Analysis of Competitiveness in Supply Chain Integration and Logistics: An Evidence From a Public Hospital Network

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Abstract

Healthcare systems are recognized for their disarticulated logistics models due to their interconnected services' complex structure. There is evidence in the literature that these systems require the implementation of supply chain management practices to strengthen their integration with customers and suppliers and improve their competitiveness. Then, this research aimed to analyze competitiveness in a supply chain integration and logistics for a Colombian public hospital applying a competence and capability assessment. The results show that the supply chain integration competitiveness of the studied hospital is 72.24%, and the logistics competitiveness is 77.79%. Based on the Bowersox model, most performance results are above the defined threshold set by the performance of established world-class companies, showing an acceptable level. To reduce the identified GAPs, we provided strategies for the improvement of competitiveness in supply chain integration and logistics for the selected Colombian public hospital.

Keywords
Competitiveness, Hospital, Logistics, Supply chain integration.

1. Introduction
Companies are facing challenges in market competition, demand variability, and shorter life cycle of their products and services due to globalization. Companies must be able to respond efficiently to the environmental changes at the lowest possible cost to acquire competitiveness. These objectives are challenging to achieve when organizations work without partners because of the number of internal resources required for this task. For that reason, competition in the global market no longer focuses on business to business relationships but instead resides in competition between supply chains (Escorcia-Caballero et al. 2019; Moreno-Luzon et al. 2019; Näslund and Hulthen 2012). According to Stank et al. (2001), one of the most important issues in a business environment is the integral management of the supply chain. To face this challenge, executives are focusing on competition between networks, hence the integration and management of key business processes among supply chain members is a critical aspect to determine an organization's success (Sahid et al. 2010).

Healthcare systems are recognized for their disarticulated logistics model due to the complex structure of their interconnected services (Ortíz-Barrios et al. 2017). In Colombia, public hospitals are vital to the healthcare system. These institutions provide care services for those who cannot afford the cost of the services provided by private hospitals, which is a large part of the population. Colombian public hospital networks present serious problems to ensure timely provision of health services due to the lack of critical resources and proficiencies (Arbelaez and Patiño 2015). Therefore, public hospital managers must consider supply chain management procedures to strengthen integration levels with customers and suppliers, thereby improving their competitiveness and providing an efficient service (Dyer and Singh 1998; Ortíz-Barrios et al. 2017; Osborne et al. 2017).

Accordingly, this research aims to show evidence for the level of competitiveness in supply chain integration and logistics in a public hospital network. Specifically, our research focuses on analyzing a case study of a Colombian public hospital and its levels of competitiveness in supply chain integration and logistics. We also compared these results to the performances of world-class companies. The motivation for doing this was to propose strategies that can be implemented to establish continuous improvement plans for critical processes in hospital networks.

This work is structured as follows. First, a theoretical framework on competitiveness in supply chain integration and logistics is presented. Subsequently, the methodology and the discussion of results are described. The final section includes the research study's conclusions and recommendations.

2. Theoretical Framework

2.1 Supply Chain Integration

Supply chain management (SCM) can be defined as a set of approaches used to efficiently manage the processes of suppliers, manufacturers, warehouses, and stores. The goal is to guarantee that products are made and distributed in appropriate quantities, places, and times to minimize costs through the entire system or network, and customer requirements may be satisfied (Simchi-Levi et al. 2004). The SCM approach mainly differs from traditional perspectives because it considers a broader object of study; it concentrates on managing activities both internal and external to the organization (Croom et al. 2000; Wisner and Tan 2000). Therefore, the purpose of SCM is to improve the performance of organizations throughout the enhanced utilization of their internal and external capabilities, ultimately creating coordinated supply chains (Lummus and Vokurka 1998; Morgan and Monczka 1996).

Supply chain integration (SCI) is considered as one of the key approaches of SCM because integration is recognized as an adequate tool to improve the efficiency and effectiveness of the members in a supply chain (Lambert and Cooper 1998). The main objective of SCI is to improve the coordination of inter-organizational and intra-organizational processes and activities in such a way that most of the competitors cannot easily match the obtained advantages (Anderson and Katz 1998).

Some researchers argue that the basis of SCI is characterized by cooperation, collaboration, exchange of information, trust, shared technology, and a fundamental change from the management of individual functional processes to an integrated process management throughout supply chains (Escorcia-Caballero et al. 2019; Akkermans et al. 1999). Flynn et al. (2010) define SCI as "the degree to which a manufacturer strategically collaborates with its supply chain partners, and collaboratively manages intra- and inter-organization processes. The goal is to achieve effective and efficient flows of products and services, information, money, and decisions, to provide maximum value to the customer at low cost and high speed" (p.59).

