

Physical-technological change as a competitive factor in the clothing and footwear industry

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Abstract. The investigation aimed to analyze the influence of physic-technological change as a factor of competitiveness in the textile and footwear industry in San José de Cúcuta, Colombia. The methodology follows a mixed approach supported by factorial, phenomenological and documentary analysis designs, using instruments such as interviews and surveys, scientific production databases and governmental and trade union reports of the sector. The physic-technological change was conceived by businessmen as a productive process, innovative, of social change, and transformation with associated factors of strategic management, culture of market planning, problem that solves, reach, control of success, materials such as systems based on silicone, polymers, panels and closed air pressure grilles, as well as improvements in sole material and use of recyclable material according to environmental policies, reduction of time of product development, marketing of the invention, resources, management of risk, productivity and competitiveness, depend on type of changes implemented or designed in companies of low, medium or high level and are associated with factor of competitiveness. It is concluded that technological change as a competitiveness factor allows maintaining or increasing market share and endogenous changes in productive and technological systems in the market.

1. Introduction

Technological change involves longitudinal studies of different decades ranging from the industrial revolution, developments in transport (air, land and water), the revolution in information and communication technologies [1]. The adoption of new technologies has not been uniform throughout the world and, therefore, the productivity and competitiveness of a company are supported by the constant technological changes that are a key tool within the business sector, so that it can emerge in the commercial field against its competitors [2]. Contributions on the development of economic theory establish that economic thinking is linked to entrepreneurship and innovation, for whom innovation is the irreversible historical change of doing things [3]; and as for capitalism, it is in constant economic change by nature [4]; from there the company takes on a fundamental role [5], which cannot remain stationary [6]; then a differentiation is made between growth and economic development of the company.

The research sought to analyze the influence of technological change as a factor of competitiveness in the industry of clothing and footwear in San José de Cúcuta, Colombia; for this purpose, the concepts



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of entrepreneurs in technological change were analyzed, as well as how they implement technological change in the city of San José de Cúcuta, Colombia; the influence of technological change as a factor of competitiveness in the industry of clothing and footwear in San José de Cúcuta, Colombia is described. Similarly, the most important aspects of technological change as a factor of competitiveness in the clothing and footwear industry in San José de Cúcuta, Colombia, are outlined.

2. Method

The mixed paradigm [7] was assumed from the qualitative point of view, using historical documentary method and involve the identification of categories in a first phase based on an interview applied to three key business informants, and quantitative deductive of descriptive character factorial design [8]. A hierarchical framework is proposed based on a group of categories, disaggregated into different factors according to interview and documentary analysis which, in turn, are divided into several indicators. Validity is guaranteed for the identification of concepts to be included in the structure through content and criteria relationship tests [9].

For the present study, the theoretical perspective was based on the interview and bibliographic review that allowed us to identify and characterize indicators of technological change. The validity of the criteria relationship was based on the practical perspective based on the validation of the structure by means of an exploratory test [10]. Once the definitive hierarchical structure was established, the next step was to carry out the interviews corresponding to the study. In this sense, it is important, in terms of representativeness with respect to the set or subset of companies and the generalization of the conclusions. The analysis of the information involves processing an $n \times m$ matrix, where n corresponds to the number of companies surveyed and m to the number of indicators established [11]; principal component analysis (PCA) as a multivariate technique that allows for the definition of the internal structure of a data set through the definition of a series of common underlying dimensions, known as factors or ratings of the principal components [12].

The value of each initial factor corresponds to the average of the rating obtained within the maturity indicators that are disaggregated from that factor; according to weight and observations with similar characteristics for the companies, cluster analysis is carried out using distance criteria [13], taking as a basis the cartesian representation, where the horizontal axis represents the first component and the vertical axis represents the second, a grouping of individuals is proposed through a hierarchical tree in which, in the lower part, the initial elements are arranged, unions between elements are represented by three straight lines, two directed to the elements that are united, which are perpendicular to the axis of the elements, and one parallel to this axis that is located at the level where they are united. The process is repeated until all the elements are connected by straight lines. Clearly the researcher must decide at what stage he wants to stop the process of fusion or division [1]. The population under study is made up of manufacturing companies in San José de Cúcuta, Colombia, in the footwear, leather and clothing sectors [14].

