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Supply Chain Management to Improve the Operational Efficiency of the Logistics Area of a Municipality in Cajamarca

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Abstract: The present research aimed to propose Supply Chain Management for improving the operational efficiency of the logistics area of a municipality of Cajamarca, to achieve the above, an applied type study was carried out, in addition to a quantitative approach, as well as a non-experimental design. The sample was made up of critical operations in the logistics area. The results showed a productivity of services in works of 24%, a productivity of offices and institutions of 30%, in addition the operational quality was 71%, in the case of speed for institutions it was 57% and cycle times ranged between 3 - 7 days, the reliability of transport was S/. 35.00, this led to a logistics efficiency of less than 50%; likewise, this problem was addressed through the TIXTOOLS MRP software and the homologation of suppliers; in which a NPV of S/2,847.08, an IRR of 11%, a profitability index (RI) of 1.31 were obtained through the economic analysis. Therefore, there is evidence of the need to implement improvements to achieve increased operational and logistical efficiency.

Keywords: supply chain management; efficiency operational; logistics

1. Introduction

The existence of difficulties in the development of supply chains is caused by the gap in capabilities, as well as cultural resistance and a limited availability of advanced technologies, as well as the limited coordination of national government programs and plans [1]. Logistics costs in Colombia represent 13.5% on average, around 18% of the value of products, compared to 9% in the countries of the Organization for Economic Cooperation and Development (OECD) [2]. Similarly, in Peru the logistics cost represents approximately 34% of the value of traded goods [3].

Considering the municipalities, it is noted that many of them face significant challenges in their logistics areas, which can affect the quality and efficiency of their operations. According to the Institute of Statistics and Informatics, 65% of the municipalities in Peru have deficiencies in the management of their logistics resources, which translates into delays in the acquisition of goods and services, waste of resources and difficulties in providing timely attention to citizens [4].

Thus, the municipality in question, located in the department of Cajamarca, faces various challenges that impact its operational efficiency in the logistics area. Thus, problems have been observed such as: lack of purchase planning because it is done empirically, delays in the processes of acquisition and distribution of goods were also evident, and there are delays in the sending of quotes by suppliers. On the other hand, there is limited coordination between the different areas involved in the supply chain, lack of training. Finally, there is no adequate warehouse control with records of inputs and outputs of materials.

Given this situation, the adoption of practices linked to Supply Chain Management (SCM), such as collaborative planning, process integration and resource optimization, have proven to be essential to improve operational efficiency and the ability of organizations to respond to unforeseen events [5].

Based on the above paragraphs, the following research problem was formulated: How does Supply Could Chain Management contribute to improving the operational efficiency of the logistics area in a municipality of Cajamarca by 2024? Therefore, the specific problems were: a) What is the current

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level of operational efficiency of the logistics area of the municipality in terms of planning, supply, distribution and inventory management?; b) What are the Supply Chain Management strategies? Chain Management that can adapt the logistics area of the municipality of Cajamarca to optimize the planning, supply, distribution and inventory control processes? c) What is the economic impact of the improvement proposals in the logistics area of a municipality in Cajamarca?

The research carried out is justified theoretically since it expands knowledge regarding SCM, within the context of public entities. The adoption of SCM practices can improve the operational efficiency of the logistics area of these entities, optimizing planning, supply, distribution and inventory control processes. The practical justification aims to contribute with the proposal for the design of supply chain management in the logistics area in the company. The practical results derived from this study can guide municipal leaders and workers in the implementation of strategies that will be proposed. The economic justification of this study is based on the capacity of the Supply Chain approach. Supply Chain Management. In particular, the implementation of Supply Chain Management concepts in the public sector has shown a significant reduction in administrative costs, an improvement in product quality and faster deliveries, as well as the ability to track orders. By improving efficiency in planning, procurement, distribution and inventory control, the implementation of a SCM system is expected to contribute to optimizing the use of financial and material resources, thereby reducing the operating costs associated with municipal logistics.

Thus, the general objective of the study is determined as follows: to propose Supply Chain Management to improve the operational efficiency of the logistics area of a municipality located in Cajamarca, 2024. The specific objectives are: a) To determine the level of operational efficiency of the logistics area of the municipality in question; b) To propose specific SCM strategies adapted to the needs of the logistics area of the municipality; c) To evaluate the economic impact of the proposed improvements in the logistics area of the municipality.

The research by Covas et al. (2022) [6] in which they aimed to propose improvements in the administration of the supply networks involved in a manufacturing and trade plan for materials used in construction in the Cienfuegos region, Cuba. The methodology used followed the Deming cycle and logical thinking, using tools such as the cause-effect relationship tree, conflict clouds, the Cross-Impact Matrix Systems (SMIC- Prob Expert) method and the participation of a team of experts. The main problem, according to the conclusions, was that the objectives of the supply chain were not aligned. Therefore, it was proposed to modify the economic strategies based on demand. It was determined that the combination of a demand survey with an analysis of the assortment, characteristics and quantity of the goods found would be the best way to resolve the conflict. In addition, involve all members in the creation of the chain strategy and filter economic decisions based on social demands. It was suggested that more attention be paid to these elements in order to optimise the management of the plan's supply network.

