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IMPLEMENTATION OF THE IOT SYSTEM IN THE SUPPLY CHAIN IN THE MANAUS INDUSTRY

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ABSTRACT

This paper presents the implementation of the Internet of Things in the current model of supply chain management in the industrial pole of Manaus. Supply Chain Management (SCM), as it is also known, is a development that consists of strategically managing various flows (of goods, services, finance and data) as well as the correlation between companies, aiming to achieve and support institutional objectives. SCM 4.0, the supply chain management adopts innovations such as (internet of things, advanced robotics, analysis and big data) to enthuse performance and customer satisfaction. Quantitative studies were carried out to obtain information about the current model of the supply chain and the requirements to qualify a model as Industry 4.0, focusing on the internet of things and what impact it had originated in the current model. Therefore, it was possible to reach the following conclusion, that there are several efficacies in the use of the Internet of Things (IoT), such as more absolute and positive feedback to its customers, greater data collection for possible current and future improvements, security, satisfaction, improvement for the product user and faster and smarter decision making.

INTRODUCTION

Nowadays, we are living in new times amid a pandemic that impacts the world and the way of life of the population. Seeking to increase the efficiency of processes, current technologies influence and positively impact, and knowing this the internet of things is another tool that can assist in the processes and activities of a company. The term Internet of Things, or Internet of Things (IoT) in English, was first introduced by Kevin Ashton of the MIT Auto Center, in a presentation on RFID and a large company's supply chain, in 1999 (Ashton, 2009).

According to O'BRIEN and MARAKAS, (2007): An information system is the set of interrelated subsystems that work to collect, process, store, transform and distribute information for planning, decision making and control purposes. It is understood, therefore, that information systems can be considered to be resources, data results or even a set of people who manipulate or generate information. With the help of the Internet of Things (IoT) in conjunction with information systems, a company can become much more productive. And assist in supply chain management.

According to Martin Christopher, (2010): In "Supply Chain Logistics and ManagementSupplies ", the supply chain is a network of organizations involved through links upstream and downstream, in the different processes and activities that produce value in the form of products and services for the end consumer, he also points out that supply chain management supply is not "vertical integration."

THEORETICAL FRAMEWORK

Information systems: First, we need to understand succinctly what is the basis of the information system.

According to DAVENPORT and PRUSAK, (1999): It is essential for the successful performance of work related to knowledge, that organizations know how to define what data, information and knowledge are, since organizational success or failure can often depend on the application of these elements for problem solving and decision making. decisions. Understanding these concepts is paramount, data is nothing more than a random thing that has not yet been analyzed or

filtered. Information is to filter this random data, in order to organize them and obtain a better resolution of the data. And knowledge, is to use properly the data and information collected, is to understand what was collected in order to know where to use it.

According to OLIVEIRA (2002, p.51): "Data is any element identified in its raw form that, by itself, does not lead to an understanding of a certain fact or situation". According to OLIVEIRA (1992), information helps in the decision-making process, because when properly structured it is of crucial importance for the company, it associates the various subsystems and enables the company to implement its objectives. Once you understand the basic concepts, it becomes easier to understand and understand why every company today needs an information system.

According to TURBAN et al, (2007) '' When it comes to information in organizations, it is natural to also mention Information Systems (IS) that allow the collection, storage, retrieval and dissemination of information for specific purposes. '' With information systems, processes and departments become efficient, because if there was no exchange of information analyzed, the company would collapse, imagine a situation where one department sends data to another, they would reach the other department and not they would know how to use the data, much less the existing information, so information systems are another fundamental part of the process. According to RAINER JR. and CEGIELSKI (2011) "They are today, almost without exception, computer-based (Computer-Based Information Systems - SIBCs) and support the functions in the operational, managerial and decision-making processes existing in the organization." With the advancement of technologies, the use of computers has become more effective, with this information systems become very efficient, because together with software on computers they can process a lot of data, information and make everything available quite quickly.

