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IMPACT OF INNOVATION MANAGEMENT THROUGH THE USE OF INFORMATION TECHNOLOGY AND INDUSTRY 4.0 RESOURCES, FOR THE DEVELOPMENT OF PRODUCTIVITY, ASSESSED BY LOGISTICS PERFORMANCE INDICATORS *(KPIs)*

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SUMMARY:

Understanding the applicability of Innovation Management in corporate logistics and its practical effects in terms of Information Technology and new technological trends demonstrates that productivity is directly optimized and results in evaluation processes using Logistics Performance Indicators *(KPIs)* for logistics decision-making across the production chain. Therefore, technology resulting from innovation strategies assertively supports logistics planning, which impacts the dynamism and fluidity of logistics sectors and service levels, developing a network of connections that direct productivity toward achieving organizational efficiency objectives in relation to the demands of the globalized market and increased profitability. Thus, establishing relationships between the technological structures of logistics sectors, production processes, and *KPI* assessment demonstrates how Innovation Management operates within an organization. This research was formulated using a qualitative approach to the variables studied with an explanatory objective, investigating the relationships between the main themes involved and establishing interpretations and conclusions based on the study's foundation. Statistical data and the development of tables were used to understand the topics discussed, directing the content to the intended purpose. Therefore, it was revealed that establishing cohesion between the aspects of innovation management for technology development and its direct uses significantly increases the productivity of logistics sectors, while evaluating the results also represents positive aspects for logistics decision-making.

Keywords: Innovation; Technology; Logistics; Productivity; Performance.

ABSTRACT:

Understanding the applicability of innovation management in corporate logistics and its practical effects in terms of information technology and new technological trends shows that productivity is directly optimized and results in evaluation processes using Key Performance Indicators (KPIs) for logistics decision-making in the production chain. Therefore, technology resulting from innovation strategies assertively supports logistics planning that impact on the dynamism and fluidity of logistics sectors and service levels, providing a network of connections that direct productivity to achieve organizational efficiency objectives in relation to the demands of the globalized market and increased profitability. Thus, establishing relationships between the technological structures of logistics, production processes and KPI assessment highlights how innovation management operates in an organization. The basis of this research was formulated by the qualitative approach of the variables studied, with an explanatory objective, to investigate the relationships between the main themes involved and establish interpretations and conclusions in accordance with the basis of the study.
Statistical data and the elaboration of tables were used to understand the themes involved, directing

to a purpose applied to the content in question. Accordingly, it was revealed that a cohesion is established between the aspects of innovation management for the development of technology, and its direct uses significantly increase the productivity of the logistics sectors, in the same way that the evaluation of the results represents positive aspects for logistics decision-making.
Keywords: Innovation; Technology; Logistics; Productivity; Performance.

1. INTRODUCTION

In principle, Innovation Management collaborates with the continuous development of new conditions to deal with technology and its uses in organizations. Thus, the technological application in companies in the logistics sector reveal increased productivity in service levels, in dynamics of production processes and profitability. Information technologies and trends Industry 4.0 technologies result in the optimization of the operation of logistics sectors by supply chain integration, being evaluated using Performance Indicators Logistics *(KPIs)* for an objective assessment of logistics management. Given the immersion of organizations in the globalized market, there is an increasing need for adaptation and participation in the functioning of the logistics sectors in current technologies, so that companies undergo constant evolution in their activities. The study's analysis contemplates the objective relationship between innovation, planning logistics, productivity, technologies and use of logistics indicators for practical development of the logistics operation. It was possible to verify the need for logistics management through the technological transformations that imply the treatment of KPI assessment results , continually forming a complete integrative mechanism due to the conjectures of the functionalities of the logistics sectors. The literature review indicated that technology is a pillar structural changes in the activity of companies that have logistics operations and their trends form a process of approximation between the production chain and logistics planning, enabling collaboration in the exercise of Industry 4.0 and other forms of technology information.

2. THEORETICAL FRAMEWORK

2.1 Innovation Management

Innovation acts and promotes development in various areas of economic sectors, social and organizational, leveraging the process of technological progress. In this way, as

Santos M. (2000) explains when thinking about technology as the purpose of the evolution of techniques, through a family of techniques, technology systems emerge. By arguing that in a technical context in agriculture the sickle, the hoe and the rake are techniques developed for execution of an activity that, individually, establishes its practical functions, but when they are in together they form a family of techniques, being a technology system that configures the evolution of techniques to a perspective of its time and its characteristics. So, technology can be seen as a process of transition of families of techniques, of technology systems that are developed over time.