2.2 Logistics

Logistics is the management of the flow of goods, resources, and information between origin and consumption points. The Council of Logistics Management defines logistics as follows: "Logistics is part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements" (Lourenço 2005, p. 333).

Therefore, logistics activities, such as planning, designing, implementing, and managing material flows in a supply chain, are useful to support some company functions, e.g., distribution, inventory management, and packaging

(Pokharel, 2005). Logistics is also a critical factor for competitive advantage, and a facilitator of business success (Bowersox and Closs 1996; Bowersox and Daugherty 1995; Simchi-Levi et al. 2003).

As in most companies' processes, logistics in hospitals has two main streams: internal and external. Hospitals should focus on managing the internal supply chain to maximize service levels and manage the external supply chain to minimize costs (Zhi Xiong and Pokharel 2007). Therefore, to improve services and reduce costs in hospitals, logistical activities such as purchases, information systems management, and transportation should be studied (Aptel and Pourjalali 2001).

The concept of logistics in the last decades has expanded and strongly included the integration of customers and suppliers. Companies are developing close relationships with customers and improving work arrangements with suppliers to have an effective control of their processes (Stank et al. 2001).

2.3 Competitiveness in Supply Chain Integration and Logistics

One of the most effective management tools to study the competitiveness of supply chain integration and logistics activities is benchmarking. When conducted with versatility, benchmarking may be applied to any company area or process; it makes it possible to learn from the best techniques of competitors and generate strategies to increase competitiveness (Sahid et al. 2010).

Donald J. Bowersox proposed to the Council of Logistic Management a strategy to benchmark the logistics processes through a supply chain (Bowersox et al. 1999). The Bowersox model established a performance standard based on world-class companies from different industries. This tool aims to perform an analysis of the SCI and logistics performance GAPs and then be able to identify critical points of improvement.

To consider an organization's logistic practices to be among the best ones, it is necessary for there to be a high level of integration in its logistics processes along the supply chain. It is also necessary for the company to possess tools that can handle a robust flow of information throughout its network. The latter is the essence of competitiveness, i.e., forming a network for supply chain partners to exchange information in real-time and responsibly, thereby generating increased profit levels (Sahid et al. 2010).

The Bowersox model consists of the assessment of the competitiveness of both supply chain integration and logistics. According to Sahid et al. (2010) and Ugarriza and Jiménez (2010), supply chain integration comprises six competencies and a total of 25 capabilities. Table 1 describes the competencies and capabilities required for a supply chain integration. For the evaluation of competitiveness in logistics, Sahid et al. (2010) and Ugarriza and Jiménez (2010) detailed four competencies and a total of 17 capabilities. Table 2 describes the competencies and capabilities required for logistics.

3. Research Methodology

According to the General System of Social Security Health, several institutions in Colombia provide health services. These institutions are dedicated to safeguarding the health and life of all citizens by providing the necessary medical attention. The supply chain of a health institutions is not different from other companies' structures. Even in this sector, human resources are responsible for the integration of the generated services.

The most efficient hospital network depends on proper medical care and the correct management of various logistical factors, e.g., controlling the stock of medical devices, avoiding storage problems, and optimizing spaces. These factors allow employees to develop their work continuously and safely. Although there have been important changes in hospital networks in the past, the information about supply chain management practice in Colombia's public hospitals is scarce (Figueroa et al. 2016).

We analyzed the competitiveness in supply chain integration and logistics using a case study of the Colombian public healthcare system. We conducted a structured questionnaire technique in a public hospital network of high complexity level. In our research, we conducted a case study of the hospital's entire supply chain, which included three of its main suppliers, three internal parties, and three customers (as shown in Figure 1).

Table 1. Competencies and capabilities in supply chain integration

COMPETENCIES	CAPABILITIES	REFERENCE CODES
Customer integration (CI)	Customer segmentation	CSCI
	Relevance	RCI
	Response capability	RCCI
	Flexibility	FCI
Internal integration (II)	Inter-functional unification	IUII
	Standardization	STII
	Simplification	SIMII
	Incentives and achievement of objectives	IAOII
	Structural adaptation	SAII
Supplier integration (SI)	Strategic alignment	SASI
	Operational merger	OMSI
	Financial leverage	FLSI
	Supplier management	SMSI
Technology and planning integration (TPI)	Information management	IMTPI
	Internal communications	ICTPI
	Connectivity	CTPI
	Cooperation in the formulation of forecasts and planning	CFFPTPI
Measurement of integration level (MIL)	Functional evaluation	FEMIL
	ABC Methodology, Total Cost and Benchmarking	ABCMIL
	Indicators of dynamic alignment	IDAMIL
	Financial impact	FIMIL
Relationships integration (RI)	Specificity of roles	SRRI
	Protocols	PRI
	Ability to share information	ASIRI
	Profits and shared risks	PSRRI