INTERNET OF THINGS (IOT)

According to Singer, (2012): The simple definition of Internet of Things as a worldwide network of connected objects that exchange information with each other is very broad. According to research by the author, the term IoT seems well accepted in Europe, while in the United States, searches are more concentrated around terms such as intelligent objects or cloud computing. The internet of things (internet of things) promotes a connection, promotes exchange, promotes and assists in many processes, which in turn provide the company with more efficient work, achieving more effectiveness in its actions and more frugality in its spending;

According to Atzori (2011): It elaborates a concept that seems quite broad, for the author, the idea of IoT central is the pervasive presence of several things or objects, with unique addresses (RFID, sensors, cell phones), that can interact with each other and cooperate with those nearby to achieve common goals. Also according to the author "Web of Things" is a related term. The internet of things is no longer a novelty, it is every day becoming present and part of the life of the population as well as helping in activities and processes in many industries and businesses, bringing them an innovation in their ways of operating, benefiting from the IOT tools that

are used in their processes, however, it is only part of this revolution that is taking place.

Supply Chain: What is Supply Chain Management?

Supply Chain also known as "Supply Chain Management", can be defined as a system of organizations that involve the storage, the productive sector and the transport of products and services, it also involves the purchase of inputs, the control of product transportation to the end customer and inventory control. However, it is necessary to have a good planning in all activities, optimizing them so that they can generate great positive results. It is necessary that planning be done integrating all sectors that influence production. As we can understand, the objective of the supply chain is to generate customer satisfaction, meeting all their requirements in the shortest possible time, with a focus on reducing costs and increasing the quality of the product or service. All of this is important for the supply chain to be widely used within the Lean Manufacturing methodology, as this philosophy also aims to increase the added value in the eyes of the customer, eliminating the waste existing in the process. The supply chain is created to assist in the interconnection between departments of a company, thus allowing entry and exit of information without delays or deviations, being sent directly to its senders, thus bringing efficiency to the company's processes.

To structure a supply chain, 6 elements are needed:

- **Production:** The main strategy should be to focus on the customer's needs and market demand. It takes into account what and how many products are needed to manufacture, as well as which parts to produce or outsource. The main elements of the process is customer satisfaction so the focus is on product quality.
- **Supplier**: It is necessary to determine where and how the goods will be produced, determining the suppliers who are able to produce economically and efficiently. When defining a supplier, it is necessary to observe the delivery time and the quality of the product supplied.
- **Inventory:** Every company needs to manage a large inventory well, as it has a high cost for the organization. If there is no stock, it can compromise the ability to meet market demand, as this point is of paramount importance in the supply chain.
- **Location Point:** a strategic location is chosen where the company can be advantageous in terms of positioning. Therefore, choosing a good location influences the process and revenues, in addition to serving as a place of easy access to customers.
- **Transport:** We know that Approximately 30% of the cost of a product is comprised of transport, so using the right mode of transport is crucial to avoid unnecessary expenses.
- **Information:** Information is essential to obtain results and achieve objectives, it is essential for companies to use information internally and of their end customers to improve their supply chain management process. Data and information are different, the data is made up of elements, the information comes from the processing of that data.

For there to be an appropriate supply chain, you need to have good control and contact with suppliers. Finding the most affordable prices, venerating for a quality raw material and

acceptable prices, all these requirements will guarantee a product of great quality in the hands of consumers. One of the greatest allies in the supply chain is the standardization of processes, it is a way to guarantee efficiency in all processes, bringing benefits such as cost reduction, effectiveness, efficient processes, and data collection to assist in decision making. Communication is paramount in the supply chain, as communication is fast, direct and efficient, streamlining the entire process involving the supply chain, facilitating decision making to obtain results. Automating processes through information technology is another ally, using management software to have better inventory control, avoiding human error and generating data effectively for supply chain management. Maintaining the focus on customer satisfaction is one of the most important and strategic points, the customer experience has to be unique and differentiated, bringing satisfaction through qualities and cost benefits. The growth and growth of any organization that acquired the supply chain and success over competitors depend on the customer's perception of the company and the way the company is able to reach its target audience.

