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Research Article

Inventory Control And Management In Commercial Enterprises In The City Of Riobamba In The Digital Age: The Role Of Dynamic Programming And Mathematical Modeling

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ABSTRACT

Inventory management has evolved rapidly from conventional techniques to the application of advanced technologies such as artificial intelligence and Big Data thanks to mathematical modeling. This study analyzes the optimization of inventories in the digital age around Dynamic Scheduling, a point in which the advantages that the tools offer in support of decision-making, cost reduction and operational efficiency are highlighted. Through the analysis of practical costs, it is demonstrated how digitization improves the optimal inventory purchase order, the appropriate dates for the placement of orders and the size of each order so that companies do not suffer for any reason from the distressing problem of shortages.

Keywords: Dynamic Programming, management tools, optimization, costs, Artificial Intelligence.

INTRODUCTION

Inventory control and management has evolved significantly with the incorporation of advanced mathematical models, emerging technologies, and practical optimization approaches. In an increasingly dynamic and competitive business environment, efficient inventory management not only involves stock regulation, but also the integration of strategies that optimize costs, times and logistics processes.

From a mathematical and financial point of view, the authors propose a stochastic mathematical model, one where only part of the information is available in a system with price-sensitive demand or a dual channel. This approach allows prices and profits to be optimised in a context of uncertainty. For their part, they emphasize the use of emerging technologies such as (Datta y otros, 2024)(Shan & Bhishma, 2024)*Iot* and *blockchain* in *Supply chain* 4.0. Ensuring productivity and operational efficiency from the beginning to the end of the process.

In the field of operational efficiency, the authors show a model based on Lean BPM to improve warehouse management in the footwear industry, that is, deliver value from the customer's perspective, eliminate waste and move towards excellence through continuous improvement. Through the use of tools such as 5s and (Acevedo y otros, 2024)*Kardex*, seeks to improve the OTIF index that comes from *on time in full*, which is a supply chain metric that measures how effectively deliveries are fulfilled, both on time and in the full quantity of orders.

Complementing this vision, (Aggarwal & Shuja, 2024) propose a comprehensive strategy for e-commerce, addressing the optimization of orders, prices, and returns through a model that considers advance reservations and screening for defective products. Finally, (Bouazizi et al., 2024) emphasize the role of data science in predictive inventory optimization, using techniques such as *Random Forest* and linear regression to reduce costs and manage products with short life cycles.

From these approaches, it is evident that inventory management has gone from being a reactive process to a strategic and technological system. This research seeks to analyze the evolution and application of these models in different

sectors, basically in the commercial sector with the aim of identifying optimal strategies to improve operational efficiency, reduce costs and strengthen competitiveness in the global market.

THEORETICAL FRAMEWORK

1.1 State of the art

(Datta, y otros, 2024) In their article on sales impact, they propose a dynamic model of online and offline dual-channel online and offline on demand, stochastic price-sensitive, integrating sales efforts and using equations of *Black Scholes* in a diffuse environment. Its innovative approach to dynamic retail management and numerical validation makes it highly relevant to today's commerce.

On the other hand, in its article integrating the (Jin & Karki, 2024)*Iot* and *blockchain* for the intelligent management of inventories in supply chains with a multi-objective optimization approach for the insurance industry integrate these emerging technologies to optimize inventory management in the insurance industry, its model minimizes costs and time and its sensitivity analysis make it an innovative and practical contribution to the *Supply chain* 4.0.

The authors apply the Lean BPM methodology to improve warehouse management in the footwear industry in Peru, achieving a significant increase in the OTIF index ((Acevedo, Jáuregui, Quiroz, & Ali, 2024)*on time, in full*). Its practical approach and measurable results make it relevant to similar businesses.

For their part, the authors address the growing importance of e-commerce, and propose an integrated inventory model that optimizes prices, return policies, and advance bookings; their focus on returns and defective products is particularly pertinent to online retailers.(Aggarwal & Shuja, 2024)

(Reddy & Khanna, 2024) highlight the use of Artificial Intelligence (AI) to improve the customer experience in the retail sector through NVIVO analysis, software that facilitates the qualitative analysis of data with a focus on demand and supply to identify consumer behavior in the market, being relevant to understand how AI is transforming commerce.

The authors present an approach based on data science that leads to the use of Supply chain 4.0 in inventory management with predictive models that employ Linear Regression algorithms and (Bouazizi y otros, 2024)*Random Forest*, the latter known as a machine learning algorithm used to solve classification and regression problems. Its practical application and quantitative results (low errors) highlight it.

They go further, using a deep neural network model combined with an optimization algorithm to predict customer behavior in metropolitan cities in India. Its low predictive error and focus on energy efficiency make it valuable to the (Suresh & Suresh, 2024)*e commerce*.

