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Industry 4.0: expectations, impediments and facilitators

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Abstract. Industry 4.0 encompasses the main technological innovations transforming the physical, digital and biological pillars and promoting changes that affect the economy as a whole. In each company, the transition to the use of new technologies is established in a different way and the diagnosis of strategic objectives in the medium and long term to understand the organizational scenario can facilitate this process. The philosophy of Lean Manufacturing appears in the literature and in this research as an important facilitator. The methodology used to carry out this article was exploratory, qualitative and quantitative, through a survey applied to 51 managers in the industrial area of companies in the automotive segment in Brazil. The main results showed that the increase in productivity and cost reduction are expected gains, that the low level of use of new technologies, connectivity, knowledge about the theme, among others, are configured as impediments to the transition, highlighting that the association of Lean Manufacturing and the technologies of Industry 4.0, can accelerate this process, minimize possible risks and facilitate solutions for implementation.

Keywords: Lean Manufacturing, Technology, Automotive Segment.

1 Introduction

The concept of Industry 4.0 encompasses the main technological innovations in the fields of automation, control, and information technology [1] emerging as an opportunity towards competitiveness. Part of the fourth industrial revolution, it is configured as a technological trend based on cyber-physical systems, the internet of things, big data, and cloud computing, which are technologies that seek to serve an advanced manufacturing system transforming the physical, digital and biological pillars and promoting changes that affect the economy as a whole [2].

The transition to Industry 4.0 is not restricted to the use of technological resources, but also to information systems, organizational structure, and culture. Establishing itself differently in each company leads to the need for diagnosis of strategic objectives in the medium and long term for a better understanding of the organizational scenario [3].

Although there is no broad knowledge about the consequences for manufacturing operations, the transition appears to be inevitable, leading companies to define their manufacturing model and plan a program for transformation [4]. Knowledge about Industry 4.0 is an important requirement for the use of new technologies, but in Brazil, industry users, in general, have low knowledge on the subject, requiring greater dissemination on the subject [5].

Another issue to highlight in relation to the transition refers to the philosophy of Lean Manufacturing, since the association of lean concepts and technologies of Industry 4.0, can accelerate this process, minimize possible risks and facilitate solutions for implementation [6].

Although the cost of the technologies needed for digital transition is decreasing, in Brazil, companies still face many obstacles, such as tax burden, logistical costs, and obtaining financial and intellectual capital [7]. Despite the difficulties in making this transition, the technologies covered by Industry 4.0 appear not as an obligation to implement, but as a real possibility of expectations of gains.

In this context, the most varied segments are affected by this scenario, and the automotive sector stands out for its relevance in the national economy. Considering the pillars of Industry 4.0, the competitiveness, and requirements of companies in the automotive segment, the question studied in this article is: How is the automotive industry in Brazil preparing for the transition to Industry 4.0? Aiming to identify and analyze the impediments, expectations of gains, and facilitators for this transition.

2 Literature Review

Industry 4.0 based on nine pillars: big data, autonomous robots, simulation, vertical and horizontal integration systems, internet of things, cyber-physical systems, cloud, additive manufacturing or 3D printing, and augmented reality [8], is based on the use of technologies that drive the transformation of the manufacturing process into digitized and intelligent [9].

New technologies and intelligent systems with advanced standards of human-machine interaction allow specificity and communication for each component of the value chain. The use of these technologies offers more comprehensive impacts in the productive sector and indirectly in other departments and can also lead to productivity gains [10]. It is noteworthy that communication in the productive chain occurs through the connectivity between devices, sensors, machines, and software [11].

The information obtained and the analysis of data between machines, streamlining, and flexibility in the production environment can make the processes more efficient with increased manufacturing productivity, leading to the production of higher quality goods at lower cost, changing the profile of the company. workforce, with a consequent improvement in competitiveness [12]. In this way, the diversity of technologies can provide more intelligent, productive, and efficient factories that stimulate economic growth and development [13].

There are many changes in the production environment caused by the use of technologies that enable production planning in a more dynamic way and the use of techniques for market analysis [14]. In the automotive industry, the development of different technologies for the production of intelligent vehicles was propitiated by the paradigm shift from high-performance vehicles to safe and comfortable vehicles, a standard of comfort and safety that can be obtained by autonomous cars, which perceive environments driving and carry out the planning and control of the route without human intervention. The development of autonomous cars aggregates technologies from the automotive industry and mobile robots, creating reliable mechanical and electrical platforms [15].