Similarly, Bag et al. (2020) [7] used dynamic capability theory as a basis to assess the role of BDA (big data analytics) capability as a strategy to achieve operational optimization in order to improve the sustainable performance of the supply network. Methodologically, the study had a quantitative perspective of explanatory scope. A survey was conducted among mining executives in the emerging economy of South Africa, reaching a total of 520. The study used Partial Least Squares Structural Equation Modeling (PLS-SEM) for data analysis. The findings reveal that management capabilities in the study of massive volumes of data have a strong and significant effect on the process of creating environmentally friendly innovative goods and on the sustainable results of the supply network. On the other hand, staff skills in big data analysis have a milder, although still significant, impact on the professional growth of employees and on the sustainable results of the supply chain. Innovation and learning performance impacts ongoing supply network efficiency, and supply network originality plays an important moderating role. One contribution of the study is to identify two avenues that managers can use to improve sustainable supply network performance in the mining industry, based on big data analytics capabilities.

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Domínguez and Villanueva (2021) [8] aimed to propose a supply chain management (SCM) plan to optimize logistics operations in a Peruvian entity. The methodology used was descriptive and purposeful, with a research scheme not based on experiments and cross-sectional. The data set was 20 workers from the aforementioned company. The findings of the study revealed that the logistics processes in the organization, during the year 2020, were at an intermediate level (80%). This state was impacted by the average levels of the strategies for the selection of supplier agents (85%), the strategies for the management of articles (80%) and the logistics administration itself (75%). It was concluded that the introduction of a supply network management plan would contribute to improving the logistics processes in said company during the year 2020. A plan based on "Lean Project Delivery Systems " was proposed, highlighting the importance of standardization with the purpose of optimizing the organization's logistics operations.

Lagos (2019) [9] in his study about an administration model based on SCM, to obtain strategic elements in state hospitals, aimed to develop a theoretical approach to management, based on systems and the best techniques for managing the supply network, which when implemented in the system, causes a reduction in delays in the supply of materials and, in effect, decrease waiting times for surgeries, positively impacting the efficiency of the process. Methodologically according to the objective, the study was applied, in terms of scope it was exploratory and explanatory, the approach was mixed. In the results, the study designed a supply network management model to reduce surgical waiting times at EsSalud, based on SCM concepts, such as the assignment of roles to the stages of the chain, the selection of suppliers that absorb the uncertainty of the demand and the implementation of practices such as vendor managed inventory (VMI) and Just in Time (JIT) inventory. The analysis identified that the lack of material is one of the important causes of dissatisfaction with the surgical wait. The proposed model integrates the chain, assigns roles, extends contract terms, uses unit prices, shares information and improves the efficiency of both EsSalud and its suppliers. Compared to the SCOR model, both are conceptual, start from the strategic level, analyze processes and define metrics.

Valle (2022) [10] sought to determine the development of supply network management and the use of digital tools in a municipality of Ica. The study adopted a qualitative perspective, with a phenomenological scheme and an exploratory level. Interviews were conducted with a selected group of 4 key informants. In order to validate the interviews, they were evaluated through specialists and reliability was guaranteed by combining different methods or sources of results data. In the findings, the study revealed that there are limitations in the use of digital media in supply and logistics processes within the municipality. Therefore, it recommended that the person in charge of the area implement and modernize the application of information and communication technologies (ICT) in supply operations and in digital media. The municipal manager is suggested to coordinate improvements with internal management to avoid bottlenecks in these platforms. In addition, it was suggested to improve workflows, train and hire qualified personnel, avoiding political favors, to promote a change in the organizational culture. It is also advisable to create a specific systems or ICT department or directorate in the institution.

2. Materials and Methods

The research developed was of an applied type, it consisted of a quantitative approach, as well as a non-experimental design and also an exploratory-descriptive scope. Regarding the variables, Supply was considered as an independent variable. Chain Management, which is defined as an integrated and strategic approach that involves the coordination and efficient management of the flows of information, materials, services and finances between all the elements that make up the chain, from input suppliers to end users [11] , in the same way the dependent variable was operational efficiency is defined as a fundamental concept in business management, since it refers to the ability of a company to maximize productivity and minimize costs, while maintaining the excellence of the product or service [12].

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Taking into account the population, it was made up of all the operations of the logistics area of the District Municipality of Nanchoc, since the objective was to improve the operational efficiency of said area through the application of Supply Chain Management., therefore the sample consisted of critical operations according to the diagnosis of the study. Therefore, the sampling was non-probabilistic for convenience.

Regarding data collection techniques and instruments for specific objective one, the technique to be used was direct observation of the logistics processes. On the other hand, for specific objective 2, the technique used was the documentary review of best SCM practices. Now, as for the instruments, they were made up of structured record sheets for data collection and a matrix or documentary record sheet to synthesize the best practices.

