Analysis of the use of industry 4.0 technologies as competitive advantage

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ABSTRACT

Industry 4.0 was born amid a technological breakthrough and development which set information out to become a valuable element in strengthening competitive advantages and innovation processes to improve organizations productivity performance. For this, the scientific and business community is debating the negative and positive effects of these technologies and their relationship with business management, in the search for sustainable solutions for organizations. In this sense, the main purpose of this article is to identify the perceptions of SME managers in Colombia on the importance of implementing information technologies to promote competitive advantages that match the pace of industry 4.0. The research method used in the study was analysed by sampling using the questionnaire as a data collection tool. 75 managers provided complete and useful answers to this research. The collected data were analysed using different regression models were carried out; showing like principal results that a greater use of these technologies generates a positive impact on the competitive ad-vantage related to price/cost, quality, delivery reliability, product innovation and time to market. Statistical Package for the Social Sciences (SPSS) was used to the analysis.

Análisis del uso de las tecnologías de la industria 4.0 como ventaja competitiva

RESUMEN

La Industria 4.0 nació debido a un gran avance y desarrollo tecnológico que han llevado a que la información se convierta en un elemento valioso para fortalecer ventajas competitivas y procesos de innovación para mejorar el desempeño productivo de las organizaciones. Para esto, la comunidad científica y empresarial está debatiendo sobre los efectos negativos y positivos de estas tecnologías y su relación con la gestión empresarial, en la búsqueda de soluciones sostenibles para las organizaciones. En este sentido, el objetivo principal de este artículo es identificar las percepciones de los gerentes de pymes en Colombia sobre la importancia de implementar tecnologías de la información para promover ventajas competitivas que coincidan con el ritmo de la industria 4.0. El método de investigación utilizado en el estudio se analizó mediante muestreo utilizando el cuestionario como herramienta de recolección de datos. 75 gerentes proporcionaron respuestas completas y útiles a esta investigación. Los datos recolectados se analizaron mediante diferentes modelos de regresión que se llevaron a cabo; mostrando como principales resultados que un mayor uso de estas tecnologías genera un impacto positivo en la ventaja competitiva relacionada con precio / costo, calidad, confiabilidad en la entrega, innovación de producto y tiempo de comercialización. Para el análisis se utilizó el paquete estadístico para las ciencias sociales (SPSS).

Palabras clave: industria 4.0; tecnología; ventaja competitiva; rendimiento empresarial.
Clasificación JEL: O14, M15.
MSC2010: 62J05, 62P25.

1. Introduction

Industry 4.0 is a term that was defined in Germany in early 2010 in reference to industry digital transformation known as "smart factory" or "industrial internet", thus coining it as the fourth industrial revolution (Morales, España, Zárate, González, & Frías, 2017). This new industrial revolution is based on the development of intelligent process chains, that communicate with each other as in means of production, machines, components, human talent, etc. (Magruk, 2016). In this way, Industry 4.0 is constituted as an alternative to adapt to the changes brought about by market demand, based on interconnection elements, generating greater customer satisfaction and a considerable improvement in business performance.

According to Lobova, Bykovskaya, Vlasova, and Sidorenko (2019), the concept of Industry 4.0 is attractive to both modern academic and economic contexts for two main reasons; the first being that innovation is linked to socio-technological progress that reconditions the new industrial revolution and that is expected throughout the global economy; the second reason is based on the expected high effectiveness of Industry 4.0 and its ability to solve modern global issues. Despite the intense growth in production volumes, modern technologies are lagging with regards to the increase in the consumption needs of society, this is mainly caused by social problems instead of natural ones, meaning that they are mostly artificially created.

Likewise, it is noticeable that companies today are focusing on the creation of value for the customer, who are increasingly aware and demanding regarding delivery time services, product availability and reliability (Witkowski, 2017). Also, companies can find developing these new technologies and identifying their competitive advantages as a great ally to towards achieving their strategic objectives. Advances in this regard are aimed at optimizing costs and reducing deadlines, reaching new markets, and facilitating consumer analysis. Therefore, offer companies new alternatives for doing business and gives them the ability to adapt to new changes in the market, facilitating the exchange of digital information between buyers and suppliers, increasing their interaction, trust and distribution benefits (Müller, Veile, & Voigt, 2020).

In accordance with this, and following Industry 4.0 concepts, new technologies have been developed where the use of these resources is a fundamental component in the optimization of company processes thus generating or strengthening their competitive advantages. This development also proposes new business management models supported by these technologies (Internet of Things, Big Data, robotics, etc.), matching the needs of the value chain and involving all actors in the product life cycle, from design to customer service. Thanks to these technologies, opportunities are created to satisfy customer needs, logistics processes and supply chain management (Witkowski, 2017). Industry 4.0 technologies for businesses; it provides benefits such as improvement in sales, increase in production amount and per capita production, increase in capacity, improvement in production speed and quality (Calış & Akdemir, 2021).

