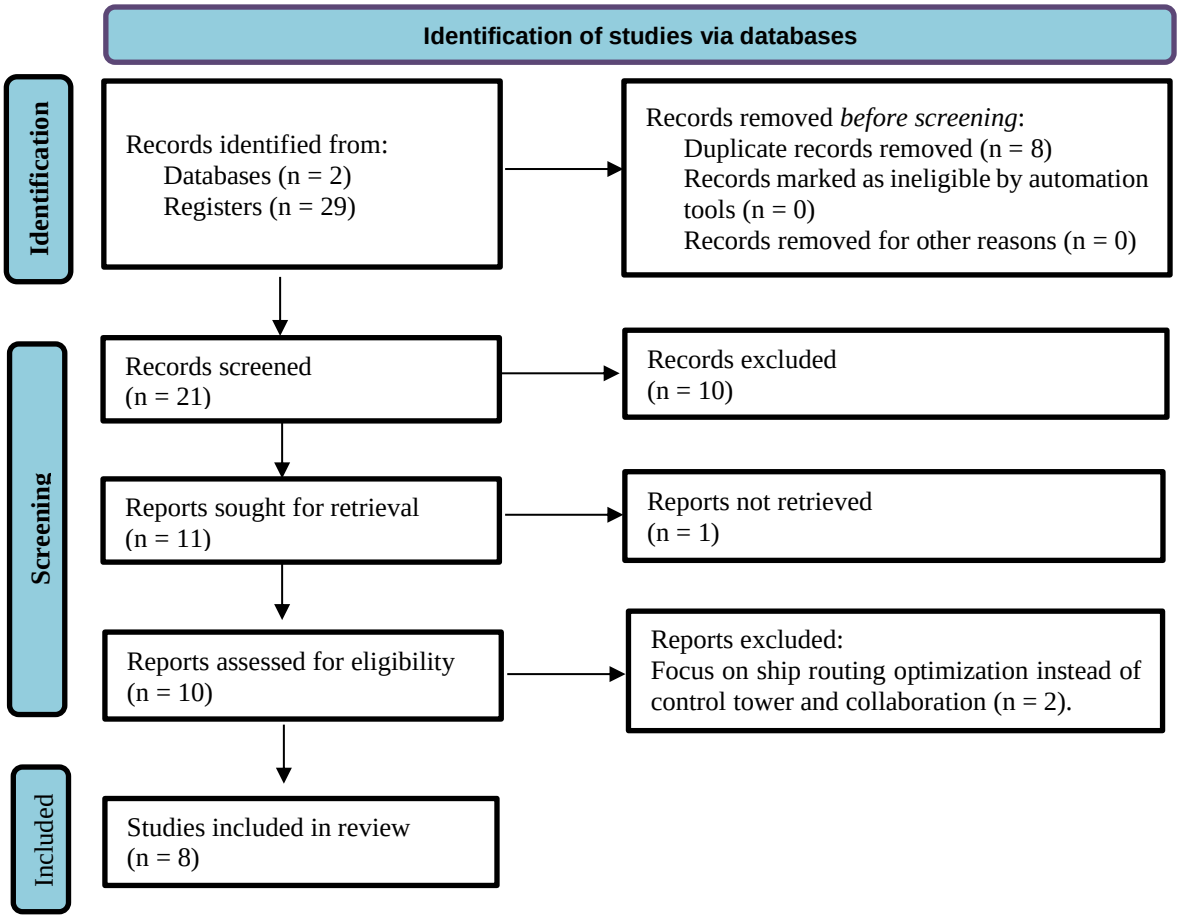

Fig. 1. The PRISMA obtained in the review process.
Source: Adapted from Rethlefsen *et al.* (2021).

4. Findings

Figure 2 shows the temporal evolution of publications about the researched subject. As can be seen, there is a slightly crescent trend in the number of papers. It can be a result of the novelty of Control Tower studies (the oldest paper found is from 2019), since SCC has been studied for

a long time. Moreover, no preeminence of a specific Journal among others was found. Each of the articles were published in a different journal, namely: Computers in Industry, Expert Systems, Frontiers in Energy Research, IET Collaborative Intelligent Manufacturing, International Journal of Industrial Engineering Computations, International Journal of Logistics Management, Journal of Autonomous Intelligence, Logistics, Milbank Quarterly, and Tecnologia em Marcha.