For data analysis, the numerical data collected through a registration form were examined; descriptive statistical methods were used for the analysis. The data were processed and analyzed using a statistical computer program or Excel that allows the organization of information according to the variables studied and their corresponding dimensions, obtaining the frequencies and percentages of the findings found. The results were presented in the form of figures and tables, accompanied by their respective interpretations.

On the other hand, ethical aspects were a fundamental aspect to consider when carrying out the research. The present study is no exception and is based on the Code of Ethics of the corresponding academic institution, whose article 3 establishes the ethical foundations of the research. Therefore, values such as responsibility, transparency, respect for human integrity, autonomy and beneficence were the pillars that guided this work, guaranteeing the confidentiality of the participants and prioritizing the needs of the people above scientific interests. Likewise, the pertinent permits and authorizations were obtained, the informed consent of those involved was obtained and all the ethical criteria required by the institution were met. The study also respected the maximum limit of textual similarity established, as certified by the Turnitin tool. Finally, the writing was adjusted to the ISO 690 standard.

3. Results

3.1. Determine the level of operational efficiency of the logistics area of the municipality in question.

An analysis of all the processes involved in the municipality was carried out, in which the problems they had were identified, as detailed in Table 1:

Table 1. Summary table of issues and improvements.

Processes	Issues	Improvements
Acquisition	Lack of purchasing planning (Empirically carried out)	Proposal 1. MRP software Proposal 2. Supplier approval
Reception	Delays in delivery of materials: The municipality is 3 hours from Chiclayo. Suppliers are slow to send quotes. Incoming materials are not recorded.	
Storage	Absence of Kardex.	
Execution of services	Limited coordination between the user area (Sends acceptance of service) and logistics (logistics does not have good control of goods and the required quantities do not exist in the warehouse).	

Likewise, the analysis of the operational efficiency indicators carried out from March to June 2024 was carried out, which is presented in Table 2 , thus focusing on productivity; an increase was shown during the months evaluated, even so the proportion remains low due to problems related to purchase planning and changes in demand because not many services are being requested from the municipality; in operational quality, some increases and decreases were shown, especially in the service of institutions, this is due to the existence of problems that are significant in the processes of the municipality; the same happened in speed, these problems show the lack of planning and

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coordination of services, which affect delivery times, also in terms of cycle time according to the types of service; finally, with regard to reliability, increases and decreases are perceived, this shows that there are problems related to logistics operations.

Table 2. Calculation of current operational efficiency indicators .

Efficiency indicators operational		Mar-24	Apr-24	may-24	Jun-24
Productivity	Productivity of services for construction works	20%	22%	20%	22%
	Office Services Productivity	25%	27%	28%	29%
	Productivity of services for institutions	27%	28%	30%	32%
Operational quality	% of works service that meet standards	77%	88%	85%	86%
	% of office services that meet standards	80%	68%	79%	73%
	% of service from institutions that meet standards	78%	79%	75%	71%
Speed	% on-time delivery of construction services	63%	60%	80%	75%
	% on-time delivery of service for offices	60%	67%	71%	63%
	% on-time delivery of service to institutions	50%	60%	67%	57%
	Cycle time (works service)	7 days	6 days	6 days	5 days
	Cycle time (office services)	5 days	4 days	4 days	3 days
	Cycle time (services for institutions)	6 days	5 days	5 days	4 days
Reliability	Cost of transport service for works	S/ 20.00	S/ 21.25	S/ 18.00	S/ 20.00
	Cost of transport service for offices	S/ 20.00	S/ 21.67	S/ 17.50	S/ 18.75
	Cost of transport service for institutions	S/ 35.00	S/ 35.00	S/ 35.00	S/ 35.00

3.2. Propose specific SCM strategies adapted to the needs of the municipality's logistics area.

3.2.1. Supply Chain Management Indicators

- Supply chain efficiency

Table 3 details the calculation of supply chain efficiency, which shows that the municipality is not meeting the established delivery times. This shows delays of 1 to 2 days in deliveries.

Table 3. Summary table of supply chain efficiency calculation.

Services	Mar-24	Apr-24	may-24	Jun-24
Works	2 days	2 days	1 day	1 day
Offices	2 days	2 days	2 days	1 day
Institutions	1 day	1 day	1 day	1 day

- Investment in technology and tools

This indicator would have a result of 0 because they do not have technologies for adequate management of the supply chain.

- Average delivery cost

Table 4 details the summary of the calculation executed for the average delivery cost, which shows that these costs are variable during the months, thus affecting part of the municipality's financial planning, due to problems related to operational efficiency.

Table 4. Summary table of the calculation of the average delivery cost (ADC).

Services	Mar-24	Apr-24	may-24	Jun-24
Works	S/. 40	S/. 44	S/. 42	S/. 39
Offices	S/. 38	S/. 40	S/. 36	S/. 33
Institutions	S/. 60	S/. 48	S/. 53	S/. 46

- Average Storage Time (TAP)

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Table 5 presents the TAP, which shows that materials for services have a variability of days in the warehouse. This shows problems related to inadequate inventory control and lack of purchase planning.

Table 5. alculation of Average Storage Time (AST).

