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Original article

TECHNOLOGICAL INTENSITY IN THE CUBAN BUSINESS CONTEXT

INTENSIDAD TECNOLÓGICA EN EL CONTEXTO EMPRESARIAL CUBANO

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Abstract

The article aims to delve into the business technological intensity from various perspectives as a support for the procedure for the evaluation, classification and improvement of the degree of technological intensity in the Cuban business context. It starts from the formulation of the theoretical and methodological referential framework of technological intensity. Additionally, the calculation expressions of the business technological capacity, the business technological intensity and the classification of the degree of technological intensity are addressed. Finally, Companies with a Significant Degree of Technological Intensity are compared with High Technology Companies, in relation to various aspects of organizational behavior.

Keywords: technological intensity, technological capacity, degree of technological intensity, company, high-tech company, innovation

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Resumen

El artículo tiene como objetivo profundizar en la intensidad tecnológica empresarial desde diversas perspectivas como soporte del procedimiento para la evaluación, clasificación y mejora del grado de intensidad tecnológica en el contexto empresarial cubano. Se parte de la formulación del marco teórico y metodológico referencial de la intensidad tecnológica. Adicionalmente se abordan las expresiones de cálculo de la capacidad tecnológica empresarial, la intensidad tecnológica empresarial y la clasificación del grado de intensidad tecnológica. Finalmente, se comparan las Empresas de Grado Significativo de Intensidad Tecnológica con las Empresas de Alta Tecnología, en relación a varios aspectos del comportamiento organizacional.

Palabras clave: intensidad tecnológica, capacidad tecnológica, grado de intensidad tecnológica, empresa, empresa de alta tecnología, innovación

Introduction

The fact that technological effort is not uniform in all branches of the economy has been one of the causes of numerous attempts to establish methodologies for measuring the technological environment. Thus, indicators of high technology products and branches stand out and, at the same time, for which the classification of companies according to their technological intensity poses numerous difficulties. On the one hand, the very concept of high technology can refer to both the organizations that produce that technology and those that use it intensively. On the other hand, it must be considered that the determination of the thresholds that delimit the different classification groups is always subject to a certain degree of arbitrariness[1,2] and various measurement criteria.

In Cuba, High Technology Enterprises (EAT) are conceived as organizations that are characterized by showing an intensive activity in R&D&i, high technological standards, closing the cycle of research, development, innovation, production and commercialization of products and services of high added value oriented with emphasis on the foreign market; and constitute a way of connecting and aligning knowledge with production, both due to the results of its own scientific and technological research, as well as the assimilation and use of knowledge from external sources.[3] An inherent characteristic of Cuban biopharmaceutical EATs is closing the R&D&i cycle, while strengthening their external alliances.[4,5]

On the other hand, León García et. al., 2021 proposes the concept of Companies with a Significant Degree of Technological Intensity (EGSIT) and states it as one that has a business strategy based on knowledge management, technology transfer and technological development to achieve new and improved products , processes and services that are based on the support of the research activity and the linking of human capital to innovation projects that add value with efficiency and quality to the marketing activity generated at the national and international level for social and environmental well-being.[6] The concepts of EAT and EGSIT do not differ from each other, they complement each other and both encourage the improvement of their technological capabilities.

The article aims to show the meaning of technological intensity and its contextualization in Cuban companies. The indicator for the evaluation of business technological capacity, technological intensity and the classification of companies according to the degree of intensity is defined. In addition, the EGSIT is conceptualized and compared with the EAT.

Materials and methods

The novelty of this research lies in the conceptualization of the Technological Intensity and the Company with a Significant Degree of Technological Intensity (EGSIT) which can serve as a reference for its generalization in the Cuban business context. To achieve the research objectives, a general index is proposed for the degree of technological intensity based on indicators of technological capacity and intensity. A simplified representation of the General Procedure for the evaluation, classification and improvement of the degree of technological intensity (MECyM-GrIT) is shown in **Figure 1**.