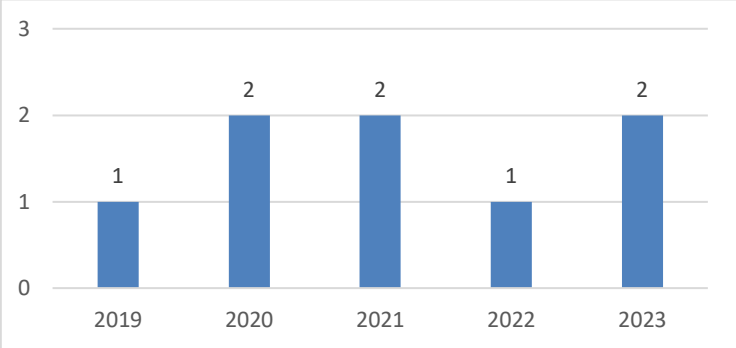

Fig. 2. Evolution of publications per year.

Among the articles found in search there are different focuses. One has studied the role of advanced technologies in CTs. Two have the foundation on the post pandemic context, analyzing how CTs can make the supply chains more resilient. Four are in the logistic industry context but providing each of them different research directions in the field. Finally, one discusses the origin of the control tower adoption trend in the market. A description of each of these articles, with their study object, and main findings is presented below.

In the pharmaceutical industry, Liotine (2019) studied how emerging autonomous intelligence technologies, such as artificial intelligence (AI) and machine learning (ML), are transforming the operational architecture and functionality of CTs. The study evaluates how these technologies can shift CTs from basic monitoring platforms to sophisticated systems capable of managing complex real-time information gathering, decision-making, and analysis processes that would otherwise be difficult for humans to handle. The author demonstrated how advanced technologies improve visibility, decision-making, and risk management, all of which are essential for fostering effective collaboration in complex supply chains.

Handfield *et al*. (2020) discusses how CTs could be used in the context of a national supply chain system in the post-pandemic restructuring of the US strategic national stockpile (SNS) to improve the management and resilience of critical supply chains. The study investigates the failures of the existing SNS model during the COVID-19, highlighting the importance of real-time data, centralized management, and collaboration in improving supply chain resilience and preparedness for future crises. In this sense, the CT is expected to promote better coordination and decision-making across all levels of the supply chain.

Still in the COVID-19 context, Hasbum *et al*. (2022) explore the supply chain strategies and technologies evolution to cope with pandemic disruptions. The study investigates both the pre-pandemic supply chain management practices, and the adjustments made during the pandemic, with an emphasis on digital solutions, such as CTs. The research highlights how the pandemic exposed vulnerabilities in global supply chains and how CTs and digital platforms helped

companies adapt to the unprecedented challenges posed by the COVID-19 pandemic. Finally, it underscores the importance of real-time visibility, risk management, and enhanced collaboration in building more resilient and adaptive supply chains.

The article of Maneengam & Udomsakdigool (2020) addresses complex vehicle routing problems (VRPs) in collaborative logistics environments. Specifically, it proposes a covering model to solve collaborative bidirectional multi-period vehicle routing problems (CBMP-VRP), where multiple stakeholders, such as transportation companies and shippers, share resources and collaborate under a profit-sharing agreement. The proposed covering model, facilitated by a control tower, showcases how real-time data and profit-sharing mechanisms can foster deeper collaboration among stakeholders, leading to more optimized and sustainable logistics operations.

Focusing on the US truck industry, Alacam & Sencer (2021) addresses how blockchain technology can be used to foster collaboration in the trucking industry by replacing traditional intermediaries (brokers) with decentralized systems. This is because in the current trucking industry, brokers facilitate collaboration between shippers and carriers, but their involvement introduces inefficiencies, high costs, and trust issues. Their proposed approach enhances collaboration by improving trust, transparency, and efficiency, eliminating the need for intermediaries like brokers and making it more sustainable and collaborative.

The article by Wyciślak (2023) explores the transformation of supply chain operations through the implementation of a CT. The study analyzes how CTs, by providing real-time data and visibility, contribute to operational efficiency but also face several tensions and challenges, especially when it comes to achieving the expected benefits. While CTs offer significant operational benefits by improving visibility and data integration, their success depends on overcoming organizational tensions and establishing robust collaborative frameworks.