Services	Mar-24	Apr-24	may-24	Jun-24
Works	3 days	4 days	5 days	4 days
Offices	4 days	5 days	3 days	4 days
Institutions	2 days	4 days	4 days	5 days

- Average Storage Cost (ASC)

Table 6 shows the CAP, where an increase in them is seen , which reflects problems related to inventory planning and control.

Table 6. Calculation of average storage cost (ASC).

Services	Mar-24	Apr-24	may-24	Jun-24
Works	S/. 25	S/. 25	S/. 25	S/. 25
Offices	S/. 23	S/. 22	S/. 22	S/. 22
Institutions	S/. 33	S/. 31	S/. 30	S/. 29

- Logistics efficiency (LE)

Regarding Table 7 , it shows that in some months the logistics efficiency in services is below 50%, which indicates that there are problems related to delivery times and also inadequate storage of materials.

Table 7. Calculation of logistics efficiency.

Services	Mar-24	Apr-24	may-24	Jun-24
Works	58%	56%	29%	49%
Offices	28%	20%	36%	27%
Institutions	43%	27%	25%	22%

Below is Figure 1, the summary of Supply indicators. Chain Management mentioned above for general services.

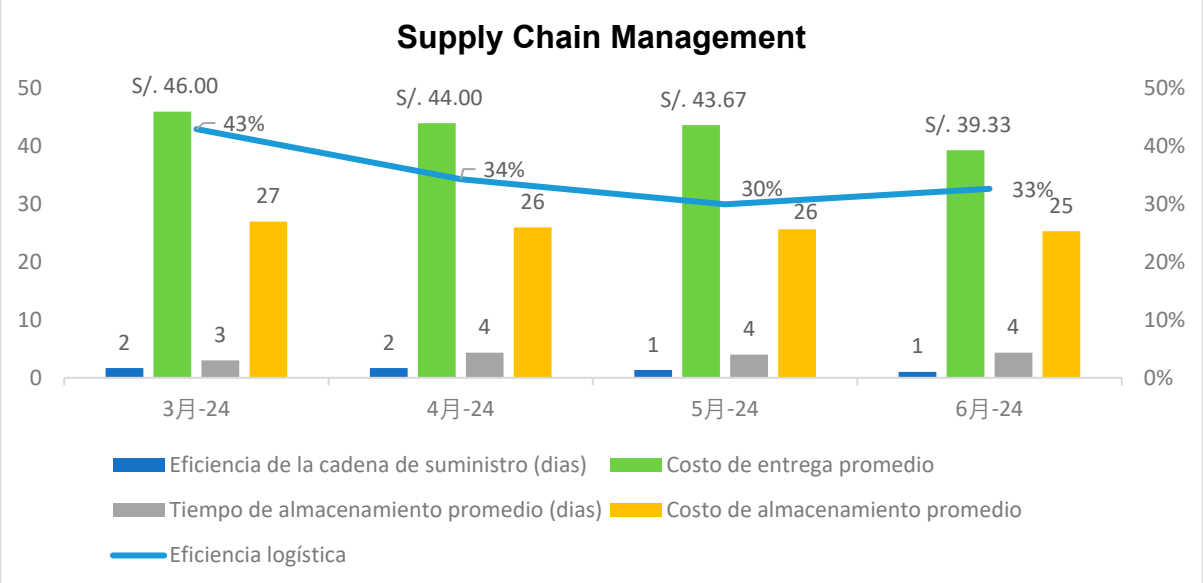

Figure 1. Operational efficiency indicators March – June 2024.

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Therefore, improvements were proposed for the problems previously identified, such as the proposal of the TIXTOOLS MRP software and supplier approval, so that the municipality can improve its operational efficiency and provide quality services.

3.2.2. Proposal 1: TIXTOOLS MRP Software

This software is designed for proper purchase planning since the municipality does not have any purchase records and they also carry out their purchases empirically.

- Operation

Purchase management module: Includes purchase request, new purchase (direct purchase order, order by purchase request and order scheduled by MRP), modify purchase, approve purchase, cancel purchase and printing purchase order note.

To generate a new purchase, enter the purchase request option, add the date, and in the word that says account, there is a square next to it where the supplier will be selected. After that, enter the purchase destination. If there are no destinations, it is considered as stock. You can see the code, description, unit, quantity, price and amount. In addition, at the bottom of the window where it says commercial conditions, the delivery time is added. Everything described above is presented in Figure 2.

