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The impact of management systems and human resources on logistics performance: an empirical study

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Abstract: The performance of logistics represents an essential dimension of supply chain management, incorporating a range of strategies and indicators to assess the proficiency and efficacy of logistics flows. This study empirically analyzes the relationships between management systems, human resources, and logistics performance in the province of Manabí, Ecuador. Using structural equation modeling (SEM), data was collected from a questionnaire of 144 questions evaluated in a Likert scale of five (5) points and applied to 117 managers across various industries. The results indicate that integration and personnel competency development significantly impact logistics performance. Likewise, the research highlights that to enhance logistics performance, companies should focus on improving their management systems, fostering integration with suppliers and customers, and providing effective training to enhance employee competencies. Additionally, the study emphasizes the importance of logistics infrastructure and human capital development as crucial factors for achieving efficient logistics performance. This paper contributes to understanding how management systems and human resources affect logistics performance in a developing region, providing a foundation for future strategies aimed at continuous improvement in local supply chains.

1 Introduction

Logistics performance is key to success at both the organizational and national levels. It affects supply chain efficiency and global trade competitiveness. It includes the effectiveness and efficiency of logistics activities, which include transportation, warehousing, inventory management, and order processing. The importance of logistics performance lies in its ability to reduce costs, improve service levels, and enhance the supply chain. This leads to a competitive edge and economic growth.

They are strategic, operational, and technological factors that affect a company's ability to manage its logistics. The promotion and development of human resources are currently as important as the creation of a logistics infrastructure in a country. Recent studies carried out in developing countries show that companies confront significant difficulties as regards hiring personnel with the skills and knowledge necessary to manage the integration of logistics processes, making this a frequently recognized problem.

In this respect, the studies carried out by Ahmad employ structural equations to analyze the influence of personnel on logistics performance in various environments. The first [1] is based on business systems and their influence on logistics performance, and future aspects of logistics are also defined simultaneously. The second [2], meanwhile, focuses on electronic reverse logistics and its development, and identifies the most critical factors and their relationship with electronic commerce. It specifies that an organization's culture has a direct influence I on electronic reverse logistics. The third [3] shows that logistics efficiency is positively correlated with electronic logistics, information technology capacity, information exchange, and the quality of service personnel. This work also emphasizes that electronic logistics favorably influences logistics performance.

Other research analyzes organizational management and logistics performance through the application of structural equations [2,4-6]. De Carvalho, et al. [4] also evaluate the performance of a city's logistics and the relationship between the actors involved, along with the efficiency and response capacity factors on the basis of urban parameters. In the case of Kankaew, et al. [5],the management and practices in an agri-food chain are mentioned, and as a result, the policies to be implemented as a consequence of a study carried out by managers.

Furthermore, in other research, integration and logistics performance are correlated by means of structural equations [7-12]. With regard to integration, the relationship between customers and suppliers and the interrelationship with performance is defined. The studies by Lai, et al. [9] also analyze information as part of integration and the relationship with collaboration in transportation. These elements are significant owing to the development of information and communications technologies and the globalization of supply chains. The work of Yingfei et al. (2022) [12], meanwhile, addresses logistics performance using a green approach. This interrelates the aforementioned concept with the service offered and the environment. This is owing to the need to implement the circular economy and the fact that logistics is a limiting factor.

Although several authors mention the variables and relationships that are analyzed in this study, this topic has not been explored in depth and there is consequently an information gap: that of validating the relationship between human resources, management systems and logistics performance.

The impact of personnel on logistics performance is mentioned in the studies cited above, although they do not, in general, analyze management as a factor that influences it. This signifies that there are not many studies that analyze the relationship between logistics performance, management systems and the work skills of logistics professionals. These elements make it possible to pose the following research questions:

Q1: What is the relationship between the organization's management systems and the logistics performance of a company?

Q2: What is the relationship as regards the integration of companies and logistics performance?

Q3: What is the relationship between human resources competencies and logistics performance?

In this respect, the objective of the research is to empirically analyze the current relationships between management systems, human resources, integration and logistics performance in the province of Manabí, Ecuador. This document is structured as follows: Section 2 presents an analysis of the application of structural models related to logistics performance and integration in the supply chain, while Section 3 shows an analysis of the training and knowledge management of logistics in Manabí, Ecuador. The materials and methods employed are provided in Section 4, and the results and analysis are shown in Section 5. Finally, Section 6 presents the conclusions, future lines and limitations of the present research.