Wyciślak & Pourhejazy (2023) examine the integration of intelligent dock booking systems within CTs into the supply chain. The adoption of intelligent dock booking systems is presented as a significant improvement in the coordination of logistics operations, leading to increased efficiency and reduced delays. This operational improvement results from streamlined dock scheduling, enhanced visibility, and better collaboration between supply chain partners. Moreover, the article highlights the key role of real-time visibility and data sharing in enhancing coordination between supply chain partners. It also identifies challenges to adoption but stresses that with proper governance and commitment to collaboration, these technologies can significantly improve supply chain operations.

Finally, investigating whether the adoption of CTs is primarily driven by technological advancements (technology push) or by market demands (market pull), Patsavellas *et al*. (2021) shed light on the evolving role of CTs in modern supply chains. The study proposes a framework to check if the organization that intends to adopt a CT is ready for it. Moreover, it explores how CTs enhance supply chain performance by improving visibility, coordination, and collaboration among supply chain stakeholders. However, it also underscores the importance of addressing trust and integration challenges to fully realize the collaborative potential of CTs in enhancing supply chain performance.

5. Discussion

The systematic review of the literature on Control Towers and Supply Chain Collaboration reveals several clear findings and offers valuable insights into both the practical and theoretical

aspects of these two interconnected concepts. This section discusses the main points of agreement in the literature, the implications for the relationship between CTs and SCC, and the identified gaps requiring further exploration. Finally, the seven dimensions of SCC (Cao & Zhang, 2010), will be compared with the findings from the reviewed articles to assess through which dimensions collaboration occurs and where further research is needed.

5.1 Control Towers and Supply Chain Collaboration: The Current Understanding

Across the reviewed studies, one of the most consistent findings is that CTs are vital enablers of enhanced collaboration within supply chains, particularly due to their ability to provide real-time visibility and decision-making capabilities (Liotine, 2019; Patsavellas *et al*., 2021). This capability is pivotal for optimizing resource sharing and planning across different supply chain partners.

In this sense, studies such as those by Hasbum *et al*. (2022) emphasize that during disruptions like the COVID-19 pandemic, the role of CTs became even more crucial as they facilitated swift decision-making by integrating real-time data from all supply chain actors. Furthermore, Maneengam & Udomsakdigool (2020) present evidence of how CTs can optimize logistics operations by facilitating collaborative vehicle routing, enabling stakeholders to share resources efficiently.

The ability of CTs to foster collaboration stems from their function as a centralized hub that aggregates and disseminates data. This allows for better communication between supply chain partners, improving transparency and reducing uncertainties that typically hinder collaboration (Patsavellas *et al*., 2021; Wyciślak & Pourhejazy, 2023). Fawcett *et al*. (2008b) also indicate that such transparency is essential for minimizing information asymmetry, which often leads to distrust and inefficiencies within supply chains.

Furthermore, the integration of advanced technologies like AI and ML into CTs, as explored by Liotine (2019), is transforming how collaboration happens. These technologies can predict disruptions and optimize supply chain operations, further reinforcing the role of CTs as a driver of collaborative practices. The reviewed studies generally agree that CTs enhance the ability of organizations to work jointly, particularly in the areas of resource sharing, joint decision-making, and real-time response to challenges.

5.2 Challenges in Collaboration through Control Towers

Despite these clear benefits, the literature also highlights several challenges that hinder the full realization of collaboration through CTs. One key issue is the asymmetry of power among supply chain partners. Larger organizations that control CT operations often hold more influence over data and decision-making, leading to tensions and mistrust among smaller partners (Patsavellas *et a*l., 2021; Liotine, 2019). This imbalance can reduce the willingness of smaller players to share critical data, limiting the effectiveness of the CT in fostering true collaboration.

In this sense, Wyciślak (2023) presents empirical evidence of these tensions, where power dynamics within the supply chain reduce collaborative efforts. The authors argue that smaller subcontractors in the transportation industry, for instance, often feel that their contributions are undervalued or overlooked by larger CT operators, creating competition rather than

collaboration. This power asymmetry poses a significant barrier to achieving the full potential of CTs in promoting collaboration.

However, blockchain technology can offer a potential solution by creating transparent profit-sharing mechanisms, as demonstrated in the trucking industry by Alacam & Sencer (2021). By decentralizing data and reducing the influence of dominant partners, blockchain ensures a more equitable distribution of benefits, helping to align incentives and encourage broader participation in CT-driven collaboration.