According to information from “Compite 360” as of October 31, 2018, 2558 companies were registered, of which 1065 in the leather and footwear subsectors (42%) and 1493 (58%) in apparel [15]. The sample was stratified by proportional allocation and comprised 142 companies in the clothing sector and 59 in the leather-footwear sector.

3. Results

The results allow us to conceptualize technological change (TC) as a tool to promote economic growth, improve product quality, restructure organizational standards and improve business competitiveness. The qualitative analysis shows that the footwear industry has moved towards the production of material for general purpose protective footwear, not exposed to the risks of physical agents of mechanical action with polyurethane materials, insoles that reduce vertical pressure and shear on the areas of the foot subject to high stress, according to their anatomy, fabrics and meshes that adjust to the shape and size of the foot, as well as air chambers to lower body temperature; a second type of protective footwear with a toe cap designed to protect the toes, where there is a risk of physical agents of mechanical action,

including graphite improvements; dielectric protective footwear for areas where there is a risk of electric shock; electrically conductive protective footwear for discharge the static energy of the human body generated by working actions; metatarsal protection footwear with a protective component for the instep of the foot, which provides reasonable protection against direct impact on the metatarsal; protective footwear resistant to penetration by sharp objects; waterproof protection footwear for protection against the risk of leakage of liquids or fine dust.

Emerging categories resulting from interviews with entrepreneurs were invention, innovation, diffusion and commercialization, perceiving as an influential factor the need and comfort of the user. The invention is perceived as the conception of an idea potentially generating transformation and improvement, of commercial benefits; the innovation is the consolidation and commercial application of an idea, its diffusion is to put in knowledge of the society the innovation and its commercialization is conceived as the achievement of the investment. Businessmen consider that the governmental support besides being directed to create a technological environment, should generate policies of innovation, support to the financing and the education of the human resource, looking for a coherent whole that organizes, as much to the guilds as to the universities developing creativity and facilitating the innovation at level of production and generating competitiveness in a local and national environment.

After a documentary review of currents of thought, four thematic categories are identified as the central axis of technological change in companies in San José de Cúcuta, Colombia, as show the Table 1, as an endogenous process of innovation in order to produce new goods, improve existing ones, develop new markets, establish more efficient processes or relocate new sources of supply [16]; as an endogenous process of transformation in which, based on technology as the main component through which the organization is not only to inform [17], but has the capacity to know itself and transform itself based on learning by doing [18]; from this same current as a productive process where learning by doing allows the growth of human resource capacities [19], the improvement of productive processes and research and development, that is, the organization can innovate and acquire competitive advantage based on its capacities [20]. For its part, the neoclassical trend states that technological change and change from the neoclassical trend [1] is due to exogenous factors such as savings, capital, education, values and health of individuals. The company must choose to produce what the customer requires and adapt to the speed of change in the culture and consumption habits of customers.

Table 1. Characteristics of the current.

Current	Characteristics	Factors
Schumpeter [16]	Production of new goods Product improvement Market development Establish processes Relocate	Innovation process
Uzawa, 1965 [17]	Ability to get to know each other Ability to Transform from Practice Growth of human	Transformation process
Lucas, 1988 [20] and De Mattos, 1999 [18]	Resource capacities Improvement of productive processes Research and development Competitive advantage	Production process
Neoclassical trend Jimenez, 2018 [1]	Transformation and innovation of the organization based on social trends and needs	Social process

During the years 2013 to 2018, in San José de Cúcuta, Colombia, the commerce chamber presented programs to entrepreneurs to strengthen the strategic dissemination of technological innovation pacts of 343 organizations; in 2015, through a diagnosis of technological innovation, more than 150 companies were impacted in 2017, organized in small, medium and large [21] where 20% actively proposed ideas that contributed to the improvement of products, processes and services, 76% to labor, 54% were

considered emerging innovators, recognize innovation as a means of sustainable growth, They stated that they are starting to acquire knowledge to generate dynamics in the textile and footwear industries, 14% are consolidating innovators, they have the resources, the size and the market to use innovation as a growth promoter, however, they lack an innovation system within the organization. 23% of San José de Cúcuta, Colombia, companies are evolving innovators, with great internal capacities to innovate, but do not have the potential, size, assets and capital to move the market to which they belong; only 9% are advanced innovators, market leaders with excellent internal and market capacities to manage innovation. Innovation focuses on the development and use of materials such as silicon-based systems, polymers, panels and closed air pressure grilles, as well as improvements in sole material and the use of recyclable material in accordance with environmental policies.