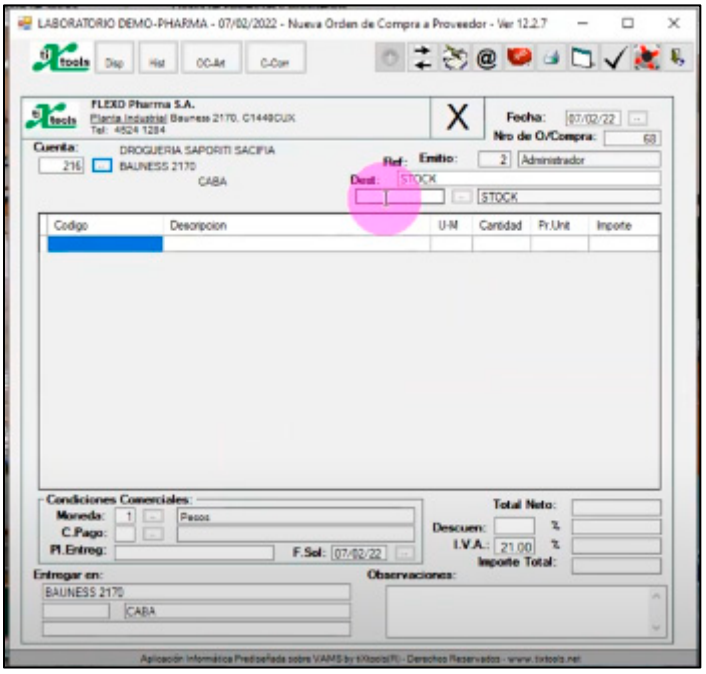

Figure 2. Purchase management window.

Stock module: Includes new stock additions, stock item modifications, product code replacement and item restoration (Figure 3a). It also presents a window in which you can add the product code, description, type of material, spare parts, brand, color, order point, economic lot, customer, supplier, costs and dates (Figure 3b).

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(**a**) (**b**)

Figure 3. Stock module window (**a**) Elements of the stock module window; (**b**) Detail of what can be displayed in the stock module window.

Production module: This module is responsible for planning the units that will be produced, but in this case the materials for a service company can also be entered, such as the production order number, description, code, quantity, delivery date, batch code and observations, if any, as shown in Figure 4.

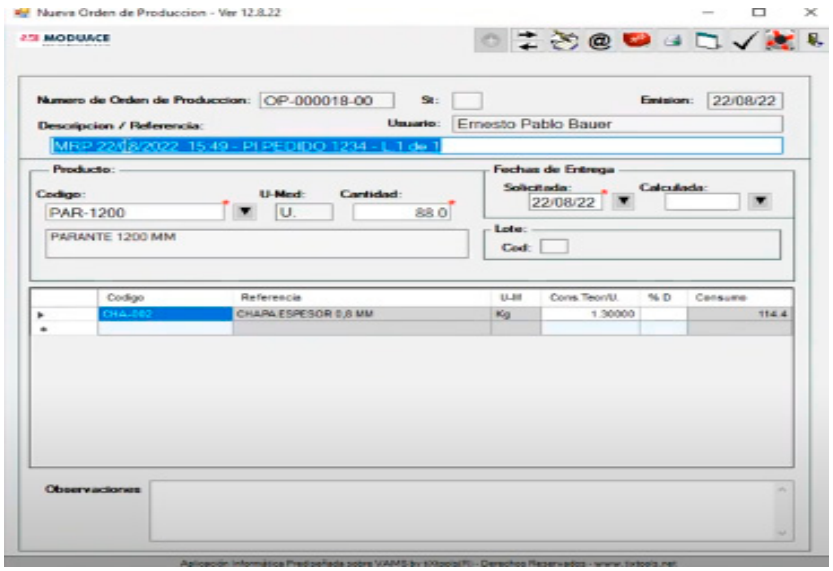

Figure 4. Production module window.

MRP Module: According to Figure 5, it can be seen that it includes the code, description, stock, purchases, reservations, orders, among others.

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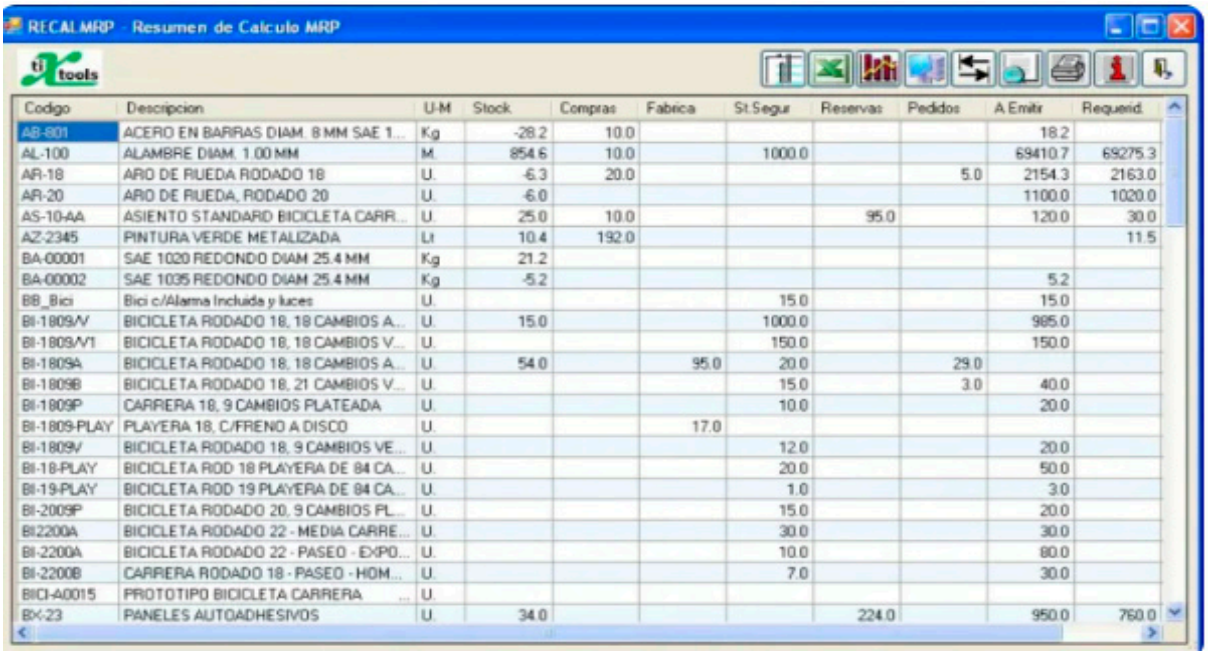