In parallel, the authors examine the impact of technologies such as RFID (Radio Frequency Identification) and barcodes on inventory management in India. Its focus on emerging countries and performance analysis in retail stores makes it significant for similar contexts. (Panigrahi, Mahapatra, & Tanty, 2024)

On the other hand, they highlight how a gadget retailer in Bangladesh is facing a global economic crisis. Its focus on product segmentation and cost management during crises makes it educational and applicable in this way, facilitating processes within commerce. (Basher, Dipto, & Rahman, 2024)

However, the authors analyze Big Mart sales data using Pearson visualization and correlation highlighting relationships between variables such as price and sales. Its simplicity and usefulness for demand forecasting make it relevant for retail traders.(Arista, Theresiawati, & Seta, 2024)

1.2 Inventory Management

Inventory management in commercial organizations has acquired a strategic character, encompassing both goods and goods on consignment, in fact, inventories of raw materials are essential inputs for the production and marketing process, while finished products are destined to satisfactorily satisfy customer demand, since these inventories represent a significant investment, their management becomes of vital importance for all types of companies.

Within the supply chain, inventory management plays a fundamental role, as it seeks to guarantee the availability of products without incurring unnecessary costs. Traditionally, methods such as just-in-time and Material Requirements Approach (MRP) have been used, however, with the advancement of digitalization, new strategies have emerged to further optimize inventory management.

It is essential to determine the objectives of inventory management, which seek to establish the optimal level of inventory, the appropriate dates for the placement of orders and the size of each order, so it is necessary that there is adequate coordination between the sales, purchases, finance and production departments, as shown in the following illustration.

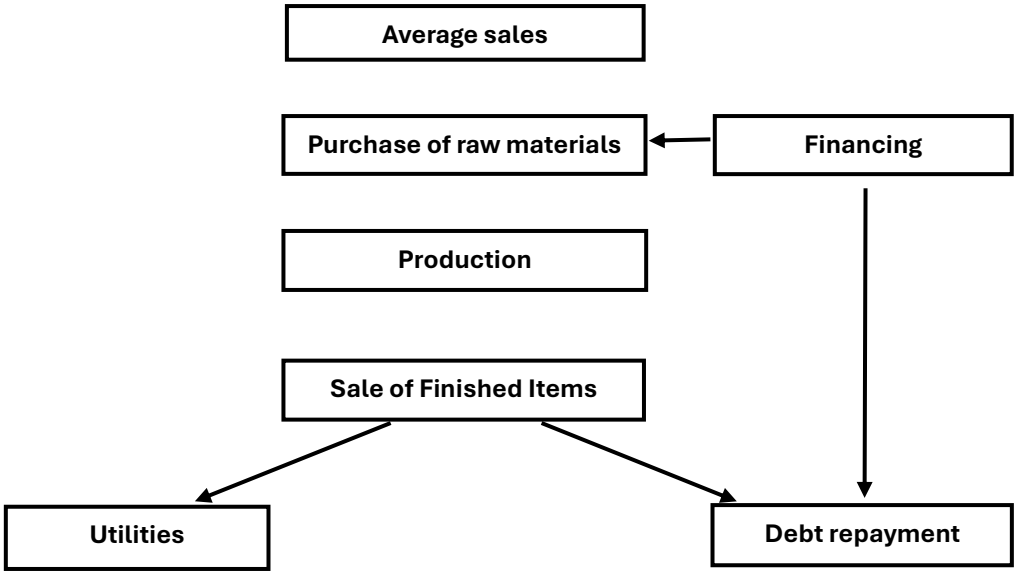


Figure 1-1: Coordination between departments

1.3 Types of inventories

In commercial companies we have inventories of:

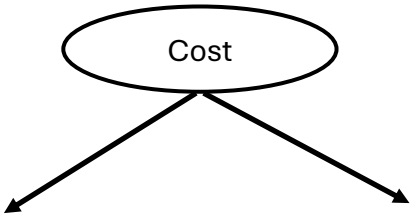
- **Commodities**: are items that are acquired and then sold at a higher price and obtain a profit in return.
- **Goods on consignment**: These are items that a company gives to another so that it can sell them in exchange for a consignment or a profit.

On the other hand, in manufacturing companies we have inventories of:

- **Raw materials** that constitute the value of the materials available to be processed,
- **Products in process** that are the value of the stock that is within the production process,
- **Finished articles**, which constitute the value of goods available for sale, and
- **Supplies and spare parts** that constitute the value of direct materials and spare parts for machinery and equipment.

1.4 Costs of managing inventory

In addition to the costs of purchasing or producing inventories, these goods cause the company costs of maintaining and ordering inventories, as shown in the following illustration.



MAINTENANCE COSTS **ORDERING COSTS**

*Costs of invested capital *Costs of placing the order

*Storage costs *Shipping costs

*Insurance and taxes *Disembarkation costs

*Obsolescence and shrinkage

Figure 1-2: Inventory Costs

1.5 Total Maintenance Cost

$$\boldsymbol{CTM} = Costo\ porcentual\ de\ Mantenimiento\ x\ Precio\ de\ compra\ x\ Inventario\ Promedio$$

$$\boldsymbol{CTM} = C\ x\ P\ x\ A$$

$$A = \frac{Unidades\ por\ orden}{2}$$

$$Unidades\ por\ orden\ = \frac{S}{N}$$

Where:

S: Number of units sold per year

N: Number of orders placed per year

Percentage Maintenance Cost

$$C\% = \frac{(Valor\ del\ inventario\ promedio\ x\ Costo\ del\ Capital\ Invertido) + (Costo\ fijos\ de\ mantenimiento)}{Costo\ total\ anual\ del\ inventario\ promedio}$$

Example.

