PETRA IJBS VOL. 6, NO. 2, DECEMBER 2023: 213-225 DOI: https://doi.org/10.9744/petraijbs.6.2.213-225
E-ISSN 2621-6426

Exploring Hospital Supply Chain Partnership Factors and Its Impact on Overall Supply Chain Performance

Marla Setiawati, Aiko Pasaribu, David Prasetya Halim*, Juan Darmawan
Institut Teknologi Harapan Bangsa, Jl. Dipatiukur 80, Bandung 40132, Indonesia
*Corresponding author; E-mail: sc-20004@students.ithb.ac.id

Abstract

Hospitals function as complex businesses with intricate supply chain networks involving collaboration among various entities to efficiently deliver information, goods, and services to end customers. This study investigates the causal relationships between hospitals, suppliers, and government entities within the supply chain network. Employing system thinking, system dynamics, and causal-loop diagrams, it assesses how coordination, collaboration, and integration impact hospital supply chain performance. The findings reveal that high coordination and collaboration among suppliers, hospitals, and government entities positively influences supply chain performance. The study identifies key factors contributing to effective partnerships, such as information sharing, trust levels, supplier quality standards, inventory capabilities, flexibility, pricing strategies, and IT integration. Additionally, the research considers hospitals' dynamic capabilities, key performance results, patient outcomes, government healthcare spending, regulations, and economic indicators. Managerial implications emphasize the importance of strong partnerships to enhance overall supply chain performance, potentially improving patient outcomes and healthcare service quality. While acknowledging limitations, the study suggests future research avenues, including exploring the impact of other stakeholders and specific factors on hospital supply chain management.

Keywords: government, hospital, partnership, supplier, supply chain.

1. Introduction

In today's ever-evolving healthcare landscape, the efficiency and effectiveness of hospital supply chains have emerged as critical determinants of healthcare system sustainability and the quality of patient care. Hospital supply chains, complex networks that facilitate the timely delivery of medical goods and services to healthcare facilities, play an irreplaceable role in supporting clinical operations and safeguarding patient outcomes. Given the complex nature of hospital supply chains, some issues emerge as the coordination among entities often falls short. The lack of seamless collaboration among these key entities results in delayed ordering processes, mismanagement of supplies, and compromises in the quality of patient care. These challenges underscore the critical need for research on the impact of partnerships within hospital supply chains. Symptomatic manifestations, including the conflicting goals among supply chain partners and inadequate performance measures, emphasize the urgency for a comprehensive understanding of the factors influencing hospital supply chain performance. Addressing these symptoms becomes imperative for optimizing the overall functionality of HSC and unlocking the potential benefits of effective partnerships in enhancing performance.

According to Singh et al. (2022), a hospital supply chain consists of three main entities, which are focal, backward entities, and forward entities. Focal entities refer to the healthcare provider responsible for ordering and purchasing activities or, in short, the hospital itself. This means that two pivotal partners are involved in the intricate web of operations in a hospital supply chain: backward entities and forward entities.

According to Kitsiou et al. (2007), backward entities are those responsible for large - volume purchasing and product flow, such as medical products and equipment fundamental to patient care. They usually include manufacturers, distributors, or purchasing groups. Thus, it can be said that backward entities refer to suppliers. Suppliers represent a diverse spectrum of contributors, from pharmaceutical companies providing life-saving drugs to manufacturers delivering state-of-the-art medical devices and equipment. The significance of their role cannot be overstated, as it spans a continuum from basic consumables to advanced medical technologies, making them the prime source of essential goods in the healthcare setting.

Kitsiou et al. (2007) also stated that forward entities refer to entities that are generally responsible for fund flow. Forward entities include private or public payers such as government or insurance companies. Public healthcare systems often receive significant funding from government sources. Government allocations play are role shaping the supply chain's structure and functionality. These funds are

essential for hospitals to procure supplies, invest in infrastructure, and deliver patient care. Government entities also wield considerable influence within the hospital supply chain, operating at local, state, and national levels. Governments establish and enforce regulations that govern medical products' safety, efficacy, and quality.

The study's objective is to understand the impact of partnerships and their potential for improving a hospital's supply chain performance. This is done by identifying the variables correlated between the two critical stakeholders within the hospital supply chain through literature reviews and examining the factors driving those relationships that impact the performance of a hospital supply chain through the lens of system thinking and system dynamics and using causal loop diagrams as analytical tools to decipher the complex relationships within the hospital supply chain.

2. Literature Review

2.1. Actors in Hospital Supply Chain

According to Singh et al. (2022), HSCs differed from standard supply chains due to their complexity, the presence of valuable medical materials, and most importantly, the fact that they dealt with human lives.

A healthcare supply chain (HSC) was defined by Kitsiou et al. (2007) as consisting of focal entities (hospitals), backward entities (manufacturers), and forward entities (private and state payers). The healthcare provider, including administration, oversaw ordering and purchasing. This is illustrated in Figure 1. Large-volume purchasing was handled by backward entities (manufacturers, distributors, and buying organizations). Insurance and government organizations were examples of forward entities (private and public payers). The three major flows were product, information, and funds.