Table 2. Competences and capabilities in logistics

COMPETENCIES	CAPABILITIES	REFERENCE CODES
Positioning (PO)	Formulation of logistics strategy	FLSP
	Extended dynamic alignment	EDAP
	Logistics network	LNP
	Organization	OP
Integration (IN)	Unification of the supply chain	USCI
	Integration of operations	IOI
	Shared information	SII
	Connectivity	COI
	Standardization	STI
	Simplification	SIMI
	Discipline	DI
Agility (AG)	Relevance	RA
	Adjustment to the client	ACA
	Flexibility	FA
Logistics performance measures (LPM)	Functional evaluation	FELPM
	Process evaluation	PELPM
	Benchmarking studies	BSLPM

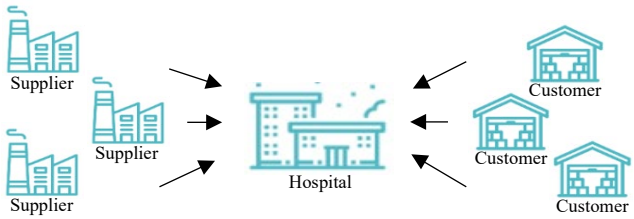

Figure 1: Supply chain of the studied hospital

To evaluate our research, we selected our sample unit based on the specific purpose of this study, which was focused on the hospital's network. It included the entire supply chain - three of its main suppliers, three internal parties, and three customers.

The study of the healthcare industry represents a challenge given its commitment to society, and it requires the articulated action of researchers to achieve the objective of creating conditions that guarantee the integral well-being and quality of life of human beings, including also the articulation of management efforts to understand how it is competitive upstream and downstream.

From the manufacturer to the patient, the engagement of all stakeholders could help improve the efficiency and effectiveness of the hospital. The integration of supply chain actors is essential for building good practices in the community; foreseeing results aimed at better service delivery and innovation in process management.

The research carried out by Sahid et al. (2010) and Ugarriza and Jiménez (2010), was used as a reference; they applied the Bowersox model to evaluate supply chain integration and logistics. All the items were measured using a Likert scale with values ranging from 1 (strongly disagree) to 5 (strongly agree).

A pilot test was carried out with academic researchers and practitioners. The process was important to assess the content validity of the construct scales, giving them consistency, coherence, and understandability. Later, the final questionnaire was sent via e-mail with a link to an online survey to other potential participants. All the questionnaires were answered.

4. Results

Based on the Bowersox model, the following concepts are described for reference:

- **Supply chain:** It is referenced as the summation of the rating for each set of questions.
- **Maximum value:** Maximum number that each item in the questionnaire can obtain as the maximum value.
- **GAP:** It is the difference between supply chain and maximum value.
- **G/MAP:** It is the percentage value of the result.
- **World-class:** Global results obtained by Bowersox used a total sample of 2,680 managers from industries in different economic sectors, all of whom are members of the Logistics Management Council.

4.1 Competitiveness in Supply Chain Integration

Competitiveness in supply chain integration is understood as the synergy derived from customer integration, internal integration, supplier integration, planning and technology integration, measurement of integration levels, and relationship integration (Sahid et al. 2010; Ugarriza and Jiménez 2010). Each competency was evaluated based on four "Best Practices" on a scale of 1 to 5, resulting in a maximum score of 20 points for each one. Given that each competency comprises 4 capabilities, except internal integration, which is composed of 5 capabilities, the highest possible score of supply chain integration competitiveness is 500 points. Table 3 describes the points distribution.

Table 3. Maximum score in competitiveness in supply chain integration

Competencies in supply chain integration	Math Calculations
Customer integration	20 points X 4 = 80
Internal integration	20 points X 5 = 100
Supplier integration	20 points X 4 = 80
Technology and planning integration	20 points X 4 = 80
Measurement of integration level	20 points X 4 = 80
Relationships integration	20 points X 4 = 80

The results related to the competitiveness of the supply chain integration are shown in detail in Table 4.