In Brazil, studies indicate that the use of digital technologies impacts the value chain of products, business models, and commercial integration, leading to important gains in productivity, providing national and international competitiveness [16, 17].

In the literature, references were found to elements that facilitate the implementation of Industry 4.0: culture of innovation and change, and the lean manufacturing management philosophy. The latter, also known as Toyota production system, is considered a method of improving manufacturing with a focus on the customer and one of the most used business strategies in the last three decades [14, 18]. Thus, Industry 4.0 associated with lean manufacturing provides benefits for companies in general, facilitating the transition process [19].

3 Method

The method used to carry out this article was of a qualitative and quantitative nature and the segment chosen was the automotive, composed of automakers and auto parts.

The primary data were obtained by the survey method, with 60 questionnaires being sent in January 2020, to directors, managers, supervisors, and leaders, who carry out activities in the areas of manufacturing and industrial engineering in companies in that segment.

The form consisted of 12 questions, presented at random, to be filled in via the electronic platform, with 2 questions being for the qualification of the sample. In the elaboration of the other questions, relevant aspects about Industry 4.0 were considered, such as the use of new technologies, impediments, expectations of gains, and facilitators for the transition. In constructing the questions, the theoretical framework on the subject was taken as the base [3] and based on the professional experience of the authors.

Of the 60 questionnaires sent, 51 returned answered and 9 did not justify their absence. The surveyed sample corresponds to 75% of small and medium-sized auto parts companies and 25% of automakers. Secondary data were obtained from bibliographic references and in the analysis of the results, the professional experience and participation of the authors in the segment were also considered.

4 Results e discussions

The results found were reported in the tables based on the responses of the research participants. Table 1 identifies the current scenario of the companies surveyed in relation to the use of new technologies, making investments, knowledge about Industry 4.0 and data connectivity.

Table 1 – Portrait of companies in relation to transition to Industry 4.0

Questions	View of the participants
Knowledge about Industry 4.0.	100% consider the topic important and claim to have some knowledge.
Making investments	Last 2 years: 25% made large investments, 3% small investments and 72% no investment; Next 5 years: 16% intend to make large investments, 80% small investments and 4% no investment.
Data connectivity	94% report a low level of data connectivity between their company, suppliers and customers.
Use of sensors in production machines and equipment.	49% indicate that the machines do not have sensors, but installation is possible; 51% claim that the machines have sensors that provide partial data.
Control level of the machines (IT network).	80% report that the level is low or nonexistent; 20% indicate that the level is medium/high.
Communication level between machines.	78% indicate that the level is low or nonexistent; 22% claim that the level is medium/high.

Source: (Prepared by the authors)

The research participants claim to have knowledge on the topic (table 1), however, in the analysis of the responses, it was noticed that the level of knowledge of the participants in relation to Industry 4.0 is embryonic since they indicate the lack of knowledge as bottleneck to the transition as described in table 3, as it occurs in industries in general [5].

Investments in new technologies appear to be insufficient, as in the last 2 years 72% of the companies surveyed have not made any investments and for the next 5 years 80% intend to make small investments, a situation that is configured as an obstacle to Industry 4.0, considering that regardless of the transition stage of each company, it is necessary to make investments [20]. It is worth mentioning that the share of high investments mentioned refers only to the automakers corroborating with secondary research in which the automakers, in Brazil, represent the share of companies with a greater possibility of investing [7].

The difficulty in relation to connectivity pointed out by 94% of the participants is in line with research in Brazil [21], in which 91% of the companies are not connected. Thus, the low level of use of digital technologies, equipment infrastructure and sensors for data collection shown in the results (tables 1 and 2) may justify the mentioned connectivity difficulties.

The use of sensors in production machines and equipment and especially the level of control and communication between machines was reported by the participants as low level, which added to the lack of connectivity and the low level of investments may explain part of the difficulties for use of new technologies as shown in Table 2, which presents the use of technologies related to Industry 4.0, considering the perception of the survey respondents.