In relation to the assessment of the heterogeneity of the project management of the companies that participated in the study, the PCA allowed, to find the combination of variables with greater heterogeneity, identifying factors that generated greater relative heterogeneity and its correlations, where the first component explains 66.5% of the variability and the second component explains 7.2%, as show the Table 2. Given the difference between the explanation provided by the first component (66.5%) and the second (7.2%), it was decided to consider the first two components, as they covered 73.7% of the variability. Each component is in turn structured by a linear combination of the contributions of each factor.

Table 2. Town values factors associated with technological competition.

Component	Total	Percentage of variance	Accumulate
1	10.820	66.5%	66.5%
2	1.297	7.2%	73.7%
3	0.993	5.9%	78.6%
4	0.982	5.8%	84.4%
5	0.569	4.9%	89.3%
6	0.417	3.8%	92.1%
7	0.399	2.9%	94.0%
8	0.285	2.2%	96.2%
9	0.173	1.0%	97.2%
10	0.120	0.8%	98.0%
11	0.112	0.6%	98.6%
12	0.076	0.5%	99.1%
13	5.10E-02	0.3%	99.4%
14	4.20E-02	0.2%	99.6%
15	3.10E-02	0.2%	99.8%
16	3.00E-02	0.1%	99.9%
17	1.30E-02	0.1%	100.0%

When analyzing the first component, the factors strategic management, market planning culture, problem solving innovation, scope of the invention, control of key success factors stands out, which with a weight over 8% each and represent 44.7%. The accumulated figure increases to 57.1% if we add the factors project selection process and reduction of product development time and marketing of the invention, which are close to 9.4%. On the other hand, in the analysis of the second component, the factors cost, resources, risk management, productivity and competitiveness stand out, which represent 73.7% of the variability contributed by the two components.

Grouping individuals according to their proximity, three subgroups of companies were obtained, a group with 40 companies that include characteristics of implementation of innovation practices with technologies in order to reduce time and improve the quality of products with a medium level of innovation, a second group of 80 with the acquisition of technologies required to reduce costs and human resources, repetition of practices of other companies, and another group with the remaining ones with a high level of innovation that have generated innovative products, plan to solve problems related to production and society's needs, carry out studies on trends, but have not registered them or applied for

the corresponding patents. Similarly, they implement particular management processes that lead to the search for 2 mediums sized (codified as E141 and E120) and 2 smalls (codified as E15 and E18). No differences were observed between types of companies ($p > 0.05$), if there is a difference in type of technologies implemented according to productive object ($p < 0.05$), factors associated with technological change depend on type of changes implemented or designed in low, medium or high level companies ($X^2 = 13.86$, $p > 0.05$) and are associated with competitiveness factor.

4. Discussion

Like stiffness studies in other countries in Colombia in polyurethane footwear, in soles, the stiffness response for footwear with polyurethane soles the results indicate, as for the energy absorbed, that the current is a statistically reliable model to model such response by presenting an adjusted $R^2 > 70\%$ according to reported in the analysis of variance. Likewise, the evaluation of the impact attenuation test on polyurethane insoles in footwear with vulcanized rubber soles presents a behavior where the energy absorbed response reaches a value of R^2 adjusted above 70% . The behavior of polyurethane shapes and templates in the evaluation of the biomechanical parameters absorbed energy and stiffness can be explained by reference to the standard, where it is emphasized that the surfaces that interact in this test both of the base of the test apparatus as well as the specimen of the material being evaluated must be flat, i.e. there must be full contact between the two surfaces. In the case of footwear with microporous soles, the design and manufacture were adequate, with improvement designs in the heel of the footwear without concavity in the sole, which allows the total contact between this surface and the surface of the insole contrary to what is expected in simulated values in Peru [3], improving results in the impact attenuation test; the sole presents a surface such that the measurements of energy absorbed and stiffness could be considered reliable, with a good percentage of adjustment of the data, which is reflected in a coefficient of determination R^2 of 83.2% adjusted above 70% expected.