"A network of connected and interdependent organizations, working together, under a regime of mutual cooperation, to control, manage and improve the flow of raw materials and information from suppliers to end customers". (Martin CHRISTOPHER, 2009). "A set of functional activities (transport, stock control, etc.) that are repeated numerous times along the channel through which raw materials are converted into finished products, which add value to the consumer" (Ronald H. BALLOU , 2006). According to CHRISTOPHER (2009) and BALLOU (2006), the supply chain is an organization network that together manage to control suppliers and customers in order to add value and loyalty to the final consumer.

INTERNET OF THINGS AND THE SUPPLY CHAIN

The Internet of Things is any physical object or even a connection between people, which can be automatically communicated through sensors and intelligent software that transmit data to the network. You can compare the devices on the IOT with a huge nervous system, which can exchange information between two or more points, or even between all connected points. Before considering the benefits of connecting items to the supply chain, it is important to remember the goal of supply chain management (SCM), which is to maximize service by increasing the time, location, quality and value of information, while reducing waste, Minimize the use of resources, optimize the use of assets and reduce inventory to minimize costs, as shown in the following figure:
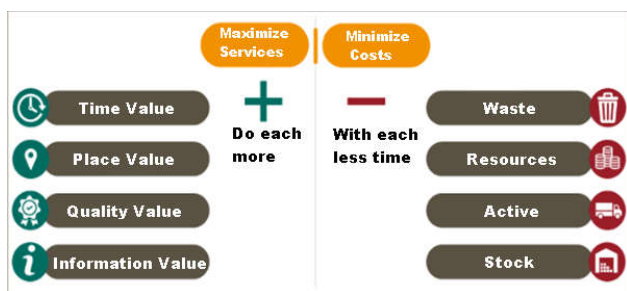
Source: ILOS
Figure 01. Supply Chain Management objectives

The Internet of Things can help SCM achieve its goals. In other words, the Internet of Things can help add more value to customers, contribute to the delivery of the product in the most appropriate form, time and place and provide the most diverse information mainly through tracking, sensors and connection technology. In addition, the Internet of Things can help increase efficiency and reduce costs in the chain, using real-time information, helping to reduce waste, optimize the flow of products and materials and optimize resource allocation.

The following is an example of an IOT deployment plan for supply chain management:

Inbound Transport:

•**Real-time tracking:** Whether in any kind of modal, air, sea or land, if you want to monitor cargo logistics more closely, cargo tracking is an essential service. Efficient management can guarantee the smooth running of the business, but it is also crucial to control the transportation of goods. Even if the carrier acts as an intermediary between you and the shipping company, you and the logistics department should be more confident in this process. By being able to track goods through tracking, you can easily access logistics information.

•**Automatic scanning of products on receipt:** Using the standard JD Edwards program, XML can be received automatically from suppliers, so that users can focus on more productive activities, bringing greater returns to the company; Only when error handling is necessary, does the user need to intervene in the receiving process.

In storage

• **Automatic inventory management with pallet truck connection:** If you want to achieve the highest product turnover rate, speed and efficiency are crucial. When operating multiple shifts in a limited space, when storing and handling a large number of items, the automatic pallet warehouse always stands out. The rack system, software and all equipment used must work perfectly together. The automatic pallet warehouse can be used as an integrated warehouse or self-supporting rack warehouse, with a height not exceeding 45 m. Space efficiency is extremely high. The storage space for pallets, lattice boxes and a single conveyor system can load up to 7.5 tons of cargo. In single depth, double depth or depth versionsmultiple, these bearings are suitable for almost all types of load.

• **Real-time item tracking:** To track products, the concept of traceability was applied in the scope of logistics due to the need to understand the position of products in the logistics chain. In this sense, product tracking is an important difference in quality control. The more effective the product tracking technology, the greater the satisfaction of consumers with their purchases and with the company. This means that product tracking can help you find long-term loyalty.