Table 2 – Use of technologies

Technologies	Not applicable	Null	Low	Medium	High
Big Data Analytics	6%	58%	10%	6%	20%
Cloud computing	6%	62%	6%	6%	20%
Communication between machines	2%	45%	25%	8%	20%
Robots	12%	60%	2%	10%	16%
Communication with machines via cell phone	4%	60%	10%	10%	16%
Real-time location system	4%	62%	8%	10%	16%
Process simulation	8%	66%	2%	8%	16%
3D printing	0%	39%	33%	16%	12%
Artificial intelligence	6%	66%	8%	10%	10%
Use of RFID to tag products and components	2%	66%	8%	22%	2%

Source: (Prepared by the authors)

In the analysis of table 2, it can be seen that the use of new technologies in most of the companies surveyed is still low and/or null in all modalities. However, in the details of the data, it was found that the percentages classified as medium and mainly high refer to the responses of the participants in the assemblers.

The scenario shown in tables 1 and 2 supports the bottlenecks depicted in table 3 which identifies, in addition to the impediments, the facilitator and the expectations of earnings of the referred companies.

Table 3 – Impediments, facilitators and expectations of gains

Questions	Expectations/impediments
Bottlenecks that hinder the transition.	Lack of connection between participants in the business chain; unavailability of financial resources; lack of indicators to measure return on investment; economic crisis or other external factors; restricted knowledge, lack of interest in the transition and qualified labor to use new technologies.
Importance of Lean Manufacturing with facilitator for Transition to Industry 4.0.	96% of respondents consider the use of Lean to be important for the transition to Industry 4.0.
Gains to be obtained from the transition to Industry 4.0.	Agility in production processes; greater availability of information; cost reduction and product quality improvement.

Source: (Prepared by the authors)

In table 3, the bottlenecks indicated by the respondents were the lack of connection, low investments, lack of qualification of manpower and little interest from managers. These impediments that are reported in secondary research [22] that point beyond the mentioned bottlenecks, others such as high logistical costs and precarious infrastructure, highlighting that some companies are in a more advanced stage of technological development and have more abundant financial resources.

The managers' lack of interest in making the transition may be related to the low knowledge, already mentioned, about Industry 4.0, as well as the respondents' perception that the gains with the transition are limited. It is noteworthy that secondary research also classified the knowledge of the industries in general as superficial when compared to the real qualification needs of the people involved [5, 23].

Considering that studies in Brazil [17, 24] point out that the level of investment is guided by the search for cost reduction and productivity gains and that the respondents of the research identified these searches as earnings expectations, the low level of investment indicated in table 1 and referred to as an impediment in table 3, it can hinder the transition process due to the lack of investments.

Despite the identified obstacles, 96% of the research participants highlighted Lean Manufacturing as an important factor in the transition to Industry 4.0, as well as highlighted in the literature that places Lean as one of the most applied and used business strategies as a basis for the implementation of new technologies [18], offering benefits to companies in general [14, 19].

It is important to mention that Lean focuses on eliminating waste, segregating what does not add value, that is, it optimizes the production process, confirming the proposal in the literature in which the association of technology and lean manufacturing can streamline the process and minimize possible risks, facilitating the implementation of Industry 4.0 [6]. That said, it can be said that the management philosophy of Lean Manufacturing and the technologies of Industry 4.0, in addition to walking together, complement each other, being more than an association becoming a synergy.

5 Conclusions

The objective of this study was to identify and analyze the impediments, gains and facilitators so that companies in the automotive segment can make the transition to Industry 4.0. Based on the results, it was possible to understand that the researched companies have been conducting this transition process at a slow pace, considering the low use of new technologies, caused by impediments such as low level of investment, connectivity and knowledge on the subject. The most cited earnings expectations were the increase in productivity and cost reduction, however this opportunity is still distant, for these companies, given the scenario portrayed in the present research.

Despite the mentioned obstacles, Lean Manufacturing appears as an important facilitator for the transition process, both in the literature and in the opinion of the research participants. Thus, the association of Lean with the technologies of Industry 4.0 opens the way to structure and streamline the transition process in the automotive segment in Brazil.

The main contribution of this article was to point out the means to facilitate the access of companies in the automotive segment to the process of transition to Industry 4.0, detecting the main impediments that need to be resolved so that the expectations pointed out are converted into gains.

Like all research, this study has limitations related to nature, especially due to the sample size, not concluding conclusions. Thus, other studies in different segments or times may present different results. As a proposal for future studies, it is recommended to further detail the development conditions for the use of Industry 4.0 technologies adapted to the Brazilian reality.

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