For these changes to occur there is a fundamental factor called the process from practical innovation to technological evolution. Thus, innovation supports the advancement of ideas and characteristics of technology to change its objectives, conditions of use and methodologies, in the face of improvement in organizational production processes, which are reflected in changes for society in general. New products, services and activities are developed with the principle of innovation in view of existing techniques migrating to new technology systems. Therefore, innovation is a continuous process of evolution that is characterized in its time in structuring what are the potentialities and society's relationships with technology.

According to Bagno *et al.* (2018), innovation also goes through a perspective of being linked to the successful development of new ideas, being evaluated and directed to the environments of business and linked to the productive sectors, innovation becomes the construction of ideas for continuous improvement objectives within and outside companies. In this way, the management of innovation in organizations is not limited to new products to be offered to the market, but encompasses the method with which it is produced, what strategies are adopted, what are the established routines and how people are managed to define how the organization operates. These aspects characterize innovation management, which is based on ideas that provide opportunities transformations in each activity that connects directly with the entire company.

Innovation management is attributed to an organizational flow that starts from ideas that synthesize the processes of change, in addition to which innovation must generate new mechanisms in business sectors, in order to reveal the needs, attributes and functions of each area for the innovative process of the production chain.

According to Bessant and Tidd (2015, p. 47), innovation management can be explained in a coordinated manner, being a continuous process that starts with a general search and ends with the capture of results. This way, it is possible to analyze whether an organization is in an investigative process,

in the search for clear strategies to manage change processes. To this end, there is a need of many questions, including whether there is a culture of innovation in the company, that is, a management for innovation. Thus, questions are sequenced towards the innovative result, firstly there is a need to seek opportunities that facilitate the path to be taken, these being valuable opportunities to capitalize on innovative ideas. It is important to understand the motivation behind the process, what in itself can be done so that the north is established and clear for continue coordinating ideas. After that comes the point of understanding for implementation, that is, to question how it will be done, what the methodologies, paths and reflections will be relevant to the implementation of ideas in practice. Then, the end of the process, in which each step involves a development of innovation as part of the whole, presents itself as value capture, which deals with the concise understanding of what the real benefits of this innovation practice are for the organization.

Given the above, innovation management applies to all areas of an organization business, substantially containing the participation of the logistics sector, which is the object of study of this research, as companies depend directly on changes, new ideas and captures values so that your processes along the supply chain can be optimized mechanisms and enable better service conditions for customers. For example, in availability of products, what are the strategic points of the delivery routes, what are the sustainable practices in logistics channels, these and other approaches are required by logistics currently and are fully involved in technology.

Therefore, the families of techniques in the logistics sector are based on the evolution of current technology. and, innovating in this area is directly related to gains in productivity, quality and management innovation, since the flow of the innovation strategy depends on sectoral applications, as changes Technological changes demand innovations and adaptations for the productivity of organizations. Thus, Business logistics is constantly changing in the structure of innovation coordination and the use of technological resources are directly applied to changes in the main practical activities of logistics services provided and demands on the supply chain sphere, given this, the innovation in the organization in its logistics sector is based on following the innovation strategy and use the questions from the new ideas gathering phases for the development of productive levels.

2.2 Application in Business Logistics

Business logistics, according to Madeira (2011), has the function of optimizing processes involving the production chain, from obtaining inputs to the dynamics of storage, transportation, and operation of customer services quickly and efficiently. The origin and logistical development took place in military contexts that allowed in their phases of construction to develop a trend analysis of the reduction of inventory costs as occurred during the Second World War and also in promoting rationalization to improve administration of products relevant to the conflicts faced during this period, later in a second phase (1970), logistics activities underwent an integration process, in which each part of the operation and logistical control was related to changes in the production process of organizations. In this way, logistics development was no longer directed as something separated from the dynamics of the sectors of the production chain, but rather as an associated process partially to the link in the production path. In the third phase (1980) this integration (production and distribution) took an expressive form for logistics processes and in the fourth (2000) it was designated if the *Supply Chain* phase in which logistics aligns in a panorama of connection between the parties, from the production base to the end customer.

In this aspect, logistics interacts with supply chain management in the administration of parts that involve the progress of the organizational sectors related to the activities productive. Managing in this context means envisioning how transportation, storage, and production patterns are carried out. quality, cost control, among other necessary conditions to be evaluated in management logistics. Such management demonstrates how necessary it is for business logistics to be optimized to that the value chain is in constant progress in the corresponding sectors in companies.