1.1 Logistic performance

Logistics performance is like the engine of supply chain management. It is essential for everything to run smoothly. It measures how well your products are moving from the suppliers to the customer [13]. There are tools that help you evaluate efficiency (how fast you do it) and effectiveness (how well you do it). Logistics managers face challenges in achieving optimal performance, which are influenced by factors such as globalization, technological advancements, and regulatory changes [3]. These contests can significantly impact the efficiency and effectiveness of logistics operations.

In the literature there are studies that cover the estimation of logistics performance and the relationship between its corresponding activities. Within these, there is a tendency to use structural equation models to solve this type of problems. For example, Azevedo and Ferreira [14], analyze the performance measurement systems in logistics, the selection criteria for evaluation, define the variables and indicators. Based on the logistics activities and the indicators, they propose a model and hypothesis of the interaction between the previous elements. This includes integration as one of the research variables.

Other researchers, [5,9,15-17], propose a performance evaluation model in supply chains. The first researchers refer to the processes of the supply chains and associate indicators [15]. The second ones include the chain strategy as a variable [16]. Along these lines, other researchers analyze the relationships of supply chain practices, logistics indicators and competitiveness [5]. Kalubanga and Namagembe also take into account the organization (commitment, competence, reliability) and integration [13].

Ahmad and Mehmood, define logistics performance indicators and their relationship with the information system for the construction of cities of the future [1]. In this case, the study is directed at the business system, but takes into account logistics performance and organizational management. Other authors, De Carvalho and collaborators, study the same object [4]. In this case, they evaluate the performance of logistics in a city.

Bag and authors investigate how Industry 4.0 resources impact smart logistics along with the sustainability of business logistics [16]. This research takes into account integration through interconnection.

On the other hand, [3,9,18], include in the equation a variable related to human resource competencies. The approach is framed in the role of human resource competencies in improving logistics performance [18], and based on this they frame their hypotheses. Mai and coauthors demonstrated the evaluation with logistics performance, technology capacity and information sharing, and the quality of service personnel [3]. These studies demonstrate how the quality of employee service personnel positively affects logistics performance, part of our research.

Based on this background, the hypotheses of this research are defined and the applications of Table 1 are analyzed.

1.2 Application of structural models related to logistics performance

The number of publications that use quantitative multivariate analysis tools such as structural equation modeling (SEM) to test hypotheses and relationships between constructs that include latent variables and observed variables has increased in recent years. In order to begin the process of creating the model, a search was carried out in updated databases so as to verify the theoretical constructs and variables used in the current literature on this subject (Table 1):

Table 1 Studies that define variables that influence logistics performance and employ SEM/ PLS

Author/year	Reference	Logistics performance	Organization management	Integration	Human resources competence	SEM	PLS
(Azevedo and Ferreira, 2007)	[14]			X			X
(Jakhar and Barua 2014)	[15]	X				X	
(Ahmad and Mehmood 2016)	[1]	X	X			X	
(De Carvalho et al. 2019)	[4]	X				X	
(Bag, et al. 2020)	[16]			X			
(Chandak et al. 2020)	[17]	X				X	
(Masudin et al. 2020)	[19]	X				X	
(Prasetya and Wibawa 2020)	[20]	X				X	X
(Davidavičienė and Al Majzoub 2021)	[2]	X				X	
(Mesra 2021)	[18]	X			X	X	
(Sénquiz-Díaz 2021)	[21]	X				X	
(Falasca et al. 2022)	[22]	X					X
(Kalubanga and Namagembe 2022)	[13]	X	X	X		X	
(Kerdpitak 2022)	[8]	X	X			X	
(Lai, et al. 2022)	[9]	X			X	X	
(Mai et al. 2022)	[3]	X			X	X	
(Mokkhamakkul, 2022)	[23]	X	X			X	
(Moroni et al. 2022)	[10]	X		X		X	
(Thilakarathne et al. 2022)	[6]	X					X
(Wang et al. 2022)	[11]	X				X	
(Yingfei et al. 2022)	[12]	X					X
(Kovalenko 2023)	[24]	X				X	
(Chen and Hasan 2023)	[25]	X				X	X
(Ewuzie et al. 2023)	[26]	X				X	X
(Getele and Ruoliu 2023)	[27]	X		X		X	
(Maemunah and Nekrasov, 2023)	[28]	X				X	
(Sitisara et al., 2023)	[29]	X				X	

