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Project management and supply chain 4.0 improvement: the case of infant formulas in the face of the challenge of COVID-19

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Abstract

The changes in the environment make it necessary for organizations to prepare to face in the most effective and flexible way without negatively affecting the quality of the products or services offered, making this area of opportunity become growth and a competitive advantage against to the other companies.

While Industry 4.0 has been a critical factor in overcoming the challenges of pandemic restrictions and improving productivity by providing continuous operations during the crisis, the smart supply chain has enabled a constant stock of products to reach their destination. Despite the efforts and success of the Industry 4.0 and the Intelligent Supply Chain during the pandemic to meet market needs, stockouts were still significant, making it a critical point to review project and risk management tools and techniques in its operations. Smart digital technologies and techniques have been useful in developing strategies to mitigate the effects of emergencies; however, these strategies are still highly vulnerable to crises of this magnitude. That is why the aim of this paper is to show the importance of adequate project and risk management within Industry 4.0 to achieve a flexible, intelligent, and resilient supply chain.

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1. Introduction

In recent years, the world population has been affected by the crisis caused by the coronavirus (COVID-19). This has not only affected the integrity of the population's health but has also been a cause of crisis in every country in the political, economic, and commercial spheres. This new disease mainly affects the world economy in two ways [1].

The first is the direct impact on production. World production has been seriously affected due to the COVID-19 pandemic that has caused shortages in many types of products. Stock-outs are estimated to have increased 35% in 2020 compared to 14% in 2019. While temporary stock-outs increased from 12% to 22% in March 2022 and permanent stock-outs were estimated to be 20% during 2020 [2].

The second is found in supply chain and market disruptions, where inventory levels have been cut or otherwise increased excessively [1].

The variables that can cause the shortage or excess of raw material have a wide variety of sources, whether random or biased. COVID-19 could be considered a random variable, which is directly impacting companies' inventories by affecting the accuracy of forecasts and increasing the associated error. Companies are facing an atypical situation in which the variability of real demand does not have a predictable behavior and depends on external situations and variables that are not taken into consideration in any sales forecasting model [1].

The restrictions and sanitary measures that are being applied in multiple countries have caused the delivery times of the raw material to vary upwards, which makes it impossible for companies to meet their commitments with their clients [1].

One of the sectors affected by the shortages and restrictions in the supply chain caused by COVID-19 was infant formulas and specialized formulas. Infant formulas are those products intended to meet either partially or totally the nutritional demands of infants when feeding by total breast milk is not possible, on the other hand, specialized formulas (FE) are administered to those babies who have intolerances or dietary allergies due to inborn errors of metabolism or gastrointestinal problems [6]. Being a sector of great importance for public health in May 2022, the US reported a shortage of 43% of infant formulas. Globally, only 43% of babies under six months of age are exclusively breastfed [3-4]. And an estimated 7% of babies under 1 year of age are lactose intolerant from birth [5].

It is expected that in 2022 there will be 4.3 million births. Considering this figure and the demand for a single baby during its first year of life that is reflected in the following table, the demand for infant formula is 30.53 billion ounces of formula per year [7 and 8].

Table 1. Demand for infant formula for a single baby.

Age (months)	Formula Amount Per Serving (oz)	Servings per day (times)
1	2-4	6-8
two	5-6	5-6
3-5	6-7	5-6
5-6	28-32	4-6
7	30-32	3-5
7-9	30-32	3-4
9-12	24-30	3-4
Total per year	710 ounces	

Since inadequate nutrition during the first year of life leads to poor child nutrition and can lead to 2.7 million malnourished children, which represents 45% of all child deaths. Infant and young child feeding is critical to improving

child survival by promoting healthy growth and development, reducing the risk of chronic disease, and improving overall development [9].

Under these arguments, it is extremely important to achieve the supply of infant and specialized formulas. Faced with this emergency and uncertainty situation, the adoption and implementation of project management techniques will help us identify and effectively attack priorities, problems, and risks, thus fulfilling the objectives of the organization (ability to resist, absorb, adapt, and recover from dangers) [2].

Proper project management leads to a resilient and flexible supply chain, with Industry 4.0 integration being an important factor for decision-making and risk reduction.

Therefore, this document aims to show the importance of proper project and risk management within Industry 4.0 to achieve a flexible, intelligent, and resilient supply chain.

Nomenclature

FE	specialized formulas
PDCA	Plan-Do-Check-Act

2. Supply chain and project management

Project management consists of applying knowledge, techniques, tools, and skills to project tasks in order to meet project objectives by adapting, applying and integrating the appropriate project management processes to execute them efficiently [10].

Through project management you get:

- Meet project and business objectives.
- Satisfy the needs and expectations of the interested parties.
- Increase the chances of success of projects.
- Deliver the products, services, or results in an appropriate manner and in a timely manner.
- Optimize the use of the resources necessary to execute the project.
- Manage and balance project constraints: scope, quality, cost, resources, and schedule.

The management of projects in the supply chain requires vision, precision, and strategy. It needs objective data and to be permanently updated. Those in charge of managing projects in the supply chain have the responsibility of taking control over the flows of goods and materials to ensure timely deliveries, or a system that facilitates doing so [11].