Logistics is integrated into multiple processes in its operating dynamics and can be defined through the thinking of the *Council of Logistics Management* (1991 *apud* Filho, 2023), “the process of planning, implementing and controlling the efficient and effective flow of goods, services and related information from the point of origin to the point of consumption, with the purpose of meeting customer demands”, revealing how the process of integration of the chain in favor of optimizing the operations involved (Filho, 2023, p. 6).

Economic globalization, according to Santos M. (2000), has changed the way things work. organizations in practical terms, with the acceleration of everyday life, convergence of moments and diffusion of global financial relations, resulting in demands for companies and organizations,

in which the exercise mechanisms were substantially measured and organized, obtaining each increasingly more results in terms of efficiency, punctuality and fluidity.

In this context, the logistics sectors of companies directly feel these movements global and the objective consequences on the functioning of their activities, listed by the impact of globalization in the reality of the internationalization of capitalism. Thus, for there to be a constant processing of global demand in companies, the logistics sectors depend directly from the management of innovation in the logistics scenario so that they adapt to global demands of productivity. Technology plays a fundamental role in uniting innovation, productivity and logistics sectors, as technology is at the service of significant changes in how to enhance the functioning of companies in their day-to-day work.

According to Bowersox J. *et al.* (2014), technology has a greater representation for the innovation logistics chain in times of process integration global productive sectors, revealing how information technology demonstrates a direct connection with the logistics sectors of the supply chain. Sharing information helps the process of logistics management for decision-making and in the company's internal and external communication. Therefore, innovation management is directly linked to aligned logistics strategy processes to information technology, so that business logistics demands innovations of a technological solutions to improve decision-making, in business communication and in adequate use of productive resources.

2.3 Information Technology, Industry 4.0 and Logistics Productivity

Information Technology presents itself in the globalized world as a source of changes in different spheres. In organizations there is an integration process in which the functioning of productivity begins to reach increasingly developed exponential growth sources for optimization of value chains and increased profitability.

In view of this, technology provides the means to accelerate productive activities and makes with which the organizational dynamics take a form of insertion into the structural processes of production with the allocation of products and services to the market, since the acceleration caused by global market incorporation promotes the need for companies to adapt to technology and constantly demands technological innovations for business logic, therefore,

information technology brings about a significant increase in productivity, as described by Alan Greenspan in a report to the US House of Representatives,

> Our country has been experiencing higher productivity growth—output per hour worked —in recent years. It appears that the impressive evolution of computer power and information and communication technologies has been a major driver of this trend... [...] raised expected profits and expanded investment opportunities. The most recent evidence remains consistent with the idea that capital spending has contributed to a remarkable recovery in productivity—perhaps greater than can be explained by the normal forces of the business cycle. (GREENSPAN A., 1998 apud CASTELLS M. 1996, p. 148)

Logistics information provided by information technology tailored to the functioning of production chains are developed by technological systems and resources that assist in decision-making in logistics management. Therefore, support elements are optimized in production processes that accelerate sectors, with information technology offering its benefit in increased productivity, through the gain of technological resources in favor of obstacles of the production chain, ensuring greater clarity for processes in the logistics chain.

Thus, according to Dantas J., *et al.* (2010), some technology systems are viable and completely suitable for logistical processing in organizations, they directly assist in connection and correspondence between business sectors, as in the case of Electronic Exchange (EDI) that is useful for exchanging accurate electronic information within companies. *The Internet* also fully represents the transformations of technology in organizations and, potential as a means of communication and data connection means there is optimization in the transmission of information. Satellite Technology also represents a significant productivity gain for the chain within the scope of logistics traffic, also Radio Frequency Data Exchange (RFDC) optimizes voice communication and operators can successfully exchange information that assist in logistical activities. Just as for the management of goods, technology is presents as positive the use of Bar Codes and optical reading, for the organization and productive storage.

Following the use of information technology, according to Santos F. (2013), there is the need to execute practical logistics planning through the use of innovative resources, that are presented to facilitate the logistics chain and increase productivity. Planning logistics is divided into stages, which contain each mechanism and technological device that corresponds with the functioning of the organizational sector. Table 1 presents the logistics planning

divided into its phases of action, demonstrating information technologies with their operationalities.

