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# Logistical Management In The Pharmaceutical Service Of Health Care Centers

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**Abstract**

Inventory management is a little studied topic in the health sector, but at the same time of great importance, since it allows optimizing costs and that the products do not expire or become obsolete as they cause effects on customer service and the health of these same. Within this research, a search was conducted in different databases to collect information related to inventory management and models which are directly related to the health sector and pharmacies within different organizations. Most of the information was found in a second language. Once the information was analyzed, we started from the effects that logistics has in this sector, continued with the common problems that the documents had, the methodologies, the performance measures were also taken into account and finally the strategies. The inventory management within the pharmacies of the health entities is an important aspect and the starting point for decision making on which evolves in the supply and demand, resulting in a reliable state of control of materials and products.

**keywords.** Supply chain, Inventory management, Hospital, Inventories, Medicines, Optimization.

## 1. Introduction

Inventory has existed since human beings began to use the Earth's resources, however, it cannot be said that its management is a solved problem and can be planned and controlled in the same way in all cases [1] Inventory management has always been the subject of research in production and industrial engineering; inventory systems were first processed mathematically using the model or method. Inventory management has become more complex given the changing market conditions, increasing competitiveness, dynamism and complexity, which makes the results of mathematical models fragile[2].

The application of Industry 4.0 in the field of logistics and inventory management should have as its main objective to understand the application of these technologies and should be adapted to the sector

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[3], the methods available for its development will be the application of technologies that facilitate and make it possible to synchronize production with logistics and information flow, thus improving the efficiency and quality of logistics system operations, and the way to increase the competitiveness of enterprises will be improved [4].

Inventory management is a widely researched topic in the field of operations control and research aimed at optimizing inventory management costs[2]. Traditional inventory models generally deal with optimizing inventory for a single organization. But recently the concept of "supply chain" has started to prevail in business management [5].

Inventory management methods include logical steps to enable levels of measurement integration and collaboration in the supply chain [6], such as defining criteria to ensure more efficient inventory classification [7]. Recent research in the field of inventory management has shown that inventory system performance is affected by the planning aspects and organizational integration of inventory systems [8].

Governments are grappling with the challenge of providing adequate medical care to address the coronavirus pandemic. For this reason, a new inventory pooling model should be proposed to help determine demand and stabilize inventory in hospital stores [9].

Inventory management in hospitals is more challenging than applications in other industries due to the importance of avoiding shortages of different products [10], since not counting items can affect patient health. resources needed for adequate treatment and/or intervention, so there is a need to develop tools that facilitate effective inventory management in such institutions[6].

From an economic and organizational perspective, the management of the procurement, storage and distribution of drug supplies is essential for hospitals. Several authors have addressed the issue of inventories taking into account different variables [5]. Unlike many industries, hospital administrators and pharmacy supervisors must control very complex distribution networks and inventory management issues without adequate guidance on effective practices. This is because most hospital administrators and pharmacy supervisors are physicians with healthcare experience, not supply chain professionals [11].

Medications are costly in the healthcare industry, thanks to the specifications in which they must be stored[11], pharmacy supply chains, and recent management practices that create conflicting choices among multiple stakeholders[12]. It focuses on inventory management of local storage units in personal care units [7].

For the selection of operating inventory, the reorder point and level of automated order-to-control demand systems (called minimum and main standard levels) must be provided. Hospital inventory management is increasingly challenged to ensure that medical and surgical supplies are available at the lowest inventory cost[13]. These limits are based on a strategy of near-optimal allocation of periods and stable stocks with storage space constraints.

## 2. Background

The primary goal of a hospital is to provide high quality medical care. Have enough medical supplies on hand for hospital staff to perform their daily tasks. Medical supplies are often stored in many locations throughout the hospital and in large quantities to avoid stock-outs as much as possible. However, hospitals lack available storage space and spend millions on inventory, which consumes an average of 20% of a patient's net income and is the second largest expense after labor [14]. Therefore, the available storage capacity must be used efficiently and it is important to find a balance between the quality of service and the level of inventory required between different items [15].

The authors of the article under the name "Modeling and analysis of inventory management systems in healthcare: a review and reflections" [16] classified and critically reviewed the modeling approaches

and solution methods related to inventory management in the healthcare sector, and propose future studies. While in the systematic literature review of with the title "Improving sustainability in a two-tier pharmaceutical supply chain through supplier-managed inventory system" they highlight knowledge gaps regarding factors affecting supply chain and inventory management in hospital pharmacies, which could lead to drug shortages [12].