The company "Green Star" shows the following data:

Annual sales 180,000 units

Order numbers per year 6

Purchase price $10

Cost of capital invested 20%

Storage Cost 18,000

Annual cost of insurance 12 000

- Units per order:

$$Unidades\ por\ orden = \frac{180\ 000}{6} = 30\ 000\ unidades$$

- Average Inventory:

$$Inventario\ promedio = \frac{30\ 000}{2} = 15\ 000\ unidades$$

- Average Inventory Value:

$$Valor\ del\ inventario\ promedio = 15\ 000\ x\ \$10 = 150\ 000$$

- Percentage Maintenance Cost:

$$C\% = \frac{(Valor\ del\ inventario\ promedio\ x\ Costo\ del\ Capital\ Invertido) + (Costo\ fijos\ de\ mantenimiento)}{Costo\ total\ anual\ del\ inventario\ promedio}$$

$$C\% = \frac{(150\ 000\ x\ 0{,}20) + (\$18\ 000 + \$\ 12\ 000)}{150\ 000} = \frac{60\ 000}{150\ 000} = 40\%$$

- Total Cost of Maintenance (TCC):

$$CTM = Costo\ porcentual\ de\ Mantenimiento\ x\ Precio\ de\ compra\ x\ Inventario\ Promedio$$

$$CTM = 40\%\ x\ \$\ 10\ x\ \$\ 15\ 000 = \$\ 60\ 000$$

- Total Cost of Sorting

$$CTO = (F)(N) = \left[\frac{F \times S}{2A}\right]$$

Where:

F: Fixed costs of each order

N: Number of orders placed (S/2A)

Assuming that the fixed costs of sorting "Green Star" are $750, the ordering cost is:

$$CTO = \$\ 750\ x\ \frac{180\ 000}{30\ 000} = \$\ 4\ 500$$

Finally, the mathematical model is integrated with the Total Cost of Holding (CTM) and Ordering (CTO), with which we obtain the Total Cost of Managing in Inventory (CTAI).

$$CTAI = CTM + CTO$$

$$CTAI = \$\ 60\ 000 + \$\ 4\ 500$$

$$CTAI = \$\ 64\ 500$$

1.6 Optimal Purchase Order Model (EQQ Model)

The goal of the EQQ model is to determine the optimal amount of inventory, that is, it seeks a balance between the two types of costs to minimize the total cost of managing inventories.

EOQ Model Assumptions

- Sales are predictable
- Sales are consistent over time
- Orders are received at the time they are expected

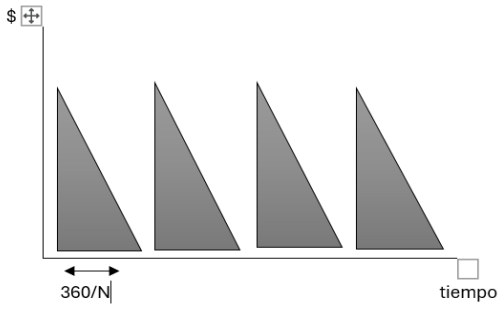


Figure 1-3: Assumptions about inventories

$$\text{EOQ} = \sqrt{\frac{2 * F * S}{C * P}}$$

EOQ= Purchase Order

F = Fixed costs of placing and receiving an order

S= annual sales in units

C= Percentage unit maintenance costs

P = Unit purchase price of inventory

Example: The company "SERACOMP" displays the following data:

Annual sales 400,000 units

Sale price $ 50

Unit Purchase Price $25

Cost to hold 20% of the purchase price

Cost to order $400 per order

Determine the EOQ, average inventory, number of orders per year, and total cost of managing inventory.

Solution.

$$EOQ = \sqrt{\frac{2(F)(S)}{(C)(P)}} = \sqrt{\frac{2(400)(400{,}000)}{(0{,}20)(\$25)}} = 8\ 000\ unidades$$

Optimal quantity to order EOQ = 8,000 units.

Average Inventory EOQ/2= 4,000 units

Number of orders per year = 400,000 / 800,000 = 0.50

$$CTAI = (0{,}20)(25)\left(\frac{8\,000}{2}\right) + \left(\frac{400\,000}{8\,000}\right)$$

$$CTAI = \$\ 40\,000$$

Reorder Point (PR)

They represent the inventory level at which a new purchase order should be placed.

$$\boldsymbol{PR} = (tiempo\ para\ recibir\ la\ orden) x (costo\ promedio\ diario)$$

$$Consumo\ promedio\ diario = \frac{Ventas\ anuales}{365}$$

Assuming that the time between the inventory order and the receipt of the inventory is 5 days, what is the reorder point of "SERACOMP"?

$$Punto\ de\ reorden = (5) x \left(\frac{400\,000}{365}\right) = 5\,480\ unidades$$