However, not each of these new alternatives offered by Industry 4.0 are within everyone's reach; some because of the expensive cost of adopting them, gaps in personnel expertise, needs of organizational culture, lack of internal training in the digital domain, and others (Türkeş et al., 2019). Additionally, and according to Shamim, Cang, Yu, and Li (2016), quantitative studies are needed to demonstrate the impact of these technologies on the different processes of a company, and to make it easier for managers to make investment decisions and adopt these technologies in each of their processes. In this sense, it is necessary to identify which elements can be benefited within an organization to facilitate the decision-making of managers in the implementation of these technologies.

This study will motivate the transition of organizations to Industry 4.0 and the results will provide managers with guidance to identify their benefits, define priorities, be a guide for the evaluation of Industry 4.0 and provide real possibilities to make appropriate decisions in this area. For this, the objective of this study is to empirically demonstrate the relationship between the use of Industry 4.0 technologies and the creation of a competitive advantage in organizations. To conclude, the goal is to

demonstrate and contribute to the academic and business community that those companies that use these technologies to a greater extent, will more easily identify their competitive advantages to face, more demanding markets within their own potential.

2. Literature review

We are witnessing a new industrial revolution known as Industry 4.0, which has a high impact on company production and management. This new industrial revolution is strongly based on technological innovation due to developments, such as IoT (Internet of Things), Big Data, Business Analytics, robotics, flexible production, 3D printing, among others. Its incorporation has been a great challenge for organizations as well as a reality that has quickly gained notoriety in the development of competitive and strategic advantages. These technological advances allow automation in almost all fields and combines the physical, digital, and biological worlds, fundamentally changing life patterns and human interaction.

Studies related to the adoption of industry 4.0 indicate that the most developed countries have come a long way, which explains why organizations today are more prepared to implement these technologies (Lobova et al., 2019). However, this situation is not the same for all types of companies, finding differences between large companies and Small and medium-sized enterprises SMEs, the former being the most prepared (Horváth & Szabó, 2019). Other studies show that organizations differ greatly in terms of what types and how many technologies they should adopt and how far along they are in their level of implementation (Dalenogare, Benitez, Ayala, & Frank, 2018). Added to this, several organizations lack the understanding of the industry 4.0 concept, which leads to attitude issues towards its adoption, as well as decision making issues; meaning that some managers are less inclined to towards adopting these technologies and strategies in their organization (Hamada, 2019).

On the other hand, research has confirmed the positive impact of technologies in company performance, not only in terms of productivity, but also processes, quality of services, market share, flexibility, value chain management, customer satisfaction, innovation, etc. (Bayo, Billón, & Lera, 2008). In this sense, industry 4.0 technologies present an approach with high expectations in terms of performance improvement as a result of their implementation, demonstrating that they can not only be used to perform internal optimizations, but also have high potential to offer their own services to the market (Müller & Däschle, 2018). This confirms that its potential for technological development will be reflected positively at the level of industrial performance and sustainable performance in SMEs (Büchi, Cugno, & Castagnoli, 2020; Dalenogare et al., 2018; Ghobakhloo, 2020; Haseeb, Hussain, Ślusarczyk, & Jermsittiparsert, 2019; Nara et al., 2021).

Likewise, technologies related to industry 4.0 (big data techniques, machine learning, data mining, crowdsourcing and time frequency analysis, etc.) have been developed to obtain useful information that helps organizations understand current and past market behaviors to predict their future needs and direction by producing innovative business models, projects, products, and services. Leveraging large volumes of data yields enormous benefits as they can be used to reduce production costs and working capital, and to further increase productivity, improve quality, and generate more business revenue for both sectors (Berawi, 2018). In addition, intelligent systems could improve the flexibility and performance of the supply chain, which would allow organizations to be better prepared to face and recover from unexpected events and respond to highly dynamic factors in the business environment (Ralston & Blackhurst, 2020). For this, it is important that companies recognize that the use of these technologies makes the flow of information between the production line, business management and supply chain management more transparent and organized, reflecting in the reduction of labor costs (Fatorachian & Kazemi, 2020).

3. Industry 4.0 as a competitive advantage

Competitive advantage is the ability companies must formulate strategies that allow achieving profit opportunities through maximizing the income of the investments made. According to Malik (2019), there are at least two basic principles that companies must have to achieve a competitive advantage; the value of customer opinions and the uniqueness of their products. The value perspective is given by the customer's opinion, who obtains a certain value from economic transactions with the company, which is why, the company should focus on the customer's needs and expectations. On the other hand, the uniqueness of the product is characterized by the goods and services developed by the company that cannot be easily imitated by competitors.