Table 4. Supply chain integration competitiveness

Competitiveness and Integration of the Supply Chain	Supply Chain	World-class	GAP	G/WC
	301,23	**416,99**	**115,76**	**27,76%**
Customer integration	49,56	66,20	16,64	25,14%
Internal integration	53,01	85,50	32,49	37,99%
Supplier integration	49,57	63,38	13,81	21,79%
Technology and planning integration	49,79	68,21	18,42	27,01%
Measurement of integration level	50,37	67,20	16,83	25,04%
Relationships integration	48,93	66,50	17,57	26,41%

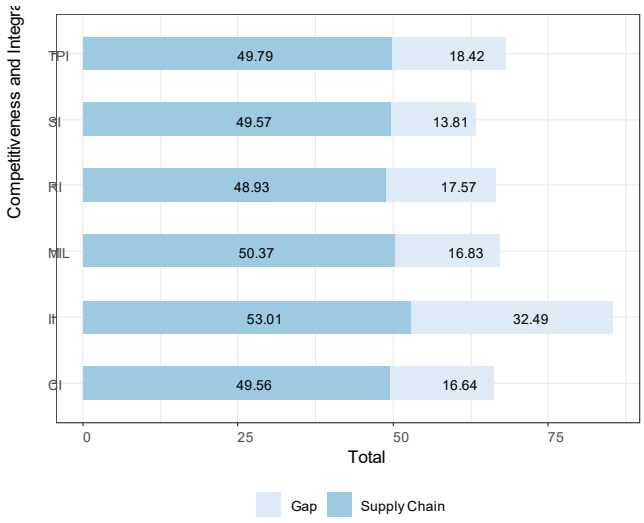

Figure 2: Competitiveness and Integration of the Supply Chain

Following Table 4 and Figure 2, the level of competitiveness in supply chain integration for the network is 301.23 points and represents a GAP of 115.76 points in reference to the world-class standard. It is also observed that the network is 72.24% competitive in supply chain integration versus world-class companies. It is important to note that none of the scores obtained equals or exceeds world-class standards, which indicates that its level of competitiveness in supply chain integration needs to be improved.

Also, following Table 4, we can see that the percentage GAPs of *customer integration, supplier integration, technology and planning integration, measurement of integration level, and relationship integration* are in the 10%-30% range, which is rated by Bowersox as an acceptable level. Although is not in a critical performance level, it advises the

hospital managers to reduce the GAP associated with world-class performance to improve those capabilities. On the other hand, we can see that the percentage GAP of *internal integration* is above 30.1%, which is classified as a critical performance in the Bowersox scale. It is therefore recommended for the network to improve its performance in this capability. This capability indicates that the hospital must improve competence in integrating processes, considering internal requirements, establishing procedures and policies for synchronization of activities, fostering synergies, and implementing superior practices for its network processes. It is also stated that the studied network has a low capability to achieve good communication, which directly connects with the accomplishment of its internal needs.

The capabilities of the competencies that measure the level of supply chain integration competitiveness are shown in Figures 3-8. The analysis results are:

Customer integration is the company's capability to build and maintain links with its customers. This competence is supported by the capabilities presented in Figure 3. Figure 3 shows that the highest capability performance in customer integration was focused on the *response capability* and *customer segmentation*. It is also noticed that *relevance* and *flexibility* capabilities showed the lowest performance. However, it is important to highlight that *customer integration* capabilities are at a good level, but efforts are recommended for increasing overall performance levels.

