
COMPETENCES TO INNOVATE IN THE BRAZILIAN TEXTILE AND CLOTHING INDUSTRIE 4.0: A SYSTEMATIC REVIEW OF LITERATURE

Kamila Rodrigues Merlemerlekamila@gmail.com

Chemical and Textile Industry
Technology Center - SENAI CETIQT,
Rio de Janeiro, RJ, Brazil.

Ricardo Kropf Santos Fermamrkfermam@inmetro.gov.br

National Institute of Metrology,
Quality, and Technology –
INMETRO, Rio de Janeiro, RJ, Brazil

ABSTRACT

For the use of the technologies of the fourth industrial revolution, organizational skills are needed to provide conditions for the implementation of new technologies, which the Brazilian textile and clothing industry does not currently have, so it needs to identify and develop the necessary skills. To this end, it is necessary to search for a robust literary base, which conditions the definition of organizational skills for innovation in this context. The methodology used has four stages. As a result of the search carried out within the theoretical framework, several concepts and definitions of the competencies to innovate in the national industrial context were identified. It was concluded that while the systematic literature review contributes to the understanding of the theme, it is still little addressed in the academic area. The organizational competencies identified will provide conditions for planning and implementing innovation, contributing to industrial competitiveness in the national textile and clothing sector.

Keywords: innovation; Industry 4.0; Brazilian Industrie 4.0; textile industry; and organizational competencies.

INTRODUCTION

In the history of humanity, as a result of population growth and the development of new survival techniques, the mastery of technologies, and new instruments of production, interventions in society have become increasingly numerous and frequent. The industrial sector is an integral part of many economies of world nations, and since the beginning of industrialization, this sector has provided changes in technological and innovative paradigms. These paradigm shifts are called industrial revolutions (SHAMIM, 2016). In this context, Branco (2012) states that the first industrial revolution was a milestone in the relationship between society and nature through the establishment of new forms of production, bringing significant changes to the economy and society and making them more complex. The changes introduced by the industrial revolutions transformed the relations between people; nations had to adapt to this new world. These changes in society produced great cultural and economic diversity.

During the movements of the industrial revolution that brought significant technological advances to the world industry, some countries invested in developing their own national skills, which contributed to sustaining national ownership in the medium-technology industries and advancing in high-technology sectors based on “leaders national.” Brazil has not taken actions like these, increasing its dependence on foreign know-how for its development. The generation of technology has often been absent since the beginning of capitalist development in Latin America. The levels of state and private investment in science and technology, research, and development were very low, in contrast to what happened, for example, in the United States, Europe, and the Asian continent (NERY, 2015).

Currently, the world industry is undergoing a new paradigm shift characterized by integration and connectivity. Known as the fourth industrial revolution, or *Indústria 4.0*, this paradigm aims at more efficient, flexible, and individual production, achieved through decentralized management of production and/or value chains completely digitally controlled (GEBHARDT, 2015), where automation and real-time sensor technologies play a crucial role in industrial production (KAGERMANN, 2013).

According to the National Confederation of Industry (CNI) (2016), the knowledge of the Brazilian industry about the digital technologies of *Indústria 4.0* is not widespread: 42% of Brazilian companies are unaware of the importance of these technologies for market competitiveness, while more than half of the companies do not use any digital technology among the ten options available in the survey. Also, according to the CNI, there is a difference in the intensity of use of these technologies; for example, the textile and clothing

sector uses approximately 29% of these technologies while the oil sector uses approximately 60%.

The fourth industrial revolution presents a new model of industrial production based on connectivity and a large volume of data managed in real time. The competition scenario and the major industrial changes present the complexity of current and future production systems. This productive environment is in the process of being formed by *Indústria 4.0*, offering opportunities for development and competitiveness for the industries that follow the technological transformation.

The concept of *Indústria 4.0* is linked to innovation and technological development, playing an important role in each organization. The adoption of *Indústria 4.0* is part of an innovation process that is not only technological but also organizational (organizational innovation) (Ferreira, 2019). Despite this, the reality of Brazilian industries, especially the textile and clothing industries due to their characteristic technological trajectory, dominated by suppliers (Pavitt, 1984), is one of difficulties and challenges in implementing these technologies. Companies dominated by suppliers are those where technological change originates almost entirely from suppliers of machinery and other production inputs (TIDD, BESSANT, and PAVITT; 2005). According to Trott (2012), companies dominated by suppliers have limited or no capacity to develop product and/or process innovations.