The future of SMEs depends on the recognition of their own strengths which, to a large extent, give them the ability to respond to their clients' expectations while maintaining a competitive advantage in their respective market (Moeuf, Pellerin, Lamouri, Tamayo-Giraldo, & Barbaray, 2018). In this sense, and according to Bratić (2011), some of the dimensions that must be taken into account to evaluate the competitive advantage of a company are regarding price / cost (an organization is capable of competing against the main competitors based on low price); quality (an organization is capable of offering product quality and performance that creates greater value for customers); confidence in delivery (an organization is capable of providing the type and volume of products requested by the customer on time); innovation product (an organization is capable of introducing new products with new characteristics to the market); customer needs (customer demand for new features is well addressed); time to market (the organization is capable of introducing new products faster than its main competitors). In this line, and according to Masood and Sonntag (2020), each of these dimensions identifies key benefits through the implementation of industry 4.0 and that are also documented in the literature and that include: cost reduction, quality improvements, efficiency, flexibility and productivity, and competitive advantage (Kusiak, 2018).

The development of these dimensions will allow the business to define its strategy and the necessary tools to guide its processes. In this sense, applying information technologies can be one of the main enhancers of such dimensions and, at the same time, a generator of competitive advantages due to the fact that contemporary companies are widely using the technology roadmap as a framework to support future technologies that could maintain a competitive advantage in research and development (Lee, Phaal, & Lee, 2013).

Likewise, industrial production must take advantage current technologies and make extensive use of them to meet heterogeneous customer needs through individualization and the realization of scale effects throughout the value chain (Brettel, Friederichsen, Keller, & Rosenberg, 2014). To achieve greater efficiency and competitiveness in these processes, companies that are heading towards Industry 4.0 must be aware of the innovation opportunities that are presented to them (Pereira & Romero, 2017). Therefore, Industry 4.0 is characterized by innovation and the introduction of new products and services as integrated systems that can be responsive and interactive being able to manage and track its activity in real time, optimizing the entire value chain and providing relevant information about its state during its life cycle (Kagermann, Helbig, Hellinger, & Wahlster, 2013).

For Witkowski (2017), the automation process developed by 4.0 technologies facilitates supply chain segmentation focusing on customer demands and specific needs, which helps reduce stock volume and, therefore, optimize costs. Likewise, through the use of advanced algorithms, the software allows to calculate the optimal intermediate transport routes and allows the manufacturing process to be carried out with the aim of obtaining the lowest cost or time (Trstenjak & Cosic, 2017). In addition, companies can achieve improvements in their performance in terms of flexibility, costs, productivity, quality, and delivery times using these technologies. Nonetheless, it is important that they recognize the need for a new set of managerial capacities that this new management model demands (Moeuf et al., 2018).

Thus, this automation and connectivity in value chains leads to reduced delivery times and improved quality (Oesterreich & Teuteberg, 2016). The use of these technologies and integration within

the different actors and stakeholders of the supply chain will guarantee full coordination and alignment within each phase of the value chain. Thus, for example, the transports will be able to communicate their location and expected arrival time to the intelligent warehouse management system, which will be able to select and prepare their arrival, thus optimizing the delivery time in the appropriate and required sequence. Simultaneously, RFID sensors will report what has been delivered and send tracking and location data throughout the supply chain. The system will automatically allocate storage space according to delivery details and autonomously order the right equipment to move the goods to the right location (Barreto, Amaral, & Pereira, 2017).

Due to Industry 4.0 growth out of a breakthrough in information and data technology, we now have valuable insight that will allow companies to better organize and manage their systems and improve productivity performance and further innovation in order to deliver more competitive advantages for organizations (Berawi, 2018). With the use of these technological and human talent improvements, higher product quality and income are also expected with less delivery time (manufacturing) and low product cost (Trstenjak & Cosic, 2017). Finally, this technological development has also allowed an industrial symbiosis, which describes the cooperation (between companies) of different factories as an alternative to obtain a competitive advantage through trade and product exchange, materials, energy, water and intelligent data to a local level. This concept towards an integral efficiency of resources is described as one of the essential advantages of Industry 4.0 (Stock & Seliger, 2016).

Finally, and as mentioned above, Industry 4.0 is a very broad research area where it is necessary to quantitatively demonstrate which elements can be benefited within an organization to facilitate the decision-making of managers in the implementation of these technologies. Based on the literature adjacent to Industry 4.0, which shows the benefits of the use of these technologies and their impact as a competitive advantage within the dimensions proposed by Bratić (2011) (price, quality, delivery reliability, product innovation and time marketing), the following are proposed as study hypotheses:

- Hypothesis 1: The level of use of industry 4.0 technologies is positively linked to a better price as a competitive advantage.