Codigo	Descripcion	U.M	Stock	Compras	Fabrica	St.Segur	Reservas	Pedidos	A Emitir	Requerid.
AB-801	ACERO EN BARRAS DIAM. 8 MM SAE 1...	Kg	-28.2	10.0					18.2	
AL-100	ALAMBRE DIAM. 1.00 MM	M	854.6	10.0		1000.0			69410.7	69275.3
AR-18	ARO DE RUEDA RODADO 18	U.	-6.3	20.0				5.0	2154.3	2163.0
AR-20	ARO DE RUEDA, RODADO 20	U.	-6.0						1100.0	1020.0
AS-10-AA	ASIENTO STANDARD BICICLETA CARR...	U.	25.0	10.0			95.0		120.0	30.0
AZ-2345	PINTURA VERDE METALIZADA	Lt	10.4	192.0						11.5
BA-00001	SAE 1020 REDONDO DIAM 25.4 MM	Kg	21.2							
BA-00002	SAE 1035 REDONDO DIAM 25.4 MM	Kg	-5.2						5.2	
BB_Bici	Bici c/Alarma Incluida y luces	U.				15.0			15.0	
BI-1809-V	BICICLETA RODADO 18, 18 CAMBIOS A...	U.	15.0			1000.0			985.0	
BI-1809-V1	BICICLETA RODADO 18, 18 CAMBIOS V...	U.				150.0			150.0	
BI-1809A	BICICLETA RODADO 18, 18 CAMBIOS A...	U.	54.0		95.0	20.0		29.0		
BI-1809B	BICICLETA RODADO 18, 21 CAMBIOS V...	U.				15.0		3.0	40.0	
BI-1809P	CARRERA 18, 9 CAMBIOS PLATEADA	U.				10.0			20.0	
BI-1809-PLAY	PLAYERA 18, C/FRENO A DISCO	U.			17.0					
BI-1809V	BICICLETA RODADO 18, 9 CAMBIOS VE...	U.				12.0			20.0	
BI-18-PLAY	BICICLETA ROD 18 PLAYERA DE 84 CA...	U.				20.0			50.0	
BI-19-PLAY	BICICLETA ROD 19 PLAYERA DE 84 CA...	U.				1.0			3.0	
BI-2009P	BICICLETA RODADO 20, 9 CAMBIOS PL...	U.				15.0			20.0	
BI2200A	BICICLETA RODADO 22 - MEDIA CARRE...	U.				30.0			30.0	
BI-2200A	BICICLETA RODADO 22 - PASEO - EXPO...	U.				10.0			80.0	
BI-2200B	CARRERA RODADO 18 - PASEO - HOM...	U.				7.0			30.0	
BICI-A0015	PROTOTIPO BICICLETA CARRERA	U.								
BX-23	PANELES AUTOADHESIVOS	U.	34.0				224.0		950.0	760.0

Figure 5. MRP module window.

From the details above, it is indicated that the proposed software called TIXTOOLS MRP has a cost of S/.146.00 per month.

- Training schedule

For proper functioning of the software, a schedule of 3 training sessions was created, presented in Table 8 , which are based on the functionality and characteristics of the software.

Table 8. TIXTOOLS MRP **software** training schedule

TIXTOOLS MRP SOFTWARE TRAINING SCHEDULE					
RESPONSIBLE: Flores Correa, Cesar Ronaldo					
		November			
No.	Activity	Week 1	Week 2	Public Aim	Mode
1	Software Features and Benefits	X		Areas of work	In person
2	Explanation of modules	X	X	Areas of work	In person
3	Related examples for correct software handling		X	Areas of work	In person

- Contribution of TIXTOOLS MRP Software

Lack of purchase planning: This software will allow the municipality to have a much more structured system, which will allow it to properly manage the planning of its purchases, that is, to buy what is necessary and not do it empirically.

Delays in the delivery of materials: This software will allow monitoring of the different services requested from the municipality and the management of its suppliers. In addition, this system will alert of possible delays so that the necessary measures are taken to ensure materials are delivered on time.

Absence of Kardex: This software offers records similar to a Kardex, thus allowing the municipality to have control of inputs and outputs of materials.