As clearly shown in the table above, few studies relate logistics performance and human resource competencies, despite the fact that this is, in our opinion, a limiting element in logistics. Using this concept as a basis, in this research the four variables are interrelated and the hypotheses used are justified. Moreover, the SEM method is simultaneously employed in order to solve these types of problems.

2 Training and knowledge management of logistics and supply chains in Manabí

The province of Manabí covers an area of 18,958 km^2 and is located within the coastal region of Ecuador. It has 22 cantons with a population of 1,369,780. The fundamental activities in the province are agriculture and fishing, and shrimp and tuna are two of the export rubles typical of the area. This demonstrates the need for logistics training in order to achieve competitiveness in the market.

With regard to professional, undergraduate and technological education in the province of Manabí, there are two training proposals. These proposals are developed in the technological field, and comprise the following courses: Higher Technology in Multimodal Logistics and Higher Technology in Port Logistics. They are studied at the Luis Arboleda Martínez Higher Technological Institute in the city of Manta.

With regard to postgraduate training in Logistics and supply chains in Manabí, one postgraduate course was identified: a Master's Degree in Industrial Engineering, which mentions logistics and supply chains. This is offered by the Technical University of Manabí in Portoviejo.

In the case of the research process at the universities of the province under study, there is a research group which states that logistics and supply chains are at the center of this area of science. This is called the UTM Production and Services Group (PROSERV). The above reaffirms the little interest that exists in the topic for research and application in this area of the country.

With regard to the lines of research, the classification of the UNESCO International Nomenclature for the fields of Science and Technology is followed by universities in Ecuador [30]. This infers that logistics is located in the area of mathematics and that supply chains are not shown in the first selection line (Table 2). This sometimes limits the focus of science.

Table 2 Six-digit level of classification of UNESCO fields

Specific field	**Detailed field**
Math	Operational Research (Distribution and transportation, inventories, queuing theory)
	Statistics (time series)
	Computer Science (Inventory Control)
Technological sciences	Environmental engineering and technology (industrial waste, recycling processes
	Regional and urban planning (transport and urban-rural relations)
	Industrial technology (Process engineering)
	Space technology (vehicle control)
	Oil and Coal Technology (Oil and Gas Storage)
	Railway Technology (Railway Services)
	Transportation systems technology (Urban traffic systems and Combination of systems)
Economic sciences	Economic activity (foreign trade, production
	General Economics (Consumer Behavior,
	International Economy (International Business,
	Business organization and management (Industrial studies, Marketing, Market studies, Operational research, Optimal production levels, Production organization and Sales management)

Source: The authors based on [30].

3 Methodology

The research was carried out from 2023 to 2024 on a total of 117 companies located in the province of Manabí, Ecuador. The sample consisted mainly of micro-enterprises located in the towns with the highest industrial activity in the province, as shown in Table 3.

Table 3 Characteristics of sample (n=117)

Company size	**Frequency**	**Percentage (%)**
Micro company (1 to 9 employees)	80	68.97
Small company (10 to 49 employees)	19	16.38
Medium company A (50 to 99 employees)	4	3.45
Medium company B (100 to 199 employees)	4	3.45
Large company (More than 200 employees)	10	8.62

The study was explanatory-correlational-causal because it analyzes the relationships between the variables of the logistics system. The decision was, therefore, made to use the SEM methodology recommended by [29], which is executed by following a series of steps, such as factor structure, exploratory factor analysis and confirmatory factor analysis. The structure and definition of the SEM methodology are followed simultaneously in order to obtain the data required for the construction of the model. With this objective in mind, a checklist evaluating the logistics system was applied [31]. This tool has 13 variables, and 144 questions evaluated in a Likert scale of five (5) points. The variables are defined as logistics concepts in the company (D1), organization and management (D2), information technology (D3), software system (D4), storage technology (D5), internal

transportation technology (D6), external transportation technology (D7), handling technology (D8), supply chain integration (D9), personnel (D10), logistics performance (D11), barriers (D12) and reverse logistics (D13).