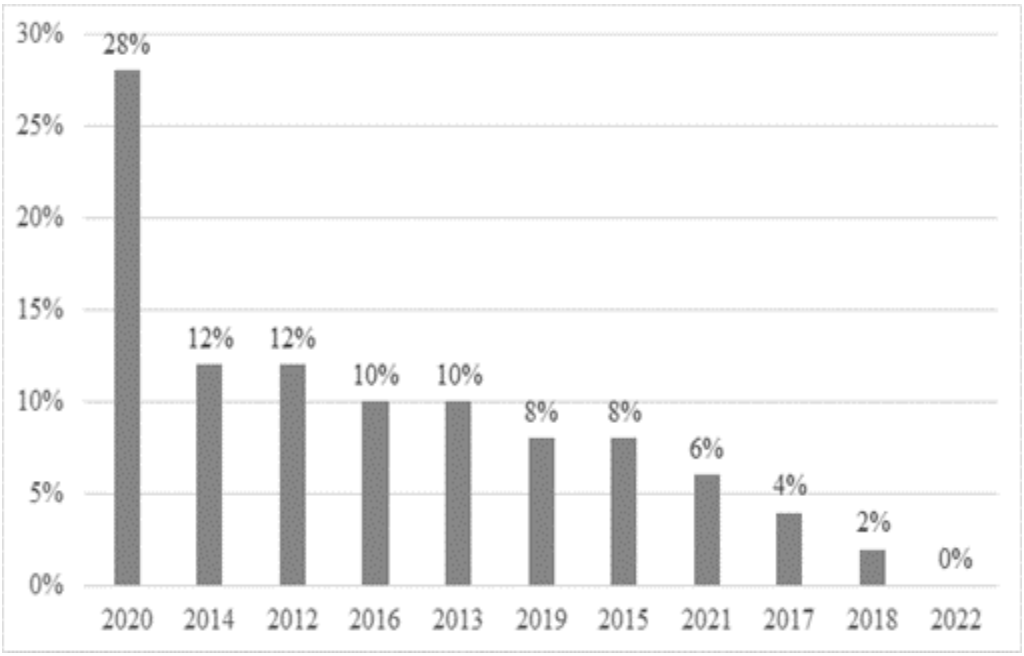
This paper proposes a state-of-the-art analysis using a literature reference that relates inventory models that take into account service levels as well as hospital capacity constraints, resulting in a guide to support management decisions in hospitals on inventory control.

## 3. Method

The present research aims to review inventory management models in hospital pharmacies. As a search strategy to find the information, the following keywords were combined (inventory management, pharmacist, inventory control, hospitals, inventory management model) and in English (inventory management, pharmacist, inventory control, hospitals, inventory management model) in databases such as Dialnet, Redalyc, Scielo, Google academic, Sciencedirect.

Figure 1 shows the consolidation of the years of the documents consulted, where 2018% are from the year 2020, the second place is shared by the years 2012 and 2014 with 12% each; in third place, there are 2013 and 2016 with 10%, the fourth place is 2015 and 2019 with 8%, finally there are the documents published in 2021 with 6%, 2017 4% and 2018 2%..

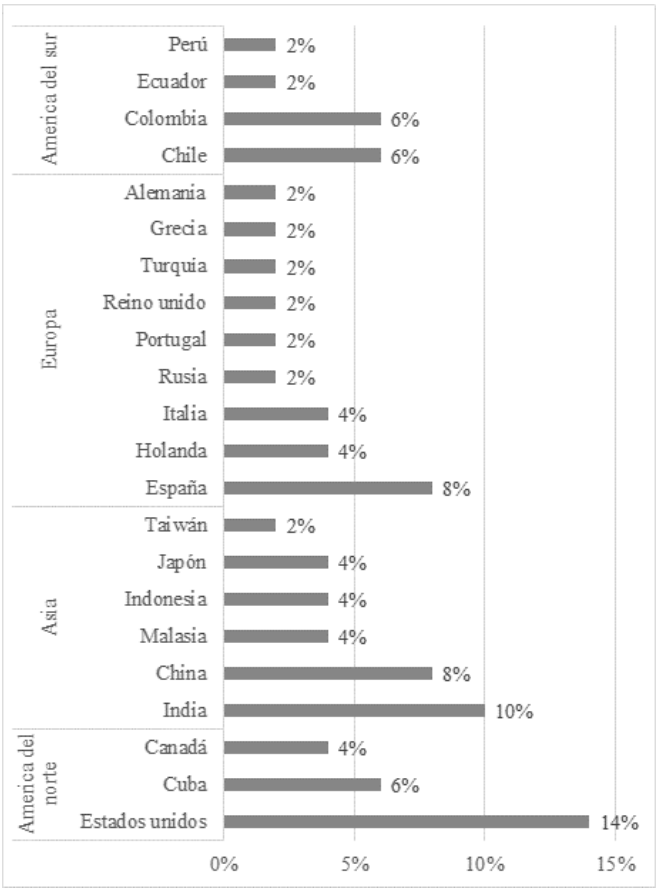
**Figure 1. Number of articles consulted in the research.**




Source: Own elaboration

Figure 2 shows the articles by continent and country, starting with Latin America, where Colombia and Chile were the countries that contributed the most research; in Europe, Spain was the country that contributed the most research with 8% (4 documents), followed by Italy and Holland with 4%; in Asia, India was the country with the most research with 10%, followed by China; finally, in North America, the United States was the country that contributed the most research with 14%, followed by Cuba with 6%.

**Figure 2. Year of publication of the articles investigated.**




Source: Own elaboration

From the selected articles we reviewed the objective of the study, the problem that affected the organization or the study that we wanted to carry out, the methodology used to solve this problem and the results obtained together with possible implementations or changes that could be made to have a greater benefit, the latter being the most important, since it will allow understanding how this article can be ordered, formulated and directed, likewise the conclusions and recommendations were studied.

## 4. Results

Inventory is essential because it allows organizations, for example, to plan their careers and keep a minimum inventory available for marketing on a continuous basis. This does not require prolonged storage of goods in warehouses, as this means costs [17]. In addition, periodic inventory allows companies to verify that accounting records match actual inventory. However, their assets can be counted to estimate their legacy costs.

Effects of logistics in the healthcare sector.Hospital logistics is a tool that allows proper management of resources, integrating all activities from the acquisition of raw materials, conversion, storage, final distribution, admission and discharge of patients, so it is considered a relevant aspect because it determines the operation of internal processes from which improved alternatives can be proposed [18]. Optimal management of hospital logistics tasks is a decisive factor in reducing costs and obtaining quality medical services [19].