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Limited coordination between areas: TIXTOOLS MRP will allow the municipality to easily access the different modules, so that the exchange of information is synchronized and thus avoid errors. For this, it will be necessary to have 2 USB tools so that the different areas can better manage the information.

3.2.3. Proposal 2: Supplier approval.

The purpose of supplier approval is to determine whether suppliers comply with the requirements and specifications in order to guarantee the quality of the goods and services supplied.

- Supplier pre-selection process:

This process begins with a list of potential suppliers, which must meet a series of criteria predetermined by the municipality based on price, delivery times and quality requirements. In addition, with regard to speed, the municipality must choose suppliers close to the area. Table 9 shows the format of the list of suppliers.

Table 9. Supplier listing format.

Description	Supplier A	Supplier B	Supplier C	Supplier D	Comments
Supplier Name					
Location					
Price (the quote presented for the services)					
Delivery time					
Certifications and quality standards they have met					
Experience					
References from past or current clients					
Supply Capacity					
Terms of payment					

- Supplier selection:

In order to carry out the selection of suppliers, they must meet the following requirements: have the capacity and willingness to carry out the necessary services, have guarantees for compliance with quality standards, as well as protection and reliability of confidential information, in addition to commitment to continuous improvement, and finally flexibility in the contract and the possibility of modifying its duration.

- Supplier selection matrix:

The suppliers that were preselected will be classified through scores (Table 10), using criteria indicated in the supplier selection matrix (Table 11).

Table 10. Ranking scores.

Score	Criterion
1	Not reliable
2	Regular
3	Excellent (reliable and recommended supplier)
4	Good (reliable)

Table 11. Classification criteria.

Criteria	Description	Supplier A	Supplier B	Supplier C	Supplier D
Quality of materials	Evaluation of the quality of the materials provided includes standards.				
Price	Comparison of material costs versus the competition.				
Delivery time	Compliance with material delivery deadlines.				

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Compliance with contracts	The supplier complies with the agreed terms.
Supply capacity	The maximum volume it provides without affecting quality
Terms of payment	Flexibility in payments.

- Steps for homologation

Step 1. The logistics department will send the invitation letter to the suppliers that will only be selected for the approval process. The supplier accepts by means of the letter to the logistics department.

Step 2. The logistics area establishes a 5-day period for suppliers to submit the documentation, which includes the following: documentation proving the legality of the company, certifications of the products or services that meet the standards, if applicable they have letters of recommendation from former clients, details of the information on the materials or services they offer with the prices and also the conditions, detailed document, about the delivery times and the logistical conditions and finally Include the insurance policies that clearly cover the possible risks associated with the provision of the service.

Step 3. The supplier obtains the form for registration in the process. This form will allow the identification of the documents that the supplier provided and also their information and experience in more detail.

Step 4. After completing the form, the supplier submits the corresponding documentation to the logistics area.

Step 5. The person in charge of the logistics area will schedule a visit to each chosen supplier and will carry out an audit, which will be executed based on the most relevant criteria. Likewise, any necessary comments will be added according to each supplier and how it should be improved so that it can work correctly without inconveniences with the municipality.

Step 6. The corresponding area will deliver the approval certificate to the supplier.

3.3. Evaluation of the economic impact of the proposed improvements in the logistics area of the municipality.

For the financial economic analysis, two factors were taken into account: expenses corresponding to the costs associated with the MRP software proposals and supplier approval. For income, economic losses generated by delays in deliveries were considered, since they incur additional expenses for compensation or accelerated work.

3.3.1. Costs incurred in the TIXTOOLS MRP software proposal

Table 12, presented below, shows the monthly costs required to carry out proposal 1 oriented to the TIXTOOLS MRP software.

Board 12. TIXTOOLS MRP Software Proposal Cost Summary

Proposal Services 1	Cost monthly S/.
Software	S/. 1,446.00
Trainings	S/. 150.00
Software enhancement designs	S/. 25.00
Material costs	S/. 50.00
Total	S/. 1,671.00

3.3.2. Costs incurred in the proposal for supplier approval

Table 13, shown in the following paragraphs, indicates the monthly costs necessary to carry out proposal 2 aimed at the approval of suppliers.

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Table 13. Summary of costs of the supplier approval proposal.

Proposal Services 2	Cost monthly S/.
Supplier selection matrix design	S/. 50.00
Process Description Form Design	S/.25.00
Design of the schedule of visits to suppliers	S/. 25.00
Design of the homologation process flow chart	S/. 50.00
Design of the certificate of approval of suppliers	S/. 25.00
Transport to visit suppliers	S/. 320.00
Total	S/. 495.00

3.3.3. Net Cash Flow

Table 14 shows the net flow, which consists of monthly expenses and income that the municipality will present when implementing the proposed proposals. In addition, the rate of 1.25% was reached, since it was convenient for the amount that is being invested in the proposals.

Table 14. Net cash Flow.

