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BETWEEN VULNERABILITY AND ACTION: AN OPERATIONAL VIEW OF PHARMACEUTICAL RESILIENCE IN VENEZUELA

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Abstract

In contexts of high operational uncertainty, such as Venezuela, where logistical, regulatory, and operational disruptions directly affect the continuity of drug supply, resilience in the pharmaceutical supply chain becomes a decisive factor in ensuring continuous access to medicines. This article presents a study based on two key strategies: the concept of Minimum Viable Personnel (MVP), inspired by the Lean Startup methodology, and the implementation of the Reorder Point under a Just-in-Case (JIC) approach. Both strategies were validated through dynamic simulation using Arena Simulation software, based on real data collected from three Venezuelan pharmaceutical laboratories.

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The methodology combined qualitative analysis based on semi-structured interviews with industry executives and quantitative analysis through simulations of operational flows with and without implementation of the proposed strategies. The results showed a 14% improvement in orders processed and a reduction of more than 65% in failures due to environmental conditions, attributable to better inventory planning and more efficient staffing.

The findings validate that, even with limited resources, the correct identification of critical roles and advance replenishment planning can significantly strengthen operational continuity. It is concluded that these strategies are applicable and scalable to similar environments and constitute a concrete basis for future resilience policies in the Latin American pharmaceutical industry.

Sustainable Development Goal(s) (SDG) to which the research work is directed

8. DECENT WORK AND ECONOMIC GROWTH

Description
Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.

Relationship
The proposal for a resilient supply chain in the pharmaceutical industry would provide greater operational stability, increasing production and contributing to sustainable economic growth.

Direct Objective

9. INDUSTRY INNOVATION AND INFRASTRUCTURE

Description
Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

Relationship
The proposal for a resilient supply chain would introduce innovative practices in the pharmaceutical sector, fostering a robust and adaptable infrastructure.

Direct Objective

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Problem statement

The pharmaceutical industry has undergone a variety of changes in the course of the pandemic and post-pandemic historical context (De Oliveira, 2022). According to Kohlmann (2021), the pandemic drove the growth and development of the pharmaceutical industry in record time, increasing investment by 4.4% compared to previous years, despite the contraction of the global economy. This allowed for a rapid response in clinical development and research to combat COVID-19.

Faced with this, many pharmaceutical companies were forced to face various challenges (regulatory changes, shortages of raw materials, among others) in order to adapt to changing situations and bring their products to international markets quickly (Interempresas, 2022).

Designing a resilient supply chain has become a fundamental role, not only for humanitarian crises but also for daily market changes, giving companies that adopt such a design the ability to adapt and recover quickly, safely, and efficiently (Tukamuhabwa et al., 2015). The design and implementation of this model requires the analysis of various factors, such as: good practices and efficient inventory management, good suppliers, the use of robust, up-to-date information systems, and active response to changing demand (Schaab, 2018). Given the nature of pharmaceutical companies, Watson (2020) and Anderson (2019) affirm the importance, as well as the need, to build resilience in supply chains in the pharmaceutical industry.

This research project set out to design and develop strategies to strengthen the resilience of the pharmaceutical supply chain in Venezuela. This was achieved by analyzing international best practices and adapting these strategies to the Venezuelan context in order to mitigate potential disruptions and increase opportunities, providing a theoretical and practical framework that can be used by laboratories nationwide.

Pharmaceutical Sector

The pharmaceutical sector is a key industry dedicated to the research, production, distribution, and marketing of medicines and supplies for the prevention, treatment, and cure of diseases. It ranges from the manufacture of active ingredients and generic drugs to the development of innovative and biotechnological drugs. It also includes the production of medical supplies

and healthcare products, such as vaccines, antibiotics, and specialized treatments for various pathologies (Araja, 2023).

Resilience in the supply chain

A supply chain can be defined as "a dynamic and interconnected system that encompasses all organizations, activities, information, and resources directly or indirectly involved in creating and delivering value to the end customer" (Mentzer et al., 2001).

Resilience in supply chains is defined as the ability to anticipate, adapt, and recover from disruptions that could compromise the continuous flow of products and services (Ponomarov and Holcomb, 2009). In the pharmaceutical sector, this ability is critically important, as any disruption can affect the availability of essential medicines, directly impacting public health.