•**Monitoring the use of assets, such as forklifts:** Monitoring assets through sensors can record their use. This information can be used to analyze later information on asset productivity, utilization rate and inactive status, providing important information for making capacity adjustment decisions. An example is to monitor the use of the forklift, observe the most common time of day and if there is space to cut the forklift from operation. Therefore, through an in-depth understanding of all assets, you can make the most of them.

•**Automatic route optimization:** Routing is the optimization of the route definition. When creating a delivery route, you can follow multiple routes. The best way to search depends on scripts.

In addition to optimizing processes, the implementation of logistics routing can also optimize the company's strategy. This is because there will be reasons for delivery in this way, not just for delivery. Routing has some benefits such as:

- Guarantee of faster deliveries;
- Increased capacity for daily deliveries without cost burden;
- Maximizing the occupancy rate and use of vehicles;
- Rationalization of the use of labor (reduction of overtime and control of the working hours of drivers - Law of the driver);
- Fuel savings and other variable vehicle costs (tire consumption, oil, maintenance);
- Comprehensive control of the entire loading and unloading process;

Outbound transportation

Automatic fleet maintenance scheduling: Fleet control software is used primarily for fleet management and cost reduction. Currently, it is the cheapest and most practical way for managers to know everything that happens to their fleets in real time. This avoids many inconveniences, in addition to qualifying route planning, but it also serves to measure the performance of each vehicle and each driver individually. It will be possible to know why a driver is more efficient than others and also where the flaws that prevent more homogeneous performance are. It will also be possible to see if one vehicle is using more fuel than another and what may be driving it, that is, with the fleet control software, you stop wasting money, being able to focus on preventive maintenance before the real problems appear.

Monitoring of product conditions (vibration, temperature, etc.): Several factors can affect the quality of the products. Among them, vibrations and bumps during the entire transport. Impact recorders are specially designed to accurately record these values. The data loggers identify whether the products have undergone vibrations during transport and whether it is necessary, therefore, to repeat the quality control.

Real-Time Operation Optimization: At this stage of the IOT implementation, there are algorithms that optimize its operation in real time. Therefore, optimization occurs automatically, without the need for further analysis of the data for decision making.

Complete System Automation: When systems interact with each other and optimize operation in real time, without the need for human interaction in the process. An example would be a warehouse shelf that updates the WMS in real time and identifies the quantities of products in stock. When the stock reaches the minimum quantity of materials, the shelf automatically communicates with the supplier's ERP and orders according to what has been programmed. Currently, IOT depends on human interaction, data analysis and decision making. Therefore, there is still much room for its evolution. In the future, the connection between objects and systems is expected to occur completely, leaving people with more

strategic decisions and the development of optimization algorithms.

Blockchain deployment for logistics and supply chain: Many companies are eager to get into blockchain technology. It has the potential to completely change the way companies exchange information in the world of logistics. In fact, BiTA already has about 500 members in more than 25 countries around the world. The current stock on the public blockchain network exceeds $ 130 billion and its value may increase. To fully understand the advantages of blockchain, executives and entrepreneurs need to understand the benefits that this technology brings to the logistics industry:

Transaction Transparency: The lack of transparency prevents companies from building mutual trust and naturally leads each member of the supply chain to protect themselves, which leads to inconsistencies and disputes in terms of information about deadlines, stocks, values, delivery locations, so common in logistics . A solution can be found on a private blockchain, in which each stakeholder retains a copy of all information, which cannot be accessed or modified by anyone outside the supply chain. As a result, transaction history is always kept transparent and trust can flourish.

Access based on security permission: Traditional logging systems have opened the door to malicious attacks, through which stored information can be accessed and modified. Fortunately, blockchain technology goes far beyond providing precision. They also provide encryption tools to ensure data security. Blockchain-based systems have ways to control and restrict access to information at all levels of the block. For example, companies can ensure data security, so that only certain parts of the supply chain can access information. Likewise, everyone can access less sensitive data, such as the weight or size of orders.