Nowadays, logistics and industry use components which are highly developed and achieve advanced management, in terms of process evolution and automation [20]. Logistics processes must also be sustainable, since they are based on three pillars: social development, economic development and environmental recovery and maintenance. The following figure shows the concepts and applications in more detail [21].

In terms of inventory management, the use of technology is essential because it allows to find the goods to be dispatched to different parts faster, which leads to a decrease in response times, and warehouse management becomes organized, efficient and effective [22]. The use of technology in the inventory system model gives an idea of the total cost, location, storage time, expiration date records, manufacturing date records of the inventory in the warehouse so that it can be quickly collected when needed [23].

Common problems in the management of hospital inventories.Table 1 shows the common problems that occur in inventory systems in hospitals, for this purpose the items were classified taking into account the problem being analyzed.

**Table 1. Common problems in the articles.**

| **Problemas** | **Numero de referencia** | **Frecuencia** |
|---|---|---|
| No dispone de suficiente espacio “No se conocen las ubicaciones, diseño del almacén, errores de picking, gestión de información”. | [17] [24] [25] [26] [27] [28] [29] [30] | 42,08% |
| Caducidad u obsolescencia de los medicamentos | [31] [32] [33] [34] [35] [36] | 31,57% |
| Integración de modelos al sistema de inventarios “modelo de control predictivo, modelo de programación lineal entera mixta, modelo estocástico y modelo de capacidad” | [14] [34] [37] [35] | 21,05% |
| Trazabilidad interna y externa del producto “determinar el lote y el tamaño del pedido óptimo” | [9] | 5,26% |

Strategic choice support focuses on important trade-offs between 3 key performance indicators: expected percentage of daily refills, service levels, and storage space deployment[11]. An inventory model for deteriorating items with an inventory-dependent demand function that accounts for the rate of deterioration over time. Based on demand and inventory, the model estimates 3 possible scenarios[32].

Given that supply chain prices account for a significant portion of hospital operating costs, which is why in the U.S. alone $27.7 billion was spent on drugs alone in 2009 [31], this is why improved drug inventory management offers enormous potential for minimizing healthcare costs [30]. Each drug has a specific unit price, supplier availability, minimum grade, and expiration date that must be taken into account.

The primary goal of inventory and supply chain management research is to reduce healthcare costs without sacrificing customer service [38]. Drug purchasing and distribution can be costly [10], but shortages of essential drugs, inappropriate drug use, and spending on unnecessary or substandard drugs can also lead to high costs: wasted resources and preventable illnesses and deaths.

Drug inventory management in hospitals has become a major challenge for the healthcare system [11]. A multistage stochastic programming model optimizes drug inventory costs under uncertain demand, lead times, and quantities received. The model assumes a continuous revision policy, using the (Q, r) model to handle multiple products in a cascading pharmacy supply chain (i.e., a hospital). Out-of-stock exceeds completely out-of-stock [39].

The inventory management of a company is an activity related to its value chain and must be aligned with the company's strategy to satisfy customers, so an organization must generate and create a methodology that alerts the warehouse on the amount of parts available, the best time to supply [26]. As well as the quantities or lots that should be ordered to be used effectively in the warehouse of a company, poor management in inventory management can generate problems in the organization and this in turn will be expressed as an economic loss that affects the financial statements [33].

Another evident problem within the company is the lack of a digital or manual inventory control format, where it is possible to define the exact amount of stock of a certain material available in the warehouse, but not how much, due to existing controls outside the administrative department [23].

It is also important to classify the different parts of the warehouse, divide it into sections to control the products [40], it is also important to identify the excesses and deficiencies within the pharmacy, and, finally, the type of inventory control to be performed, because it is impossible to mitigate loss reduction without taking into account the above factors, since when the material is not in common rotation, it runs the risk of being damaged and becoming a loss [19]. Proper controls keep the inventory in good condition and decisions can be made in a timely manner for items with low demand [14].

Inventory efficiency in any production activity involves everything from the selection of suppliers, to the acquisition of raw materials, storage, handling of materials, machinery and tools, for this reason [34], inventory within an organization is critical and, if performed effectively, will allow The company can maintain control over its materials, supplies, work in progress and finished goods [37].

It is also important for the warehouse manager or warehouse manager to keep in mind the need to have or have an inventory control system as this will help in keeping a daily record of the inventory so that it can continue to serve without any interruption and inconvenience [35]. A good and proper inventory control system can reduce the error rate and avoid re-generating the same purchase order, thus reducing its expense by efficiently using products that are still useful in the warehouse [25].

An inventory is a record of goods belonging to a natural or legal person. Therefore, there is evidence of a variety of goods or items. In other words, in general, an inventory is a document in which all the assets of a natural or legal person are recorded this is for accounting or other purposes [29]. It usually involves an inventory list that records raw materials, intermediate products, and final products that the company supplies to customers, in this case drugs. Also, if we mention a person, he/she should indicate what goods he/she owns in case he/she wants to take out theft insurance [27].

Common item methodologies.In addition to organizational issues, inventory optimization aims to shorten lead times, save space and achieve higher profits. Table 2 shows the methodologies used in the application of inventory management. Therefore, inventory optimization aims to achieve the most appropriate product mix in the warehouse according to the service strategy [36].