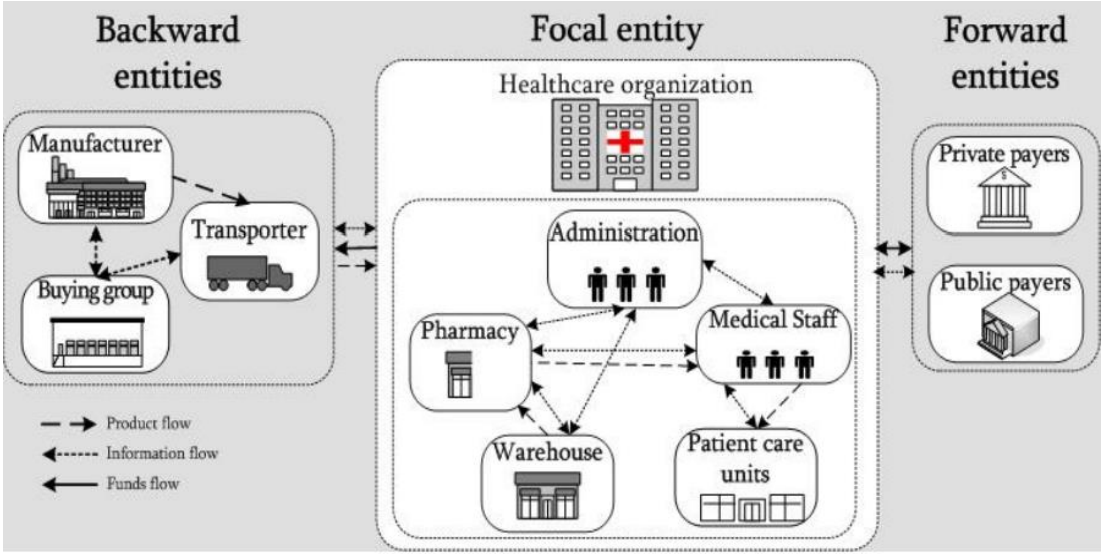

Figure 1. A schematic representation of the healthcare supply chain (Kitsiou et al., 2007)

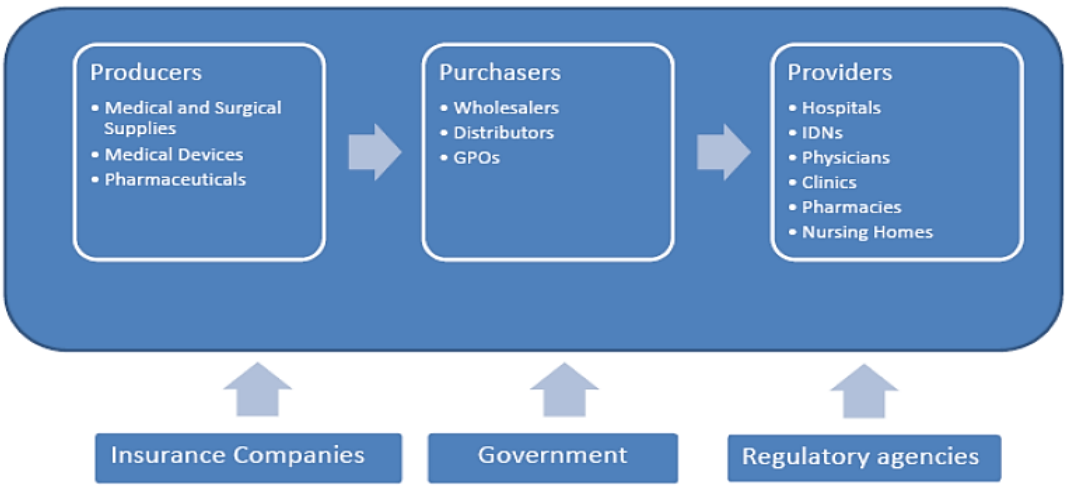

Figure 2. Healthcare supply chain configuration (Matthew et al., 2013)

A different version of HSC was defined by Mathew et al. (2013). According to him, the chain began with the flow of various items and involved several stakeholders. The primary goal of the healthcare supply chain was to deliver products on time to meet the needs of providers. Stakeholders in the healthcare supply chain could be split into three broad groups based on their functions: manufacturers, purchasers, and providers. In addition, HSC needed the involvement of governmental entities, regulatory agencies, and insurance firms (Ryan et al., 2005). This is illustrated in Figure 2. All actors and their roles in the HSC are illustrated through the mind map in Figure 3.