The Competitive Logistics Reference Model (MRLC) questionnaire was then refined for the SEM model [31] and only the items concerning the variables under study were left in order to determine the extent to which the factors analyzed affect logistics performance. The independent variables selected were: organizational management systems (X1), integration (X2) and human resources competence (X3). One dependent variable was also selected: the performance of the logistics system (Y).

Management systems (X1) refer to planned actions and the updating of technologies to achieve demand forecasts and customer studies. The management systems scale therefore includes 5 items. The integration variable (X2) analyzes how the company incorporates the relationships and viewpoints of customers and suppliers to establish alliances that improve the services offered. X2 contains 12 items; some examples include: Level of use of alliances in the distribution channel and connection of the information system with customers. Human resources competence (X3) refers to the capacity of employees who perform logistics functions, encompassing aspects of knowledge, skills, and experience in the performance of their duties. X3 consists of 10 items. The dependent variable, the performance of the logistics system (Y), was defined as good practices aimed at meeting user needs through the use of a system of logistics indicators and contains 6 items. Some examples include: Frequent analysis of customer service level and Application of Benchmarking. All the items studied come from previously validated scales studied in the Competitive Logistics Reference Model (MRLC).

4 Result and discussion

4.1 Construction of the structural model

The population that was the object of this study comprised the 117 organizations in the province of Manabí, Ecuador, and all members of the population were, therefore, used as convenience samples. This study uses primary data, that is, the data obtained refers to first-hand information obtained by the researchers and related to the variables of interest for the specific purposes of the study. This information was used in order to define the hypotheses to be demonstrated in the construction of the model, as shown in Figure 1:

H1: Management systems competences (X1) positively influences logistics performance (Y).

H2: Companies' integration competence (X2) positively influences logistics performance (Y).

H3: Human resources competence (X3) positively influences logistics performance (Y).

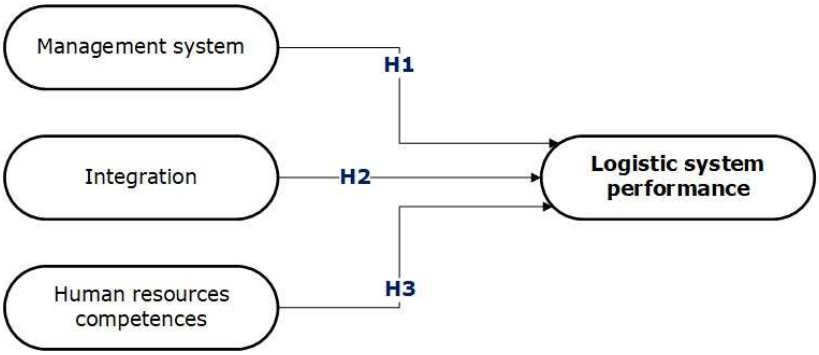

Figure 1 Theoretical model

Structural equation modeling using partial least squares (PLS-SEM) was employed to verify the proposed structural relationships and determine whether the model aligned with the hypotheses established in the research. The software used was Smart PLS version 4.1.0.

Structural equation modeling (SEM) was used to test the proposed relationships and meet the objectives set out in the research. In addition to coherently grouping the items, the exploratory factor analysis method of each scale was used to establish the items on the basis of their factor loadings. Items with factor loadings greater than 0.6 were retained as being optimal for further analysis, while items with low factor loadings were discarded [32], signifying that 14 articles were excluded. Once these elements had been eliminated, the correlations were recalculated. The items used to calculate the constructs are provided in Table 4.

The measures were validated using indices recommended in literature: Bartlett's test of sphericity, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). A construct is considered to have good validity if the value of the average variance extracted is ≥ 0.50, while the reliability will be satisfactory if the value is ≥ 0.70 [14] (Table 5).