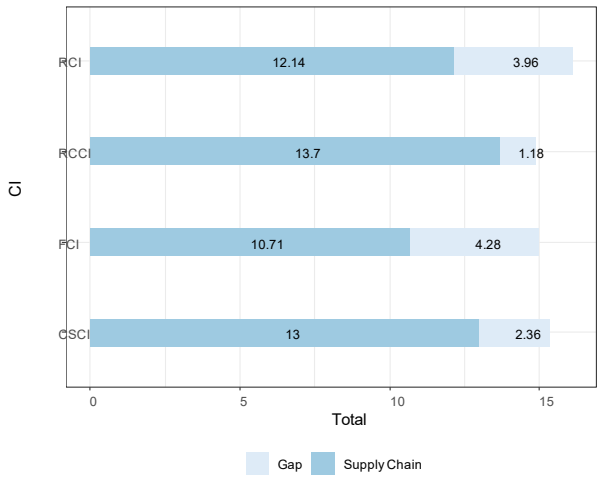

Figure 3: Competitiveness in customer integration

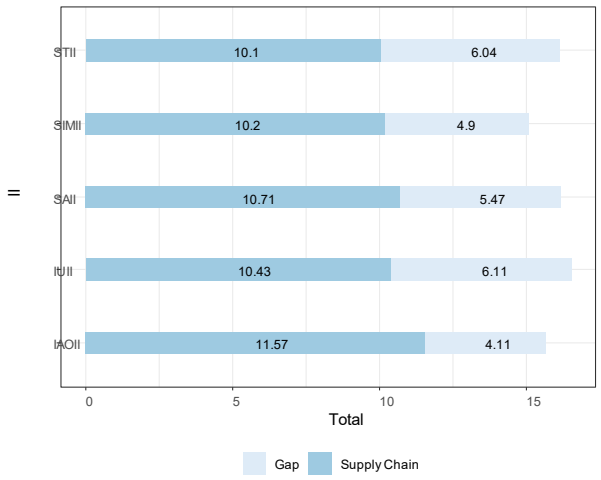

Figure 4: Competitiveness in internal integration

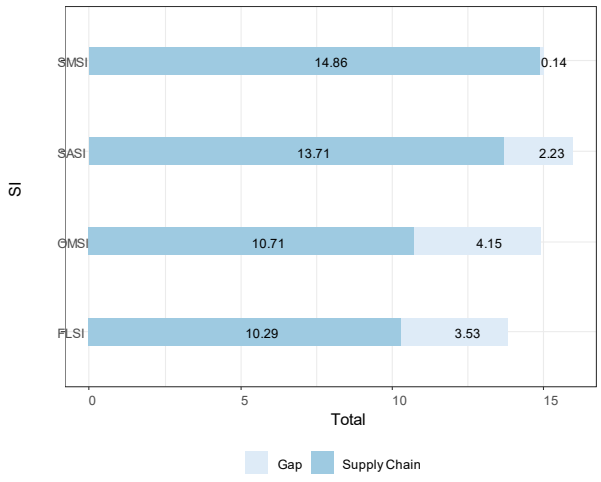

Figure 5: Competitiveness in supplier integration

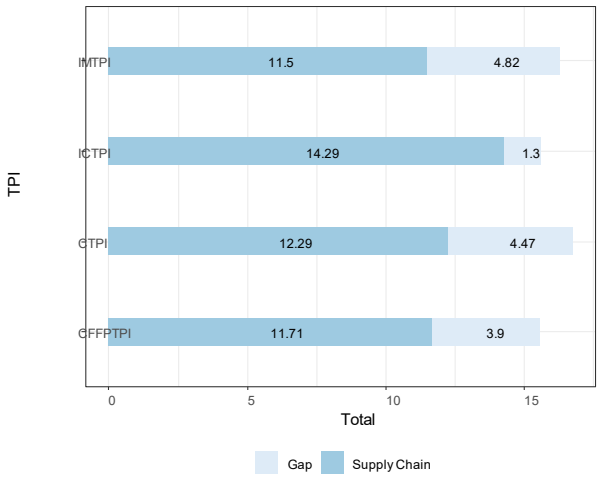

Figure 6: Competitiveness in technology and planning integration

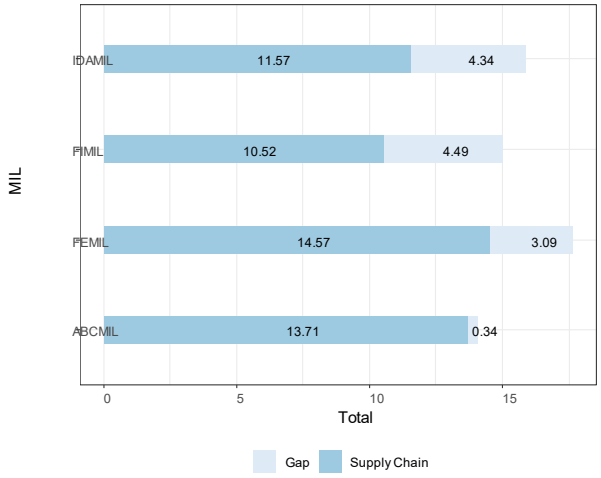

Figure 7: Competitiveness in measurement of integration level

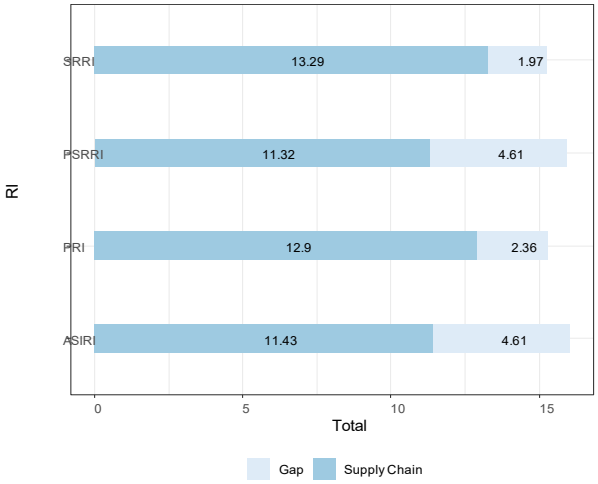

Figure 8: Competitiveness in relationships integration

Internal integration is the ability of the company to integrate its internal processes with external processes. This competence is supported by the capabilities presented in Figure 4. In Figure 4, we can observe that only the capability of *incentives and achievement of objectives* shows an acceptable level. It is also noticed that *inter-functional unification, standardization, simplification*, and *structural adaptation* need attention. It is important to highlight that the *internal integration* capabilities require a sizeable effort to advance from critical to a good performance level.