Organizational transformation is one of the challenges to be faced. This article aims to review the literature on organizational competences, or competences to innovate, necessary to the organizational innovation of the textile and clothing industries by assimilating the *Indústria 4.0* paradigm.

LITERATURE REVIEW: METHODOLOGY

A literature review is an essential part of the formation of knowledge on subjects determined in academic studies, not only to define the problem it seeks to solve but also to know precisely the current state of technical content and knowledge on specific topics and the remaining gaps (Bento, 2012).

Figueiredo (1990) states that the literature review process is an integral part of the development of science, providing information about current studies of science and its technical knowledge, as a way of updating. Noronha and Ferreira (2000) agree with this understanding: for these authors, studies of literature reviews serve to analyse the bibliographic production in specific areas within a time limit, generate information on a specific theme, and present new ideas, methods, and opportunities for further studies. For

Taylor and Procter (2001), a literature review is defined as an account of what has been published about a specific topic.

According to Bento (2012), the methodology of a systematic review of the comprehensive literature involves four steps: identification of keywords; secondary source review; analysis of primary sources; and critical reading and summary of the content. The systematic literature review in this article involved the four steps presented above.

In the first stage, keywords were identified for searching for content and authors on the specific delimited theme. The keywords used were: Industrie 4.0, Brazilian Industrie 4.0, Textile Industry, and organizational skills. The research bases used were Google Scholar, Spacenet, Scielo, Capes, and Science Direct.

In the second stage, secondary sources of literature were identified and selected, comprising material that presents the interpretation of primary works, such as encyclopedias, manuals, and thematic dictionaries. Sector reports, event presentations, manuals, booklets referring to textile and clothing industries, and class institutions were identified and selected.

The third stage was characterized by the search and reading of titles and abstracts from primary sources of literature that include works on the subject, such as books and articles. All selected literature was based on the title and summary of the work, based on the selection and exclusion criteria. The criteria used for the inclusion of the literature were approach of the textile and/or clothing sector, world context of Industrie 4.0, an international economic and technological panorama of the global textile and clothing sector, economic and technological overview of the national textile and clothing sector, innovation studies in the textile and/or clothing industry, and organizational skills and competences needed to innovate in the industry. The exclusion criteria were approach to personal skills, approach to other industrial sectors besides the manufacturing industry, and generalist studies on enabling technologies of Industrie 4.0. Literature in Portuguese and English was accepted.

A total of 347 studies of a technical and scientific nature were found. Two of these studies were excluded due to duplication. After applying the exclusion criteria, 176 studies were removed, and 171 primary sources of literature were selected for reading titles and abstracts. All the 171 of the selected material were eligible for reading and critical analysis and were classified as essential, relevant, and complementary.

The fourth and last stage was the complete reading of the indicated literature and critical analysis, collecting informa-

tion, technical content, and definitions with references on the topic studied.

LITERATURE ANALYSIS

Innovation concepts and definitions

A multiplicity of concepts and definitions of innovation proposed by several authors were identified, among which those that were most suitable for this work were selected.

Therefore, ARANHA (2009) proposes that innovation is, among other issues, the process of meeting requirements according to consumers' needs through creativity, allowing knowledge to be transformed into products and services.

With a focus on demand, innovation is defined by the result of creativity in solving the needs of the consumer market, be they products or services. CHIAVENATO (2003) explains that creativity plays a fundamental role in the innovation process, allowing innumerable possibilities for creation to later be put into practice as innovation.

In the Oslo Manual (2006), innovation is defined as the implementation of a new or significantly improved product (good or service), a process, a new marketing method, or a new organizational method in business practices, in the organization's workplace, or external relations.

Innovation can be analysed from the commerce or resource perspective (TROTT, 2012); according to the latter, it must be understood in the context of organizations linked to their resources, capacities, and skills. The internal resources² of the companies should be considered assets necessary for the organizational changes (or transformations) required for the development and appropriation of the advantages obtained by innovation, especially those changes imposed by the Industrie 4.0 paradigm.