Table 1 – List of the main information technologies used in the business logistics sector with its phases and operations

LOGISTICS PLANNING	
Technology of Information	**Description of Operationality**
PLANNING PHASE	
Sales Forecast *(Forecast)*	Demonstrates the forecast of demand for supply.
CRM (Customer Relationship Management)	Personalized customer service system.
SRM (Supplier Relationship Management)	Relationship function, in this case with suppliers.
ERP (Enterprise Resources Planning	Data organization system that involves the entire production chain.
MRP (MRPI – Material Requirements Planning and MRPII – Manufacturing Resources Planning	Controls the need for production materials.
DRP (Distribution Resources Planning	Performs distribution planning.
APS (Advanced Planning and Scheduling)	Optimizes production.
EXECUTION PHASE	
***WMS* (Warranty Management System) Management of Warehouses)**	Comprehensively manages the process of storing, stocking and organizing goods.
***TMS* (Test System) Management of Transportation)**	Automates transportation for freight control, vehicle tracking, among others.
MES (Manufacturing Execution System)	Automates production planning.
CONTROL AND COMMUNICATION PHASE	
Laser Readers	They help manage and transmit information in real time.
EDI - Electronic Data Interchange	
DSS (Decision Support) System)	Provides useful information for decision-making and logistics management.

Source: Adapted from Santos F. (2013, p. 12).

These technologies, systems and *software* lead to substantial growth in productivity throughout the logistics chain and better use of resources, offering optimized conditions to deliver higher quality services to customers, increasing companies' profitability.

Currently, according to Cabral and Gomes (2023), in the reality of Industry 4.0, technology *Big Data* analysis has been highly requested by the Logistics sectors, mega data analysis is carried out in companies as a way of organizing and processing information and has represented a use of 75.4% in logistics areas, Cloud Computing represents about 71.2% of use in the same sector. The *Internet* of Things *(IoT)* area registered 71.4% of use in the sector logistics. Meanwhile, Artificial Intelligence (AI) also expresses its benefits in the areas of production and logistics, 48.4% of the companies analyzed indicated its use in their processes. This data represent how technology is constantly evolving in the logistics sectors and its applications occur in increasingly advanced conditions. Furthermore, logistics presents each increasingly a gain in productivity as new technologies emerge, since processes are optimized, the organization of relationships is stabilized and organizational objectives are achieved more efficiently.

New technological trends are direct results of the use of innovation management and are integrated objectively in the management of logistics planning, directly influencing the gains of productivity and service of logistics levels, revealing a fundamental cohesion between innovations technological, their uses in logistics and productive optimization.

As is the case with Artificial Intelligence (AI), in promoting databases and capacity information processing, as explained by IEDI (2019, *apud.* Junior; Silverio, 2022). With this, are directed to be properly analyzed and treated for the functioning of the analysis of performance, in the planning, execution, control and communication phases, is given by representativeness of the use of innovative computational developments that dialogue openly with production processes, meeting the development of productivity to optimize the practical efficiency of the logistics sector in Industry 4.0. The Internet of Things (IoT) allows connection and communication between material objects, reports KPMG and IEDI (2018; 2019, *apud.* Junior; Silverio, 2022). In this way, it explains that the connection step between virtual reality and physical reality is possible through the use of technological devices that act directly on integrated logistics chain. *Big Data* promotes, through a high level of information, innovative processing for better insights, decision making and process automation, describes UPADHYAYA; KYNCLOVA (2017, *apud.* Junior; Silverio, 2022). Since it is possible establish logistical planning in terms of large amounts of information, fundamental to establish performance analysis and record of business activities for the systems that validate and assist in logistics services and processes, while Cloud Computing

reveals the processing, storage and sharing of databases, says IEDI (2019, *apud* Junior; Silverio, 2022). In this aspect, the ability to store and organize these data so that interpretations and conclusions can be made about the main logistical indicators of each period examined.

Technological updates are consequences of innovations, demonstrating a new step in which they use their operations to collaborate with the mechanisms involved in logistics chain.

2.4 Positioning of Logistics Performance Indicators *(KPIs)*

The Logistics Performance indicators, reported by TOTVS (2023), are measures of evaluation and monitoring of the logistics chain, with the purpose of monitoring the processes and interpret the productive results, so that it is possible to make improvements and adaptations in chain. At this point, *KPIs (Key Performance Indicators)* are the basis for logistics activities business, as they help in the construction of the objectives and strategies necessary for the improvement of services, based on customer demands and increased profitability. The indicators allow mapping of how the logistics service is being performed and which are the variables that require adjustments and improvement of decision-making capacity in supply chain sectors. Table 2 presents the main *KPIs* associated with their functions in the logistics chain.

Table 2 – List of the main Logistics Performance Indicators (KPIs) and their respective features

Indicator of Logistics performance *(KPI)*	Feature Description
Delivery time	Fundamental to business logistics activities, it is based on customer satisfaction and fluidity in the final processes of the logistics chain.
On-Time and In-Full (OTIF)	Essential for controlling and monitoring delivery activities, associated with this are also the costs of transportation and storage.
Transportation and Storage	
Perfect Order Rate	Dialogues directly with the supply chain regarding its operation, fluidity and development of functions up to the end customer
Lead Time	Provides data that is relevant to the process from customer demand to delivery, representing the condition of the organization's shipments.