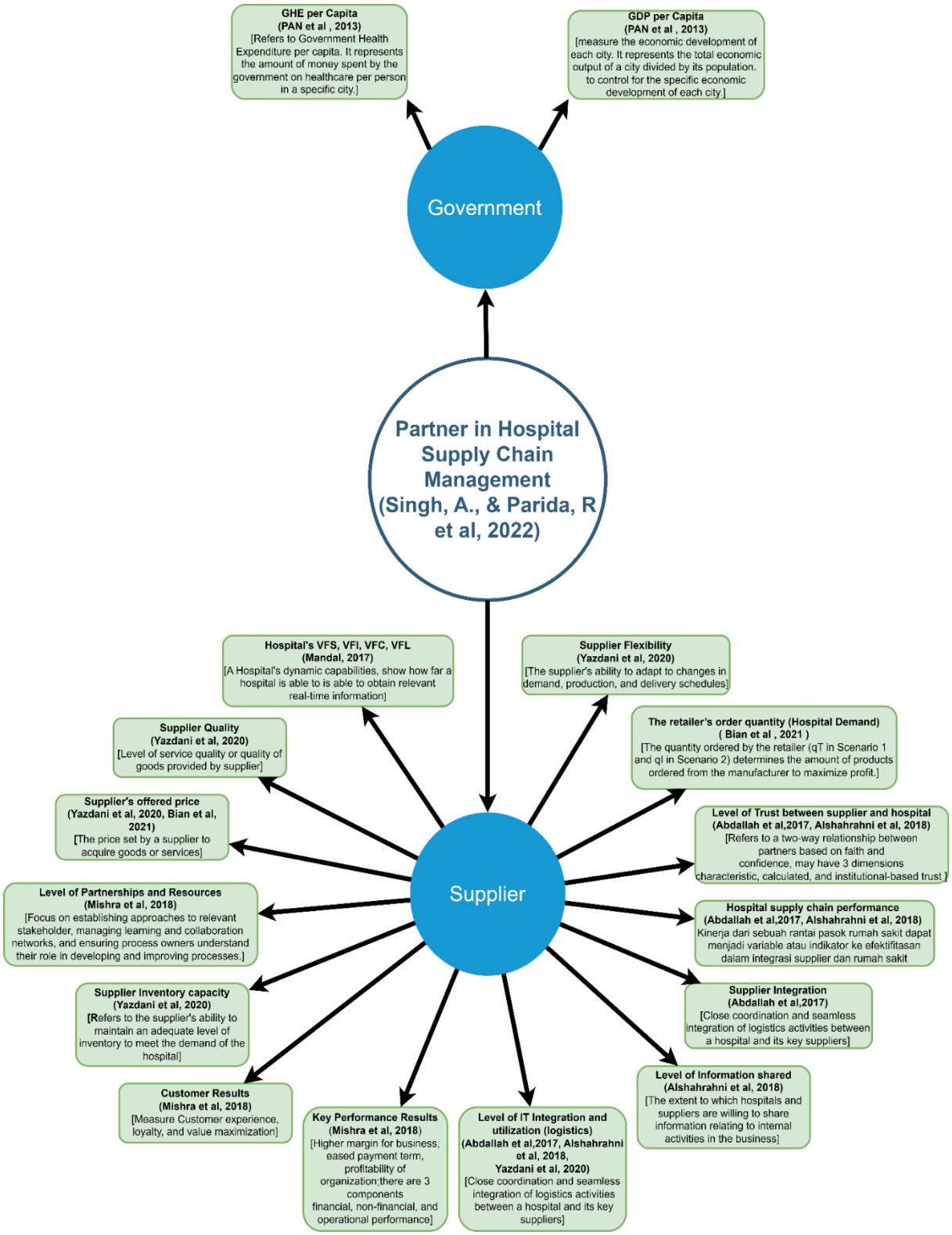

Figure 3. Healthcare supply chain actors and variables

2.2. Suppliers in the Hospital Supply Chain

There are many studies that focus on the impacts of suppliers in a hospital. One of those focuses was on the impact of supplier-hospital integration and collaboration on a hospital's overall performance. The goal of any organization is to improve its overall performance. The performance of an organization could be measured in multiple ways, either financially or non-financially (Abdallah et al., 2017). Integration and collaboration between hospitals and their suppliers positively impact a hospital's overall performance. Studies provided evidence of improved performance when successful integration and collaboration were practiced. One piece of evidence derived from a study on hospitals in Saudi Arabia stated that higher levels of supplier integration led to superior service delivery and higher dependability. The successful integration in logistics indicated positive impacts on a hospital's performance from hospital suppliers, information technology integration, information sharing, and trust between hospitals and suppliers (Alshahrani et al., 2018). One study proved that information sharing positively impacts supplier quality management. Integrated systems in the supply chain help monitor supplier performance and adjust internal operations to external changes. Sharing product quality and price information supports supply chain agility. Research on information sharing can improve a company's ability to adapt to external changes (Setyawan et al., 2022). Another study on the effect of trust between suppliers and hospitals concluded that trust and supply chain integration positively impacted supply chain performance (Abdallah et al., 2017).

Another piece of evidence was presented in a study in Greece. An example of a collaborative practice was the implementation of CMI (Collaborative managed inventory). CMI practices could significantly improve hospital performance and supply chain control. CMI implementation resulted in direct financial benefits, such as a reduction in expired supplies, and indirect benefits, like wasted working hours and capital savings (Matopoulos & Michailidou, 2013). Another study also concluded that Hospital-supplier collaboration positively impacted hospital supply chain performance (Mandal, 2017). Thus, it could be simplified that integration and collaboration between suppliers and hospitals were important factors in a successful hospital supply chain.

But what exactly drives a positive collaboration and integration between suppliers and hospitals? Some studies presented some indications that contributed to successful hospital-supplier integration. One of the most prevalent was the level of trust between hospitals and suppliers. Trust with suppliers was an enabler and had a positive impact on hospital-supplier integration and, in turn, on hospital supply chain performance (Abdallah et al., 2017). Another study included a hospital's dynamic capabilities such as VFS (visibility for sensing), VFL (Visibility for learning), VFI (visibility for integrating), and technology orientation as attributes that positively impacted hospital-supplier collaboration (Mandal, 2017). However, in Mandal's study, it was found that VFC (visibility for Coordinating) had an insignificant impact on hospital-supplier collaboration. Though not specifically stated, the level of information sharing or transparency also significantly contributed to successful supplier integration (Alshahrani et al., 2018).

It is also important for a hospital to be able to choose a supplier optimally and maintain a good relationship with said supplier. A study that conducted a model construction for decision-making indicated that several variables could be used to measure the potential of a supplier, including the supplier's offered price, the supplier's flexibility towards changes, the supplier's goods or service quality, inventory capacity, and the supplier's utilization of technologies (Yazdani et al., 2020). Many other studies also included the level of technological Utilization and IT integration (Abdallah et al., 2017; Alshahrahni et al., 2018; Mettler, 2011). Other studies used nine criteria that directly address an organization's effectiveness and efficiency in terms of resources, activities, and performance, namely enablers and results. The enablers consisted of leadership, people, policy and strategy, partnership and resource, and processes, while results included people results, customer results, society results, and key performance results. This method not only reviewed the organization's strengths but also identified areas of improvement.

2.3. Government's Role

The government plays a crucial role in regulating and overseeing healthcare delivery networks, referring to the interconnected system of healthcare providers, facilities, and organizations that work together to deliver healthcare services to patients. It sets policies and payment systems to ensure safe, effective, efficient, and timely outcomes in healthcare. Government regulations and payment systems varied across countries, but they generally focused on controlling costs, managing hospital Utilization, emphasizing primary physician care services, ensuring quality care, and managing information (Dobrzykowski et al., 2019).

For example, in the United States, the government enforced regulations such as the Health Portability and Accountability Act (HIPAA) and the Health Information Technology for Economic and Clinical Health (HITECH) Act to protect Patient

Data. Also, the government regulated financial coordination between physicians and hospitals through laws like Stark, the Office of Inspector General, and Anti-Kickback Laws. These regulations aimed to prevent fraud and abuse while ensuring proper coordination in the downstream healthcare supply chain (Dobrzykowski et al., 2019).