Supplier integration is the capability of the company to build and maintain links with its suppliers. This competence is supported by the capabilities presented in Figure 5. Figure 5 shows that the highest capability performance is focused on the *strategic alignment* and *supplier management*. It is also noticed that *operational merger* and *financial leverage* capabilities showed a lower performance. It is important to highlight that the *supplier integration* capabilities show a good level, but efforts are required for further development.

Technology and planning integration is the capability that the company has to lead the operational needs to attend the market segments. This competence is supported by the capabilities presented in Figure 6. In Figure 6, we can observe that the highest capability performance is focused on *internal communications*. It is also noticed that *information management, connectivity,* and *cooperation in the formulation of forecasts and planning* showed a lower performance. It is important to highlight that the *technology and planning integration* capabilities show a good level, but efforts are required for further development.

Measurement of integration level is the company's capability to facilitate the formulation and execution of strategies for the optimization of processes. This competence is supported by the capabilities presented in Figure 7. Figure 7 shows that the highest capability performance is focused on the *total cost and benchmarking, functional evaluation,* and *ABC methodology*. It is also noticed that the *indicators of dynamic alignment* and *financial impact* showed a lower performance. It is important to highlight that the *measurement of integration level* capability shows a good level, but efforts are required for further development.

Relationships integration is the capability of the company to develop principles of cooperation with customers and suppliers. This competence is supported by the capabilities presented in Figure 8. In Figure 8, we can observe that the highest capability performance is focused on the *specificity of roles* and *protocols*. It is also noticed that the ability to *share information, profits,* and *shared risk* capabilities showed a lower performance. It is important to highlight that the *relationship integration* capability shows a good level, but efforts are required for further development.

4.2 Competitiveness in Logistics

Competitiveness in logistics is understood as the synergy derived from: positioning, integration, agility, and logistics performance measures (Sahid et al. 2010; Ugarriza and Jiménez 2010). Each competency is evaluated based on four "Best Practices" on a scale of 1 to 5, resulting in a maximum score of 20 points for each one. Since each competence

is composed of 4, 7, 3, and 3 capabilities respectively, the highest score on logistics competitiveness is 340 points. Table 5 describes the points distribution.

Table 5. Maximum score for logistics competitiveness

Competencies in logistics	Math Calculations
Positioning	20 points X 4 = 80
Integration	20 points X 7 = 140
Agility	20 points X 3 = 60
Logistics performance measures	20 points X 3 = 60

The results of logistics competitiveness are shown below:

Table 6: Logistics competitiveness

Competitiveness in Logistics	Supply Chain	World-class	GAP	G/WC
	224,85	**289,04**	**64,19**	**22,21%**
Positioning	52,71	70,19	17,48	24,91%
Integration	89,43	117,47	28,04	23,87%
Agility	41,71	50,68	8,97	17,69%
Logistics performance measures	41,00	50,70	9,70	19,13%

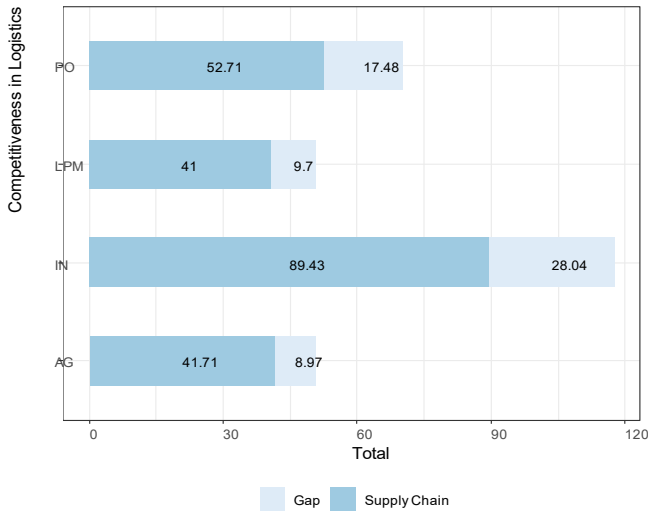

Figure 9: Competitiveness in logistics

Following Table 6 and Figure 9, the logistics competitiveness level is 224.85 points and represents a GAP of 64.19 points with respect to the world-class standard. It is also observed that the network is 77.79% competitive in its logistics versus world-class companies, thereby indicating that to achieve an optimal performance at this level, a 22.21% increase is needed. It is important to note that none of the scores obtained at the hospital equals or exceeds world-class standards, which indicates that its level of competitiveness in logistics has to be improved.