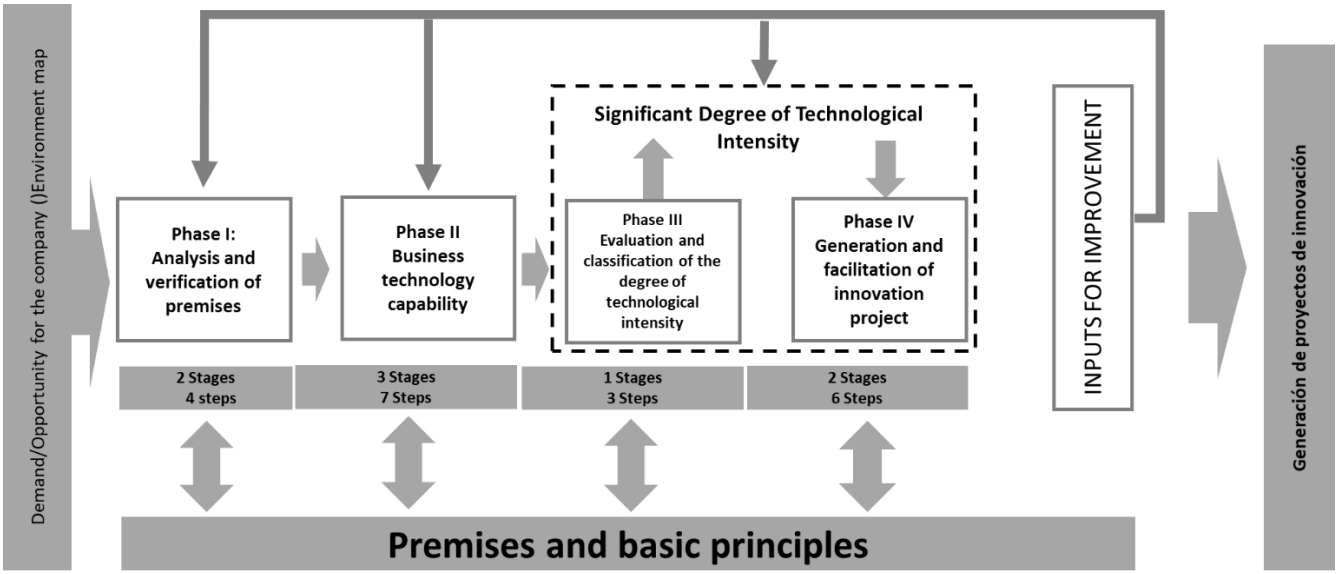


Figure 1. Diagram of the general procedure for the evaluation, classification and improvement of the degree of technological intensity (MECyM-GrIT)
Source: De León, 2021[7]

This article deals with those aspects contained in Phases II and III related to technological intensity. The research method was developed in the following four steps:

- Formulation of the theoretical and methodological reference framework on technological intensity.
- Evaluation of the technological capacity and the degree of technological intensity.
- Comparative analysis between the EGSIT and the EAT.

Results and Discussion

Formulation of the theoretical and methodological framework of reference on technological intensity

Bascolo et al. (2012) states that the classification of technological intensity seeks to capture the technological differentiation of the various industrial branches and identifies four types of sectors: high technology, medium-high technology, medium-low technology and low technology. This classification is based on the direct intensities of Research and Development (R&D) calculated from two measures of production (value added and value of production).[8] The dynamics of R&D processes also generate a

recategorization of the sectors producing goods and services that is part of a temporary classification by virtue of its attributes and may undergo modifications in the scale of technological intensity according to new scientific developments in its conception.[9] Thus, an industrial sector, product or A service that is currently classified as high-tech may cease to be so in a few years, and the reverse may also happen.[10]

On the other hand, the methodology of the Economic Commission for Latin America and the Caribbean (CELAC) classifies various edges for products and goods according to technological intensity, such as primary products and manufactures based on natural resources, low technology, medium technology and high technology.[11] On the other hand, high technology knowledge-intensive sectors have the characteristic of combining both knowledge intensity and technological intensity, and are considered key sectors for the development of the so-called knowledge society.[12]