Managing the supply chain consists of the process of integrating the activities of the companies involved in the production of a product in order to obtain value for all, including the final consumer [12].

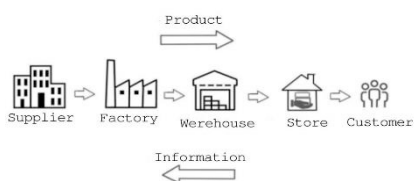


Fig. 1. Supply chain elements.

To effectively achieve the integration of supply chain management, four types of integration must be taken into account, which used at the same time determine the level and capacity of a company to optimize its supply chains [12].

These types of integration are:

- Functional integration of purchasing activities, manufacturing, transportation, inventory management and storage.
- Spatial integration through the geographical dispersion of suppliers, factories, service centers distribution and customers.
- Inter-temporal integration of the strategic, tactical, and operational planning activities of each company and each chain.
- Business integration including supply chain plans, marketing and sales plans, and financial plans.

Implementing effective supply plans from a project and risk management perspective can help build resilient and intelligent supply chains.

Strategic supply is the process that has as its objective the search, evaluation and acquisition of services and consumer and capital goods requested by interest groups in optimal conditions in terms of cost, quality, and service levels, in addition to the contribution of value generation and innovation of the organization, with the parallel responsibility of mitigating the different risks resulting from said interactions with suppliers and external stakeholders [13].

To correctly prepare a supply plan, it is convenient to follow a series of steps, shown in figure 2, which will help ensure that nothing is left out [14].

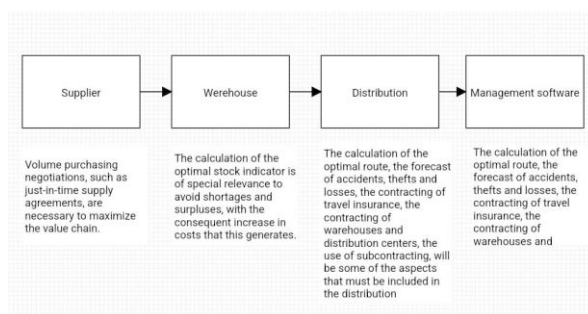


Fig. 2. Sourcing plan.

To achieve this, there must be a systematic exchange of information with suppliers and there is an adequate integration of information technology. Due to this exchange of information, the customer maintains a permanent relationship with the company and has access at any time to information on the status of his order and on the production process itself [12].

To guarantee the above, connectivity between the information systems of the company with those of suppliers and clients must be facilitated, based on a high standardization of the information formats and the means used [12].

The organization works as a system, it is made up of several subsystems that work in harmony, achieving the necessary synergy to adapt to the changing environment. In this sense, the design and implementation must be carried out with the cohesion and participation of all members.

2.1. Supply chain and industry 4.0

Industry 4.0 can help us in the exchange of information with suppliers and customers, already mentioned above, since it uses cyber-physical systems with the aim of making factories more intelligent and capable of responding to the growing demands of society. We can say that supply chain 4.0 is the application of technologies to different processes of a supply chain. These are differentiated by a high degree of connectivity between the physical and digital domains, where sensors allow the collection and transmission of information in real time that allow decisions to be made for different processes, to improve the performance of the thread in real time. Integrating the Industry Supply chain 4.0 is expected to save time and costs, agility and risk management [15].

Some of the industry 4.0 tools, without being limiting, in the supply chain are [16]:

- Big data and artificial intelligence: Have a special relevance in the supply chain since its contribution to factors such as intelligent transport or autonomous vehicles stands out. This will make transport more optimal by building beneficial transport routes, improving the logistics of the company. Furthermore, these tools can offer an objective understanding of consumers' preferences which will lead to a better decision-making process, including decisions regarding product development and delivery. An additional benefit would stand in a wider visibility of the system's needs giving important insights for the company.
- Collaborative robotics: It is going to have a great impact on manufacturing, since it is going to allow production tasks to be carried out not only by operators but to have the collaboration of the machines. It also makes it possible to control the course of a product throughout the supply chain so that the level of inventory, time spent, queues in the supply chain are known for each product.
- Internet of Things: Along with internet of things, "customers could have real-time information on the status of their orders, or the execution of production operations that could affect them, on their mobile devices." [17]. It also provides visibility on the state of the warehouses, by having control over raw materials and other materials. And how the transport and storage of the products is being carried out.

2.2. Flexible and intelligent supply chain

Companies must attack a need, in this case, the customer has the need. This is where flexibility in the supply chain comes in. To achieve effectiveness in supply chains, it is of vital importance to seek to satisfy the needs of customers and be efficient in the costs incurred [18].

Flexibility in the supply chain encompasses important factors for our case study described below [18]:

- Sourcing flexibility: It has different options in terms of suppliers to meet customer requirements.
- Routing flexibility: Occurs by optimizing routes, primary and secondary transports.
- Transshipment flexibility: be efficient in both time and cost in routing the product to the various points of demand.
- Delivery flexibility: It is the company's ability to meet customer delivery needs.
- Distribution flexibility: delivery of the product regardless of the circumstances, giving priority to places and times indicated.
- Response flexibility: company's ability to respond to market demand.