- Hypothesis 2: The level of use of industry 4.0 technologies is positively linked to product quality as a competitive advantage.

- Hypothesis 3: The level of use of industry 4.0 technologies is positively linked to the reliability of product delivery as a competitive advantage.

- Hypothesis 4: The level of use of industry 4.0 technologies is positively linked to product innovation as a competitive advantage.

- Hypothesis 5: The level of use of industry 4.0 technologies is positively linked to time to market the product as a competitive advantage.

In accordance with these hypotheses, a theoretical research model is presented with which it is intended to relate the study variables and respond to the proposed research objective. These variables and hypotheses organized in Figure 1 have been the support for the design of the research instruments that have been applied within the study sample. The variables age and size have been taken as control variables.

Figure 1. Theoretical research model.
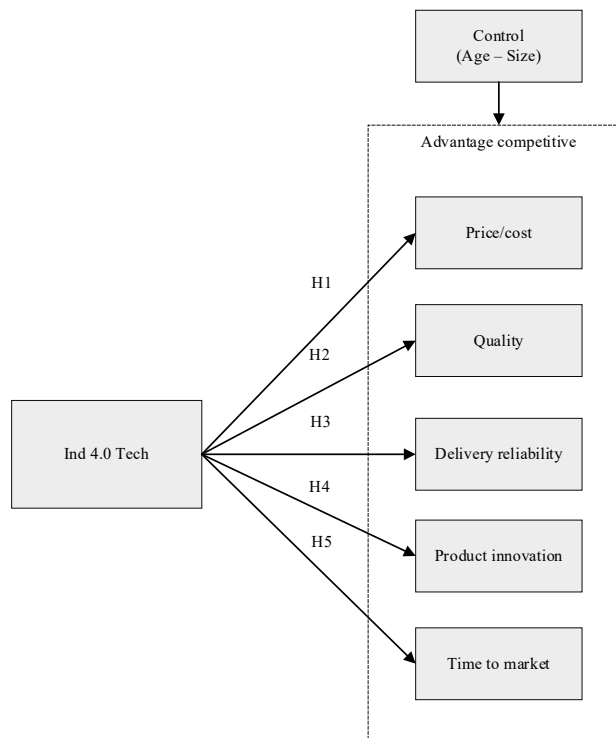
Source: Own elaboration.

Unlike previous studies (Adamik & Nowicki, 2018; Natalia & Ellitan, 2019; Pietrewicz, 2019), this document combines competitive advantage variables to provide a better interpretation of Industry 4.0. To our knowledge, no previous empirical work has considered the context of competitive advantage in all its dimensions, which is essential to understand the phenomenon.

The importance of these analysis elements lies in the fact that organizations can achieve a competitive advantage using these information technologies, which have contributed significantly to the economic and social development of today's society (Rivero, Soler, & Delgado, 2022). For this it is important to know that today's customer sees each of these elements as tacit in the product or service delivered by the company, which frames the importance of its analysis. In addition to this, it is important to understand its application in these business aspects of competitive advantage to facilitate its implementation processes (Wippel, 2021).

4. Method

This study has the characteristics of a quantitative approach, since "It uses data collection to test hypotheses and is based on numerical measurement and statistical analysis to establish behavioral patterns and test theories" (Hernández, Fernández, & Baptista, 2010, p.4). Likewise, it has both descriptive and correlational study conditions, since it describes trends in a group and associates variables using a predictable pattern for a target population. The data was obtained through a questionnaire aimed at identifying the use of Industry 4.0 technologies for business development. The questionnaire focused on SMEs and was distributed in the months of February to April 2020 in various industrial sectors. Different free databases were used to identify the relevant population. All the companies were contacted via email and some in person. In total, 98 questionnaires were received, of which 23 were cancelled because they were not adequately completed or did not meet the sample characteristics. The study sample consisted of 75 companies of different sectors that answered the questionnaire (95% confidence level, $pq = 0.50$: 11.3%). The highest percentage of the sample obtained

was from the Information and communications (29.1%), services sector (22.8%), Manufacturing industries (18.1%) and professional, scientific, and technical activities (10.2%). Table 1 shows the distribution of the sample classified according to economic activity.

Table 1. Distribution of the sample by economic activity.

Activity	Sample percentage
Information and communications	29.1
Other service activities	22.8
Manufacturing industries	18.1
Professional, scientific, and technical activities	10.2
Construction	4.7
Transport and storage	3.1
Agriculture, livestock, hunting, forestry, and fishing	1.6
Accommodation and food services	1.6
Administrative and support service activities	1.6
Education	1.6
Electricity, gas, steam, and air conditioning supply	0.8
Water distribution, waste management and environmental sanitation activities	0.8
Wholesale and Retail; repair of motor vehicles and motorcycles	0.8
Financial and insurance activities	0.8
Real estate activities	0.8
Artistic, entertainment and recreation activities	0.8
Activities of extraterritorial organizations and entities	0.8

Source: Own elaboration.