Technological intensity has been approached from different perspectives: R&D intensity between countries[13-15] and in companies[16-19] technological intensity between countries[14,20,21] and in companies,[22,23,24] as well as the innovative intensity in companies.[14,25-29]

Regarding research on the intensity of R&D between countries, an indicator defined by the ratio between R&D expenses and industrial added value is used, to identify the distance that Brazilian companies are (differentiated into four groups of intensity: high, medium-high, medium-low and low), in terms of technological effort measured by this indicator, in relation to the average of a group of selected countries (12 European countries, Japan, Korea, Mexico and the USA).[15] Investment in R&D has also been evaluated, and with it the intensity and its effect on the performance of Small and Medium-sized Enterprises (SMEs) of 28 countries of the European Union, which are not high-tech (what is commonly studied on this topic are technology-based companies) and they found that this effect is also key in this type of company.[19]

González Bravo and Pargas Carmona (2010) characterized the performance of a group of US SMEs that develop R&D activities in the period 1999-2003, to determine if there were differences in performance according to their intensity in R&D and they found differences mainly in cash flow from operations and in the results obtained in relation to the number of workers and R&D expenses.[16] Likewise, it was verified that these differences were unfavorable for highly R&D-intensive companies, which is an indication of the existence of a critical point of investment in R&D in which its remuneration begins to decline.

A study on numerous countries from various continents considers the intensity of R&D from the investment in R&D as a percentage of the gross domestic product for a country as two key indicators to evaluate the resources dedicated to science and technology.[13] In This study produces a ranking of the innovative performance and R&D intensity of the countries, and it can be seen that the 10 most innovative countries are among the ten that invest the most in R&D. Also, Delgado and others (2008; 2011) carry out studies on some R&D&i indicators, in particular indicators of science and technology products, inputs and resources in 17 European countries using factor analysis, which allowed knowing that the first factorial axis is expressed by the positive variables of European patents, high technology patents per million inhabitants, percentage of R&D with respect to GDP and the percentage with respect to GDP of investment in venture capital in the first installation.[14,30]

In addition, various innovation measurement instruments are designed and applied.[14,27-32] With the application of the innovation evaluation guide by Delgado (2005; 2017; 2019)[27,28] to a sample of 63

respondents from the boards of directors of nine companies in the agriculture, food, construction, automation and biopharmaceutical sectors, it was possible to know the relationship between the generic strategies with the sector and the technological intensity of the companies analyzed, verifying that in the biopharmaceutical sector, the innovation strategy has the highest priority and the companies with high technological intensity are the ones that most take innovation, differentiation and diversification strategies into account.[33]

Lee et al. (2014) assess how and when business innovative capacity is determined by R&D intensity; this capacity is approached as the degree of use of the new knowledge by the company for innovation. For this, they study 311 industrial companies in Japan, Germany, the United Kingdom and the United States of America between 1999 and 2003 and the results reveal that a high degree of R&D intensity makes companies more exploitative and less knowledge explorers.[18]

On the other hand, Abdal et al. (2016) integrate and adapt to the Brazilian context two classifications of economic activity proposed by the Organization for Economic Cooperation and Development (OECD) and the European Statistical Office (Eurostat), which group industrial sectors according to their technological intensity and its intensity in knowledge, and includes service activities respectively. These authors developed the so-called Classification of economic activities according to technological and knowledge intensity, which made it possible to overcome the dichotomy between manufacturing and services, with a flexible classification that ranges from high-tech and knowledge-intensive activities to those with low knowledge. technology and less knowledge-intensive.[21]