Models such as that of Christopher and Peck (2004) establish that resilience is based on four principles: visibility, flexibility, collaboration, and a culture of risk control. For his part, Sheffi (2005) highlights the importance of redundant capabilities, supplier diversification, and collaborative planning as mitigation mechanisms for disruptive events.

WHO Report 37 on Good Manufacturing Practices

Good manufacturing practices (GMP) are technical guidelines for a quality management system that ensures that products are consistently produced and controlled according to quality standards appropriate for their intended use and as required by marketing authorization. The main objective of GMP is to reduce the risks inherent in any pharmaceutical production, which can be classified into two groups: cross-contamination/confusion and mislabeling. Above all, manufacturers must not put patients at risk due to inadequate safety, quality, or efficacy. (World Health Organization, 2024)

ISO 9001:2015 Standard

According to the International Organization for Standardization (2015), the ISO 9001:2015 standard promotes a process-based approach, in which the organization must identify, control, and continuously improve the interactions between the different elements of its production system. This standard emphasizes risk management, continuous improvement, and customer satisfaction as the core of any quality system.

Reorder Point (ROP)

The Reorder Point (ROP) is the inventory level at which a new purchase order must be generated to avoid shortages during the supplier's delivery time (Zoho, 2024). Its basic calculation considers average daily demand and lead time, but to strengthen resilience, a safety stock is included to cover unexpected variations in demand or delivery delays (ShipBob, 2025).

Lean Startup

The *Lean Startup* methodology is an agile approach to product and business development that emphasizes rapid experimentation, validated learning, and waste minimization. Although it was popularized by Eric Ries in 2011, its application has evolved and been integrated into various industries beyond the realm of tech startups. This methodology proposes quickly launching a Minimum Viable Product (MVP) to the market to obtain early feedback from users, allowing for continuous iterations and adaptations based on real data. In this way, it seeks to reduce risks, optimize resources, and increase the chances of success in highly uncertain environments. (Ries, 2011)

Minimum Viable Personnel

Although the term *Minimum Viable Team* (MVT) is not formally recognized in academic literature on human talent management, its concept derives from the *Lean Startup* philosophy and the well-known Minimum Viable Product (MVP). The MVP, introduced by Ries (2011), refers to the simplest version of a product that allows for the maximum validated learning about the market to be gathered with the least possible effort (Van der Geest, 2019).

Applying this principle to the field of team management gives rise to the notion of Minimum Viable Personnel (MVP), also known as *Minimum Viable Team* (MVT). This approach seeks to identify the smallest group of professionals who, due to their critical skills, are capable of keeping an organization's essential functions operational, especially in situations of high uncertainty, operational crisis, or resource scarcity.

The application of MVT is particularly relevant in environments such as the pharmaceutical supply chain, where operational continuity and the availability of key talent are determining factors for organizational resilience. Implementing this strategy allows for the optimization of resources, the preservation of essential capabilities, and a more agile recovery from disruptions.

Population and sample

According to data provided by the Chamber of the Pharmaceutical Industry (CIFAR), there are currently around 120 companies operating in the pharmaceutical sector in Venezuela, of which around 30 represent the most active industrial core in terms of manufacturing and marketing. The three companies selected in this research—two national and one multinational—account for around 11.69% of the Venezuelan market.

The study population consisted of companies in the pharmaceutical sector in Venezuela, specifically laboratories with operational headquarters in the city of Caracas. For the selection of the sample, a non-probabilistic, intentional sampling method was applied, aimed at obtaining qualitative information from representatives with proven experience and direct responsibility for strategic decision-making within the supply chain.

Information collection technique

To prepare this research paper, qualitative and quantitative data were first collected directly from a meeting with representatives of the Chamber of the Pharmaceutical Industry (CIFAR), where it was possible to obtain a first impression of the current situation facing the sector, both in terms of risks and growth in recent years. Subsequently, a series of semi-structured interviews (see Appendix A) were conducted with various experts in the pharmaceutical sector to analyze in depth the current situation and context of the sector's supply chain, as well as the possible risks and obstacles that these companies may face. Finally, data was collected on the strategies that these companies can take to mitigate the identified risks.

Scope of the study

This research focused on analyzing the vulnerability of the active pharmaceutical ingredient (API) supply chain in at least three (3) pharmaceutical companies located in Caracas, Venezuela, with the aim of designing strategies to strengthen their resilience. The analysis of these companies' suppliers, inventory management, and risk management systems was examined in depth.