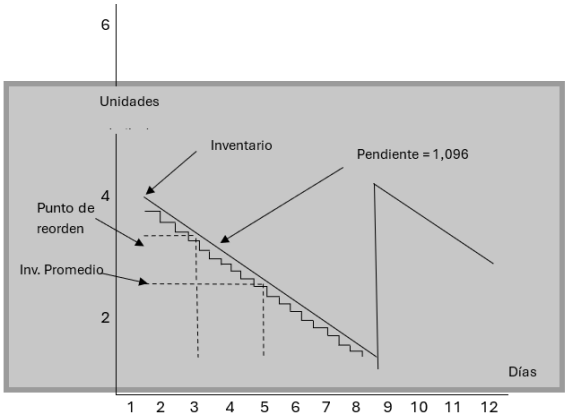


Figure 1-4: Reorder Point

Goods in transit

Goods that have been ordered but have not yet been received. If the normal delivery time is longer than the time between orders, then the goods in transit should be considered to be the reorder point:

$$\boldsymbol{PR} = (tiempo\ para\ recibir\ la\ reorden\ \boldsymbol{x}\ consumo\ promedio\ diario) - (mercancías\ en\ tránsito)$$

Assuming that "SERACOMP" will order 8,000 units every 7 days and that the delivery time is 10 days. This indicates that when each order is ordered, 8,000 units are in transit. The reorder point would be as follows:

$$Punto\ de\ reorden = (10\ x\ 1{,}096) - 8\,000 = 2\,960\ unidades$$

Safety Inventory

It is one that is maintained to protect against changes in sales or delays in production or shipment.

Safety inventory increases with uncertainty in sales forecasting and the likelihood of delayed receipt of merchandise. Decreases when inventory holding costs increase.

$$\boldsymbol{Tamaño\ de\ la\ orden} = EOQ + Margen\ de\ seguridad$$

$$\boldsymbol{Punto\ de\ Reorden} = (Punto\ de\ Reorden) + (Margen\ de\ Seguridad)$$

Now suppose that "SERACOMP" wants to have 4,000 units as a safety inventory.

$$Tamaño\ de\ la\ orden = 8\,000 + 4\,000 = 12\,000\ unidades$$

$$Punto\ de\ reorden = 2\,960 + 4\,000 = 6\,960\ unidades$$

Applies to large inventory orders when the minimum amount to get the discount is greater than the EOQ order, an evaluation should be made to see if it is appropriate to take advantage of the discount.

In the evaluation, it must be taken into account that the costs of maintaining inventory increase and the costs of ordering decrease. If the incremental costs are less than the savings of the discount, the discount should be taken advantage of.

If the suppliers of "SERACOMP" offer a discount of 2% on orders over 10,000 units. Should you take advantage of the discount?, is the dilemma of every entrepreneur.

$$CTAI = (1)(5)\left(\frac{10\,000}{2}\right) + (400)\left(\frac{400\,000}{10\,000}\right) = 41\,000$$

$$Ahorro = (5 * 0{,}2)x\ (400\,000) = \$40\,000$$

$$Ahorro\ neto = \$40\,000 - \ \$41\,000 = -\$\ 1\,000$$

Considering the difference between the savings and the total cost of managing the inventory **,** it is NOT advisable to take the discount because it would cause a loss.

1.7 Purchasing model: no deficit

This is one of the simplest inventory models. It is based on the following assumptions:

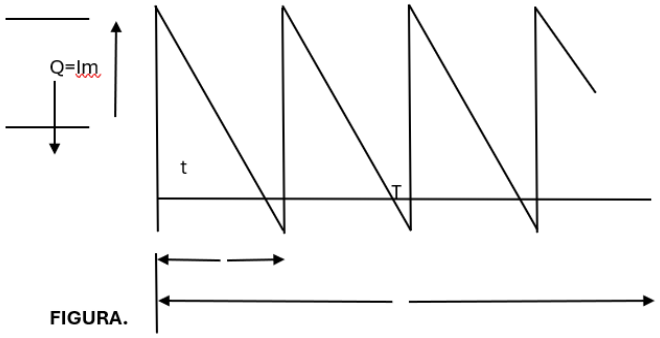


Figure 1-5: Purchasing model (no deficit)

- Demand is made at a constant rate.
- Replacement is immediate (the replacement rate is infinite).
- For all cost factors (C1, C2, C3) they will be constant.

Figure 1-5 shows the Maximum Inventory **Im** and the economic quantity ordered (order) **Q** as equal. This is not always true. Actually, in most inventory models this condition (**Q = Im**) is not true. The time t is time between orders or the time of a period. The planned period T is taken as 1 year in the calculation of this and the other inventory models.

The total cost of the model is made up of 3 cost components:

Costo total / año
= costo unitario / año + costo de ordenar una compra / año
+ costo de mantener inventario / año

The total cost per year is obtained by determining the total cost for period **C'** and then multiplying this cost by the number of periods per year:

Costo total / año = (Costo total / período) * (número de períodos / año)

The unit cost per period is simply the cost of **Q** units or **C1Q**

Where:

C1 is the cost per unit.