To measure the use of industry 4.0 technologies within the company, entrepreneurs were asked to indicate how they consider the level of use of each (1. Big Data and Analytics, 2. Autonomous robots, 3. Simulation, 4. Horizontal and vertical system integration, 5. Internet of Things, 6. Cybersecurity, 7. Additive Manufacturing, 8. Augmented Reality, 9. Cloud Computing, 10. Mobile Technologies, 11. Artificial Intelligence, 12. Radio Frequency Identification (RFID) and Real-Time Location System Technologies). This variable consists of the arithmetic mean obtained from a Five-point Likert scale (Alpha Cronbach (0.950), KMO (0.900) and Bartlett (0.000). In addition, the McDonald's omega has been used to confirm the reliability of the scale. For this, the omega coefficient, unlike the alpha coefficient, works with factor loadings that are the weighted sum of the standardized variables, a transformation that makes the calculations more stable and reflects the true level of reliability (Hayes & Coutts, 2020). To consider an acceptable value of reliability through the omega coefficient, they must be above 0.700 (Streiner, 2003). For this case the value obtained is 0.948.

Regarding the level of company competitive advantage, a multidimensional model based on Bratić (2011), has been proposed to measure it, for which the following 5 dimensions have been chosen: price, quality, delivery reliability, product innovation and time to market. This variable consists of the arithmetic mean obtained from a five-point Likert scale in each of the evaluated dimensions where 1 means that the respondent strongly disagrees and 5 that he strongly agrees. Likewise, the KMO is also

adequate, being 0.889 and the Bartlett Test of Sphericity significant (0.000). On the other hand, the communalities also confirm the suitability of the technique by presenting values for all variables greater than 0.600. Table 2 shows how Cronbach's Alpha statistic validates the scale used (appropriate according to the number of items of each variable).

Table 2 Validation of competitive advantage scales.

Variable	Number of Item	Cronbach's alpha
Price/Cost	CA_P1 CA_P2	0,782
Quality	CA_Q1 CA_Q2 CA_Q3 CA_Q4	0,949
Delivery reliability	CA_D1 CA_D2 CA_D3	0,957
Product innovation	CA_PI1 CA_PI2 CA_PI3	0,730
Time to market	CA_T1 CA_T2 CA_T3 CA_T4	0,878
Global competitive advantage	All Items	0,950

Source: Own elaboration.

Although it is recommended to have at least 3 items on the scale or measurement instrument to be able to estimate the value of Cronbach's alpha coefficient, 2 items have been used for the case of the Price/cost variable, validating its reliability and verifying its use in other studies (Abdelkader & Abed, 2016; Abubakar & Mohammad, 2019; Nyuur, Ofori, & Amponsah, 2019).

The variables size (number of employees in the company) and age (number of years since the constitution or the start of the activity) have been taken as control variables. The results of the descriptive analysis and the subsequent regression analysis are presented below to confirm the analyzed variables correlation.
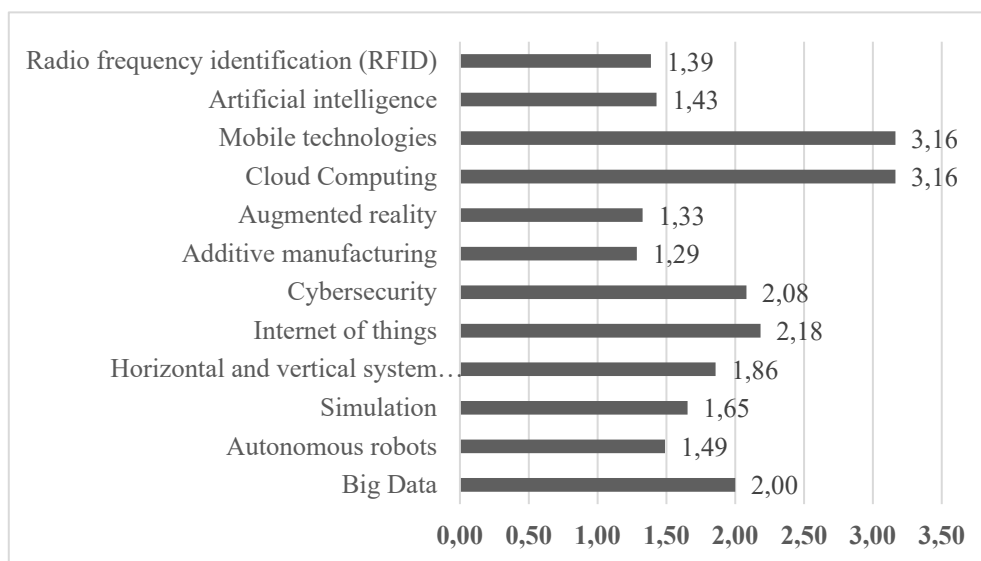
5. Results

5.1. Descriptive analysis

For this analysis, the different variables of interest considered in the research and applied to the sample companies have been reviewed. This analysis describes current state of things regarding the intervening variables: use of industry 4.0 technologies and competitive advantage, which provides information that facilitates the interpretation of subsequent analyses.