**Table 2. Common methodologies in the articles.**

| **Metodologías enfocadas** | **Numero de referencia** | **Frecuencia** |
|---|---|---|
| Gestión "riesgo de deterioro, robo y daños, logística, lead time". | [2] [6] [9] [10] [15] [16] [41] [42] [43] [44] [45] | 36,67% |
| Control de inventarios "VMI, MCP, LT, (Q,r), (CC-MPC), (RS) (PSO), (DDBR), (SD)". | [12] [13] [46] [47] [48] [49] [50] [51] [52] [53] | 33,34% |
| Modelos "máximo y mínimo, políticas, Lean Thinking, el Sistema Kanban, KPI operativos" | [1] [4] [5] [8] [11] [38] [39] [40] [54] | 30% |

This can be achieved by properly modeling supply and demand uncertainty for each product, where forecasting and demand optimization techniques are applied to product sets [2] . By automating the processing of thousands of SKUs, inventory balances, capital investment targets and service levels can be optimized, thereby increasing profitability [46].

An inadequate idealization of inventory results in an inability to meet consumer demand, so if it is known that internal controls can maintain a certain inventory model, the organization is profitable and earns revenue in a short period of time, this will prevent failures in inter-company communication [40]. The problem of not being able to observe what is in the warehouse due to the inability to control inventory is presented to consumers, as they are given wrong information and access products that may not be in the store or warehouse [7].

Inventory management should be considered as a strategic component in the management of companies since this type of organization is the one that represents the largest economy of a region since if it is not taken into account there will be a loss of productivity that will result in a good performance for the organization in the long term [8]. In addition to excess inventory is detrimental, since maintenance prices are entered, this is done to avoid damage or defects in the product, another drawback of colleagues is the constant monitoring of the warehouses where the goods are stored to avoid the economy of the product Losses when costs are high [5].

Poor management of a company's inventories can cause quite serious problems, reaching the loss of merchandise and financial statements, for such reason the optimal policies of ordering, issuance and disposal of inventories [54]. An optimal inventory management system model consists of functions that involve the inventory of various raw materials and products that must be kept in stock [13]. in addition, the internal components they contain must also be considered, along with external factors that ultimately compromise the management and decisions made from the application of quantitative models and management policies developed for this purpose, all of the above revolves around the buyer, since the main movement is related to the agreed delivery time [39].

Hospitals applying Lean Thinking (LT) can do both. LT reduces the 8 waste commonly found in healthcare processes and functions [47]. In particular, if unnecessary inventory related to costly medical supplies is reduced, the resulting price savings have the potential to help provide affordable and accessible healthcare.

The benefits of an inventory-managed enterprise are the control and issuance of raw materials, supplies, and products; the second is the continuous monitoring of product quality; the third benefit is the

identification of theft and misplacement in the warehouse, as real-time inventory information will be maintained on an ongoing basis [1].

All this leads to the fourth benefit perceived by consumers, which is the optimization of services, since in the face of such formulated needs, they will have the corresponding information for the marketing and supply of each good; finally , the organization obtains [4]. Since it allows it to know the seasonality and consumption of goods in high season, thus saving on prices, since it requires that the needs of these seasons are supplied by the necessary ones.

**Table 3. Performance measures.**

| **Medidas de desempeño** | **Numero de referencia** | **Frecuencia** |
|---|---|---|
| Indicadores de aprovisionamiento “tiempo de entrega, lead time del proveedor, tamaño óptimo del lote, transporte” | [13] [15] [28] [42] [43] [47] [49] [52] [53] [54] [55] | 55% |
| Nivel de servicio al cliente “eficiencia, flexibilidad” | [16] [24] [37] [44] [45] [49] [50] | 35% |
| Indicadores financieros “costos, rentabilidad” | [46] [49] | 10% |

Industrial engineering and operations research have the potential to be actively used to lower drug prices in hospitals [49], where pharmacies play an important role in the central selection of drug procurement and distribution so inventory control strategies have been developed that combine mechanisms based on traditional inventory mix and control to optimize inventory prices for pharmaceutical logistics [43].

To obtain information on operations planning and inventory control, simulation is a good tool because its approach has yielded results in the analysis of the dynamic behavior of complicated supply networks [44].

Inventories in an organization have an enormous cost since they represent a very important aspect and poor management can cause dissatisfaction in the consumer and also generate financial problems in the short, medium and long term, such value is reflected in allowing to have a fair control over the merchandise [42]. Inventory management in a healthcare system must be compatible with its critical operations and characteristics [16]. Services can support future negotiations of the organization, meet deadlines easily, without surprises, with consensus, and finally track the proportion of accessible items [37].

Proper inventory management can prevent an organization from failure if reviewed from 3 points, firstly it depends on the product and its cost in the market, as they have the potential to disappear or be stolen, to avoid this accurate inventory should be performed and continuously monitored [50]. The number of stock in stock to ensure that the stored products are not lost, the second criterion is to see if the company has perishable products, since, if they are not properly rotated and controlled, they have the potential to be damaged and cause financial losses. Finally, there is the lack of awareness. Their consumption may cause the company to stop production or have no inventory available for sale [51].

Inventory management serves a variety of purposes, as they range from minimizing inventory to confirming that there is always the best part to sell them availability, a large part of which is minimizing

the associated price (ordering costs, reserves, and non-stock) [43]. To ensure the efficiency of the organization's financial reporting. Proper inventory control allows consumers to continue to increase, get certain benefits in other ways, can provide systematic information, simple operation of the system, instant access to information [44].

Policies are given by a pull or pull system, i.e., work as required, however, customer requirements cannot be effectively met due to the inability to control raw material inventory and work in process [15]. In this case, there is a cost of holding inventory as raw materials may be affected and unavailable to be converted into final products with quality standards. This is because orders are placed for raw materials when they are not needed, or, conversely, prior inventory has been accumulated and needed production time is wasted by sending workers to perform raw material inventory work, all of which occurs when the owners of the company have been emergent. with the company empirically allows these types of inefficiencies and errors to be made in these departments [52].