The implication is that such resources must be considered strategic in the competition for new markets created by innovative products, as explained by Teece and Pisano (1994). Furthermore, it is essential that these resources can be worked on dynamically by companies, seeking congruence with changes in the business environment, especially when the time to place products on the market is critical, the rate of technological change is rapid, and the nature of competition and future commerce are difficult to determine (TEECE, PISANO, and SHUEN, 1997). The company's ability to use a given resource strategically to obtain competitive advantages is called competency. Such resources are not of a static nature but dynamic; that is, they are constantly changing and updating (TROTT, 2012). According to Francis (2006) and

Alves and Bomtempo (2007), there is an interdependent relationship between the competences of a company and its innovative behaviour: the company develops competencies to innovate, and, conversely, innovation starts with these new competencies.

Competencies to innovate

The study area opened by the resource-based approach of the firm, which proposes the valuation of the firm's internal attributes as a source of sustainable competitive advantage, has its roots in Penrose (1959), which introduced a new concept of firm, fundamental for the further development of the Resource-Based View (VBR) approach: "The firm is more than an administrative unit; it is also a collection of productive resources whose disposition between different uses and over time is determined by administrative decisions." In Penrose's view, the delimitation of a firm's resources is somewhat restricted. It essentially considers tangible resources, such as plants, equipment, land, raw materials, and others, in addition to the human resources available. Barney (1991) defines resources as all assets, capabilities, organizational processes, company attributes, information, knowledge, etc. controlled by a company to implement its strategy to improve efficiency and effectiveness. The resources, although important for the company's growth, are only a set of potential services: The ways in which they will be used will define the competitive advantage of one firm over the others (ALVES, BOMTEMPO, and COUTINHO, 2005).

Fernandes and Comini (2008) declare that when resources are combined and properly coordinated, they give rise to organizational skills. These resources constituting one or

more competences can be classified into different categories according to **Table 1**.

Ruas (2009) defines organizational competencies as "competencies that result from the relationship and cooperation of resources and collective capacities of the organization, as well as from the interactions of its groups and areas of activity, and that have a decisive role in the strategic performance of organizations. These competencies can be analysed under three different approaches defined by Ruas (2009) and are divided according to their contribution to competitiveness and/or survival, their stage of maturity and consolidation, and their relationship with the business. According to Monteiro (2001), organizational competencies are those that differentiate organizations from their competitors, constituting a reason for their survival.

The expression "competencies to innovate" is based on the understanding that innovation by a given company is provided not only by access to technology but also by competence in the use of organizational resources* within and outside the company, which provide the creation of new knowledge (COUTINHO and MARTINS, 2005).

According to Jugend (2012), to have the skills to innovate, the industry needs to have ten organizational skills as follows: development of inventions, insertion of innovation in the company's strategy, monitoring of the evolution of commerce, cooperation for innovation, financing of innovation, management of intellectual property, management of knowledge, absorption of external technologies, management of human resources from the perspective of innovation, and commercialization of innovation. According to the authors, these items form the global organizational competencies to innovate.

Table 1 - Category of component resources by competence

Resource categories	Description
Tangible	Buildings, plants, equipment, exclusive licenses, geographical position, patents, and employees
Knowledge, Skills, and Experiences	A group that is often not inscribed, tacit, and whose owners are often unaware of it.
Systems and procedures	Set of tangible documents, from recruitment and selection systems, performance and reward evaluation, purchasing processes etc. Although they are tangible, they require intangible resources to function efficiently.
Culture and values	Intangible resource and developed over time, almost always dependent on the founders' attitudes and past events. They include memories of critical incidents, values, and beliefs.
Network	Interest groups within the company, networks involving people from the company with suppliers, customers, the government, and consultants. It includes brand and reputation.
Important for change	Recognition of when valuable resources become outdated and need to change or even be destroyed

Source: Fernandes and (2008).