Improving Public Procurement strategies of medical suppliers such as ventilators and personal protective equipment. Both Italy and the US used to procure agencies. The challenge was that public procurement transferred higher levels of contract risk onto public agencies in times of disaster (Buor, 2019; Gabler et al., 2017; McKnight & Linnenluacke, 2016; Walker et al., 2013).

Disaster situations called for the immediate creation of reactive, short-term collaborative relationships, also called hastily generated partnerships (Busch & Givens, 2013) between public and private entities, enhancing resilience but also paving the way for the creation of trust on a larger scale. Indeed, developing relationships and trust enabled collaborative procurement arrangements to deal more effectively with complex policy areas (Walker et al., 2013).

During the outbreak, procuring authorities understood the relevance of identifying reliable and proactive suppliers. This could pave the way for establishing vendor rating solutions in the future. A vendor rating system would allow procuring authorities to select providers based on a broader set of parameters, such as their previous experiences, environmental, social, and governance (ESG) policies, and risk management capabilities. Such help could help build trust between buyers and suppliers.

Private and public sectors argued that the search for price minimization, even for less important supplies such as masks and sanitizers, had harmed the national market. During the outbreak, some procuring authorities worked with clinicians, local companies, and universities to increase the production of PPEs and conceptualize the manufacture of incremental innovations. This example of co-innovation enforced the opportunity to shift public procurement toward a more strategic role (with procuring authorities working as sophisticated public buyers, able to stimulate the market to conceptualize and offer solutions and not just replicate existing products). This also illustrated the importance of small- and medium-sized enterprises (SMEs) having access to public procurement markets. Despite the widespread adoption of official policies, this effort was still limited.

3. Methods

3.1. System Thinking

Elucidate the significance of system thinking as a comprehensive problem-solving methodology rooted in the notion of a system—conceived as a purposefully arranged assortment of components. This approach aims to fathom the intricate interdependence among these components and their profound influence on both planned and unforeseen system outcomes. Diverse manifestations of systems thinking include systems science, systems engineering, and systems dynamics (Amissah et al., 2020).

These methodological tools prove invaluable in disentangling substantial problems by breaking them into more manageable components facilitating in-depth analyses of their interrelationships. Moreover, systems thinking aids in discerning unintended repercussions stemming from problem-solving actions, pinpointing optimal intervention points, fostering collaborative endeavors, and nurturing an environment conducive to continual learning.

The applicability of systems thinking is particularly pronounced in domains such as systems science, engineering, and systems dynamics. Its strength lies in its ability to holistically evaluate an entire system holistically, illuminating how even minute changes can exert profound and transformative effects on outcomes.

3.2. System Dynamics

System Dynamics is a modeling approach to unravel the complexities inherent in intricate systems, aiming to enhance comprehension and inform decision-making. This methodology proves instrumental for decision-makers as it identifies myriad factors influencing a system, facilitating the development of interventions and solutions based on insights derived from the model (Malbon et al. 2023).

The System Dynamics process encompasses various stages, including problem framing and definition, system conceptualization, model development, simulation and evaluation, and the eventual introduction of solutions to the system. This holistic approach aligns with the broader concept of system thinking, which involves understanding the relationships among system components and their interactions, ultimately shaping system behavior. System dynamics, as a subset of system thinking, utilizes mathematical models to simulate the behavior of complex systems.

The resulting model serves as a problem frame, providing a structured framework for gaining deeper

insights into the system. While biases and simplifications may be introduced during the modeling process, they also serve to recognize and address these limitations. This generated model functions as a lens through which decision-makers can cultivate a nuanced understanding of the system, offering a valuable tool for navigating the intricacies of complex systems and informing effective interventions.

3.3. Causal Loop Diagram

(Littlejohns et al. 2021) Causal Loop Diagrams (CLDs) are visual instruments that depict intricate relationships and feedback loops within a system. Particularly relevant in public health research, CLDs serve to delineate the myriad factors influencing health outcomes and pinpoint potential intervention leverage points. This visual representation is invaluable in comprehending the complex interplay of factors contributing to health outcomes, enabling researchers to formulate more effective strategies for enhancing population health.

Adopting CLDs aligns with a broader paradigm shift in public health research toward embracing complex systems, thinking methods, and tools. This approach analyzes systems as intricate networks encompassing sectors, institutions, people, structures, and interventions, all working in concert to maintain and enhance population health. By leveraging CLDs, researchers engage with the complexity inherent in public health dynamics, fostering a more nuanced understanding that transcends linear cause-and-effect models. This shift towards holistic visualization and analysis enhances the ability to navigate and intervene in the multifaceted factors shaping public health outcomes.

4. Result

The following is the causal-loop diagram showing the relationships between the variables proposed in the literature review regarding the influences and impacts of key partners, primarily regarding government entities and suppliers. The CLD is shown in Figure 4, and the explanation for each variable and their relations are shown in Table 1 and Table 2.

The Causal Loop Diagram (CLD) is a visual tool to represent complex relationships and feedback loops in hospital supply chain management. It identifies three main stock variables: supplier performance (S.Prf), hospital-supplier integration (H-S Inte), and hospital supply chain performance (HSCP), which leads to higher integration between hospitals and their suppliers, thereby improving the hospital's supply chain performance.

A supplier's performance is influenced by various factors, including the quality of goods and services (SQ). An increase in the quality of goods and services leads to higher performance. Factors such as inventory capacity (SIC), offered price (S.OP), and the level of integration and utilization of IT and other technologies (S lvl ITIU) also play a role in determining the quality of goods and services provided by a supplier. An increase in SIC can positively impact the quality of goods and services, while an increase in S.OP can inevitably increase the quality. This relationship is reinforcing and direct, as an increase in the quality of goods and services usually indicates an increase in the integration and utilization of IT and other technologies.