The price of providing medical care has recently skyrocketed[13]. On the one hand, patients expect the highest quality of service, while healthcare providers want to reduce overall operating costs. In particular, if unnecessary inventory related to expensive medical supplies is reduced, the resulting price savings have the potential to help provide affordable and accessible healthcare[47].

Hospitals need to understand pharmacy management, especially pharmacy inventory management [45]. In that vein, a new inventory policy is needed to reduce the amount of out-of-stock drugs and minimize the total inventory costs incurred by hospitals, and one such method is to create ABC models for drug rotation [55].

The first key context for a hospital's drug supply is its initial operations [28]. During this period, data collection for forecasting is inefficient, therefore the implementation of a Pharmacy Computer Inventory Program can optimize drug supply and would reduce drug shortages [24]. This can be complemented under first-in, first-out issuance, the added value of the optimal disposal policy would be high. The optimal disposal strategy combined with optimal ordering can reduce the average cost only when the issuance of old products is penalized [54].

Fluctuations in demand behavior and variability in replenishment times are the main reasons why any organization keeps inventory, so it is necessary to design and implement systems to optimize inventory management, such as inventory strategies using a hybrid heuristic algorithm for the cyclic inventory routing problem [46]. In the cases analyzed, it can be appreciated how having an adequate inventory policy can ensure the availability of products under uncertainty, which becomes a key factor for the success of this type of companies [53].

The main objective of a hospital in terms of inventory management should be the level of service or inventory availability, however, it is necessary to achieve a balance of prices in relation to inventory levels [56]. so many times an internal composition is presented within hospitals, which will reduce the performance of the company without compromising service levels inventory level.

Strategies used in the items.- Implement Inventory Optimization Degree: Implement and optimize all inventory control mechanisms among other fundamental aspects [11]. The term refers to inventory ratios that do not present excesses that increase storage costs, but also do not present deficiencies that prevent responding to consumer demand. Ideally, this is based on historical data. By conceptualizing this metric,

a good strategy can be established to improve inventory control by determining the ideal portion of each product in stock and prioritizing its management.

## 5. Discussion

Accurately track inventory: once you have determined the optimal inventory level, you must ensure that it is maintained in this way at all times [38]. This is a complex task, but with the help of tools you can implement an inventory management program, you get all the information about items going out or coming in and the main feature is that it is being updated in real time.

Regular physical inventory counts: this is one of the best strategies to improve inventory control [12]. While the system has information on each inventory, it can provide information on when items became unoccupied (unregistered sales, operator negligence, theft, etc.). Therefore, even if random, periodic physical counts are required to verify that the actual inventory is consistent with the recorded inventory.

Implement a comprehensive and integrated logistics strategy: Improvising inventory operations is akin to managing money and costs without any control. After all, it is composed of assets that become liquid in the short term, so they have a large financial weight and cost [41]. Therefore, from the moment you define a business project, you must implement a logistics and strategic strategy that encompasses all activities related to the control of the area.

Develop management reports: To strengthen and consolidate inventory control, make periodic management reports that allow you to identify optimization perspectives, drawbacks and progress relative to several months or recent years [48]. Losses during a specific time period and the difference between physical and digital inventory are a couple of really good indicators that you can check and record [49].

## 6. Conclusions

This research shows the importance of inventory management in hospitals in different countries, since it is a topic that professionals in this area do not handle very well, and for this reason, as could be seen in the graphs presented in the last few years, it has become relevant, and the country where most research was collected was the United States, followed by China and Spain, while in Colombia, so far, research on this topic is just beginning, so there is much to contribute from careers such as industrial engineering.

The management of an inventory system provides the organizational structure and operational policies to maintain and control the existence of medicines needed to control people's illnesses and provide them with timely treatments, in turn optimizing resources, which generates competitive advantages in entities that are in the same sector.

An inventory management system allows any entity to be efficient and effective in the use of space, resource savings, decision making and costs associated with maintaining inventories, for this reason the implementation of policies or an inventory management system large enough to cover all associated variables and in turn if you want to make constant follow-up to this issue, you must assign a professional in this area for monitoring and generation of future strategies.

Establishing an optimal inventory level is fundamental to implement and optimize all inventory control mechanisms, since by defining this metric, a good strategy can be established to improve inventory control and therefore what the quantity will be. Ideal inventory for each product for priority management.

## References

[1] I. Lopes-Martínez and M. Inés Gómez-Acosta, “Auditoría logística para evaluar el nivel de gestión de inventarios en empresas The logistics auditory to assess the level of inventory management

in companies," Ing. Indutstrial, vol. XXXIV, no. 1, pp. 108–118, 2013, Accessed: May 30, 2022. [Online]. Available: http://scielo.sld.cu/pdf/rii/v34n1/rii11113.pdf

[2] J. A. P. A. D. Diaz Batista, "Inventory Levels Optimization in a Supply Chain.," Ing. Ind., vol. 33, no. 2, pp. 8–16, 2012, Accessed: May 30, 2022. [Online]. Available: www.scielo.sld.cu/scielo.php?script=scl_arttex&pid=s1815-59362012000200004

[3] M. Fernández-Villacañas, "Reflexiones sobre la adaptación del sector industrial de defensa y seguridad de España a la nueva logística 4.0: la aplicación de modelos de cooperación público-privada," Econ. Ind. 0422-2784, pp. 89–100, 2019, Accessed: Jun. 05, 2022. [Online]. Available: https://dialnet.unirioja.es/servlet/articulo?codigo=7101942

[4] C. Castro, T. Pereira, J. C. Sá, and G. Santos, "Logistics reorganization and management of the ambulatory pharmacy of a local health unit in Portugal," Eval. Program Plann., vol. 80, p. 101801, Jun. 2020, doi: 10.1016/j.evalprogplan.2020.101801.