Order Cycle Time (OCT)	Indicator of order processing time until dispatch
On-Time Delivery (OTD)	Percentage that analyzes the willingness to deliver within the customer's deadline
Inventory Accuracy	Measures inventory management
Percentage of grades with errors	Measures the amount of relevant tax information from the logistics sector for companies
Occurrence Rate	Assesses risk incidents in operational activities
Percentage of traceable loads	Used to track and order the transit of cargo
Average Stock Level	Reveals the quantity of goods to be stored and managed in a given period of time

Source: Adapted from TOTVS (2023).

Therefore, performance indicators promote the management and analysis of results and are based on the technologies used in logistics planning, in addition to the fact that such indicators are innovation mechanisms for the control and support of activities that directly align with logistical decision-making in organizations. Therefore, the operating parts are structured of the logistics chain, based on information technologies and Industry 4.0.

With these indicators, the results for optimizing productivity are stated, revealing a situation that starts with innovation management as a strategic measure for the logistics planning, in which its categories and steps admit information technology as acceleration of the production chain and enable the use of current technological processes for the establishment of effective measures, in which the indicators respond to companies what is the market dynamics under logistics operations and what are the needs for adjustments and adaptations in response to customer requests, so that there is objective direction for logistics applications and profitability.

In light of this, a network is formed that connects the logic between innovation strategies and logistics planning in its phases, with information technology of systems and *software* business, technological resources of Industry 4.0. The comprehensive measurement of network operation by performance indicators, applies to the harmonic progress that configures the reality of organizations in their logistics sectors to develop productivity.

3. MATERIAL AND METHOD

The methodology used to prepare the research was based on a qualitative method of study, formed by links between the variables addressed to assign objective relationships

that would take structure for interpretations and conclusions. In this way, an approach was observed of applied purpose, because through the cohesion between the points researched it was guided by seeking how technology promotes changes in the logistics sector in view of the impact of innovation management on organizations. The objective, however, had the explanatory nature of dialoguing with the concepts, and the problem was approached qualitatively with descriptive operations of how relationships exist among the main areas studied, innovation management, business logistics, planning logistics, information technology, its trends and process evaluation. This situation was aimed at investigating the connections and possible links between the entities researched. In this aspect, the techniques and procedures were bibliographic, such as the use of statistics and the preparation of tables with the aim of demonstrating which ideas are listed by the argument, in which the functioning of the analysis processes could be presented.

4. RESULTS AND DISCUSSION

The results shown in the research indicate that innovation management has a direct impact in business logistics through the use of information technologies and Industry 4.0 trends, being fundamental for increasing productivity, assessed by performance indicators logistical. Thus, it is concluded that the coordination of the innovation strategy process effectively involves technological advancement, through the evolution of techniques within the sectors logistics.

For the technological condition to effectively function in the supply chain, the logistical planning in stages is necessary, with the use of essential technological resources in dynamics of organizational operation. Thus, technologies also traverse new paths that further influence decision-making and optimization of logistics processes, as is the case of 4.0 technologies that play an important role in innovation and optimization in companies. In this context, so that the results are expressive and well evaluated to be interpreted in the logistics decision making, *KPIs* are substantial in terms of visualizing indicators for the context of analyzing the technological repercussions of organizations.

A network system is created that symbolizes the impact of Innovation Management on the elements analyzed, clarifying how coordinated innovation strategies imply consequences practices in logistics. Through the evolution of techniques, the connection is made between the structure of innovation and logistics, in terms of technology and productivity, described in logistics planning. In this

aspect, practical applications continue to serve technology directly by increasing productivity, given the use of information technology and Industry 4.0 trends in managing supply chain and, in evaluating the processes by *KPIs,* which correspond to new and applicable connections for logistics and innovation mechanisms.

FINAL CONSIDERATIONS

By understanding the results, it is understood how technology is relevant to the logistics sectors, fostered through innovation management. Its ability to obtain solutions practices for the production process ensures constant progress in the evolution of techniques for innovative technology systems.

In view of this, new technology trends and Artificial Intelligence (AI) take over relevant roles for new and unprecedented technologies, as they promote the production stages of the chain logistics in order to connect operations with their databases. The analysis of the indicators become more efficient and enable increasingly faster decision-making, while also contributes to relationships with customers and suppliers, facilitating service, sharing of data and agility in the means of communication, with the clear consequence of increasing profitability for organizations that use such resources in logistics operations.

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