Another mainstream topic is trust. It consistently emerges as a foundational element in supporting collaboration within supply chain management and the implementation of control towers. Wyciślak & Pourhejazy (2023) highlight that trust is fundamental to successful data sharing and collaboration, ensuring that partners are willing to share accurate and complete information. Likewise, Maneengam & Udomsakdigool (2020) points out that trust ensures data integrity and fosters cooperation supporting collaborative shipment.

However, Liotine (2019) advises that although CTs foster collaboration through enhanced visibility, they can create tensions related to power dynamics. Larger organizations controlling the CT often have more influence, potentially leading to imbalances in data sharing and decision-making. This power imbalance can create mistrust, as smaller players may feel vulnerable in disclosing sensitive data to more dominant partners in competitive environments. Therefore, data retaining, and misrepresentation can occur, leading to conflicts and reduced cooperation (Wyciślak, 2023).

Solving this issue, effective governance frameworks and trust-building mechanisms are therefore critical to mitigating these tensions (Liotine, 2019). In this context, Patsavellas *et al*., (2021) suggests that companies should use clear data-sharing agreements and governance structures to balance power dynamics, ensuring that all partners feel secure in contributing data and insights.

Another example is provided by Alacam & Sencer (2020), which suggests that the use of blockchain systems can build trust, through transparency and immutability, enhancing data sharing and collaboration among partners in the USA truck industry. Finally, although some articles indicate that governance frameworks may fill this gap, empirical evidence on how these frameworks work in practice remains sparse.

5.3 Analyzing the Seven Dimensions of Supply Chain Collaboration with Control Towers

Cao & Zhang (2010) describe seven interconnected dimensions of Supply Chain Collaboration, namely: Information Sharing, Goal Congruence, Decision Synchronization, Incentive Alignment, Resource Sharing, Collaborative Communication, and Joint Knowledge Creation. By comparing these dimensions with the findings from the eight reviewed articles, we can find how collaboration is facilitated through these dimensions in the context of Control Towers and identify which dimensions may be more and less relevant. Table 3 summarizes the result of the analysis of each dimension.

5.3.1 Information Sharing

Information sharing is fundamental to the successful operation of CTs. Several articles highlight how CTs enable the free flow of information across supply chain partners by providing real-time visibility into operations, such as inventory levels, transportation status, and disruptions (Liotine, 2019; Hasbum *et al*., 2022). The ability of CTs to aggregate and disseminate data from

various sources enhances transparency and builds trust, fostering collaboration among partners. The study by Wyciślak (2023) also shows how real-time data from CTs improves operational efficiency by allowing partners to respond faster than usual to changes in demand or supply conditions. Consequently, this dimension is seen as central to collaboration within CTs, as it supports not only operational decision-making but also strategic alignment between partners.

5.3.2 Goal Congruence

Goal congruence, or the alignment of objectives between partners, is somewhat less emphasized in the articles. Although several studies suggest that CTs can help align operational goals by improving visibility and coordination (Patsavellas *et al*., 2021), there is less explicit discussion about the alignment of higher-level strategic goals among supply chain partners. Liotine (2019) notes that while CTs can support decision-making and operational performance, they may not inherently address this dimension, particularly when power imbalances exist between partners. Therefore, while goal congruence is likely to be supported by CTs, the literature does not provide enough evidence of how it could happen.

5.3.3 Decision Synchronization

Decision synchronization is another dimension where CTs excel. Several articles highlight how CTs facilitate joint decision-making by enabling partners to coordinate their responses to real-time data. For example, Wyciślak & Pourhejazy (2023) illustrate how CTs allow for synchronized scheduling, such as dock booking, which improves the efficiency of logistics operations. Similarly, the articles by Liotine (2019) and Hasbum *et al*. (2022) show that CTs enable predictive decision-making, allowing supply chain actors to respond proactively to disruptions or changes in demand. Thus, decision synchronization is well-supported by CT technology, which provides the tools for real-time coordination across multiple partners.

5.3.4 Incentive Alignment

Incentive alignment, which involves sharing the costs, risks, and benefits of collaboration, is one of the dimensions with limited evidence in the literature. While the reviewed studies focus on the technological and operational benefits of CTs, there is little discussion of how CTs help in aligning incentives among partners. The articles by Patsavellas *et al*. (2021) and Wyciślak (2023) touch on the issue of power asymmetry and how larger partners may dominate decision-making processes, which suggests that incentive alignment might be challenging in CT-driven collaborations.