[5] S. A. Lasprilla, W. Ardila Rueda, L. Figueroa, and D. H. Romero Rodríguez, "Parametrization and evaluation of Inventory Policy (s,Q) in Hospitals: A case of study in Barranquilla," vol. 13, no. 1, pp. 99–105, 2015, doi: 10.15665/rp.v13i1.364.

[6] K. Salas-Navarro, H. Maiguel-Mejía, and J. Acevedo-Chedid, "Metodología de Gestión de Inventarios para determinar los niveles de integración y colaboración en una cadena de suministro," Ingeniare, vol. 25, no. 2, pp. 326–337, 2017, doi: 10.4067/S0718-33052017000200326.

[7] A. M. Paredes Rodriguez, V. L. Chud Pantoja, and J. C. Osorio, "Sistema de control de inventarios multicriterio difuso para repuestos," Sci. Tech., vol. 24, no. 4, p. 595, 2019, doi: 10.22517/23447214.22331.

[8] J. de Vries, "Identifying inventory project management conflicts: Results of an empirical study," Int. J. Prod. Econ., vol. 226, 2020, doi: 10.1016/j.ijpe.2020.107620.

[9] F. Rojas, P. Wanke, F. Bravo, and Y. Tan, "Inventory pooling decisions under demand scenarios in times of COVID-19," Comput. Ind. Eng., vol. 161, p. 107591, Nov. 2021, doi: 10.1016/j.cie.2021.107591.

[10] R. Uthayakumar and S. Priyan, "Pharmaceutical supply chain and inventory management strategies: Optimization for a pharmaceutical company and a hospital," Oper. Res. Heal. Care, vol. 2, no. 3, pp. 52–64, 2013, doi: 10.1016/j.orhc.2013.08.001.

[11] P. Kelle, J. Woosley, and H. Schneider, "Pharmaceutical supply chain specifics and inventory solutions for a hospital case," Oper. Res. Heal. Care, vol. 1, no. 2–3, pp. 54–63, Jun. 2012, doi: 10.1016/j.orhc.2012.07.001.

[12] D. Weraikat, M. K. Zanjani, and N. Lehoux, "Improving sustainability in a two-level pharmaceutical supply chain through Vendor-Managed Inventory system," Oper. Res. Heal. Care, vol. 21, pp. 44–55, Jun. 2019, doi: 10.1016/j.orhc.2019.04.004.

[13] L. C. Wang, C. Y. Cheng, Y. T. Tseng, and Y. F. Liu, "Demand-pull replenishment model for

hospital inventory management: A dynamic buffer-adjustment approach," Int. J. Prod. Res., vol. 53, no. 24, pp. 7533–7546, Dec. 2015, doi: 10.1080/00207543.2015.1102353.

[14] M. Bijvank and I. F. A. Vis, "Inventory control for point-of-use locations in hospitals," J. Oper. Res. Soc., vol. 63, no. 4, pp. 497–510, 2012, doi: 10.1057/jors.2011.52.

[15] J. Li, L. Liu, H. Hu, Q. Zhao, and L. Guo, "An inventory model for deteriorating drugs with stochastic lead time," Int. J. Environ. Res. Public Health, vol. 15, no. 12, Dec. 2018, doi: 10.3390/ijerph15122772.

[16] E. Saha and P. K. Ray, "Modelling and analysis of inventory management systems in healthcare: A review and reflections," Comput. Ind. Eng., vol. 137, p. 106051, Nov. 2019, doi: 10.1016/j.cie.2019.106051.

[17] S. P. Sethi and R. Shi, "Managing with incomplete inventory information (i3)," in IFAC Proceedings Volumes (IFAC-PapersOnline), Jan. 2013, vol. 46, no. 9, pp. 1–6. doi: 10.3182/20130619-3-RU-3018.00636.

[18] L. I. Figueroa Geraldino, M. J. Wilches Arango, D. Romero, and S. Aguirre, "Análisis de la Logística Hospitalaria aplicada en las Entidades de Salud de Nivel 3 y 4 en la ciudad de Barranquilla," Sci. Tech., vol. 21, no. 4, p. 307, Dec. 2016, doi: 10.22517/23447214.11391.

[19] E. V. Gutiérrez, O. D. Galvis, D. A. López, J. S. Mock-Kow, I. Zapata, and C. J. Vidal, "Gestión logística en la prestación de servicios de hospitalización domiciliaria en el Valle del Cauca: caracterización y diagnóstico," Estud. Gerenciales, vol. 30, no. 133, pp. 441–450, 2014, doi: 10.1016/j.estger.2014.06.004.

[20] D. H. R. Parrales, K. L. V. Bailón, C. E. Z. Andrade, and G. G. T. Quijije, "El inventario: como herramienta de utilidad en el laboratorio clínico The inventory: as a useful tool in the clinical laborator."
https://webcache.googleusercontent.com/search?q=cache:ulF7mjzJEK4J:https://dialnet.unirioja.es/descarga/articulo/8383851.pdf+&cd=1&hl=es&ct=clnk&gl=co (accessed Jun. 09, 2022).

[21] T. Fontalvo-Herrera, E. De-la-Hoz-Granadillo, and A. Mendoza-Mendoza, "Los Procesos Logísticos y La Administración de la Cadena de Suministro.," Saber, Cienc. y Lib., vol. 14, no. 2, Dec. 2019, doi: 10.18041/2382-3240/saber.2019v14n2.5880.