The results obtained in the sample showed that the average use of Industry 4.0 Technologies in the surveyed companies is 1.92 out of 5.0; indicating that there continues to be a very low rating, evidence that concurs with other studies (Stentoft, Jensen, Philipsen, & Haug, 2019). After thorough analysis of each of these technologies, it is observed that cloud computing (3.16) and mobile technologies (3.16) are the ones with the highest assessment, which in turn reflects the commitment companies have for these technologies. Likewise, the Internet of Things (2.18) has been showing an increase in its application in companies. Contrary to this, the use of autonomous robots (1.33), and additive manufacturing (1.3) present the lowest assessment and show a still incipient development in the companies and industries of the region. One of the main reasons for the low use of such technologies may be related to purchasing and supply chain necessary for its implementation and operation to be viable. The assessments of each of the technologies is shown in Graph 1.

Graph 1. Average of the individual assessment of industry 4.0 technologies in companies.

Source: Own elaboration.

Regarding the results on the competitive advantage, companies consider themselves to be more competitive with respect to quality (4.1) and delivery commitments (3.9) than in other dimensions. This indicates that companies are committed to meeting the quality requirements demanded by the client and delivering their products on time. When it comes to product innovation, the scores are relatively average (3.5) compared to the other dimensions. For example, price / cost (3.4) and time to market (3.3); although not low, there is a decrease in the assessment of these aspects. Graph 2 shows that, according to company size, those with less than 10 employees have a lower average in terms of these dimensions of competitive advantage compared to medium and large companies. Likewise, it is evident that all companies, regardless of size, have a greater commitment to product quality than to other dimensions.

Graph 2. Analysis of competitive advantage by company size.
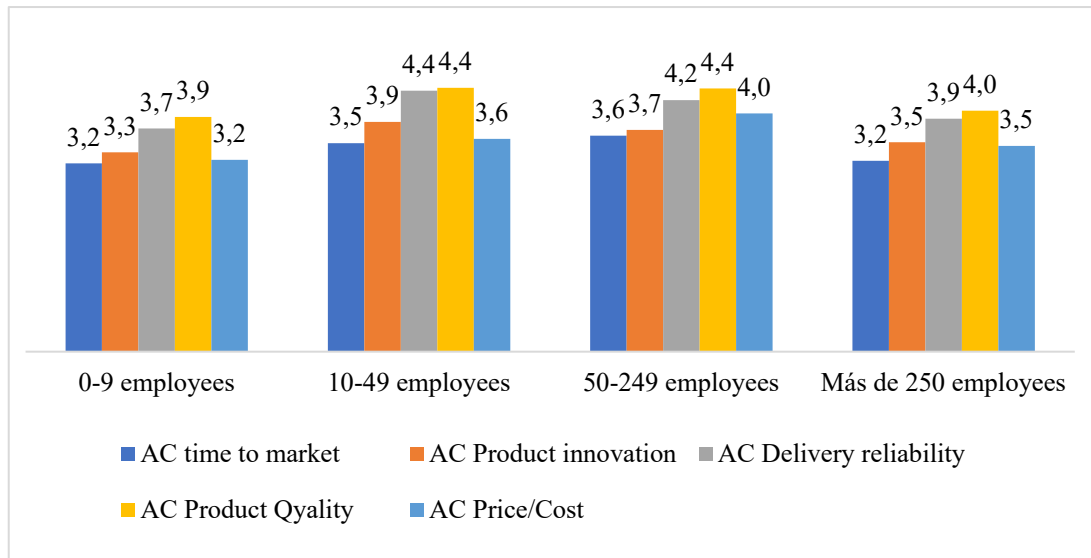
Source: Own elaboration.