Santamaría and Nieto (2011) analyzed the relevance of product innovation associated with low technological intensity in the competitiveness of Spanish manufacturing companies, by increasing the international market share, where a positive relationship can be seen.[22] While Moura et al. (2017) investigated the absorption capacity associated with low technological intensity in 80 companies in a footwear industry cluster in the state of São Paulo.[24] Demonel and Marx (2015) evaluated how six Brazilian industrial companies with low technological intensity, belonging to sectors called low-tech, organize and manage the value chain of innovation, with emphasis on innovations in management, in a similar way to how the so-called high-tech companies do it.[25] Measurement of business competitiveness at a territorial level with a comprehensive approach to development oriented to the customer-market dimensions, economic-financial, technical, social and environmental management[34] and comparability between companies in the same territory, from different sectors and technological intensity with composite indicators.[35]

Additionally, Monzón Sánchez (2014)[25] and Monzón Sánchez et al. (2014)[26] develop a method for evaluating innovative intensity, through a global index, appropriate for technology-based companies (EBT) in the Cuban hydraulic sector, where the concepts of internal control, quality, innovation and environment, with the purpose of improving the innovative process and business management. Likewise, Duarte Masi (2010) evaluated the degree of intensity of innovation in Paraguayan companies, and found that said intensity is lower when the size of the companies decreases, and the greatest incidence is in innovation of technology in product and process, with respect to of organization and commercialization.[36] For their part, March Chordá and Yagüe Perales (2010) evaluate the relationship between the innovative and export intensities of EBT in Spain and in 41 countries, where the weaknesses of Spain are appreciated, as well as of Portugal, Greece and Italy, with respect to the rest.[37]

With the previous analysis and based on the objective of this article, the concept issued by Brigante (2018) is assumed, which addresses technological intensity, as a contribution of technologically intensive activities to the increase in labor productivity in the industrial sector in 28 countries (from several continents), it is possible to separate 150 industrial classes into four groups based on their content in technology (high, medium-high, medium-low and low), and found that the sectors of low technological intensity also have a high contribution to the productivity of the work and sectoral efficiency.[15] On the other hand, it is verified that there are many aspects to take into account to increase business efficiency and effectiveness in relation to technological capacity and intensity.

Assessment of technological capacity and degree of technological intensity

In Phase II, the technological capacity of the company is evaluated, through the Technological Capacity Index, which is expressed in five dimensions or factors of technological capacity, these are: R&D, strategic direction of innovation, market, for the production and management of financial resources. A summary is shown in **Table 1**.

Table 1. Business technological capacity

Factor	Indicators
FCT_{ID}	R&D intensity
	R&D process
	R&D products and technological learning
	Learning of new technologies
FCT_I	innovation strategy
	Prospective analysis and technology analysis
	Management culture and values
FCT_m	Market positioning
	Marketing of new products and versions
	Market strategy
	Marketing and sales resources
FCT_P	Advanced methodologies and technologies
	Certification
	Human talent
FCTrf	Access to financial resources
	growth level
	Staff

$$FCT_x = \sum_{i=1}^{k} I_i$$

(In) Indicator, m=17
(Ini) Variables, i=49

$$I_n = \left(\frac{\sum_{i=1}^{m} I_{ni}}{m}\right)$$

(CTemp) Technological Capability Index

$$CT_{emp} = \left(\frac{\sum FCT_x}{\sum \text{máx}\,(FCT_x)}\right) 100$$

CT_{emp}	$CT_{emp} \geq 80\%$	$50\% \leq CT_{emp} < 80\%$	$30\% \leq CT_{emp} < 50\%$	$CT_{emp} < 30\%$
Dimensions	**High**	**Regular**	**Medium**	**Low**
Management of financial resources	Mixed funds are managed for innovation, including our own	External financing is required for the development of innovation activities and technologies	Innovation and technology management are carried out in those aspects of lower demand for financial resources	No items allocated to innovation and technology activities are executed

Source: De León, 2021[7,38]

In Phase III of the General Procedure for the evaluation, classification and improvement of the degree of technological intensity (MECyM-GrIT) the degree of technological intensity is classified by means of the general index called GrIT, which is based on the business technological intensity index and that of

technological capacity, as established in Phase II. A summary of the aspects analyzed is shown in **Table 2**, in which it is observed that the indicators established for the EAT are used.