The main challenges faced by these companies in ensuring a continuous supply of raw materials in the Venezuelan context were identified. The results of this study made it possible to propose a set of recommendations to improve the supply chain (SC) with a resilient approach for the Venezuelan pharmaceutical industry.

This research project lasted 12 weeks, from November 2024 to January 2025.

Results and Discussion of Results

Current situation of pharmaceutical supply chains in Venezuela

According to information provided by the president of the Chamber of the Pharmaceutical Industry (CIFAR), T. López (personal communication, January 2025), domestic drug production reached 196 million units at the end of 2022, representing a 14% increase over the previous year. Although this growth has been interpreted as a sign of recovery in the sector, the CIFAR representative himself clarifies that it is a breath of fresh air, but does not yet reflect the production levels expected for a stable and fully operational industry.

The sector has experienced a sharp contraction in the last decade: currently, around 2,200 companies remain active, a figure considerably lower than the more than 13,000 that were operating ten years ago. However, projections for 2025 are moderately optimistic, with estimates of sustained growth between 6% and 8% per year, backed by four consecutive years of positive balance sheets, according to CIFAR (T. López, personal communication, January 2025).

In terms of supply, domestic production in 2024 accounted for approximately 72% of the total market, while the rest was covered by imports. However, production self-sufficiency is partial, as most raw materials—particularly active pharmaceutical ingredients (APIs)—continue to be imported, mainly from Asia and South America. The only significant exceptions to this external dependence are basic inputs such as caustic soda and some secondary packaging, which are produced locally.

Despite these challenges, the pharmaceutical sector has been classified as a priority industry at the national level, which grants it certain differentiated benefits, especially in terms of access to electricity and diesel fuel supplies, as well as tariff exemptions and reductions, which are critical inputs for ensuring the operational continuity of industrial processes.

In addition, all laboratories in the country are required to comply with strict technical regulations, including compliance with Good Manufacturing Practices as stipulated in Report 37 of the World Health Organization (WHO), which establishes criteria for quality, hygiene, and traceability in the manufacture of pharmaceutical products (QbD Group, 2024). They must also adhere to industry-specific ISO standards, which represents a significant technical requirement for laboratories operating with limited resources or infrastructure.

As for suppliers, access to inputs is conditioned by multiple factors. On the one hand, international economic sanctions have restricted import routes and limited transactions with parent companies, especially when it comes to medicines containing controlled or sensitive active ingredients. This forces laboratories to plan their demand precisely, as the national supplier must coordinate directly with the international manufacturer to ensure supply within the required timeframes.

Interview results

In order to accurately characterize the operations of the national pharmaceutical sector and assess its ability to respond to disruptions, semi-structured interviews were conducted with key representatives of three pharmaceutical laboratories. Based on the analysis of the interviews, the main elements that shape the current functioning of their supply chains were identified.

This pattern reflects current practices in supplier, inventory, and risk management, highlighting both strengths and weaknesses that condition their operational resilience.

1. Supplier management

One of the main challenges observed is related to the dependence on international suppliers for the procurement of active ingredients and critical inputs such as excipients, primary packaging, and formulation materials, whose approval is regulated by the *Rafael Rangel* National Institute of Hygiene (INHRR). This requirement, although necessary to ensure health quality, limits the agility to incorporate new suppliers, affecting the capacity for diversification and response to disruptions.

Laboratories A and B have implemented supplier evaluation and rating mechanisms based on internal audits, quality criteria, response time, payment terms, and regulatory compliance. There is an effort to develop stable commercial relationships that, in some cases, allow access to credit terms, partially overcoming the generalized requirement for advance payments, conditioned by country risk. On the other hand, laboratory C, as part of a transnational corporation, has a network of suppliers assigned by its parent company, which facilitates access to quality inputs.

Suppliers are selected based on cost, delivery capacity, and product stability. This criterion was common to all three laboratories analyzed, although the level of formalization varied according to the availability of management systems and operational autonomy.

In the case of Laboratory A, two to three suppliers are used for each strategic input, allowing some leeway in purchasing and production planning. Comparative analyses of quotes are also carried out, integrating demand *forecasts* to prioritize decisions.