Hence, the lack of explicit discussion on incentive alignment points to a gap in the literature, indicating that more research is needed to explore how CTs can facilitate fair distribution of risks and rewards among partners. In this context, Patsavellas *et al*. (2021) already suggest that future research should focus on creating KPIs that evaluate how CTs improve collaboration-related outcomes, such as cost reductions, enhanced resource sharing, and lead time improvements. Similarly, Wyciślak & Pourhejazy (2023) highlight the need for empirical

frameworks to quantify the impact of CT-enabled collaboration on logistics efficiency and operational performance.

5.3.5 Resource Sharing

Resource sharing is an important aspect of collaboration, and several studies indicate that CTs support this by enabling better resource allocation across supply chain networks. For instance, Maneengam & Udomsakdigool (2020) highlight how CTs enable collaborative vehicle routing, allowing multiple stakeholders to share transportation resources more efficiently. Similarly, Wyciślak & Pourhejazy (2023) shows that CTs help manage shared logistics resources, such as dock space, to improve overall supply chain performance. In this sense, CTs clearly support resource sharing by providing the necessary visibility and coordination tools to optimize the use of shared assets across partners.

5.3.6 Collaborative Communication

Collaborative communication is closely related to information sharing but focuses on the quality and frequency of interactions between partners. Some articles, including those by Hasbum *et al*. (2022) and Wyciślak (2023), emphasize that CTs facilitate better communication between supply chain partners by providing a common platform for sharing real-time updates and alerts. This transparency is expected to reduce misunderstandings and allow more effective collaboration. Therefore, it is understood that the literature strongly supports the role of CTs in fostering collaborative communication, particularly by enhancing the speed and accuracy of information exchange between partners.

5.3.7 Joint Knowledge Creation

Joint knowledge creation refers to the process through which supply chain partners develop new insights or innovations together. This dimension is less directly presented in the reviewed articles, although some studies suggest that CTs enable partners to learn from shared data. For example, Liotine (2019) points out that the use of AI and predictive analytics within CTs allows partners to gain new insights into supply chain trends and risks. However, the literature does not provide substantial evidence that CTs actively promote joint knowledge creation beyond operational decision-making. This suggests that this dimension is an underexplored area in the context of CTs.

Table 3. Analysis of SCC Dimensions and CTs in Literature.

SCC Dimension	Evidence	Notes
Information Sharing	Strong	Well-supported as central to collaboration in CTs.
Decision Synchronization	Strong	CTs best in supporting joint decision-making.
Resource Sharing	Strong	CTs help optimize shared resources across supply chains.
Collaborative Communication	Strong	CTs foster efficient communication and transparency.
Goal Congruence	Moderate	Less emphasis on strategic goal alignment.
Joint Knowledge Creation	Moderate	Some support through data-driven insights, but research is needed.
Incentive Alignment	Limited	Little evidence on how CTs facilitate risk/benefit sharing.

5.4 Gaps in the Literature

While much has been explored about the role of CTs in enhancing collaboration, there are still several gaps in the literature that need further investigation. Table 4 presents a brief description of identified gaps.

First, some papers (e.g., Liotine, 2019; Patsavellas *et al*., 2021) suggest governance mechanisms such as data-sharing agreements to foster trust among supply chain partners. However, there is little empirical evidence demonstrating how effective these trust-building mechanisms are in practice. Hence, more research is needed to explore the conditions under which these frameworks succeed or fail in mitigating mistrust and power imbalances.

Secondly, most studies focus on short-term outcomes of CT implementation, particularly in response to disruptions like the COVID-19 pandemic. However, there is a lack of longitudinal studies that track the long-term effects of CT-supported collaboration on supply chain performance and resilience. Understanding how CTs shape collaboration over time, particularly in stable market conditions, would provide deeper insights into their true value.

Another gap is related to the role of small and medium enterprises (SMEs). It was identified that the literature tends to focus on larger organizations' adoption of CTs and how they leverage these platforms to collaborate with smaller supply chain actors. However, there is limited research on how SMEs can better integrate into CT ecosystems and what specific challenges they face in contributing to and benefiting from these collaborative platforms.

Another possible research avenue relates to new technologies. While some studies (Liotine, 2019) explore the use of AI and ML in CTs, the full potential of emerging technologies such as blockchain for fostering more secure and transparent collaboration among supply chain partners remains underexplored (Alacam & Sencer, 2021). More research is required to understand how these technologies could overcome current challenges in data sharing and trust-building.