Table 6 shows that the percentage GAPs for *positioning, integration, agility,* and *logistic performance measures* are in the 10%-30% range, which is rated by Bowersox as an acceptable level. Although is not in critical performance level indicator, it suggests the hospital managers to improve these capabilities while reducing the GAP associated with world-class performance.

The most significant GAP is related to *competitiveness in integration,* stating that the studied hospital requires to perform investments, such as information systems, to support business management strategies and facilitate the decision-making process. Likewise, it can improve the integration and transferring of information among operational, technical, and financial aspects under a responsibility format. Procedures must be established to facilitate logistics operations to improve the effectiveness of the overall logistics system. There is also a significant GAP in the *competitiveness in positioning,* which implies the lack of monitoring systems for the logistics system's performance of external and internal processes.

The capabilities of each competence that measure the level of competitiveness in logistics are presented in Figures 10-13:

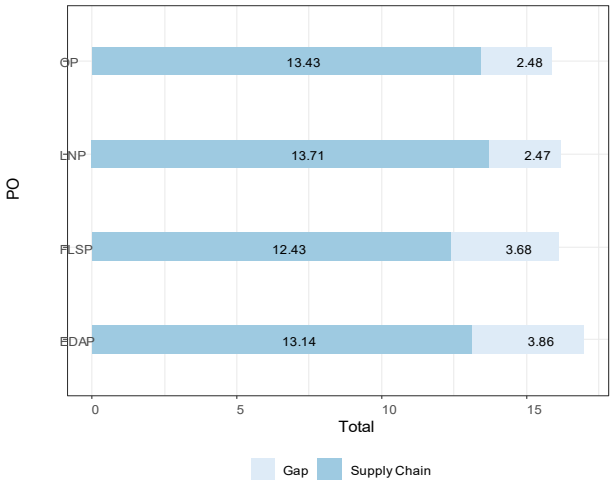

Figure 10: Competitiveness in positioning

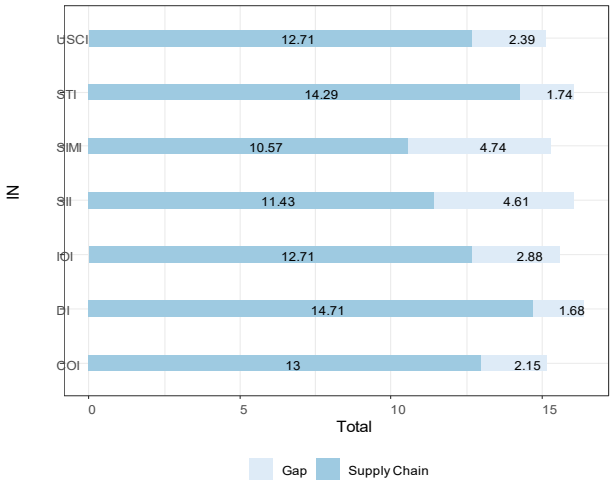

Figure 11: Competitiveness in integration

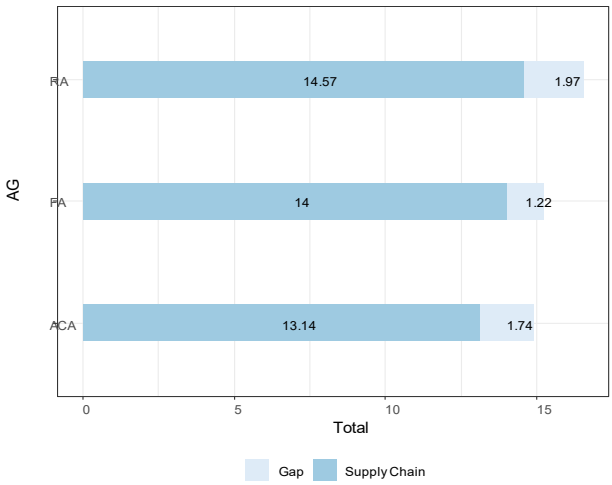

Figure 12: Competitiveness in agility

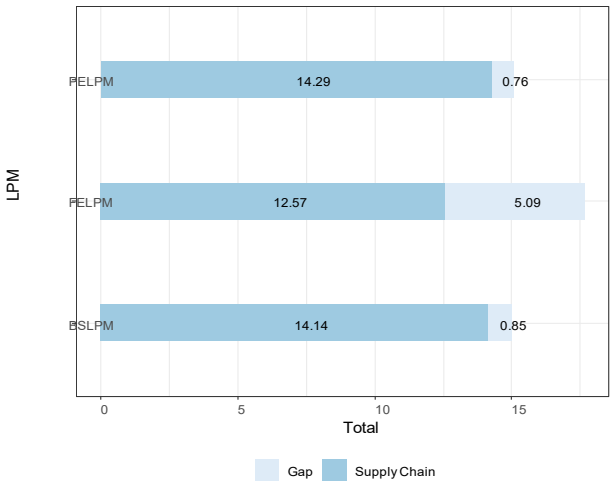

Figure 13: Competitiveness in logistics performance measures

Positioning is supported according to the capabilities described in Figure 10. Figure 10 shows that the highest performance capabilities are focused on *logistics networks* and *organizations*. It is also noticed that the *logistic strategy formulation* and *extended dynamic alignment* capabilities presented a lower performance.