2. Inventory management

Inventory management combines made-to-order production models and planned storage based on annual demand projections. Different strategies are evident depending on the type of input: while raw materials for suspensions are stored for up to one year, primary and secondary packaging materials are kept with projections of up to six months in laboratories A and B. In the case of laboratory C, an inventory policy of more than three months is applied.

The laboratories adopt a *Just-in-Case* approach, prioritizing inventory availability over storage cost optimization, which is justified by the logistical and regulatory limitations of the environment. In this sense, budget is sacrificed to ensure operational continuity and avoid production interruptions.

Information systems play an important role in inventory management. Laboratories A and B use the SCALA system, although with different levels of integration. Laboratory A has limitations in terms of interconnection between departments and automated updating of requirements, so it resorts to the use of complementary tools such as *Excel, Power BI*, and *Power Query.* Despite this, there is evidence of traceability in transactions and *stock* control through cyclical counts and monitoring of key performance indicators (KPIs).

On the other hand, laboratory C uses more advanced systems such as *SAP IBP*, which performs multiple demand forecasting scenarios automatically and allows for more efficient communication between the purchasing, production, and marketing departments.

Batch planning, the use of master formulas, cycle counting, and traceability of logistics processes are other common practices among laboratories. However, some weaknesses are still identified in safety stock management, indicator standardization, and effective synchronization between critical areas of the laboratories.

3. Risk management

The main threats identified include power failures, limitations in the availability of drinking water, operational risks derived from the physical environment (rain, sector security), and logistical difficulties for imports. In response to these risks, certain contingency mechanisms have been established, such as planning adjusted to the weekly schedule to avoid interruptions due to power outages, the use of power generators, and direct coordination with government entities to ensure the provision of basic services.

Laboratory C has a structured contingency plan, with monthly analysis of products at risk, energy and telecommunications protocols, packaging diversification strategies, among other strategies. In the case of Laboratory B, there is an emergency plan for the liquid product filling process, in addition to the implementation of environmental controls in warehouses, including temperature and humidity monitoring in Laboratory A. However, there is no report of a structured response plan for failures in environmental conditions.

All organizations recognize the importance of continuous staff training as a cornerstone of operational resilience. Annual training plans have been established in accordance with Good Manufacturing Practices (GMP) and WHO regulations, although with varying degrees of effectiveness. In Laboratory A, updates are implemented progressively and with formal evaluations that measure the level of knowledge acquisition by staff; however, training is not a formal standard of the corporation.

4. Exchange rate variability

In the Venezuelan context, high exchange rate variability is one of the main factors of uncertainty for pharmaceutical companies when purchasing imported raw materials, especially active pharmaceutical ingredients (APIs). The volatility of the official exchange rate, coupled with the existence of multiple rates and restrictions on access to foreign currency, forces organizations to implement financial triangulation mechanisms to guarantee purchases. In many cases, these operations involve the use of parent companies or international intermediaries with dollar accounts abroad, thus facilitating the channeling of payments to Asian or South American suppliers. Additionally, some companies resort to commercial credit lines, prepayments, or short-term financing backed by strategic alliances to mitigate exchange rate risk and ensure operational continuity in environments of high economic distortion.

5. Operational flow and organizational structure

The identified operational pattern involves a decentralized structure, in which each department partially manages its inventory, but with centralized coordination through general warehouses. This dynamic is complemented by monthly planning meetings and collaborative decisions between areas to adjust purchasing and production plans. The flow of materials includes reception under prior alert, document verification, and qualitative evaluation of the supplier at the point of entry.

The information system, although digitized, has different levels of integration. In laboratory C, the synchronization of the operational modules is robust, while in the other two (2) cases, manual data cleansing and analysis processes are still required. Even so, effective traceability of operations is maintained, especially in terms of inventory turnover, dispatch control, and compliance with storage conditions. The absence of SKUs on finished products and the need to improve report standardization represent clear opportunities for improvement.