Finally, some gaps arose from the analysis of SCC Dimensions and Control Towers in Literature. While the literature provides strong evidence that CTs facilitate dimensions such as information sharing, decision synchronization, and resource sharing, there is a lack of research focused on measuring the tangible outcomes of collaboration. Few studies offer metrics or frameworks for evaluating how these collaborative efforts translate into improved supply chain performance, reduced costs, or enhanced partner relationships. Thus, more empirical research is needed to quantify the impact of CT-driven collaboration across all dimensions, particularly in real-world supply chain environments.

Table 4. CTs and SCC gaps in the literature.

Gap in Literature	Description
Trust-Building Mechanisms	Lack of empirical evidence on the effectiveness of governance mechanisms such as data-sharing agreements in mitigating mistrust and power imbalances.
Long-Term Impact Studies	Lack of longitudinal studies tracking long-term effects of CT-supported collaboration on performance and resilience, particularly in stable conditions.
SME Integration	Limited research on how SMEs integrate into CT ecosystems and the specific challenges they face in contributing to and benefiting from collaboration.
Emerging Technologies	Underexplored potential of emerging technologies like blockchain for enhancing transparency, data sharing, and trust-building.
Measuring Collaboration Outcomes	Few studies offer metrics or frameworks for measuring the tangible outcomes of CT-supported collaboration in terms of performance, cost, or partner relationships.

5.5 Implications for Future Research and Practice

The findings in the reviewed literature provide a solid foundation for both researchers and practitioners. From a practical standpoint, organizations implementing CTs must pay close attention to governance frameworks that ensure equitable data sharing and decision-making across all supply chain partners. Building a culture of trust, transparency, and mutual benefit is crucial for CTs to function as effective collaborative tools.

For future research, the key areas identified above present significant opportunities. Investigating the real-world effectiveness of trust-building mechanisms, understanding the long-term impact of CTs on supply chain collaboration, and focusing more on the integration of SMEs into CT ecosystems are essential next steps. Moreover, exploring how advanced technologies can enhance transparency and trust will be crucial for overcoming the current challenges that hinder collaboration.

6. Conclusion

This article aimed to organize and identify what is known about the consequences of adopting control towers on supply chain collaboration. By analyzing eight key articles, through a Systematic Literature Review, this research aimed to answer the two research questions established: How do control towers enhance collaboration among supply chain partners? And What challenges inhibit their effectiveness?

The study found that CTs enhance collaboration by improving real-time visibility, facilitating joint decision-making, and optimizing planning, control and resource sharing. Moreover, the analysis of the seven interconnected dimensions of SCC (Cao & Zhang, 2010) provided a comprehensive framework to understand how collaboration occurs through CTs, while also highlighting areas where challenges persist.

Despite these benefits, the challenges mentioned, especially regarding power dynamics and trust deficits, shed light on the need for robust governance frameworks and trust-building mechanisms. The analysis also revealed that dimensions such as incentive alignment remain underdeveloped in the literature, pointing to a gap in understanding how CTs can distribute risks and benefits fairly among partners. Emerging solutions, like blockchain, were identified as potential tools to help address these challenges and ensure transparent, equitable collaboration.

This study has several limitations that should be acknowledged. First, the systematic literature review was based on a relatively small sample of articles, which may limit the diversity of perspectives and the comprehensiveness of the findings. Additionally, the research did not account for variations in geographical regions, industries or supply chain sectors, which could introduce different challenges or opportunities in the application of Control Towers and Supply

Chain Collaboration. Furthermore, the review primarily focused on large organizations, which could mean that the findings are less applicable to SMEs.

In terms of contributions, this study advances the understanding of how CTs function as technological platforms that enable not only operational efficiency but also collaborative synergy among supply chain partners. By addressing real-time information sharing and joint decision-making, this article contributes to the ongoing discussion of how CTs can foster a more integrated and cooperative supply chain environment.

Finally, future research should focus on addressing the gaps identified above. First, longitudinal studies are needed to assess the long-term impact of CTs on collaboration and resilience over time. Second, further exploration into how SMEs can better integrate into CT ecosystems is needed. Third, emerging technologies should be examined more carefully for their potential in addressing trust and power dynamics issues. Lastly, more work is required to develop empirical frameworks and metrics that quantify the tangible outcomes of CT-supported collaboration, such as cost reductions, performance improvements, and enhanced partner relationships.

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