The connectivity of all the elements of the supply chain that Industry 4.0 provides offers the possibility of tracking every element of it. To take advantage of the information that is generated from an intelligent supply chain as the real conditions that affect it change, it is necessary to register them in virtual models (digital twin) in real time, which allows an instant simulation of the environment, generating better communication, greater agility in the detection and solution of faults, the opportunity to anticipate problems by making better, more optimized decisions in less time, a fact that represents a competitive advantage and an improvement in performance. Thus, achieving a flexible and intelligent chain [19].

2.3. Risks in the supply chain

COVID-19 has shown the vulnerability of supply chains that, in the face of any threat, logistics must evolve to build more intelligent and flexible supply chains to respond in real time. The pandemic made us understand the inherent risks and develop an action plan that considers immediate responses, in the medium and long term, that allows a decisive response. These risks are understood in the literature as the intersection of supply chain management and risk management [20].

As the supply network increases, new risks arise due to the dependence and integration of companies with the chains. But not only such complex incidents, such as the one experienced in 2022, interrupt supply chains, but also the most common and daily problems can affect them. Not knowing the environment of risks in supply chains in logistics networks in the face of demand global has produced little agility so its response is insufficient [20].

The Security Management System for the Supply Chain: ISO 28000/2007 is the first certifiable security management system, including all the critical security factors of the supply chain. It has been shown to follow the Deming cycle methodology approach: Plan-Do-Check-Act (PDCA Cycle) which strongly promotes continuous improvement of processes, this provides better ease of integration. Another type of tool that we can use are the different risk matrices [20].

Management of these risks must be customer-based to effectively achieve stakeholder satisfaction. The security of the supply chain allows risks to be managed in this sense by integrating flows of resources, processes, and logistics areas in each link of the network. The correct integrated risk management in supply chains will make it possible to reduce gaps in customer service and achieve greater immediate response capacity in supply chains [21].

3. Discussion

In 2022, there was a shortage of infant and specialized formulas due to high demand and disruptions in supply chains around the world due to the health situation that occurred during that year. This generates price increases, social concern, and crisis among consumers [22].

To deal with the problem, new strategies or business models are being chosen that leave aside the vision of a traditional supply chain and move to supply chain 4.0 (intelligent and flexible) to obtain visibility of the network from end to end. extreme, greater collaboration, capacity, and shorter response time [1].

The supply chain helps us to:

- Anticipate future scenarios
- Locate inefficiencies and prevent problems
- Make more agile decisions
- Improve productivity and integrate processes

The smart and flexible supply chain is the process of implementing technologically advanced production and inventory management technologies and methods that increase productivity and operational efficiency. This new trend uses technologies such as blockchain, process automation, digital transformation, artificial intelligence, big data, machine learning and the Internet of Things to achieve more efficient supply, production, and distribution operations. This implementation not only brings efficiency and productivity, the automation and digitization of processes also ensures cost reduction [23].

In addition, projects require the analysis of both quantitative and qualitative data in order to have more robust results and a more resilient response. Currently, most systems focus on quantitative data, leaving aside qualitative

variables such as: cultural aspects, political issues, social dynamics, population responses to emergencies, relationships with suppliers, trade agreements, material source, resource availability, etc. additional nutritional needs (in the case of infant formulas), among others. These variables are crucial to determine a stock and supply plan appropriate to the needs of the area, with an emergency inventory for times of crisis and backup plans for unforeseen situations.

In order to carry out the supply plans, the tools analyzed in the present paper (project management, flexible and intelligent supply chain, industry 4.0 and risk analysis) are key to know the situation in real time and keep records of the risks to which we are exposed to make the decisions that lead us to have a competitive advantage and mitigate the damage within the supply chain.

4. Conclusions

Everything that is produced has an expected date of use and disuse, and that is the importance of project management. A project manager must always keep in mind that the product is available when it is needed, where it is needed and in the conditions in which it is needed.

We must bear in mind that situations can always arise that entail a risk in the management of our projects, it is at this point that the project manager must put into practice all his skills keeping an open mind to be able to solve everything that arises. presents itself in the way of project management and obtain results as close to those expected.

In the case study that we address, we could conclude in the first instance that the delay is not the fault of the company but that it is a problem of the supply chain that provides us with the product, but it is not, of course. We will not always be able to have control of everything, but we must have as much control as possible inside and outside our process. We can only achieve this by having full knowledge of the areas involved, and what is happening in real time, in order to be able to anticipate, carrying out an analysis of what could go wrong (the risks) to eliminate them before they occur or mitigate them.

It is important to remember that a project does not have to be perfect, and that unforeseen events are the rule rather than the exception. Consequently, projects must be approached with the idea that it is dynamically changing in terms of quantitative and qualitative variables that affect the user for whom we are working.

This approach could be used for several products, understanding that in a complex system, additional factors could intervene more significantly than others in the decision-making process.

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