Analysis of Successful Cases

Table 1

Key success factors of the case studies analyzed

	1. Technology Management and Digital Transformation	2. Operational Optimization and Production Efficiency	3. Human Capital Development and Collaboration	4. Risk Management and Operational Resilience	5. Regulatory Compliance and Ethical Sustainability
Grand River Aseptic Manufacturing	• Expansion of production capacity. • Implementation of the VarioSys system.	• Redesign of internal processes to minimize wait times and maximize productivity.	• Ongoing training programs focused on critical technologies and processes.	• Establishment of rigorous monitoring and maintenance protocols.	• Incorporation of environmental monitoring and continuous validation systems to ensure product integrity.
Amerisource Bergen	• Robust data analysis using advanced analytical tools. • Investment in information technologies.	• Strategic inventory management by implementing real-time control and tracking systems.	• Training programs on regulatory compliance and supply chain management.	• Contingency planning (design of response plans for crisis scenarios).	• Sustainability initiatives to reduce waste and emissions in the supply chain.
REVIEW ON PHARMACEUTICAL SUPPLY CHAIN RESILIENCE: STRATEGIES FOR MANAGING DISRUPTIONS AND ENSURING	• Integrated digital technologies (IoT and Big Data; AI and Blockchain).	• Diversification and strategic redundancy (multiple suppliers and geographically distributed production plants). • JIT–JIC balance by defining optimal safety stock levels.	• Formal early warning protocols and crisis committees involving suppliers, logistics operators, and regulators.	• Systematic mapping of internal and external vulnerabilities (geopolitical, logistical, technological) using tools such as SWOT and FMEA to guide investments and contingencies.	• Regulatory agility through permanent dialogue channels. • Environmental and social criteria in the selection of suppliers.

Risks in the supply chain of the current Venezuelan pharmaceutical industry

Before defining strategies for supply chain design, a Supply Chain Risk Management (SCRM) process was carried out. This process involved a comprehensive assessment of both internal and external threats present in supplier management, inventory management, and risk management. The objective was to determine the relevance of each risk and then develop

and implement actions that could mitigate the most critical ones. A well-implemented SCRM is essential for strengthening supplier relationships, preventing bottlenecks, and ensuring operations that are both responsible and ethical. In essence, it provides a robust contingency plan to deal with as many supply disruptions as possible (Stinson, 2024). To carry out this assessment, a multi-criteria matrix was used to objectively weigh the criticality of each risk, based on its probability of occurrence and the severity of its impact.

Table 2

Identified risks.

Risk	Description	Stage in the supply chain	Source
1) Lack of formal safety stock	There is no buffer against delays in supplies or peaks in demand. This compromises operational continuity.	Supply, Planning, and Inventory	(Sanket & Ankitkumar, 2024)
2) ERP systems not integrated across areas	Data fragmentation and task duplication weaken operational efficiency, increasing the risk of obsolescence or inventory shortages.	Planning and Inventories	Ownership
3) Decentralized inventory management between departments	Lack of coordination can lead to overstocking in some sectors and shortages in others. It hinders information consolidation and logistical efficiency.	Planning and Inventories	Own authorship
4) Staff training with limited or uneven scope	Low response capacity in emergencies, operational errors, non-compliance with BPM standards, and reduced overall system efficiency.	Supply, Planning, and Inventory	Own authorship

Selection and proposal of strategies for a resilient supply chain model for the Venezuelan pharmaceutical industry

Based on the risks identified and weighted in the matrix, it was possible to analyze possible solutions for building a resilient supply chain that ensures good supplier management, good inventory management, and good risk management. In this context, the strategies implemented in the simulated model of a resilient supply chain are detailed below. This information served as the basis for a *benchmarking* exercise*,* allowing both simulations to be compared in terms of their efficiency, with the aim of designing and proposing an efficient supply chain that ensures the operational continuity of the industry.

Proposals to create a resilient supply chain that guarantees efficiency and operational continuity in supplier management, inventory management, and risk management:

1. *Formal safety stocks*

- Mitigated risks: absence of formal safety stocks

Explanation: proposes the definition and parameterization of minimum inventory levels for strategic inputs, covering:

- Implementation of the *Just-in-Case* (JIC) methodology, which prioritizes stock availability in the face of external disruptions. Taking into account maintaining a balance with *Just-in-Time* (JIT).
- Establish *stock* levels considering variables such as average demand, consumption variability, and replenishment time.
- Integrating these levels into the ERP system through automatic reorder point (ROP) alerts.
- Periodically evaluate and adjust these parameters based on operational data.
- *Minimum viable personnel*
- Mitigated risks: training of personnel with limited or uneven reach.