Countries such as Peru, have evolved the textile industry and technician in a vertiginous way the levels of production [2], in Colombia as well as Ecuador, where the footwear industry has demonstrated the reality of the characterizing sectors of importance for the transformation of the productivity towards the competitiveness and the technological change [3], the introduction of new materials makes difficult the permanence in the market, for having clearly artisan regions, resistant to the innovation and the technological change [4]. The Colombian association of the fashion and footwear industry, leather and its manufactures, according to the "Departamento administrativo nacional de estadística (DANE)", monthly manufacturing survey, reflects the production and sales in this sector for 2018, which reveals variations of -7.1% and -5.5% respectively [6], as for employment it registered falls of -4.6% [2]. These signs of variation are mainly explained by the high indexes of inventories, low bids, fall of orders from national clients, closing of points of sale, minimum exports and at the same time the decrease in the demand of products.

The planning presents results-oriented characteristics such as identifying objectives, indicators and goals, in order to evaluate the proposed targets through strategic planning developments, a basic tool to prioritize resources and establish the basis for control and evaluation of proposals [22]. There are countless types of fashions and footwear, their basic function depending on the materials with which they are made [7]. The full cycle of technological change occurs when the stages of invention, innovation and diffusion of new products, processes, markets or organizational standards are met. For this reason, Schumpeter's notion depends on the appearance of innovations, which alter the course of the circular flow. Now, with respect to the economic sectors of clothing and footwear in the San José de Cúcuta, Colombia which is the object of this study and based on the surveys of development and technological Innovation [22] there are scenarios towards which technological change should be focused, such as the improvement in the quality of the product, the opening of new markets and the use of free trade agreements.

Finally, other companies of the same nature and size in Colombia, therefore, the footwear industry in Colombia, according to the ministry of commerce, for the footwear industry has achieved reaching especially the markets of the United States. The companies of the clothing and footwear industry have

had innovation in production processes, change of machinery and training of personnel; however, their market has difficulties since its main destination was Venezuela and due to the closure of the border in 2008, this market was lost; so far there is a general lack of knowledge and therefore an inability to motivate initiatives of technological change in the industry of San José de Cúcuta, Colombia, especially in the current circumstances, where any result in favor of the industry of San José de Cúcuta, Colombia, must be maximized because of the economic panorama lived by the socioeconomic crisis of Venezuela, but the technological change will be fundamental to achieve regional competitiveness and in external markets.

In the clothing and footwear industry, technological change has had significant advances, in the endogenous technology produced a stationary market, and in relation to the changes in innovation, are considered accumulators of knowledge, which generate increased costs; likewise, competitiveness involves companies in constant innovation to maintain or increase their participation against other competitors in the market, whose competitiveness is derived from the advantage that the company has through the application of its modes of production and organization; and also associated with the quality of the interactions that the organization has to establish with factors such as the economic environment, the efficiency of the value chain, the physical plant, human capital, financial services, technological assistance and process systems.

5. Conclusions

Technological change is conceived as a productive, innovative, social change and transformation process to promote economic growth, improve product quality, restructure organizational standards and improve business competitiveness.

Factors associated with technological change in footwear and textile companies in San José de Cúcuta, Colombia are strategic management, market planning culture, problem solving innovation, scope of the invention, control of key success factors, project selection and reduction of product development time and marketing of the invention, costs, resources, risk management, productivity and competitiveness, depend on the type of changes implemented or designed in companies of low, medium or high level and are associated with competitiveness factor.