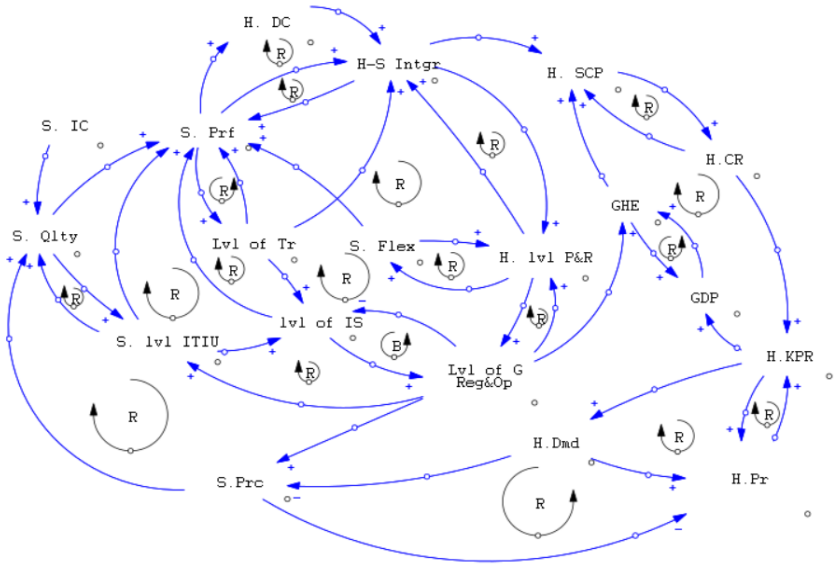

Figure 4. Causal-loop Diagram of hospital supply chain partners

Table 1. Detailed information regarding abbreviations and variables used in the CLD

Actor	Variables	Vensim Version	Formula	Definitions	Sources
Supplier	Supplier Performance	S. Prf	((H-S inte + lvl of IS + lvl of T + S flex + lvl of ITIU + SQ))/6) * 100%	Level of faith and confidence between the hospital and its key supplier	(Yazdani et al.,2020)
Supplier and Hospital	Supplier-hospital Integration	H-S Intgr	((lvl of P&R + HDC + lvl of T + SP) / 4) * 100%	The level of coordination and seamless integration of logistic activity between the hospital and its key supplier.	(Abdallah et al,2013)
Hospital	Hospital Supply Chain Performance	H. SCP	((H-S inte + GHE) / 2) * 100%	How strong is the partner in managing the supply chain process	(Abdallah et al,2013 & Alshahrahni et al, 2018)
Supplier	Supplier Quality	S. Q	((lvl of ITIU + S.Prc + SIC)/3) * 100%	Level of service or goods quality provided by supplier	(Yazdani et al, 2020)
Supplier and Hospital	Level of Trust	S-H lvl T	((H-S Inte + S.Prf)/2) * 100%	Level of faith and confidence between the hospital and its key supplier	(Abdallah et al,2013 & Alshahrahni et al, 2018)
Supplier	Supplier Flexibility	S. Flex	-	Supplier's ability to adapt (production, demand, delivery schedule)	(Yazdani et al, 2020)
Supplier	Supplier Offered Price	S. Prc	lvl gov Reg&Op / HD	The price set by the supplier to offer a good or service	(Yazdani et al, 2020)
Supplier and hospital	Level of Information Shared	S-H lvl IS	((Lvl of Gov Reg&Op + lvl of T + lvl of ITIU)/3) * 100%	The extent to which hospitals and suppliers are willing to share information related to internal activities in the business	(Alshahrahni et al, 2018)
Supplier	Supplier Inventory Capacity	S. IC	-	Supplier ability to maintain an adequate level of inventory	(Yazdani et al, 2020)
Supplier	level of integration and utilization of IT and other technologies	S. lvl ITIU	((Lvl of Gov Reg&Op+ SQ)/2) *100%	Level of information technology and other technologies being utilized and integrated within a hospital and supplier	(Abdallah et al., 2013; Alshahrahni et al., 2018, Mettler, 2011, Yazdani et al., 2020)
Hospital	Hospital Dynamic Capabilities	H. DC	-	Hospital VFS, VFL, VFC, and VFI. It shows how far a hospital can be able to obtain relevant real-time information regarding their business process and the changing of their business environment.	(Mandal, 2017,)
Government	Government Healthcare Expenditure per capita	GHE	GDP * lvl of Reg&Op	Measure the economic development of each city. It represents the total economic output of a city divided by its population. To control the specific economic development of each city.	(PAN et al., 2013)
Government	Gross Domestic Profit per capita	GDP	HKPR * GHE	Measure the economic development of each city. It represents the total economic output of a city divided by its population. To control the specific economic development of each city.	(PAN et al., 2013)
Government	Government regulatory and operational control	Lvl of G reg & Op	((Lvl of P&R + lvl of IS)/2) *100%	The government acts as a "Referee" in the hospital supply chain by actively influencing both the regulatory framework and operational aspects of healthcare institutions,	(PAN et al., 2013)
Hospital	Hospital Customer Results	H. CR	-	Customer experience, loyalty, and value maximization	(Mishra et al., 2018)

Actor	Variables	Vensim Version	Formula	Definitions	Sources
Hospital	Hospital Key Performance Result	H. KPR	(CR + S.Prf)/2) * 100%	The higher the margin for business, the profitability of the organization; there are three components. financial, non-financial, and operational performance	(Mishra et al., 2018)
Hospital	Hospital Demand	H. Dmd	-	Hospital Demand from Patient	-
Hospital	Hospital Profit	H. Pr	HD * H.KPR / S. OP	Hospital Profit from all services and product	-
Hospital	Level of Partnerships and Resources	H lvl P&R	H-S Inte + lvl of G reg &Op + S. Flex / 3 * 100	How a hospital builds relationships and manages suppliers to run well	(Mishra et al., 2018)