Table 4 Construct scales and descriptive statistics

Variables	Items	Loadings	Mean
Management systems	Level of skills and knowledge of logistics-related personnel	0.752	2.90
	Availability of personnel in logistics	0.637	2.67
	Degree of participation of logistics-related personnel in training programs	0.805	2.03
	Degree of decentralization of logistics services.	0.799	2.36
	Innovative management structures	0.731	2.72
Integration	Joint improvement programs with suppliers	0.721	2.66
	Assortment index for each supplier	0.632	3.38
	Level of use of alliances in the distribution channel	0.627	2.17
	Level of support with established alliance contracts	0.618	2.79
	Using alliances to improve customer service	0.805	3.08
	Connection of the information system with customers	0.722	2.98
	Level of customer access to information	0.652	2.07
	Coordination of improvement programs with customers	0.855	2.40
	The extent to which a supplier certification program is implemented	0.777	2.21
	Level of integration with suppliers regarding load unitizing means	0.761	2.61
	Level of integration with customers regarding load unitizing means	0.674	3.26
	Level of integration of logistics plans with participants in distribution channels	0.724	3.16
Human resources competence	Availability of administrative and operating personnel	0.615	2.70
	Level of experience of executive and technical staff	0.604	1.97
	Level of university training of executive and technical staff	0.730	2.77
	Operation of a logistics-related personnel training program	0.864	1.95
	Possibility of promotion and professional improvement and logistics personnel	0.747	2.48
	Operation of a performance evaluation system for logistics personnel	0.834	2.56
	Mastery and application of the objectives, policies, standards and procedures by logistics personnel	0.843	2.03
	Level of decentralization of logistics-related decision-making	0.778	2.25
	The ability of logistics staff to exercise decentralized decision-making	0.832	2.21
	Level of employment by logistics staff of delegated powers	0.799	2.51
Logistics system performance	Use of a system of indicators in logistics	0.868	2.36
	The existence of a permanent record of the indicator system	0.869	3.15
	Application of Benchmarking	0.679	2.76
	Frequent analysis of customer service level	0.614	2.19
	Existence of a record that allows perfect orders to be measured	0.656	1.97
	Systematic execution of surveys and other surveys with customers	0.894	2.49

Table 5 Validation measures employed in model

Construct	CA	Sig Barlett	CR (> 0.70)	AVE (> 0.50)
Management system (X1)	.863	.000	.863	.631
Integration (X2)	.928	.000	.930	.558
Human resources competence (X3)	.935	.000	.940	.588
Logistics system performance (Y)	.899	.000	.910	.664

Note: CA = Cronbach's alpha; CR = Composite reliability; AVE = Average variance extracted
*p-value < 0.05; **p-value < 0.01; ***p-value < 0.001
Source: Table compiled by the authors from PLS.

For the validation of the measurement scale, discriminant validity analysis was applied. For this purpose, the Heterotrait-Monotrait (HTMT) relationship criterion was selected. This criterion indicates that the confidence intervals should not exceed 0.9, thus validating the first-order model (Table 6).

Table 6 Discriminant validity

Heterotrait-Monotrait ratio	1	2	3
1. X1			
2. X2	0.726		
3. X3	0.756	0.726	
4. Y	0.802	0.739	0.775

Source: Table compiled by the authors from PLS.

4.2 Structural model

The overall quality of the model was assessed with the square root mean residual (SRMR) normalization index, where values below 0.05 are considered acceptable. In this case, the value reached was 0.076, which shows the overall validity of the model. Regarding multicollinearity and common method bias, the variance inflation factor (VIF) analysis was used, which reflects values below 3.3 and is therefore considered valid [14] (Table 7).

Figure 2 shows the research model and the path coefficients considered. The results show a consistent relationship of average R squared (R^2) that amounts to 0.777 between the independent and dependent variables [33]. This implies that the variables X1, X2, and X3 explain 77.7% of the logistics performance. Table 7 provides a summary of the final results of the hypothesis test.

Table 7 Variables and relationships in model

Dependent variables	Independent variables	Ratio coefficient	T (Bootstrap)	VIF	Relationship
Y	X1	.322	2.287	1.30	Accepted
	X2	.330	2.165	1.39	Accepted
	X3	.303	2.082	1.26	Accepted

Source: Table compiled by the authors from PLS.

These elements confirm that the three independent variables directly affect the dependent variable (logistics performance, Figure 2).