Table 2. Calculation of the Technology Intensity Index (IIT)

Aspects		Value in EAT	Business Indicator Result	Indicators of Technological Intensity
A_1	Net sales from exports of goods and/or services with high added value and income from intangibles	≥ 20 %	**A_{1e}**	$I_{r1} = \frac{A_{1e}}{A_1}$
A_2	Ratio of total imports and exports	≤ 0,7	**A_{2e}**	$I_{r2} = \frac{A_{2e}}{A_2}$
A_3	Resources dedicated to research, development, innovation, in relation to billing	≥ 10 %	**A_{3e}**	$I_{r3} = \frac{A_{3e}}{A_3}$
A_4	Labor productivity expressed in pesos of Gross Added Value per average number of workers	≥ 50 000	**A_{4e}**	$I_{r4} = \frac{A_{4e}}{A_4}$
A_5	Intellectual property registries (patents, author registration, industrial secret, trademarks, among others)	≥ 1 por año	**A_{5e}**	$I_{r5} = \frac{A_{5e}}{A_5}$
A_6	Introduction of innovative products (goods and services) in the market, or technological improvements that reduce costs, increase productivity	≥ 1 por año	**A_{6e}**	$I_{r6} = \frac{A_{6e}}{A_6}$

$$IIT = \sum_{i=1}^{6} P_{ri}\, I_{ri}$$

Technology Intensity Index (IIT)

$$P_{ri} = \frac{I_{ri}}{\sum_{i=1}^{6} I_{ri}}$$

Source: De León, 2021[7]

Table 3 shows the expression for calculating the degree of technological intensity (GrIT), which allows defining the type of degree I, II and III, considering degrees I and II as Companies with a Significant Degree of Technological Intensity (EGSIT).

Table 3. Degree of Technological Intensity

GrIT Ranges	Grade Type	
GrIT ≥ 1.0	**Grade I**	High degree of technological intensity
0.85 ≤ **GrIT** < 1.0	**Grade II**	Medium-high degree of technological intensity
0.55 ≤ **GrIT** < 0.85		Medium degree of technological intensity
0.35 ≤ **GrIT** < 0.55		Medium-low degree of technological intensity
0.10 ≤ **GrIT** < 0.35	**Grade III**	Low degree of technological intensity
GrIT < 0.10		Very low degree of technological intensity

$$GrIT = \text{IIT} \cdot CT_{emp}$$

Source: De León, 2021[7]

Comparative analysis between the EGSIT and the EAT

After delving into the meaning and evaluation criteria of technological intensity, a comparison is made between Companies with a Significant Degree of Technological Intensity (EGSIT) and High Technology Companies (EAT), in relation to various aspects of organizational behavior, as shown in **Table 4**.