Smart Contracts: Blockchain technologies allow the adoption of smart contracts that automate legal negotiations throughout the logistics process. These systems use smart contracts to monitor each stage of the process. They can check some of the contract rules to ensure that all parties achieve their objectives in the contract. The most interesting thing about smart contracts is that they guarantee reliability for all sides of the chain. As a result,even smaller partners can participate in this process. This is important because for small businesses, such as startups, it is extremely difficult to enter the supply chain. Traditionally, they need the support of stronger and more reputable companies. However, a smart contract ensures that all parties involved fully comply with their contracts.

Clarity in Assets and Order Management: The digital ledger created by the blockchain can help you easily track and combine assets and their candidates without any doubt about ownership. Compared to other modern methods, this register allows companies to handle verification and transfer of assets in a simpler way. The scalability of the technology is almost limitless. This means that even the process of allocating a large number of objects will not have a bottleneck effect. Due to the popularity of services delivered on the same day, the importance of ensuring clarity is more important than ever.

Realtime Tracking for Distribution: Real-time tracking systems can be created through the integration of IoT, blockchain and mobile technologies. The use of data from GPS

systems can update delivery statuses with geolocation data. These systems are open to integration with other IoT devices. In general, the Internet of Things is capable of providing competitive supply chains for companies. However, without a proper understanding of how it works and how to ensure profitability, companies can face half the problems that can impede development in an ever-changing market. In addition, IoT technology, infrastructure, management and integration are needed before blockchain and more sophisticated Iot technologies become more useful. However, companies that can handle this business-based approach can expect to abandon competition in the long run!.

It is important to consider the application of the Internet of Things in the future SCM, because the Internet of Things has announced some changes, such as the use of big data, 3D printing, robots, drones, autonomous vehicles, etc. The Internet of Things will use all of these technologies and will become the backdrop for this revolution. Therefore, the Internet of Things is a transformative tool that affects not only old operating methods and traditional supply chain management objectives, but will also become an important promoter of future plans. Companies that do not yet use the technology need to understand it at least and consider it in future strategies to remain competitive in the growing connected market.

METHODOLOGY

This research aims to be exploratory with a quantitative approach. This is because in the course of the research, a sample was applied to a small group of the population of Manaus, through an online questionnaire. An indirect approach, for the bibliographic objective, so that the basis is consistent, in order to show the characteristics and data that we are looking for, and still interconnect with the researched content. This is justified because the method used allows an indirect data collection, without the need for field research, which is currently restricted due to the pandemic, caused by the corona virus. As a process, this work will take place through indirect observation because the choice allows data collection without social exposure, which is currently restricted due to measures of social isolation due to the pandemic generated by the corona virus. The survey is relying on the use of online tools, based on forms that were disclosed directly to the group that were applied to the survey.

The collected material, such as, the due analyzes will be exposed in an organized way so that the reader can absorb what is intended to be shown with this research. In the conception of the Portuguese language, research is understood as "the action of researching, searching, investigating; scientific work that records the results of an investigation "(BORBA, 2004, p. 1.067). Therefore, the literary review looked for references in books, websites and other research, in order to give a consistency in its bases, as well as a way of being inspired in order to be able to express the concept in its visions and to bring to the reader a new way to see the content, under a new in-depth view and in search of clarity in the fundamentals that were presented in this article. Lakatos and Marconi (1991, p. 15), research is understood as "to investigate something in detail, it is to investigate". According to this principle, the search and investigation of all material were done in an ethical and direct way, seeking authors and other views so that researchers had a guiding view of what to expect to find during the research, just using them as

references and following their own concepts, expose the work in a summarized form, however, without losing the minimum important details acquired during the foundation and research.