Net cash flow	Month 0	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Expenses	S/.2,166.00	S/.100.00	S/.146.00	S/.196.00	S/.146.00	S/.146.00	S/.691.00
Income	S/.730.00	S/.730.00	S/.730.00	S/.730.00	S/.730.00	S/.730.00	S/.730.00
Total	-S/.2,166.00	S/.630.00	S/.584.00	S/.534.00	S/.584.00	S/.584.00	S/.39.00
					Rate 1.25%		

3.3.4. Profitability indicators

According to the details in Table 15 , a positive NPV and an adequate IRR were obtained, which indicates the viability of the proposals presented, and the IR also indicates that a return of 0.31 cents is expected for each sol invested.

Table 15. Profitability indicators.

VAN	S/. 2,847.08
IRR	11%
GO	1.31

4. Discussion

The operational efficiency indicators of the district municipality of Nanchoc in the logistics area have shown that significant improvements are required to increase its indicators. Regarding the productivity of services in works and offices, it remains at an average of 24%. On the other hand, the service for institutions reached 30% and 32%, thus increasing the productivity of the services, but still low due to problems related to purchase planning and changes in demand. Likewise, regarding operational quality, it is evident that the works service only meets some standards, thus representing 77%; for office and institutional services, only 71% was achieved, showing a downward trend, due to the existence of problems related to the processes.

On the other hand, the speed indicator in the service for works and offices obtained 63% and finally the service for institutions represented 57%, which is a low percentage. These problems show the lack of planning and coordination of services, which affect delivery times. In addition, cycle times range from 3 to 7 days, which is too long and should be reduced to increase speed. Finally, with regard to reliability, transportation costs for works and offices were 20 soles, which remained at a stable level, and for institutions they were 35 soles, but in the following months the costs increased in some services and decreased in others. These increases show that there are problems related to logistics operations. Comparing with the research by Domínguez and Villanueva (2021) [8]. They

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revealed that logistics processes in a Peruvian entity in 2020 were at an intermediate level of 80%, which was reflected in the average levels of supplier strategies, thus representing 85%, item management strategies being 80% and logistics administration 75%. The authors concluded that the supply network management plan will contribute to the improvement of logistics processes.

As it is a proposal, it is necessary for the municipality to implement improvements in the supply chain and therefore optimize the operational efficiency of the area. In this sense, the approach proposed by the authors Domínguez and Villanueva is viable.

Supply indicators Chain Management in regards to the efficiency of the supply chain, given that the established delivery times are not being met, since the average times exceed the objective delivery times in the services. This shows delays of 1 to 2 days in deliveries. In addition, the average delivery costs vary significantly between S/. 36 and S/. 60, thus affecting part of the financial planning of the municipality. With regards to storage time, materials for construction services take between 3 to 5 days in the warehouse, for offices they take between 3 to 5 days and finally for institutions they take between 2 to 5 days in the warehouse. This shows problems related to inadequate inventory control and lack of purchase planning. Likewise, it was shown that storage costs in services for institutions have been increasing, reaching S/. 31. Finally, the logistics efficiency of services is below 50%, which indicates that there are problems related to delivery times and also inadequate storage of materials.

With the problems mentioned above, improvements were proposed regarding MRP software and supplier approval, which is supported by Valle's research (2022) [10] The study sought to determine the development of supply network management and employment through digital tools in a municipality of Ica. It revealed existing findings regarding the limitation in the use of digital media in supply and logistics processes within the municipality, improving work flows, training and hiring qualified personnel, improving communication between areas to make it more fluid and improving bottlenecks. Therefore, it proposed implementing and modernizing the application of information technologies in supply operations.

The municipalities of the Nanchoc district and ICA, as indicated by the author, present problems related to poor communication in the areas, bottlenecks that are generated in cycle times, for which both seek to improve their logistical efficiency with digital tools.

5. Conclusions

It is concluded that the acquisition process presented problems regarding the lack of purchase planning, the reception process, delays in the delivery of materials, delays by suppliers in sending their quotes, unregistered materials were identified. Regarding storage, the absence of Kardex was evident and finally, in the process of executing services, limited coordination between the areas. On the other hand, the operational efficiency indicators regarding the productivity of services in works, offices and institutions are 24% and 30% respectively. Likewise, regarding operational quality, it was evident that the office and institutions service only managed to comply with 71%, the speed indicator for institutions was 57%, which is low compared to the other services. In addition, cycle times range from 3 to 7 days and finally, regarding reliability, transportation costs for works and offices were S/. 20, which remained at a stable level, and for institutions they were S/. 35.

Likewise, it was shown that the Supply Chain Management indicators regarding supply chain efficiency showed delays of 1 to 2 days in deliveries. In addition, the average delivery costs vary significantly between S/. 36 and S/. 60. Regarding the storage time of materials for services, they take an average of 2 to 5 days. Likewise, it was shown that storage costs for institutional services increased, reaching a cost of S/. 31. Finally, logistics efficiency was found to be below 50%, thus indicating problems related to delivery times and inadequate storage of materials. To address all these problems, the TIXTOOLS MRP software and supplier approval were proposed.

In the economic analysis, the NPV was positive at S/2,847.08, and the IRR was 11%, which indicated the viability of the proposals for the municipality. Finally, with a Profitability Index (RI) of 1.31, a return of 0.31 cents can be expected for each sol invested.

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