Explanation: Proposes the implementation of a Minimum Viable Staff (MVS) culture focused on optimizing essential human talent within the warehouse to ensure the continuity and adaptability of critical operations, including:

- Implementation of training programs in versatility and cross-skills oriented toward the curriculum design of critical roles, planned job rotation, and the development of detailed standard operating procedures (SOPs).
- Adoption of enabling technologies for Minimum Viable Staff (MVS) efficiency and training in data analysis tools.
- Development of contingency protocols and crisis simulation focused on the development of specific Business Continuity Plans (BCPs) for the warehouse.
- Establishment of an Emergency Communication System.

Validation of the proposed model through simulation

To evaluate the impact of Minimum Viable Staff (MVS) and reorder point strategies under the Just-in-Case (JIC) methodology, two operational models were developed using Arena Simulation software: one based on current operations reported by the laboratories interviewed, and another incorporating the proposed strategies.

The simulation was run over a 120-day time horizon, with 30 replicates per scenario. Variables such as supplier response time, inventory availability, critical operator utilization, and the occurrence of environmental failures affecting storage were modeled. Based on this data, the two systems were compared using key operational metrics.

Table 3

Simulation results

Indicator	Normal Model	Resilient Model
Orders entered (Average)	119.26	123.30
Orders completed (Average)	100.93	115.23
Operator usage (Average number of times required)	14.63	24.17
Operator utilization (%)	93.16	43.09

The results show that the resilient model managed to process 14% more orders on average, attributable to the anticipation generated by the reorder point and inventory stability. As for the PMV operator, although it was required more often than in the traditional model, its average occupancy level was significantly lower (43.09% vs. 93.16%), suggesting greater efficiency, less overload, and a more intelligent distribution of critical tasks in the warehousing process.

These results validate the effectiveness of both strategies in terms of efficiency, operational continuity, and logistics risk mitigation.

Operationality of the proposed model

The application of the proposed resilient supply chain model requires a clear operational roadmap to facilitate its integration into the current dynamics of the Venezuelan pharmaceutical sector. This model is not designed as a single, rigid solution, but as a scalable platform that can

be adjusted to the degree of operational and technological maturity of each company. Below is a phased operational plan.

Phase 1: Training of critical personnel

A specialized training program should be developed, focusing on the principles of resilience, Just-in-Case methodologies, risk-based planning, and technologies associated with the Internet of Things (IoT). This will allow the technical team to understand the functioning and benefits of the model before its implementation.

Phase 2: Modular implementation of the model

It is recommended to implement the model in functional blocks, starting with procurement and storage in order to automate reorder points (ROP), replenishment alerts, and supplier evaluation. This should be followed by operational risks through scenario simulation and the definition of emergency protocols. This modular approach allows implementation without halting operations, validating results at each stage.

Conclusions

The research validated, through operational simulation, the effectiveness of two key strategies for strengthening the resilience of the pharmaceutical supply chain in highly vulnerable contexts: the implementation of the Minimum Viable Staff (MVS) concept and reorder point (ROP) planning under the Just-in-Case (JIC) approach.

Both strategies, applied to the storage and supply process, demonstrated positive impacts on operational efficiency and stability. Advance planning using ROP made it possible to maintain a continuous flow of inventory, avoiding production interruptions due to depletion of supplies. Meanwhile, the strategic allocation of human talent based on criteria of versatility and functional criticality (specific to the MMS approach) optimized the use of essential personnel, reducing their average occupancy level without sacrificing performance.

The simulated resilient model managed to process 14% more orders than the traditional model, demonstrating that, even in conditions of limited resources, it is possible to achieve significant improvements in operational continuity through low-cost, high-impact tactical decisions.

These strategies, due to their modular and adaptable nature, can be progressively scaled up by companies in the sector without requiring structural transformations. Their adoption represents a practical way to reduce logistical vulnerabilities in environments with high exposure to regulatory, financial, or supply risks.

Finally, it is recommended that future research delve deeper into the combination of these strategies with emerging digital tools and their application in other links of the chain to extend their impact.

Recommendations

The Minimum Viable Staff strategy, considered as part of operational continuity in the face of disruptive events, must be addressed individually by each laboratory. It is suggested that an internal analysis be carried out to identify the critical roles and competencies necessary to maintain essential functions during an interruption. This exercise should be accompanied by cross-training plans, tactical redistribution of responsibilities, and drills to validate the effectiveness of the strategy in real conditions.

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