Since only one purchase is made per period, the cost of ordering the purchase is the cost of placing an order, and is called C2.

The average inventory per period is **Q/2.** Therefore, the cost of maintaining inventory per period is $C_3 t \frac{Q}{2}$

Be:

C2 = Cost of placing an order (or setting up production)

C3 = Annual cost of maintaining a unit of inventory.

D= Total annual usage (demand), in units

Q = Optimal Order Size, in Units (The Unknown Factor)

Notice that the annual number of orders depends on D and Q:

$\frac{D}{Q}$=Annual number of orders

Also:

$\frac{Q}{2}$= Average Inventory (assuming linear utilization)

Then:

$\frac{Q}{2}C_3$= Annual cost of holding inventory (average inventory multiplied by , the annual storage cost per unit).C_3

$\frac{D}{Q}C_2$ = Annual cost of order formulation (annual number of orders, D/Q, multiplied by the cost of order formulation,).C_2

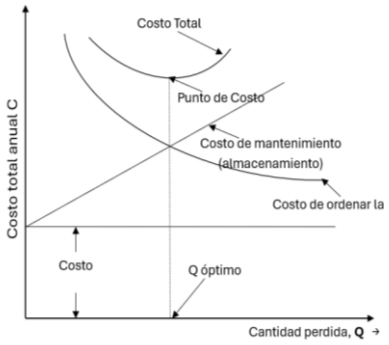


Figure 1-6: Model Cost Patterns

Where = maintenance cost or cost of keeping a unit in inventory for 1 year, $/unit-year.$C_3$

t = time of a period in years

The total cost C per period is

$$C = C_1Q + C_2 + C_3\, t\frac{Q}{2}$$

The time of a period, expressed in years, is $t\frac{Q}{2}$

$$N = \frac{D}{Q}$$

Where D = demand for a particular item in units/year

The number N of periods or orders per year is the reciprocal of the equation.

Substituting in the equation yields:

$$C = C_1D + C_2\frac{D}{Q} + C_3\frac{Q}{2}$$

When the cost components of the equation are plotted as shown in Figure (1-6), a sweet spot (minimum cost) is obtained.

One way to determine optimal Q is to assume several values of Q and substitute it until the minimum cost point is found.

A simple procedure is to derive the equation relative to Q and equal the derivative to zero. Since the term is constant, the derivative of the equation is C_1D

$$\frac{dC}{dQ} = o = -\frac{C_2\,D}{Q^2} + \frac{C_3}{2}$$

If you clear Q you get:

$$Q = \sqrt{\frac{2\,C_2\,D}{C_3}}$$

The equation gives the quantity ordered (Q) that causes a minimum cost and is based on a balance between the two variable costs (storage costs and purchase cost) included in the model. Any other amount requested causes a higher cost.

Example: The demand for a particular item is 18,000 units/year – the cost of storage per unit is $1.20 per year and the cost of ordering a purchase is $400. No deficit is allowed, and the replacement rate is instantaneous. Determine:

a) The optimal quantity ordered
b) The total cost for years if the cost of 1 unit is $1
c) The number of orders per year
d) The time between orders

The optimal quantity ordered is calculated according to the equation of Q.

$$Q = \sqrt{\frac{2\,C_2\,D}{C_3}} = \sqrt{\frac{2\,(400)\,(18\,000)}{1{,}2}} \qquad Q = 3\,465\ unidades$$

The total cost is calculated according to equation (C)

$$C = C_1 D + C_2\frac{D}{Q} + C_3\frac{Q}{2}$$

$$C = 1(18\,000) + 400\frac{18\,000}{3\,465} + 1.2\,\frac{3\,465}{2}$$

$$C = 22\,156\ por\ año$$

The number of orders per year is:

$$N = \frac{D}{Q} = \frac{18\,000}{3\,465} \qquad N = 5.2\ pedidos\ por\ año$$

The time between orders is:

$$t = \frac{1}{N} = \frac{Q}{D} = N = \frac{3\,465}{18\,000} \qquad t = 0.1925\ años$$

METHODOLOGY

In the research, inventory management models are applied in medium-sized companies in the Riobamba canton. It considers statistical and mathematical models applied to the analysis of costs as a preponderant factor of the products they market.

The research had a mixed approach, qualitative and quantitative, the methods that have been used are the documentary review, that is, a literature analysis on inventory management, dynamic scheduling and artificial intelligence, the instruments that were applied for the surveys are generally questionnaires and it was carried out by managers and/or those in charge of logistics and inventory management in their respective companies, for this purpose, a representative sample of shopping centers or places in different sectors of the city of Riobamba was used, with a total population of 1 882 businesses that in calculation of the sample using the finite formula it was established that 319 businesses should be surveyed, on the data obtained the data analysis was carried out through statistical methods, and mathematical modeling, with which dynamic programming is evaluated.

RESULTS

The surveys in questions 5, 6, and 7, let us see the current state of inventory management in commercial companies in the city of Riobamba, at this point a concern is reflected about the costs of implementing digital tools which suggests that many companies may still be using traditional methods.