References

- [1] Jiménez Y 2018 Aproximación crítica a las principales teorías sobre el cambio tecnológico *Revista Latinoamericana de Economía* **49(193)** 171-192
- [2] Luque A 2018 Elementos que favorecen la producción textil transnacional y relación con su responsabilidad social empresarial *Cuadernos Latinoamericanos de Administración* **XIV(26)** 73-89
- [3] Cadena J, Aguilar M, Buitron P 2018 Competitividad en las pequeñas y medianas empresas del distrito metropolitano de Quito *Small Business International Review* **2(2)** 71-94
- [4] Arandes J, Luna K y Cisneros D 2017 Teoría de los efectos olvidados en el rescate de la imagen comercial de los artesanos del calzado en el cantón Gualaceo provincia del Azuay, Ecuador *Visión Gerencial* **1** 24-42
- [5] Díez J 2016 Organizaciones, redes y desarrollo económico en ciudades medias: el caso de Bahía Blanca, Argentina *Región y Sociedad* **28(67)** 277-313
- [6] Ahumada R, Pinzón C 2019 Toma de decisiones de inversión mediante métodos probabilísticos (investment decision making using probabilistic methods) *Apuntes Contables* **24** 125-150
- [7] Moros Briceño J 2018 Evaluación de las competencias investigativas en los estudiantes de maestría de la Universidad Nacional Experimental del Táchira mediante el uso de modelos de regresión multinivel *Ecomatematico* **9(1)** 50-63
- [8] Vergel-Ortega M, Martínez J, Nieto F 2016 Validez de instrumento para medir el aprendizaje creativo *Comunicaciones en Estadística* **9(2)** 239-254
- [9] Duarte Y, Sánchez-Frank J, Gómez C 2019 El trabajo colaborativo en las competencias económicas y financieras en estudiantes del Instituto Agrícola Región del Catatumbo-Colombia *Covalente* **1** 37-41
- [10] Parra-López H, Rojas-Suárez J P, Vergel-Ortega M 2019 Curricular trends in the Universidad Francisco de Paula Santander academic program offerings *Journal of Physics: Conference Series* **1329** 012013:1-5
- [11] Díaz L 2002 *Estadística Multivariada: inferencia y métodos* (Bogotá: Universidad Nacional de Colombia)
- [12] Lora E 2018 *Economía Esencial de Colombia* (Bogotá: Penguin Random House Group Editorial S.A.S.)

- [13] Vergel-Ortega M, Duarte H I, Martínez-Lozano J J 2015 Desarrollo del pensamiento matemático en estudiantes de cálculo integral, su relación con la planificación docente *Revista Científica* **3(23)** 17-29
- [14] Santamaría M 2019 *Los Números Positivos de la Industria Automotriz en Colombia* (Colombia: Revista Semana)
- [15] Tarapuez E, García M, Castellano N 2018 Aspectos socioeconómicos e intención emprendedora en estudiantes universitarios del Quindío (Colombia) *Innovar: Revista de Ciencias Administrativas y Sociales* **28(67)** 123-135
- [16] Schumpeter J 1939 *Business Cycles A Theoretical, Historical and Statistical Analysis of The Capitalist Process* (New York: McGrawHill)
- [17] Uzawa H 1965 Optimal Technical Change in an Aggregative Model of Economic Growth *International Economic Review* **6(1)** 18-31
- [18] De Mattos C 1999 Santiago de Chile, globalización y expansión metropolitana: lo que existía sigue existiendo *EURE (Santiago)* **25(76)** 29-56
- [19] Bataller E, Serra V, Palomar E V 2011 Gestión asistencial y evaluación de costes: una orientación hacia la gestión de los procesos *Revista Iberoamericana de Contabilidad de Gestión* **9(17)** 1-13
- [20] Lucas R 1988 On the mechanism of economic development *Journal of Monetary Economics* **22** 3-42
- [21] Cañizares M, Suárez A 2018 Medioambiente y salud. Pilares en asignaturas optativas de la carrera de contabilidad y finanzas Cuba *Apuntes Contables* **21** 89-102
- [22] Castaldi A, Dosi C 2009 Cambio tecnológico y crecimiento económico: Algunas lecciones de pautas seculares y algunas conjeturas sobre el impacto actual de las TIC *Economía: Teoría y Práctica* **1** 81-129

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