Competences to innovate in the textile and clothing Industrie 4.0

According to Alves (2005), the organizational competencies to innovate, which should be common to industries in view of the Industrie 4.0 paradigm, can be divided into four groups: infrastructure, which comprises machinery, equipment, qualified personnel, financial resources, research and development, financing for innovation, and the sale of innovation; techniques, through the ability to manage production and technologies, the skills to acquire and accumulate knowledge, production management, and technology management; organizational, through a set of knowledge, skills, technologies, physical management systems and values that generate competitive differential in organizations; and relational, which comprises the firm's ability to exploit external knowledge to develop innovations. These are the competencies that act on the markets (competition and demand) and that concern the firm's ability to form strategic alliances with appropriate external technologies.

For Stjepandic et al. (2018), the necessary competencies to innovate for Industrie 4.0 are present in three dimensions: conditions (culture, leadership, and innovation strategy), resources (human capital and external relations), and processes (management of R&D activities, systematic learning, and evaluation of results).

According to Jugend (2012), to have the competencies to innovate, the industry needs to have ten organizational competencies as follows: development of inventions, insertion of innovation in the company's strategy, monitoring of the evolution of markets, cooperation for innovation, financing of innovation, intellectual property management, knowledge management, absorption of external technologies, management of human resources from the perspective of innovation, and commercialization of innovation. According to the author, these items form the global organizational competencies to innovate.

The literature search on the Google Scholar, Spacenet, Scielo, Capes, and Science Direct databases did not return any specific, indexed work on competences to innovate in the textile and clothing industry in the context of Industrie 4.0. However, the e-book entitled "The Fourth Industrial Revolution of the Textile and Clothing Sector: The Vision of the Future for 2030" was identified and prepared in 2016 by Flávio da Silveira Bruno within the Superior Committee of the Textile and Clothing Industry in Brazil (Bruno, 2016). The study, containing information, analysis, and recommendations, addresses the strategic positioning of the Brazilian textile and clothing industry until 2030 in view of the opportunities and challenges imposed by the Industrie 4.0 paradigm. Based on Bruno's (2016) analysis, it is possible to

identify ten (10) competencies needed by the textile and clothing industries for organizational innovation in the face of the new paradigm of Industrie 4.0. These competencies are listed in **Table 2**.

Table 2 – Organization competencies comom to Industrie 4.0

Organizational Competencies
Product development based on new technologies
Social and environmental sustainability
Strategic sectoral and intersectoral alliances
Acquisition of commerce technologies
Real-time data analysis
Infrastructure and equipment
Use of enabling technologies
Added value in products and services
Transformation of human resources
Innovation management

Source: Authors.

CONCLUSION

This article aims to contribute to technological development and innovation in the Brazilian textile and clothing sector through a literature review that allows the identification of the skills needed to innovate for the incorporation of the Industrie 4.0 paradigm, thus enabling support in knowledge for directing technological efforts towards sectoral development.

According to the literature found in the systematic review conducted in this article, it is clear from the definition of innovation that the competencies to innovate are related to the resources of the company and its innovative characteristics. The literature review shows that scientific studies and economic indexes in a global context prove the relationship between innovation and technological development and economic growth acceleration.

The company's resources and how companies use them will define the competitive advantage in commerce and directly influence its characterization as innovative. Indicators such as infrastructure, research, and development factors such as technology purchase and sale, resources, and investments directly influence innovation. The competencies to innovate in Industrie 4.0, considering the Brazilian textile and clothing sector, arise from the combination of product development resources, the presence of innovation in company management, the purchase of innovation, the management of intellectual property, knowledge management, the purchase of external technologies, and human resource management from the perspective of innovation and the sale of innovation.

The systematic literature review made in this article contributes to understanding the specific subject, which is currently little addressed nationally in the textile and clothing sectors, through the methodology and referenced literature presented. Based on the indicated competencies, industries can structure applicable strategies to compete in a completely innovative market characterized by advanced manufacturing.

The organizational competencies to innovate in the Industry 4.0 paradigm identified in this work will contribute to the structuring and visualization of innovation strategies, allowing industries to remain competitive using their resources. As a suggestion for future work, it is recommended to validate the competencies identified with the textile industries and propose strategies to obtain these competencies.

These organizational resources of companies are, generically, “all assets, capabilities, competencies, organizational processes, firm attributes, information, knowledge, and everything else that is controlled by the firm and that allows it to conceptualize and implement strategies that increase its efficiency and effectiveness” (ALVES and BOMTEMPO, 2007).

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