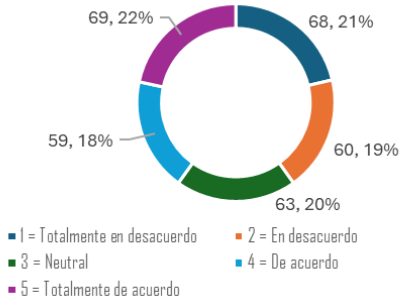


Illustration 1 Cost of implementation as a barrier. In original Spanish language

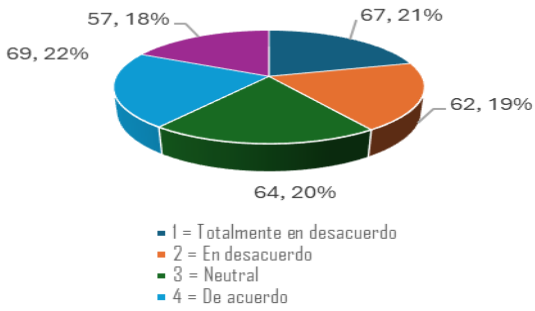


Illustration 2 Lack of technological knowledge. In original Spanish language

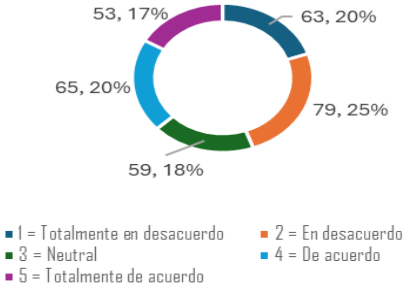


Illustration 3 Companies that have implemented technologies in inventory management. In original Spanish language

Divided opinions on improving performance with digital technologies implies a variety in the degree of adoption and effectiveness of inventory management practices. Concerns about a lack of technological knowledge reinforce the idea that many companies could be lagging behind in adopting new technologies.

When talking about the degree of digitalization of inventory management, the surveys in their questions 5, 6 and 8 show a significant awareness about the importance of digitization and automation for the future of inventory control, however, the concern about costs and the lack of technological knowledge indicates that the degree of digitization and automation for the future of inventory control, however, the concern about costs and Lack of technological knowledge indicates that the degree of digitalization varies considerably between companies.

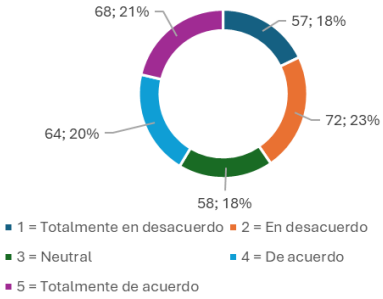


Illustration 4 Digitalization and automation as the future of inventory control in companies. In original Spanish language

The existence of a significant number of people who do not consider that digital technologies improve performance implies that there is still a large number of companies that have not used digital tools, although there is a recognition of the importance of digitalization the actual adoption varies on the other hand there are significant barriers that prevent complete digitalization in all companies

Regarding the practical application of the dynamic programming model in inventory optimization, it is evidenced in the surveys, especially in question 4, a perception that dynamic adoption offers advantages over traditional methods, however, the division of options suggests that the practical application and in-depth knowledge of these models may

be limited, although there is recognition of the potential of dynamic programming, its practical application may be limited due to the to the lack of knowledge and the barriers to implementation.

The survey in its questions 1 and 4 directly explores the perception of the advantages of dynamic programming (an optimization approach) over traditional methods also explores the perception of performance improvement with the adoption of digital technologies.

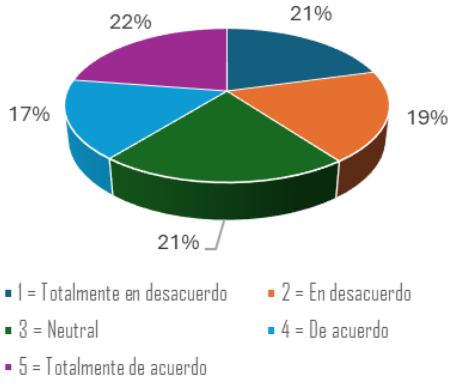


Illustration 5 Use of digital strategies in inventory control and management . In original Spanish language

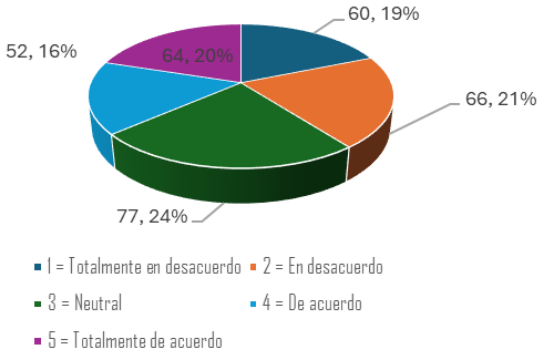


Illustration 6 Significant advantages over traditional methods in inventory control. In original Spanish language

The results demonstrate a division of options, implying that the comparison between these methods is not uniform, there is an implicit comparison in the responses, but there is no clear consensus, the perception of the advantages of digital approaches and optimization varies among respondents.