RESULTS AND DISCUSSION

After collecting data from the research done through online questionnaires that were applied during a period of two weeks to a group of 100 people in the population of Manaus (AM), of the most varied age groups, genders and occupations. The form had 7 questions, with unique answers between the options, "yes " or" no ", the data obtained were collected and are shown below in graphs, with the respective information for each question provided.
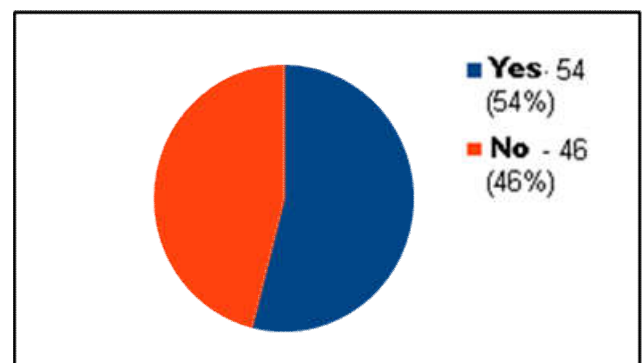
Source: Own authorship, 2020.

Graph 01. Do you know what internet of things (IOT) is?

The graph shows that the respondents to the questionnaire mostly know what the Internet of Things (IoT) is, however another part of the group also does not yet know this tool. What can be seen is that although it is becoming more present, the tool is still unknown to another part of the population.
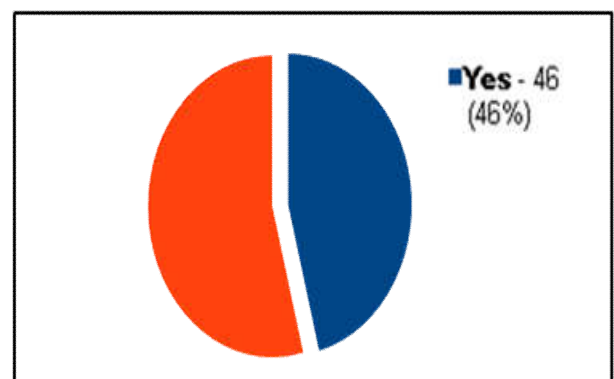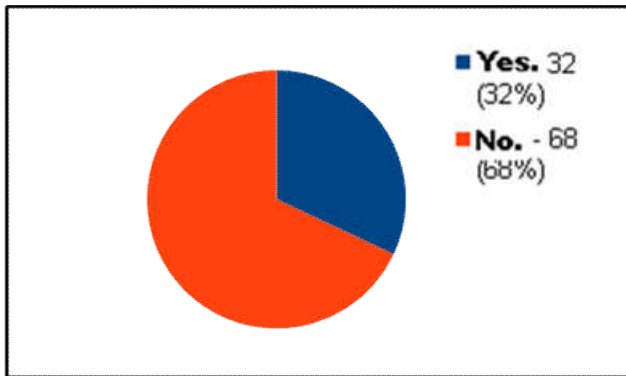

Source: Own authorship, 2020.

**Graph 02. Have you ever heard someone talk about internet of things (IOT)?**

In this other question, we observed that despite the great majority of the researched group, the majority did not hear anyone talking about this tool, which preliminarily shows that despite knowing what its concept is, few people talk about this tool or can delve into the subject. Which makes sharing the tool to new people limited. During the development of research and data collection, it is noted that when analyzing the data from the question above, about 63% agree that the use of the IOT tool has brought benefits to industries, that is, they recognize that even they do notfully understanding its bases

and applications, they see the potential in it and note that they can bring results to industries. And it opens up the possibility of being integrated with other departments, because as noted, it can benefit much more than an industry in itself.
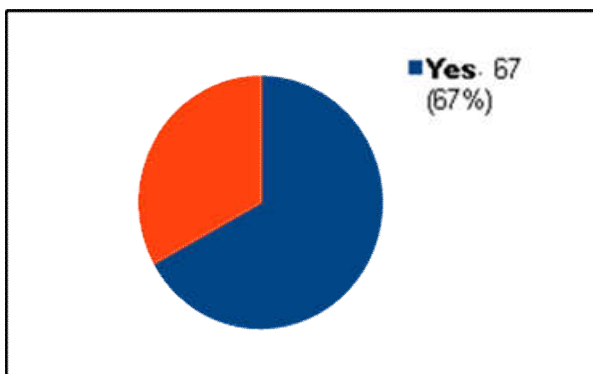