5.2. Relational analysis

According to the definition of competitive advantage, the hypotheses suggest that the use of Industry 4.0 technologies can be an important factor for companies to improve and strength then each of the dimensions and aspects that make them more competitive. To test the presented hypotheses the Ordinary Least Squares (OLS) is used. OLS is the best known and most used regression technique in the social sciences, including organizational management in which this research is oriented. Provides a global model of the variable or process you are trying to understand or anticipate; creates a simple regression equation to represent that process. Regression is used to evaluate the relationships that exist between two or more feature attributes. Identifying and measuring relationships allows you to better understand what is happening in a place, anticipate where something is likely to happen, or examine the causes that make something happen in a particular place. This characteristic is important for this study since it allows developing managerial implications (Hair et al., 2010). The following model was considered, using a linear regression by OLS.

$$Y_i = b_0 + b_1 Ind4.0\_TechC_i + b_2 Size_i + b_3 Age_i + \varepsilon_i.$$

The size and age of the company have been taken as control variables. Table 3 summarizes each of the variables used.

Table 3. Summary of Industry 4.0 relation variables and competitive advantage.

Dependent variable Yi	
AC_P/C	Price/Cost as competitive advantage
AC_Q	Quality as competitive advantage
AC_D	Delivery reliability as competitive advantage
AC_IP	Product innovation as competitive advantage
AC_TM	Time to market as competitive advantage
AC_Global	Global assessment as competitive advantage

Explanatory variable	
Ind4.0_Tech	Degree of company use of Industry 4.0 Technologies
Control	
Size	Number of employees
Age	Years of economic activity

Source: Own elaboration.

On the other hand, Table 4 shows the results of the estimate made to examine the relations between the degree of use of Industry 4.0 Technologies and the five dimensions of the advantage competitive. This analysis aims to validate the 5 hypotheses raised that relate the use of these emerging technologies to the generation of competitive advantages. The data was processed using multiple linear regressions by OLS; confirming that the repressors of all the models presented an inflation factor of variance (VIF) that ruled out the presence of multicollinearity.

Table 4. Summary model use of industry 4.0 technologies and competitive advantage.

	AC_P/C	AC_Q	AC_D	AC_IP	AC_TM	AC_Global
Ind4.0_Tech	0.388**	0,406**	0,407**	0,476***	0,491***	0,513***
	2.576	2658	2,662**	3,227***	3,349***	3551***
F	3.076**	2.546**	2,533*	3.802**	3,093**	4.623***
R2 adjusted	0,115	0,088	0,087	0,149	0,160	0,185
Durbin-Watson	1.524	2.063	2.313	2.692	2.117	2.216
Notes: * = p £ 0.1; ** = p £ 0.05; *** = p £ 0.01. Under each standardized coefficient, in parentheses, the value of the t-student statistic. Highest VIF: 1,230. Residual mean for all models 0.000						

Source: Own elaboration.

It is then observed that the use of industry 4.0 technologies in companies generates a positive impact on the perception of competitive advantage at a general level, finding a positive and significant statistic 0.388 (p <0.05). This show that the use of the different technological tools focused on Industry 4.0 are key to improving, in general, the aspects and skills related to competitive advantage in organizations.

Regarding the relationship between technologies related to industry 4.0 and price / cost as a competitive advantage, it is statistically positive and significant 0.406 (p <0.05); confirming that the use of these technologies is associated with a decrease in sale prices. Therefore, the hypothesis is verified (1), and the results are consistent with other authors (Trstenjak & Cosic, 2017). These results show that these technological advances have been aimed at optimizing manufacturing costs and can generate favorable results in this regard for companies as well as for clients.

In the same way, the statistical analysis has identified a significant coefficient between the relationship of using these technologies and the product quality as a competitive advantage 0.406 (p <0.05); this indicates that the use of these technologies in the analyzed companies is associated to better quality product development by said organizations. This result is consistent with what was exposed by Trstenjak and Cosic (2017) with the hypothesis verified (2). Likewise, regarding the relationship of these technologies with delivery times, 0.407 (p <0.05) it is statistically positive and significant, which reveals that the use of these technologies is associated with a decrease in product delivery times

(hypothesis 3). In addition, and in accordance with Trstenjak and Cosic (2017) it is a fact that these technological improvements, accompanied by a qualified human talent, provide greater productivity with less product delivery time (manufacturing).

On the other hand, the relationship between industry 4.0 technologies and product innovation is statistically positive and significant 0.476 (p <0.05); indicating that the use of the analysed technologies means that companies can use the design and innovation of new products as a competitive advantage, for which the hypothesis is tested (4). These results are in agreement with (Alvarez-Aros & Bernal-Torres, 2021; Shamim et al., 2016; Wilkesmann & Wilkesmann, 2018), who proposes that the development of industry 4.0 is compatible and is a strategy that leads to innovation, and, thus, can also be used as a competitive advantage (Berawi, 2018). This is seen in technologies such as additive manufacturing (represented by 3D printing) which is associated with the expected benefits for the development of new products.