Table 2. Detailed causal relationships

Relationships	Variables	Definitions
Reinforcing	Supplier performance and hospital-supplier integration	An increase in supplier performance increases the level of integration between hospitals and their suppliers
	Supplier performance, Hospital-Supplier integration, Hospital level of partnerships and resources, supplier's level of flexibility	An increase in supplier performance increases the level of integration. This means that there is an increase in a hospital's level of partnership and resources and allows for an increase in a supplier's flexibility, which in turn also increases the performance of a supplier.
	Supplier performance, Hospital-Supplier integration, Hospital level of partnerships and resources, level of government regulatory and operational control, level of information shared	An increase in supplier performance increases the level of integration. This means that there is an increase in the level of a hospital's level of partnership and resources, which increases the level of government regulatory and operational control; this in turn increases the level of information sharing between suppliers and hospitals, which increases supplier performance.
	Supplier performance, Hospital-Supplier integration, Hospital level of partnerships and resources, level of government regulatory and operational control, level of integration and utilization of IT and other technologies	An increase in supplier performance increases the level of integration. This means that there is an increase in a hospital's level of partnership and resources, which increases the level of government regulatory and operational control and the level of IT and other technology utilization and integration. This will ultimately increase a supplier's performance.
	Supplier performance, Hospital-Supplier integration, Hospital level of partnerships and resources, level of government regulatory and operational control, supplier's level of integration and utilization of IT and other technologies, Supplier Quality	An increase in supplier performance increases the level of integration. This means that there is an increase in a hospital's level of partnership and resources, which increases the level of government regulatory and operational control, which increases the level of IT and other technology utilization and integration. Other than just a supplier's overall performance, integration and utilization of IT also increase the quality of goods and services a supplier offers.
	Supplier performance level of trust	An increase in a supplier's performance will likely increase the trust between the supplier and a hospital, which will, in turn, also increase the supplier's performance.
	Supplier performance, level of trust, level of information shared	An increase in a supplier's performance will likely increase trust between the supplier and the hospital. This, in turn, will most likely increase the level of information shared between both parties, ultimately increasing the supplier's performance.

Relationships	Variables	Definitions
	Supplier performance, hospital's dynamic capabilities, hospital-supplier integration	Increasing the supplier's performance may positively impact the hospital's dynamic capabilities. An increase in a hospital's dynamic capabilities increases the integration between the hospital and suppliers, increasing the supplier's performance.
	Supplier quality and supplier's level of integration and utilization of IT and other technologies	Increased IT integration and utilization will increase a supplier's quality of goods and services. This goes both ways. A supplier with an increase in the quality of services will usually mark an increase in IT and other technology utilization and integration.
	Supplier Flexibility & Hospital's level of partnership and resources	An increase in a supplier's flexibility usually means that there is an increase or a high level of hospital partnerships and resources
	Hospital-supplier integration hospital's level of partnership and resources	An increase in the level of integration between hospitals and suppliers usually indicates an increase in the hospital's level of partnership and resources.
	Supplier's level of integration and utilization of IT and other technologies, level of information shared, level of government regulatory and operational control	Increased utilization and integration of IT and other technologies usually increases information shared between hospitals and suppliers. This, in turn, may lead the government to increase its level of control both in regulations and operations.
	Hospital supply chain performance & Hospital customer results	An increase in the overall performance of the hospital supply chain would increase the hospital's customer results
	Government healthcare spending Gross domestic product	An increase in GDP allows for the government to increase its healthcare spending. An increase in GHE also helps contribute to the increase of a country's GDP
	The level of government regulatory and operational control hospital's level of partnership and resources	An increase in government control over regulations and operations means an increase in a hospital's partnership with said government, and so do its resources.
	Supplier's offered price, Supplier quality, supplier's level of integration and utilization of IT and other technologies, level of information shared, level of government regulatory and operational control	The price of certain goods or services may increase due to higher quality from suppliers, increased utilization of IT and other technologies, increased information sharing, and increased government regulatory and operational control, ultimately leading to an increase in the offered price.
	Supplier offered price, Hospital profits, Hospital key performance results, hospital demand	An increase in the price of certain goods and services offered by suppliers may actually decrease the profits made by hospitals. However, an increase in profits actually means an increase in hospital key performance results, which means a higher demand for the hospital and thus may lead to a decrease in the price of those goods and services.
	Hospital supply chain performance, hospital customer results, hospital key performance results, GDP, GHE	An increase in the overall performance of the hospital supply chain would increase the hospital's customer results. A higher customer result means an increase in the hospital's key performance results, which may increase GDP and, in turn, increase GHE, which will increase the hospital supply chain performance further.
	Hospital key performance results, hospital demand, Hospital profits	An increase in hospital key performance results means an increase in hospital's demands, which inevitably increases the hospital's profits

Relationships	Variables	Definitions
	Hospital key performance results & hospital profits	An increase in hospital key performance results means an increase in the hospital's profits.
Balancing	Level of government regulatory and operational control level of information shared	An increase in the level of government regulatory and operational control may result in a decrease in the level of information shared between hospitals and suppliers.

The relationship between suppliers and hospitals is influenced by trust and information sharing. An increase in trust can boost a supplier's performance, increasing trust between hospitals and suppliers. This trust also boosts information sharing, positively impacting a supplier's performance. This creates a reinforcing loop. Lastly, a supplier's flexibility can also impact their performance. A higher level of flexibility correlates with a hospital's level of Partnerships and Resources (Hlvl P&R), with an increase in S. Flex increasing Hlvl P&R and vice versa. This relationship highlights the importance of trust, information sharing, and flexibility in a supplier's performance.

Other than a supplier's performance, other variables correlate with the level of integration between hospitals and their suppliers. First is the hospital's dynamic capabilities (HDC). An increase in a hospital's dynamic capabilities, in turn, increases the integration between hospitals and suppliers. A hospital's dynamic capabilities increase accordingly with an increase in supplier performance. The relationship between SP, HDC, and H-S Inte creates a reinforcing loop. An increase in trust (S-H lvl T) also increases the level of H-S Inte. Finally, an increase in Partnerships and Resources increases the hospital-supplier integration. This relationship is also reinforcing both ways.