Source: Own authorship, 2020

Graph 03. Did the use of IOT tools benefit the industries?
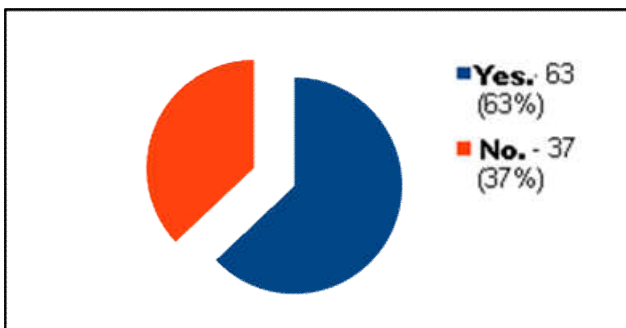
Source: Own authorship, 2020.

Graph 04 . Is the use of IOT tools a revolution that would influence the way of life of the Amazonian population?

When we reach this point, we can see that the numbers vary, however, here we can see that once again the group at the top knows that the IOT tool can influence the daily lives of the Amazon population, a great example of the tool's impact would be in the supply chain, using to make the company more. Efficient, consequently making your services and products improve, benefiting the end customer.
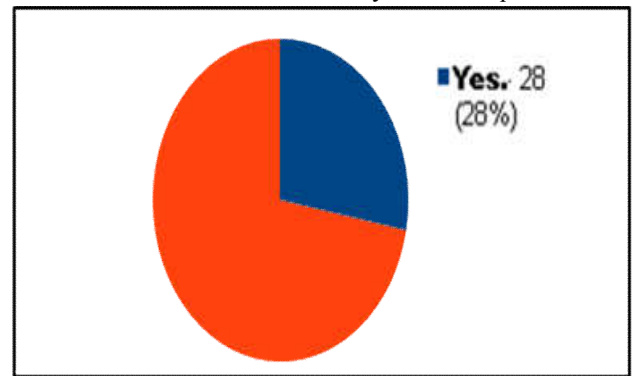

Source: Own authorship, 2020.

**Graph 05. Do you know someone who uses or has used an IOT tool?**

The IOT tool is becoming present in first world countries, however, in countries still in development, the use of these tools is still not widely seen, which can be seen by looking at graph 05, as the percentage of the sample shows that around 68% do not know anyone who has used this tool. The question

seems to be repeated, however, it provides a new perspective regarding the knowledge of the IOT tool in the Amazon region, according to the data collection, about 72% of the researched group never saw anyone using the tool, which can be observed with the data obtained by the other questions.

Source: Own authorship, 2020.

Graph 06. Have you ever seen someone using IOT?
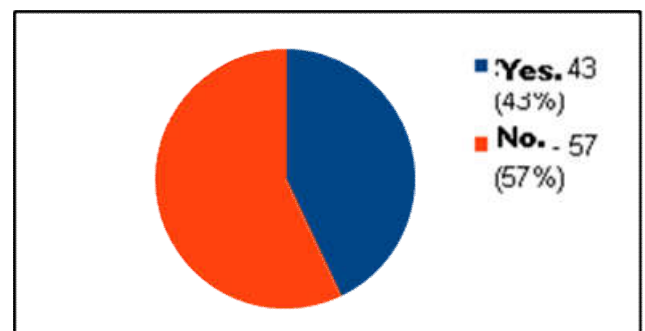
Source: Authors, 2020.

Graph 07. In your opinion, we have the structure to make the IOT present in most of the factories developed in the Amazonas?