Regarding the relationship of the competitive advantage with the time to market, a significant coefficient of 0.491 (p<0.01) has been identified, which reveals that the use of Industry 4.0 Technologies in the analyzed companies is associated with a lower time expectation for companies to bring new products to the market, for which the hypothesis is tested (5). This shows that progress in this regard is also directed towards the reduction of terms and commercialization, giving companies the ability to adapt to new changes in a market that requires greater speed in the purchasing and sales processes.

Once it has been determined that the relationship of the variable ind.4.0 and each of the competitive advantage variables are positive and statistically significant, it can be concluded that it confirms that the variables are linearly related and that the hypotheses initially raised are confirmed. It can be seen in Figure 2.
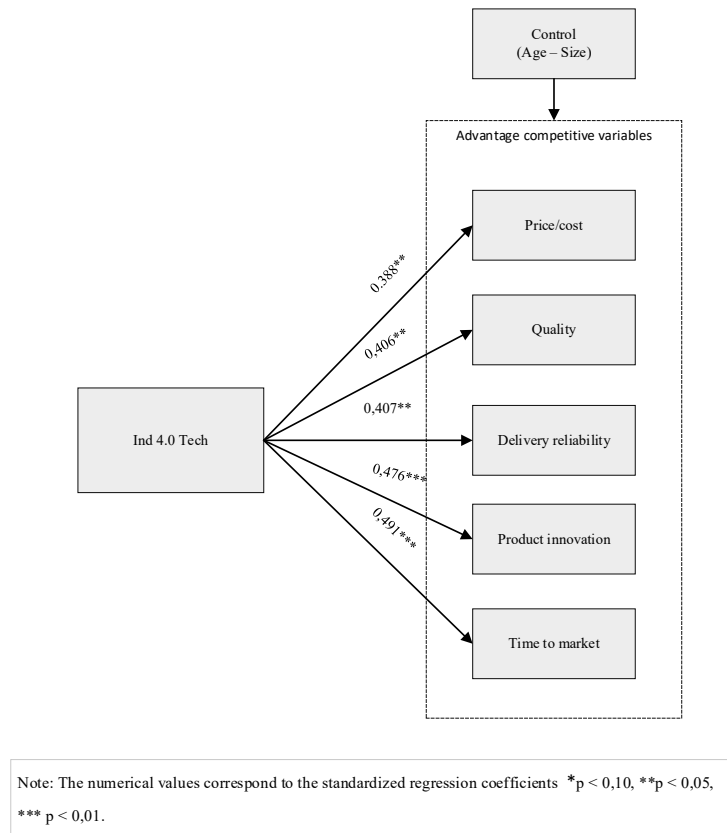
According to our preliminary determination, to drive the successful adoption of Industry 4.0 technologies, companies must have a clear understanding of the benefit of implementing these technologies to generate competitive advantages for their organization in a rapidly changing environment. In this sense, these results satisfactorily demonstrate that the company will be able to strengthen its competencies face to face other organizations with respect to price, product quality, product delivery, innovation, and time to market.

6. Conclusions

Industry 4.0 has been presented as an important alternative to improve the competitive advantages of companies based on the growing volume of data that facilitates decision-making processes and enables new customer requirements to be met. These improvements in competitive advantages are due to the development of new information technologies, which are clearly seen in the different dimensions such as price / cost, quality, product innovation, time to market and delivery times.

Both the literature and the results of this research show that the fourth industrial revolution presents several challenges for companies. We identified a factor that was little covered in previous studies: empirically demonstrating the relationship of industry 4.0 technologies with the generation of competitive advantages. As with any change, organizational resistance to the introduction of new technologies can be expected. For the rest, studies like this one are necessary to facilitate decision-making by managers to move towards this new type of industry.

Figure 2. Representation of the relationships between the Ind 4.0 variable and the competitive advantage variables.

Note: The numerical values correspond to the standardized regression coefficients *p < 0,10, **p < 0,05, *** p < 0,01.

Source: Own elaboration.

The empirical analysis suggested that companies are keen on improving their competitive advantages using technologies related to industry 4.0. Therefore, the adoption of these technologies seems to be keen on improving company that intends to carry out innovative activities and stay afloat in increasingly demanding markets. Despite these findings, and because the implementation of these technologies is still very low, companies still seem to have little confidence in the investment that must be made in these resources. Therefore, we have proposed an explanatory model regarding the use of these technologies, in aspects related to the competitive advantages dimensions. The development of this model can be valuable for the analysis of organizational policies that motivate its implementation and facilitate the company's decision-making so that its development matches the pace that industry 4.0 has been imposing.

Studies related to Industry 4.0 have been growing in recent years, leading to several new research questions. In the future, researchers should explore more aspects related to the management of the implementation of projects related to Industry 4.0 and how these can affect working and leadership conditions.

Acknowledgements

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