As stated before, the hospital-supplier integration level positively affects a hospital's supply chain performance. An increase in the level of supply chain performance creates a positive looping outcome between several variables. Firstly, the level of a hospital's customer results (HCR) increases. This, in turn increases the hospital's key performance results (HKR). An increase in said variable contributes positively towards a country's gross domestic product (GDP), which in turn may increase the government's health expenditure (GHE), which will also increase a hospital's supply chain performance. The relationship between GDP and GHE can go both ways; an increase in GHE may also increase GDP. The correlations between H.SP, HCR, HKPR, GDP, and GHE form one loop, which reinforces.

The hospital's key performance results create another loop in the CLD. An increase in HKPR will increase the demand for hospitals (HD). The increase in HD will, in turn, increase the profitability of a hospital (HP). Hospital profits also directly affect a hospital's key performance results. An increase in profits increases a hospital's key performance results. These relationships create a reinforcing loop. The price offered by a supplier is influenced by various factors, including demand for goods or services in hospitals. An increase in demand can lead to a decrease in the price offered by suppliers, as hospitals may order more goods or services from them. This can result in suppliers offering discounts on their prices. Moreover, an increase in supplier prices can decrease a hospital's profitability. Furthermore, government regulatory and operational control can also affect suppliers' prices. An increase in government intervention through regulation and operations control may be directly proportional to the price offered by suppliers.

The relationship between government regulatory and operational control (G reg & OPC) and IT integration and utilization is crucial. An increase in G reg & opc leads to increased IT integration and utilization, which in turn positively affects information sharing. This information sharing increases government intervention, creating a reinforcing loop. However, the level of government intervention may decrease information sharing between hospitals and key partners. Additionally, increasing government regulatory and operational control increases government health expenditure and a hospital's level of partnership and resources. This relationship goes both ways, highlighting the importance of understanding these factors' relationships.

5. Discussion

The study examines the factors influencing the hospital supply chain (HSC) performance through a system thinking and system dynamics approach, analyzing the intricate interdependencies and feedback loops within the hospital supply chain ecosystem.

Compared to other work reported in the literature, this study emphasizes the critical role of partnerships in managing hospital supply chains. This study highlights the interdependence between hospitals, suppliers, and governments, where the

actions and decisions of one stakeholder significantly influence the other. Establishing a strong partnership between these three critical entities is essential for ensuring the efficient and sustainable operations of the hospital supply chain.

One study that supports the findings of this research is the work of Setiawati et al. (2014), which also emphasizes the importance of partnerships in hospital supply chain management. The study highlights the need for collaboration among hospitals, suppliers, and government entities to ensure the efficient and effective delivery of healthcare services. The study also emphasizes the importance of information sharing and communication among stakeholders to ensure the smooth functioning of the hospital supply chain.

Other work by Mishra et al. (2018) emphasizes the importance of financial, non-financial, and operational performance in hospital supply chain management. They emphasize the need for strong relationships with suppliers and effective management of technology and information systems. The research highlights the importance of partnerships in effective hospital supply chain management, highlighting the collaboration among diverse stakeholders for efficient and sustainable operations. Healthcare businesses should focus on building strong partnerships.

The study emphasizes the importance of partnerships in managing hospital supply chains, highlighting the interdependence between hospitals, suppliers, and governments. It underscores the need for businesses in the healthcare industry to establish strong relationships with suppliers and government entities to ensure efficient and sustainable hospital supply chain operations. The findings have significant implications for business practice and business practices in the healthcare industry.

5.1. Managerial Implications

The study highlights the importance of partnerships in effective hospital supply chain management. Collaboration among stakeholders, including hospitals, suppliers, and government agencies, is crucial for maximizing supplier performance and integrating suppliers into hospital operations. Partnerships involve information sharing, quality standards, performance metrics, trust-building, flexibility, pricing strategies, inventory management, IT integration, dynamic capabilities, healthcare spending, economic indicators, regulatory controls, operational management, customer outcomes, key performance indicators, demand forecasting, and profitability.

To improve the overall performance of the hospital supply chain, managers should enhance the hospital supply chain by building strong relationships with suppliers and government entities, prioritizing stakeholder collaboration through information exchange, quality standards, and trust-building. They should also integrate IT, dynamic capabilities, and pricing methods to maximize supplier performance. Additionally, effective inventory management systems should be implemented to ensure the hospital has the necessary resources to meet patient demands.

5.2. Limitations and Future Research

The study on hospital supply chain collaborations has several shortcomings. It focuses only on vendor-government agency links and overlooks additional stakeholders like hospitals and patients. It only examines the hospital supply chain in one setting, neglecting collaborations in different countries or healthcare systems. The study uses system thinking and system dynamics, which should be explored further. It also lacks a comprehensive analysis of factors contributing to effective partnerships, such as pricing strategies or inventory management. Future research should explore different analytical methods and conduct case studies to gather quantitative data on stakeholder relationships.

This study suggests that further research on people, processes, and technology in hospital supply chain management can enhance overall performance. It suggests that process improvement can help identify inefficiencies and bottlenecks, while technology can improve supply chain visibility, inventory management, and supplier performance. Additionally, people research can help managers develop skills and competencies to build and maintain effective partnerships with suppliers and government entities.

6. Conclusion

The primary objective of this study is to understand the impact of partnerships and their potential for improving a hospital's supply chain performance by investigating the relationships between hospitals, suppliers, and government bodies in the hospital supply chain, focusing on the factors driving these relationships and their impact on the performance of the supply chain. Firstly, this study highlights the interdependence between hospitals, suppliers, and governments, where the actions and decisions of one stakeholder significantly influence the other. The establishment of a strong partnership between these three critical entities is essential for ensuring the efficient and sustainable operations of the hospital supply chain. This study highlights that integration

among hospitals and suppliers is crucial for optimizing supplier performance and enhancing overall supply chain performance. Supplier and hospital integration is positively driven by variables such as information sharing, trust, supplier quality standards, IT integration, hospital capabilities, and other variables stated in the CLD. Government interventions such as government healthcare expenditures also impact the overall performance of a hospital supply chain. These factors reinforce effective partnerships and may increase supply chain performance. Ultimately, the success of key partnerships in the healthcare systems holds the potential for positive patient outcomes and the overall quality of healthcare services.