[22] N. M. Delicado Teixeira, "La contribución de los sistemas de control de gestión para el éxito empresarial," Cuad. Contab., vol. 15, no. 39, pp. 853–881, Dec. 2014, doi: 10.11144/javeriana.cc15-39.cscg.

[23] N. D. Silva Álvarez, D. Peña Suarez, G. R. Navas Espín, and G. D. Kaisar Chuinda, "Las nuevas tecnologías aplicadas al control de inventarios en la Cruz Roja de Pastaza.," Dilemas Contemp. Educ. Política y Valores, vol. 9, no. SPE1, Oct. 2021, doi: 10.46377/dilemas.v9i.3028.

[24] M. R. Holm, M. I. Rudis, and J. W. Wilson, "Medication supply chain management through implementation of a hospital pharmacy computerized inventory program in Haiti," Glob.

Health Action, vol. 8, no. 1, 2015, doi: 10.3402/gha.v8.26546.

[25] C. Bialas, A. Revanoglou, and V. Manthou, "Improving hospital pharmacy inventory management using data segmentation," Am. J. Heal. Pharm., vol. 77, no. 5, pp. 371–377, Mar. 2020, doi: 10.1093/ajhp/zxz264.

[26] A. Azzi, A. Persona, F. Sgarbossa, and M. Bonin, "Drug inventory management and distribution: outsourcing logistics to third□party providers," Strateg. Outsourcing An Int. J., vol. 6, no. 1, pp. 48–64, Feb. 2013, doi: 10.1108/17538291311316063.

[27] I. Lopes Martínez, M. Gómez Acosta, and A. Acevedo Suárez, "Situación de la gestión de inventarios en Cuba," Ing. Ind., vol. XXXIII, no. 3, pp. 317–330, 2012, Accessed: Jun. 06, 2022. [Online]. Available: https://www.redalyc.org/articulo.oa?id=360433581011

[28] M. K. M. Nasution, S. Azman, M. Noah, and U. Harahap, "Overview of The Pharmacy Management System in a Hospital," Syst. Rev. Pharm., vol. 11, no. 11, pp. 650–655, 2020.

[29] D. Wu, M. D. Rossetti, and J. E. Tepper, "Possibility of Inventory Pooling in China's public hospital and appraisal about its performance," Appl. Math. Model., vol. 39, no. 23–24, pp. 7277–7290, Dec. 2013, doi: 10.1016/j.apm.2015.02.042.

[30] A. Romero, "Managing Medicines in the Hospital Pharmacy: Logistics Inefficiencies ," 2013. http://www.iaeng.org/publication/WCECS2013/WCECS2013_pp1120-1125.pdf (accessed Jun. 01, 2022).

[31] M. Gebicki, E. Mooney, S. J. (Gary) Chen, and L. M. Mazur, "Evaluation of hospital medication inventory policies," Heal. Care Manag. Sci. 2013 173, vol. 17, no. 3, pp. 215–229, Sep. 2013, doi: 10.1007/S10729-013-9251-1.

[32] B. Sarkar and S. Sarkar, "Variable deterioration and demand-An inventory model," Econ. Model., vol. 31, no. 1, pp. 548–556, Mar. 2013, doi: 10.1016/j.econmod.2012.11.045.

[33] K. F. See, N. Md Hamzah, and M. M. Yu, "Metafrontier efficiency analysis for hospital pharmacy services using dynamic network DEA framework," Socioecon. Plann. Sci., vol. 78, Dec. 2021, doi: 10.1016/j.seps.2021.101044.

[34] S. Saedi, O. Erhun Kundakcioglu, and A. C. Henry, "Mitigating the impact of drug shortages for a healthcare facility: An inventory management approach," Eur. J. Oper. Res., vol. 251, no. 1, pp. 107–123, May 2016, doi: 10.1016/j.ejor.2015.11.017.

[35] P. Cappanera, M. Nonato, and R. Rossi, "Stakeholder involvement in drug inventory policies," Oper. Res. Heal. Care, vol. 23, p. 100188, Dec. 2019, doi: 10.1016/j.orhc.2019.100188.

[36] K. Paredes, "EVALUACIÓN DE LA SITUACIÓN DE LOS INVENTARIOS Y APLICACIÓN DE UN MODELO DE GESTIÓN DE LA FARMACIA INSTITUCIONAL DE UNA INSTITUCIÓN DE SALUD ESTATAL DE TERCER NIVEL DE GUAYAQUIL," 2020. Accessed: Jun. 06, 2022. [Online]. Available: http://repositorio.ucsg.edu.ec/handle/3317/15410

[37] I. Jurado et al., "Stock management in hospital pharmacy using chance-constrained model

predictive control," Comput. Biol. Med., vol. 72, pp. 248–255, May 2016, doi: 10.1016/j.compbiomed.2015.11.011.

[38] S. Priyan and R. Uthayakumar, "Optimal inventory management strategies for pharmaceutical company and hospital supply chain in a fuzzy-stochastic environment," Oper. Res. Heal. Care, vol. 3, no. 4, pp. 177–190, Dec. 2014, doi: 10.1016/j.orhc.2014.08.001.

[39] Afnaria, Tulus, H. Mawengkang, and Wiryanto, "An optimization model for hospitals inventory management in pharmaceutical supply chain," Syst. Rev. Pharm., vol. 11, no. 3, pp. 324–332, 2020, doi: 10.5530/srp.2020.3.38.

[40] A. L. Kjos, N. T. Binh, C. Robertson, and J. Rovers, "A drug procurement, storage and distribution model in public hospitals in a developing country," Res. Soc. Adm. Pharm., vol. 12, no. 3, pp. 371–383, May 2016, doi: 10.1016/j.sapharm.2015.07.007.