Table 4. Comparison between the EGSIT and EAT

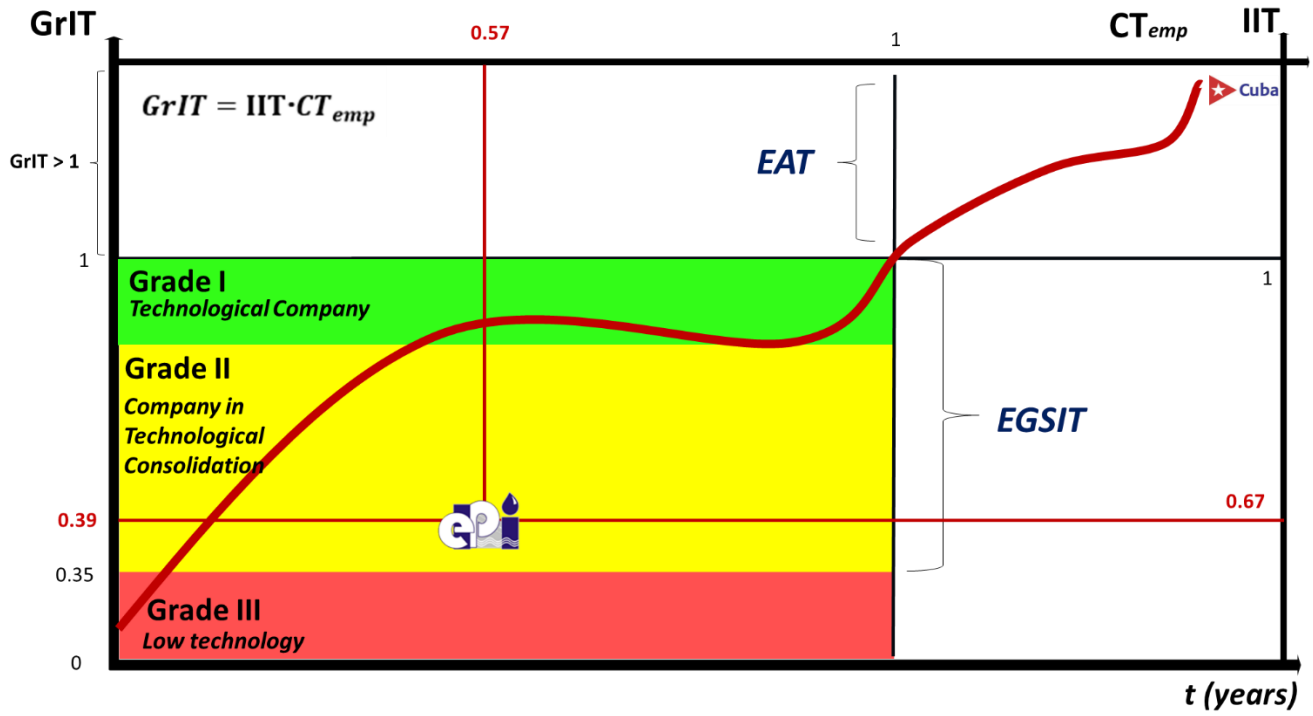
As to	Companies with a Significant Degree of Technological Intensity	High Technology Companies
Scientific, technological and innovation resources	Research support (external source). technological potential	R&D&i (own and external) and financial resources ≥ 10% of turnover
Technological standards	Growth of innovation projects	Scientific and technological potential with doctors, science masters and postgraduate specialists ≥ 15% of the total number of university professionals.
R&D cycle	Trend towards increased productivity and efficiency	Consolidated R&D projects
Market	Moderate technological standards	High productivity, among the highest in its sector and in the country
Technological capacity	Intellectual property registration, author registration, industrial secret, trademarks, among others	High technological standards and integrated and standardized management systems.
Technological Intensity	The cycle of research, development, innovation, production and marketing (R&D&i) of products and services with high added value is not necessarily closed	Intellectual property registries (patents, author registration, industrial secret, trademarks, among others). ≥ 1 per year

Source: self-made

The EATs have an export orientation and for this it is important to increase their production volume, expand their market, especially based on the penetration of foreign markets as one of the main challenges that arise. It is also necessary to permanently reinvest in quality and technology standards, they compete for differentiation in products and services, they handle a high component of negotiation on intangibles, risk is incorporated into management, and human resources become irreplaceable.

Figure 2 shows a map that links technological intensity, technological capacity and the Degree of Technological Intensity[7] (by León García, 2021) where the regions covered by the EGSIT and the EAT are observed. It is appreciated that the EGSIT can constitute an intermediate stage for some companies that have not yet reached the EAT condition, although not all of them, as a strategy to achieve business success, require deploying this transition to high technological intensity. However, the degree of technological intensity in which the company in question is evaluated, can always project improvements in this regard and achieve higher goals in its organizational performance.