Integration is supported according to the capabilities described in Figure 11. Figure 11 shows that the highest performance capabilities are focused on the *unification of the supply chain, connectivity, standardization,* and

discipline. It is also noticed that the *integration of operations, shared information,* and *simplification* capabilities presented a lower performance.

Agility is supported according to the capabilities described in Figure 12. Figure 12 shows that the highest performance capabilities are focused on *relevance, adjustment to the client,* and *flexibility*.

Logistics performance measures is supported according to the capabilities described in Figure 13. Figure 13 shows that the highest performance capabilities are focused on *process evaluation* and *benchmarking studies*. It is also noticed that the *functional evaluation* presented a lower performance.

5. Conclusions

This research aimed to study the supply chain integration and logistics competitiveness of a public hospital network in Colombia to support their need to improve their performance.

We observed that the supply chain integration competitiveness of the studied hospital is 72.24%. We found that related to *customer integration*, the hospital has the adaptation capability for customers' unplanned requirements, and the ability to execute specific programs to generate customer satisfaction. However, it needs to reinforce its ability to maintain customer interest and to adjust for unexpected operational circumstances.

Regarding the *internal integration*, it was found that the hospital has the capability to encourage people to learn about operational and administrative policies and procedures, and also to use incentive programs designed to reward achievements obtained by employees. However, there is a substantial need for more efforts to operationalize activities to build synergies for process management, the execution of clear policies on the synchronization of operations, the identification, implementation, and improvement of best practices in SCM, and the extension to its internal processes upstream and downstream.

Regarding *supplier integration*, the hospital has the capability to actively collaborate with its main supplier in the formulation process of strategic planning upstream to obtain shared benefits. However, it needs more significant endeavors in its operational synchronization to reduce process redundancy with suppliers. As pertains to *technological and planning integration*, the hospital has an adequate flow of information that interrelates the data of functional silos in real time. However, it is necessary to improve demand forecasting procedures. With regards to with *measurement of integration levels*, the hospital requires more focus on the SCM indicator. Finally, in *relationship integration*, the hospital understands its responsibilities towards its customers and suppliers, but a significant investment is required to reinforce its ability to exchange key information, as profits, with its customers and suppliers.

The logistics competitiveness for the studied hospital is 77.79%. We found that regarding *positioning*, the hospital has a hierarchical structure that requires a greater focus on marketing programs to promote strategies that improve customer relationships. Regarding *integration*, the hospital has a process standardization program through a quality assurance system. As pertains to *agility*, the hospital has a strong capability to respond to a rupture of upstream and downstream relationships, and it takes into consideration the needs of customers and patients.

Finally, concerning the *logistics performance measure*, the hospital's staff is trained to carry out benchmarking studies regarding logistics, and it does have enough controls to monitor market fluctuations. The results in the capabilities of each competence of the supply chain integration and logistics competitiveness show that most of them have a rating in the 10%-30% range, meaning an acceptable level. The only exception is internal integration with a rating above 30.1%, meaning a critical performance. Although most indicator showed an acceptable performance level, it suggests to improve its competencies to reduce the existing gap relative to world-class performance.

We propose some key recommendations that could increase the network's overall competitiveness: (1) Create awareness at the executive level about the importance of executing downstream and upstream cooperation agreements. (2) Design measurement systems and incentives focused on determining the effort required by employees, and through their implementation to control and adopt the development and compliance with goals, objectives, and strategic plans drawn in each of the functional silos. (3) Design a good communication plan within the company to inform the findings of benchmarking, involve employees in their processes, and generate commitment at different levels of the organization. (4). Establish and implement training plans in the supply chain for organizational silos and clusters supported by the CEO of the companies members. (5) Outsource all operational processes that do not add value to the

organization and promote improvement programs focused on increasing the company's competitiveness. (6) Promote a level of maturity of the supply chain value network by stimulating suppliers and customers to develop and implement quality management systems that support their business excellence.

The findings of this study make significant contributions, but they have limitations that encourage future research. This study only focuses on competitiveness in a Colombian hospital supply chain integration and logistics using a cross-sectional design. Then, for future research, the effect of other organizational attributes should be evaluated using longitudinal data that could allow more relevant findings and expand the model to companies in other economic sectors, and countries.

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