Such data may provide a parameter for observing that the development of technology in the region has not yet made great strides, however, that yes, there is technology present in the region and that it is still private in large places where there is an adequate structure, far from the large population. . It is still a technology that is progressing and making it increasingly present in various locations, from homes to industries, it can be conceived that the tool may still take time to fully develop in the region due to incentives. The final question addressed to the respondents asks whether we have enough structure so that the technology can be used efficiently and effectively. About 57% of respondents reveal that we are not yet prepared for such technology, which can be understood, due to the region and the lack of investments in the area. And another 43% reveal that yes, we are ready to receive such a tool, although there are no major investments, the region presents the tool being used, and it shows its results, and we can consider that if applied and invested in the region, it can generate a lot of benefits .

Conclusion

We can verify from the research and the bases used that the supply chain covers a large grid of multiple operations, which are interdependent and interconnected. We realized that an interconnected supply chain can offer a very high level of service, in addition to providing the delivery of more efficient processes, consequently effective results, given that the interconnection of the various departments present in the supply chain offers speed, efficiency and helps in other tasks ranging from information exchange to transportation. This

connection is only possible through a good information system and a structure that provides the proper use, in addition to systems, they must have a connection network that provides the basis for the IOT tool to be used, so that interaction can take place efficiency of the systems, making the deployment of IOT tools become productive and bring results. We can emphasize the importance of making the IOT tool more present in the Amazon region, since it can offer operations in several areas of industry in the region, that is, investing in this region can generate great benefits, in addition to providing the IOT tool with a variety of applications of its resources. The Amazon region is wide-ranging and of a large size, today it covers several operations, containing a large industrial pole. Investing in Iot technologies in the region offers great benefits, ranging from more efficient information management andintelligent in terms of entry and exit management, transport and other operations. The first three industrial revolutions started production, electricity, assembly lines, and information technology, increasing workers' income and making technological competition the growth of economic development.

The fourth industrial revolution, which will have a deeper impact and is characterized by a set of technologies, bringing new challenges and innovation to the industries. The fourth industrial revolution, called industry 4.0, will be a great opportunity for the growth of the industrial pole of Manaus, in addition, it will be a differential for companies to seek innovations to stand out in the competitive market. This saving involves efficiency gains in the production process, reduced maintenance costs for machines and energy consumption. This revolution brought a technology that is standing out all over the world, a technology that will bring new changes to the industries in a way that will impact and optimize the entire production process. We are talking about IOT technology, which involves the integration of all industrial systems to create an interconnected smart factory. The sensors capture data across the enterprise, allowing managers to remotely and comprehensively access information from each department. In this case, more automated processes will be used, which simplifies the management and optimization of the production process. In addition, connected devices begin to report and prevent problems without manual intervention.

The implementation of this technology at the Manaus Industrial Pole would be of utmost importance for a great technological advance in companies, bringing a great impact through technology, optimizing processes and increasing the level ofproductivity. From the moment that IOT technology is implemented, companies will have great economic growth. The IOT would be a great challenge for the industrial hub, as the implementation would bring about a radical change in the productive scenario, requiring companies to qualify people, invest in technologies in which it will generate a high cost but also many will bring many benefits to the company, such as: Less costs (decrease in the number of employees, as the machines will perform the functions that many people currently occupy in the productive sector), Operation in real time (construction of a database linked to each process of the productive sector, making it easier to operate in real time and also obtain more accurate decision-making), integrated operation (industries will be more intelligent, facilitating contact with the supply chain and customers providing more benefits to the company), optimization (with the implementation of intelligent systems, the machines will not

need rest like people, providing a greater number of production). The growth expectation for the Industrial Pole of Manaus through technological advancement is very high, but for this the Pole will face many challenges due to the infrastructure that the city of Manaus presents.

The factories will be fully connected, with human participation only to carry out the supervision of the work done by the machines. Like other countries, the updating of the industry has been the initial focus of the journey towards a new future. But we can say that Manaus is heading every day to a new scenario that will revolutionize industries through technology 4.0. To finish the job, we can verify that the Amazon region has great potential so that the IOT tool in conjunction with the supply chain can be integrated, obtaining experiences and results much superior to those it already has.

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