Figure 2. Technological intensity, Technological capacity and Degree of Technological Intensity of the EGSIT and the EAT



Source: self-made

There are marked differences between the sources of growth and the obtaining of positive results in conventional-type companies, within which one can find the EGSITs that work for domestic demand and have low productivity and those that have high productivity and belong to the sector. Cuban biotechnological sector, this sector brings together most of the EATs in the country.

In Cuba, six entities belonging to the Group of Biotechnological and Pharmaceutical Industries (BioCubaFarma) and one belonging to the INNOMAX business group of the Ministry of Science, Technology and Environment (CITMA) have obtained the status of EAT after the approval of the current regulations in 2020.[39] The first to obtain EAT status were the National Center for Biopreparations (BioCen), a scientific-industrial complex that provides manufacturing outlets for more than 30 biotechnology productions, and the Center for Genetic Engineering and Biotechnology (CIGB), where on 25 % of sales corresponds to export products. The Molecular Immunology Center (CIM) also has this classification, with 42 objects of invention and more than 800 scientific articles, and the Information Technology and Telematic Services Company (Citmatel), which works on lines of innovation projects, some linked to electronic commerce, IP telephony, IoT and digital signage, distance education, software projects for administration and science, the development of applications for emerging Cuban technologies, among others. Subsequently, the AICA Laboratories Company, the Immunoassay Center (CIE) and the Cuban Neuroscience Center (Cneuro) obtained this condition.

The biopharmaceutical EATs have some common characteristics, such as the direct attributions of export and import, the presence of marketing companies and priority in the selection of personnel,[40] the

specialization of their personnel in advanced technologies,[41] the closure of the R&D cycle i with a focus on quality and innovation,[4,29] industrial property with products and intangibles with high added value,[42,43,44] and systematic organizational improvements,[4,5] with high standards in its management systems that meet various regulatory requirements and the national and international market[4,45] and the significant growth of exports, the satisfaction of the demand for medicines and specialized services and the diversification of markets and products.[46]

Finally, it is recommended to monitor the transition in business technological intensity in the current context of digital transformation with surveillance, intelligence and observatory processes.[47] Digital orientation, digital maturity, and digital intensity are shown to be determinants of financial success,[48] Similarly, digital technologies, employee digital skills, and transformation strategies can help drive digital transformation and with it improving the financial performance of SMEs.[49] In addition, this new environment is altering the innovation ecosystem,[50,51] with a paradigm shift characterized by hyper-connectivity and collaboration of consumers and organizations across the full range of chain activities. of value: co-design, co-creation, co-production, co-marketing, co-distribution and co-financing.[52] It is not only necessary to have digital assets, but also to acquire or develop capacities related to digital agility, digital networks, analysis of big data, organizational structures and specific performance metrics,[53] as well as changes in the business model,[54] with new skills, business processes, work culture and digital leadership[55,56] and its analysis requires a holistic approach,[57] Thus, the factors associated with technological capabilities and the indicators for the calculation of business technological capacity and the technological intensity index could be adapted and modified in the immediate future.

Conclusions

Science and innovation, as one of the pillars of government management, constitutes a necessary path for productive transformation and international insertion, which requires technologies that allow evaluating, classifying and improving the degree of technological intensity in Cuban companies with the generation of technological development and innovation projects.

The evaluation, classification and improvement of the degree of technological intensity is based on a referential theoretical and methodological framework and the Cuban business context and has a rigorously established set of factors and indicators, with calculation expressions, measurement criteria for the classification of the degree of technological intensity and must always take into account a holistic and comprehensive approach to the aspects to be assessed, which may change over time and due to the conditions in which it is applied.

The elaboration of a contextualized, preventive-corrective technology, which offers the possibility of historical storage of data and their respective information on the technological capacity and the technological intensity of the company, with its degree of intensity, facilitates the generation of innovation projects in companies of Significant Degree of Technological Intensity and its potential generalization to High Technology Companies, with the modifications that are required.

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Conflict of interests

The authors declare no conflicts of interest

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