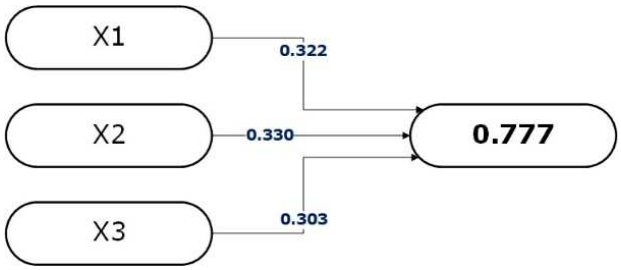

Figure 2 Structural model

Each independent variable in the model has relevance indicators. For example, with regard to the Control variable (X1), the most relevant indicators were the degree of staff participation (0.805) and the degree of decentralization of services (0.799). In the case of the Integration variable (X2), the most representative indicators were the coordination of improvement programs with customers (0.855) and the use of alliances to improve services (0.805), while in that of the Human resource variable (X3), the most relevant was the operation of a training program for personnel related to logistics (0.864) and the mastery and application by logistics personnel of the objectives, policies, standards and procedures (0.843).

Several relationships between the variables are investigated in the literature analyzed (management systems, integration, human resources competence, and the performance of the logistics system), such as the concept that logistics performance affects the management of the organization [34], and vice versa: that the management of the organization influences logistics performance [2,4-6]. Other studies state that logistics performance influences integration [13], and vice versa: that integration affects logistics performance [7-12]. There is also evidence that logistics performance directly affects job skills [19], and that job skills affect logistics performance [1-3].

These relationships were verified in the hypotheses formulated in the research in a particular way, although they demonstrate that no other previous study takes into account all the factors investigated as regards the performance of logistics in general. The correlations and results concerning human resource practices likewise demonstrated that training and compliance with policies, standards and procedures impact on the development of logistics performance.

5 Conclusions

5.1 Practical and managerial implications

This study identifies human resource management and development practices that lead to continuous improvement in logistics flows. The study shows that if a manager wishes to improve logistics performance, the improvements must include: management, the integration of suppliers and customers, and the training of personnel in order for them to achieve their work competencies. Government and local entities could, therefore, use these initial results as a basis on which to outline strategies and adaptations for the development of local supply chains.

In this context, universities and technological institutes in the region should offer training and capacity building programs in the field of logistics and supply chains. In addition, they should promote technology transfer to companies, entities and ventures through their research and linkage processes, focused on logistics and supply chains. These actions would contribute to the logistics development of the region and the country and promote business competitiveness and the reduction between academia and the productive sector.

5.2 Final remarks

This study contributes to logistics management literature by empirically analyzing the influence of the variables of management systems, business integration and human resources competencies on the logistics performance of 117 companies in a developing country in which these aspects have not yet been widely explored. A quantitative approach was used in order to test 3 study hypotheses. The results show that all 3 could be tested by means of significant positive relationships, evidencing that these factors are precursors to satisfactory logistics performance. Managers and decision-makers should, therefore, plan, organize and commit the necessary resources to these 3 factors in order to promote a positive outcome.

At the same time, this research provides guidance on the gap between the academic offering and the needs of the business sector in terms of logistics and supply chains in the region. This need is evidenced by the low growth of the logistics performance index estimated by the World Bank for Ecuador [35], with a value of 0.11 from 2007 to 2018 (no data are subsequently provided). This is exacerbated when nearby countries such as Colombia and Peru present higher values of the logistics performance index, and show better logistics services and costs.

5.3 Limitations and future work

With regard to the limitations of this research, it is necessary to consider that the sample was intentional and not probabilistic, and originated from companies based in Manabí, Ecuador, which have their own particularities, giving rise to a contextual bias that may pose problems as regards the generalization of the results. Secondly, the findings detected are conditioned by the use of 4 latent variables, which makes it necessary for future research to incorporate other valuable attributes into the analysis so as to provide a more complete understanding of the contrasted empirical model.

A further limitation of this research is the non-inclusion of reverse logistics as an analysis variable. This is owing to the need to strengthen compliance with the sustainable development goals of the 2030 agenda. Future research could develop variables such as green logistics and collect primary data in different geographical locations of the country in order to test a new model. In addition, research will continue with the analysis of possible solutions for companies and their logistics.

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