In general, we can see that the information analyzed reveals a transition towards digitalization in inventory management in commercial companies in the city of Riobamba, but with significant barriers, that is, there is a recognition of the potential of optimization and dynamic programming, but its practical application is limited, so the comparison between traditional methods and the digital approach shows a wide division of opinions.

DISCUSSION OF RESULTS

The results of the surveys reflect the perception of commercial companies in Riobamba on the use of digital tools in inventory management, key trends related to their implementation, impact and barriers are identified, as well as comparisons with previous studies and success stories on the impact of digitalization on the efficiency of inventory management.

The findings indicate a favorable trend towards the digitization and automation of inventory management, the majority of respondents recognize improvements in accuracy and reduction of errors, however, a significant minority do not perceive positive changes or consider that these tools are not essential, previous experience with digital technologies, knowledge of success stories and understanding of benefits are determining factors in the positive perception of In contrast, resistance to digitalization is often associated with a lack of technological knowledge and concerns about implementation costs.

Doubts about the return on investment for an effective transition guide companies to carefully evaluate the costs and benefits of digitalization, ensuring staff training and process optimization. Digital solution providers on the other hand must emphasize the value of their product and provide adequate technical support to facilitate its adoption in relation to the advantages and challenges of applying dynamic scheduling in inventory management, the majority of respondents recognize that dynamic scheduling provides significant advantages over traditional inventory control methods, however, a considerable group maintains a neutral or disagreeing position, which highlights the need for greater dissemination about its benefits,

We can observe that the optimization of decision-making in complex scenarios by considering multiple variables and constraints it is very important to manage the accuracy in demand forecasts that the reduction of inventory costs and increase of operational efficiency is a great objective on the challenges requires specialized technical knowledge and a significant investment in corresponding software and hardware, so some companies prefer traditional methods for their simplicity and familiarity.

Within the implications we see that companies must evaluate whether the benefits of dynamic scheduling justify the costs and challenges of its implementation, staff training and the availability of technical support are key to effective adoption.

Compared to previous studies and success stories, it is observed that the increasing digitalization and automation in inventory management, dynamic scheduling has proven to be effective in various industries, optimizing processes and improving results. Companies in different countries have registered significant improvements in their performance after implementing digital technologies and dynamic programming, these cases can serve as a reference for commercial companies in Riobamba.

A prominent example is that of Domino's pizza which has implemented a real-time tracking system called Domino's Tracker. This system allows customers to see every stage of their order, from preparation to delivery, which has led to a 10% increase in customer satisfaction and a 25% increase in order volume by using real-time data Domino's is not only improving the customer experience, but also optimizing its operations by quickly adjusting delivery capabilities and reducing wait times, which it translates into greater efficiency. (VORECOL, 2024).

Another interesting case is that of Zara, part of the INDITEX group, which in 2019 faced a challenge of implementing real-time data analysis to optimize its supply chain, at first the company had difficulties delivering its information systems on different platforms, which complicated the consolidation of data in a single source, however, after months of efforts and considerable investment in technology, Zara managed to transform its operating model thanks to real-time data analysis, the brand was able to reduce its response time to market by 30% by quickly adjusting its inventory based on emerging shopping trends. (VORECOL, 2024)

On the other hand, the main obstacles identified are the high cost of technology and the lack of technological knowledge in the staff, these factors may be limiting or limiting the mass adoption of digital solutions in the region, in terms of profitability a significant part of the respondents report financial improvements and reduction of losses after the implementation of digital tools, however, some participants, they maintain a neutral or skeptical stance, which could be related to the lack of concrete data in the incipient stage of adoption in which they find themselves.

Although the results offer a clear view on digitalization in inventory management, there are some limitations of the study, such as the size of the sample may restrict the generalization of the findings to all commercial companies in Riobamba, followed by the bias of the responses, respondents could have responded according to what they consider socially acceptable.

In view of the above, possible improvements arise around expanding the study with a more representative sample, incorporating qualitative methods such as focus group interviews to obtain more in-depth information and formulating more special questions specified about digital tools and dynamic programming times known to respondents in the future, automation and digitization of inventory control is emerging as a key trend for most of the Many of the respondents agree that these tools will be increasingly indispensable for the competitiveness of commercial companies in this canton.

To ensure a successful implementation, it is essential to train staff, facilitate access to affordable technologies and develop strategies that maximize the impact of these solutions on business management.

CONCLUSIONS

The results of the study suggest that digitalization and dynamic scheduling have the potential to significantly improve the efficiency of inventory management in commercial enterprises in the city of Riobamba, however, it is important to consider the challenges and limitations of its implementation and adopt the strategies to the specific needs of the market.

In conclusion, the results of the survey reflect a panorama of transition towards digitalization with notable advances, but also important challenges that must be addressed, especially in terms of costs and staff training. The implementation of training and financing strategies could facilitate a more effective adoption of these tools in the commercial sector of Riobamba.