References

Abdallah, A. B., Abdullah, M. I., & Mahmoud Saleh, F. I. (2017, April 3). The effect of trust with suppliers on hospital supply chain performance. *Benchmarking: An International Journal*, *24*(3), 694–715. doi: 10.1108/BIJ-05-2016-0062

Alshahrani, S., Rahman, S., & Chan, C. (2018, February 12). Hospital-supplier integration and hospital performance: Evidence from Saudi Arabia. *The International Journal of Logistics Management, 29*(1), 22–45. doi:10.1108/IJLM-12-2016-0287

Amissah, M., Gannon, T. F., & Monat, J. P. (2020, February 27). *What is systems thinking? Expert Perspectives from the WPI Systems Thinking Colloquium* of October 2, 2019. Systems; Multidisciplinary Digital Publishing Institute. doi: 10.3390/systems8010006

Azzi, A., Persona, A., Sgarbossa, F., & Bonin, M. (2013). Drug inventory management and distribution: Outsourcing logistics to third-party providers. *Strategic Outsourcing: An International Journal*, *6*(1), 48–64. doi: 10.1108/17538291311316063

Beerli, A., & Martín, J. D. (2004). Factors influencing destination image. *Annals of Tourism Research, 31*(3), 657-681. doi: 10.1504/IJLSM.2013.053773

Bian, W., Yang, X., Li, S., Yang, X., & Hua, G. (2021). Advantages of 3PLs as healthcare supply chain orchestrators. *Computers & Industrial Engineering, 161*, 107628. doi: 10.1016%2Fj.cie.2021.107628

Burns, R. Lawton. (2002). *The healthcare value chain: Producers, purchasers, and providers. jossey-bass*

Deshwal, P. (2016). Customer experience quality and demographic variables (Age, gender, education level, and family income) in retail stores. *International Journal of Retail & Distribution Management, 44*(9), 940-955. doi: 10.1108/IJRDM-03-2016-0031

Dobrzykowski, D. (2019, April). Understanding the downstream healthcare supply chain: unpacking regulatory and industry characteristics. *Journal of Supply Chain Management, 55*(2), 26–46. doi: 10.1111/jscm.12195

Malbon, E., & Parkhurst, J. (2023). System dynamics modeling and the use of evidence to inform policymaking. *Policy Studies, 44*(4), 454-472. doi: 10.1080/01442872.2022.2080814

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis: A global perspective (7th ed.).* Upper Saddle River: Pearson Education.

Iacocca, K. M., & Mahar, S. (2018, August 6). Cooperative partnerships and pricing in the pharmaceutical supply chain. *International Journal of Production Research, 57*(6), 1724–1740. doi: 10.1007/s12351-021-00674-x

Kitsiou, S., Matopoulos, A., Manthou, V., & Vlachopoulou, M. (2007). Evaluation of integration technology approaches in the healthcare supply chain. *International Journal of Value Chain Management, 1*(4), 325–343. doi: 10.1504/IJVCM.2007.015091

Kuo, T. C., Chen, K. J., Shiang, W. J., Huang, P. B., Otieno, W., & Chiu, M. C. (2021). Collaborative data-driven analytics of material resource management in the smart supply chain by using a hybrid Industry 3.5 strategy. *Resources, Conservation and Recycling, 164*, 105160. https://doi.org/10.1016/j.resconrec.2020.105160

Mandal, S. (2017, May 2). The influence of dynamic capabilities on hospital-supplier collaboration and hospital supply chain performance. *International Journal of Operations & Production Management, 37*(5), 664–684. doi: 10.1108/IJOPM-05-2016-0249

Mathew, J., John, J., & Kumar, S. (2013). New trends in the healthcare supply chain. In *Annals of POMS conference proceedings*, pp. 1-10. doi: 10.1007/s42943-021-00045-5

Matopoulos, A., & Michailidou, L. (2013). Implementing collaborative practices in the healthcare supply chain: insights into hospital-vendor operations. *International Journal of Logistics Systems and Management, 15*(2/3), 288.

Mettler, T. (2011, April 1). Transformation of the hospital supply chain. *International Journal of Healthcare Information Systems and Informatics, 6*(2), 1–13. doi: 10.4018/jhisi.2011040101

Mishra, V., Samuel, C., & Sharma, S. (2018, July 9). Supply chain partnership assessment of a diabetes clinic. *International Journal of Health Care Quality Assurance, 31*(6), 646–658. doi: 10.1108/IJHCQA-06-2017-0113

National Academy of Engineering (US) and Institute of Medicine (US) Committee on Engineering and the Health Care System, Reid, P. P., Compton, W. D., Grossman, J. H., & Fanjiang, G. (Eds.). (2005). *Building a better delivery system: A New Engineering / Health Care Partnership*. National Academies Press (US). doi: 10.17226/11378

Pan, J., Liu, G. G., & Gao, C. (2013). How does separating government regulatory and operational control of public hospitals matter to healthcare supply? *China Economic Review, 27*, 1–14. doi: 10.1016/j.chieco.2013.07.002

Ryan, K. Jennifer. (2005). *Systems engineering: Opportunities for health care, building a better delivery system: A new engineering / health care partnership*. National Academy Press.

Setiawati, M., Sutopo, W., & Wijayanti, A. (2014). Hospital supply chain management: A literature review. *International Journal of Applied Business Research, 2*(2), 1-14.

Setyawan Firmansyah, H., & Siagian, H. (2022, December 15). Impact of information sharing on supply chain performance through supplier quality management, supply chain agility, and supply chain innovation. *Petra International Journal of Business Studies, 5*(2), 119–131. https://doi.org/10.9744/ijbs.5.2.119-131

Singh, A., & Parida, R. (2022). Decision-making models for healthcare supply chain disruptions: Review and insights for post-pandemic era. *International Journal of Global Business and Competitiveness, 17*(2), 130–141. doi: 10.1007/s42943-021-00045-5