[41] X. L. Hua et al., "Pharmacy administration and pharmaceutical care practice in a module hospital during the COVID-19 epidemic," J. Am. Pharm. Assoc., vol. 60, no. 3, pp. 431-438.e1, May 2020, doi: 10.1016/j.japh.2020.04.006.

[42] M. I. Fernandez, P. Chanfreut, I. Jurado, and J. M. Maestre, "A Data-Based Model Predictive Decision Support System for Inventory Management in Hospitals," IEEE J. Biomed. Heal. Informatics, vol. 25, no. 6, pp. 2227–2236, Jun. 2021, doi: 10.1109/JBHI.2020.3039692.

[43] J. M. Maestre, M. I. Fernández, and I. Jurado, "An application of economic model predictive control to inventory management in hospitals," Control Eng. Pract., vol. 71, pp. 120–128, Feb. 2018, doi: 10.1016/j.conengprac.2017.10.012.

[44] N. Tsolakis and J. S. Srai, "Inventory planning and control in 'green' pharmacies supply chains – A System Dynamics modelling perspective," in Computer Aided Chemical Engineering, vol. 40, Elsevier, 2017, pp. 1285–1290. doi: 10.1016/B978-0-444-63965-3.50216-6.

[45] C. del P. Faune Pinto, "Rediseño de la gestión del stock de medicamentos de la farmacia de un hospital público," 2016, Accessed: Jun. 06, 2022. [Online]. Available: https://repositorio.uchile.cl/handle/2250/140397

[46] Z. Dai, K. Gao, and B. C. Giri, "A hybrid heuristic algorithm for cyclic inventory-routing problem with perishable products in VMI supply chain," Expert Syst. Appl., vol. 153, p. 113322, Sep. 2020, doi: 10.1016/j.eswa.2020.113322.

[47] A. Gurumurthy, V. K. Nair, and S. Vinodh, "Application of a hybrid selective inventory control technique in a hospital: a precursor for inventory reduction through lean thinking," TQM J., vol. 33, no. 3, pp. 568–595, 2020, doi: 10.1108/TQM-06-2020-0123.

[48] I. Saracoglu, S. Topaloglu, and T. Keskinturk, "A genetic algorithm approach for multi-product multi-period continuous review inventory models," Expert Syst. Appl., vol. 41, no. 18, pp. 8189–8202, Dec. 2014, doi: 10.1016/j.eswa.2014.07.003.

[49] G. Stecca, I. Baffo, and T. Kaihara, "Design and operation of strategic inventory control system for drug delivery in healthcare industry," in IFAC-PapersOnLine, Jan. 2016, vol. 49, no. 12, pp.

904–909. doi: 10.1016/j.ifacol.2016.07.890.

[50] C. J. Solano Payares, D. A. García Barrios, A. Mendoza Mendoza, and D. A. Palencia Castro, "Modelos de inventario administrado por el Vendedor (VMI): Síntesis de investigación 2012-2017.," Rev. EIA, vol. 17, no. 34, pp. 1–21, Oct. 2020, doi: 10.24050/reia.v17i34.1358.

[51] "La aplicación del Control Simultáneo en el manejo de los inventarios del Hospital Nacional Arzobispo Loayza en el distrito de Lima en el año 2019," 2019, Accessed: Jun. 06, 2022. [Online]. Available: https://repositorio.utp.edu.pe/handle/20.500.12867/3326

[52] J. M. Maestre et al., "An application of chance-constrained model predictive control to inventory management in Hospitalary Pharmacy," in Proceedings of the IEEE Conference on Decision and Control, 2014, vol. 2015-Febru, no. February, pp. 5901–5906. doi: 10.1109/CDC.2014.7040313.

[53] R. A. Gómez, F. Salazar, and N. Rincón, "Metaheuristics for solving the routing problem of collecting leftover medicines and supplies in hospitals," Inf. Tecnol., vol. 30, no. 2, pp. 303–314, Mar. 2019, doi: 10.4067/S0718-07642019000200303.

[54] R. Haijema, "Optimal ordering, issuance and disposal policies for inventory management of perishable products," in International Journal of Production Economics, Nov. 2014, vol. 157, no. 1, pp. 158–169. doi: 10.1016/j.ijpe.2014.06.014.

[55] A. Muluk, Jonrinaldi, and F. M. Asri, "A proposed policy of medication inventory system in pharmacy installation (case study in Semen Padang Hospital)," in AIP Conference Proceedings, Apr. 2020, vol. 2217, no. 1, p. 030179. doi: 10.1063/5.0000714.

[56] J. P. Zamora Aguas, W. Adarme Jaimes, and E. P. Vanegas Escamilla, "COORDINACIÓN EN REDES DE SUMINISTRO DE MEDICAMENTOS. CASO APLICADO AL SECTOR SALUD COLOMBIANO," Rev. EIA, vol. 13, no. 25, pp. 171–183, 2016, doi: 10.24050/reia.v13i25.1025.

## Appendix A. An example appendix

Authors including an appendix section should do so after References section. Multiple appendices should all have headings in the style used above. They will automatically be ordered A, B, C etc.

A.1. Example of a sub-heading within an appendix

There is also the option to include a subheading within the Appendix if you wish.

Makalenin Türkçe başlığı buraya yazılır….

**Özet**

Türkçe özet.

Anahtar sözcükler: anahtar sözcükler1; anahtar sözcükler2; anahtar sözcükler3

**AUTHOR BIODATA**

Insert here author biodata**.**