Digitalization improves accuracy and efficiency in inventory management, that is, there is a widespread perception that digitization and automation will improve efficiency in inventory management and will be crucial for the future of companies in Riobamba.

Dynamic scheduling offers an optimal model to reduce costs and improve product availability, however, its potential is recognized in times of uncertainty about the real advantages of dynamic scheduling compared to traditional methods, suggesting a possible lack of in-depth knowledge as a lack of technological skills, which hinders the adoption of digital tools for inventory optimization, underlining the importance of training and technical support.

RECOMMENDATIONS

It is important to recommend the implementation of training programs in digital technologies and dynamic programming for employees of commercial companies in the city of Riobamba, that is, we must organize workshops and seminars to disseminate best practices and success stories in inventory management.

It is advisable to develop software and hardware packages tailored to small and medium-sized enterprises in the city of Riobamba that include the necessary technical support and training with financing options and subsidies to facilitate the adoption of digital technologies.

It will be important to carry out case studies and prepare reports that quantify the benefits of digitalization and dynamic programming in similar companies in the city of Riobamba.

Facilitate the exchange of experiences between companies that have already implemented digital technologies and those that are in the process of doing so, establishing alliances between the public, private and popular and solidarity economy sectors with academia to promote the digitalization of the region.

It is recommended to conduct market research to understand the particularities of the Riobamba market and design tailor-made technological solutions considering factors such as the size of the companies, the predominant economic sectors and the availability of technological infrastructure.

REFERENCES

[1] Acevedo, A., Jáuregui, A., Quiroz, J., & Ali, A. (2024). Optimizing Warehouse Management in Footwear Commercial Companies: A Case Study on Lean-BPM. SSRG International Journal of Mechanical Engineering, 11(1), 16-27. doi:https://doi.org/10.14445/23488360/IJME-V11I1P102

[2] Aggarwal, K., & Shuja, A. (2024). Optimizing ordering, pricing and return strategies in an advanced sales inventory system with product screening. International Journal of System Assurance Engineering and Management , 15, 5548 - 5573. doi:https://doi.org/10.1007/s13198-024-02524-3

[3] Arista, A., Theresiawati, T., & Seta, H. (2024). Big Mart sales data visualization and correlation. International Journal on Informatics Visualization, 8(2), 576-582. doi:https://doi.org/10.62527/joiv.8.2.1780

[4] Basher, M., Dipto, S., & Rahman, M. (2024). Managing business during global economic crisis: The case of Global Gadget Limited, Bangladesh. Emerald Emerging Markets Case Studies, 14(2), 1-24. doi:https://doi.org/10.1108/EEMCS-09-2023-0322

[5] Bouazizi, E., Khedr, A., Elfaioumy, S., & Belal, M. (2024). Inventory Optimization Using Data Science Technologies for Supply Chain 4.0. The International Arab Journal of Information Technology, 21(6), 996-1005. doi:https://doi.org/10.34028/iajit/21/6/4

[6] Datta, A., Sarkar, B., Koli, B., Sangal, I., Yang, L., Kai, S., . . . Thangavelu, L. (2024). The impact of sales effort on a dual-channel dynamical system under a price-sensitive stochastic demand. Journal of Retailing and Consumer Services, 76, 103561. doi:https://doi.org/10.1016/j.jretconser.2023.103561

[7] Jin, S., & Karki, B. (2024). Integrating IoT and blockchain for intelligent inventory management in supply chains: A multi-objective optimization approach for the insurance industry. Journal of Engineering Research (Kuwait). doi:https://doi.org/10.1016/j.jer.2024.04.021

[8] Panigrahi, R., Mahapatra, S., & Tanty, G. (2024). Automated practices in inventory management on performance – A prospect of emerging country. International Journal of Business Performance Management, 25(3), 369-391. doi:https://doi.org/10.1504/IJBPM.2024.138179

[9] Reddy, N., & Khanna, P. (2024). The role of artificial intelligence in reimaging the customer experience in retail sector – NVIVO analysis for customer journey mapping. nternational Journal of Intelligent Systems and Applications in Engineering, 4s(566-585), 12. doi:https://www.scopus.com/inward/record.uri?eid=2-s2.0-85179660885&partnerID=40&md5=26a9310a37243fce6683c008ddbebace

[10] Shan, J., & Bhishma, K. (2024). Integrating IoT and blockchain for intelligent inventory management in supply chains: A multi-objective optimization approach for the insurance industry. Journal of Engineering Research. doi:https://doi.org/10.1016/j.jer.2024.04.021

[11] Suresh, B., & Suresh, M. (2024). Efficient customer behaviour prediction in Indian metropolitan cities for e-commerce applications. . Expert Systems, 41(9). doi:https://doi.org/10.1111/exsy.13604

[12] VORECOL. (2024, 8 of 28). Using Real-Time Data Analytics to Optimize Operational Processes: Success Stories. Retrieved from Vorecol Editing Team: https://vorecol.com/es/articulos/articulo-uso-de-analisis-de-datos-en-tiempo-real-para-optimizar-procesos-operativos-casos-de-exito-169210