

Knowledge management and innovativeness effects on product innovation in the textile context of Brazil

Gestão do conhecimento e efeitos da inovatividade na inovação de produtos no contexto têxtil do Brasil

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ABSTRACT

The main goal of this research is to examine the relationship between knowledge management processes, innovativeness, and product innovation in the Brazilian textile sector, based on a theoretical model that represents the positive impact that knowledge management processes have on innovativeness and product innovation. The proposed theoretical model was operationalized through a survey conducted with 157 Brazilian textile industries. The results showed that knowledge management processes impact product innovation through innovativeness. We concluded that when launching products, according to market trends and based on knowledge acquired, stored, and applied, companies seek to update their product portfolios based on the launch of new products, innovating to differentiate themselves from the competition and enhance better market and economic-financial results in the markets they operate.

Keywords: Knowledge Management Processes. Innovativeness. Product Innovation. Competitiveness. Textile Sector.

RESUMO

O principal objetivo desta pesquisa é analisar a relação entre processos de gestão do conhecimento, inovatividade e inovação de produtos no setor têxtil brasileiro, com base em um modelo teórico que representa o impacto positivo que os processos de gestão do conhecimento têm sobre a inovatividade e a inovação de produtos. O modelo teórico proposto foi operacionalizado através de uma pesquisa realizada com 157 indústrias têxteis brasileiras. Os resultados mostraram que os processos de gestão do conhecimento têm impacto na inovação de produtos através da inovatividade. Concluímos que ao lançar produtos, de acordo com as tendências do mercado e com base no conhecimento adquirido, armazenado e aplicado, as empresas buscam atualizar suas carteiras de produtos com base no lançamento de novos produtos, inovando para se diferenciar da concorrência e melhorar os resultados econômico-financeiros e de mercado nos mercados em que atuam.

Palavras-chave: Processos de Gestão do Conhecimento. Inovatividade. Inovação de produtos. Competitividade. Setor Têxtil.

1 INTRODUCTION

Knowledge is an essential competence, a primary source of competitive advantage, and value creation for organizations worldwide (Liu *et al.*, 2018). Knowledge management (KM) is an increasingly essential capability for an organization to succeed in both the public and private sectors (Al Ahbabi, Singh, Balasubramanian, & Gaur, 2018; Gaviria-Marin, Merigó, & Baier-Fuentes, 2019; Gonzaga de Albuquerque, Melo, Medeiros, Tomaz de Aquino, & Jerônimo, 2018).

The importance of KM consolidation at the international level reflects the convergence of KM use in organizations. A set of three mechanisms explain the KM practices: "learning and knowledge creation culture; organizational knowledge architecture for adaptive and exaptive capacity; and 'business model' for knowledge capitalisation and value capture" (Loon, 2019, p. 433).

Knowledge management increases the information exchange among stakeholders and boosts innovation generation. Therefore, KM enables cooperation within companies (Hamdoun, Chiappetta Jabbour, & Ben Othman, 2018; Santoro, Vrontis, Thrassou, & Dezi, 2018; Singh & El-Kassar, 2019). Managing the information flow in the organization make beneficial changes in the KM. Through KM, companies can share information from different sectors and different groups of employees in order to obtain strategic gains (Nisar, Prabhakar, & Strakova, 2019).

Knowledge management emerged as a discrete area in the study of organizations, considered an antecedent of organizational performance (Wiig, 1993). Organizations that successfully implement knowledge management processes maintain their competitive advantage intelligently by developing their knowledge assets (Wiig, 1993). Therefore, it is essential to know how to generate and disseminate knowledge within an organization and what factors can make these processes easier (Stewart, 1997).

The knowledge management concept became a topic of interest because it held the promise of a new management paradigm focused on capturing and using organizational knowledge in new or recurrent situations (Ponzi, 2002). It is associated with an organizational process (Anand & Singh, 2011; Ponzi & Koenig, 2002) and stimulates innovation, creativity, and fast learning (Gu, 2004).

Innovation is a key element of the knowledge-based economy (OECD, 2018). It is related to knowledge, as it creates new possibilities through the combination of distinctive groups of knowledge (Tidd, Bessant, & Pavitt, 2005), knowledge generation (Amidon, 1998; Leiponen,

2006; Nonaka, Byosiére, Borucki, & Konnot, 1994), or knowledge application (Johannessen, Olsen, & Olaisen, 1999; Quintas, Lefrère, & Jones, 1997).

Product innovation is the process input adopted to improve the production of a standard product (Abernathy & Utterback, 1988) and is used in different sectors (Pavitt, 1984).

Knowledge management, innovativeness, and innovation impact on business development and survival. Thus, analyzing these three concepts is essential due to their theories' importance for creating competitive advantages (Kör & Maden, 2013).

Recently, a study identified that knowledge management, supported by determinants such as collaboration in idea exploration, idea advocacy, and encouraging participation in idea implementation, contributed significantly to the product innovation process (Bratianu, C., Stănescu & Mocanu, 2022). Another study found that product innovation is a strategic driver in bridging the gap between knowledge management and performance for specific companies (Setiyono, Iqbal, Alfisyahr, Pebrianggara, & Shofyan, 2022).

Furthermore, research has identified that knowledge management processes have a significant and positive relationship with competitive strategy and innovativeness (Trivedi & Srivastava, 2022). And another study conducted in the hospitality sector confirmed that innovativeness mediates the relationship between knowledge management and organizational performance (Urban & Matela, 2022). In Malaysia, an investigation confirmed that knowledge acquisition, application, and protection were positively and significantly related to firm innovativeness (Mohamad, Ramayah & Lo, 2020).

Brazil ranks fourth among the world's largest clothing producers and fifth among the largest textile producers. General data for the sector for 2021 (updated in August 2022) places the sector as the second-largest employer in the manufacturing industry, losing only to food and beverages (together). Brazil is the fourth-largest producer and consumer of denim globally, representing 19,87% of jobs and 5% of the transformation industry revenue. Fashion Week is among the five biggest fashion weeks in the world. Also, more than 50 fashion schools and colleges are in the country. With the discovery of Pre-salt, Brazil ceased to be an importer and became a potential exporter for the global Synthetic Textile Chain, the largest complete Textile Network in the west. Brazil produces fibers, such as cotton plantations, and also develops fashion shows, spinning, weaving, processing, confection, and strong retail (ABIT, 2022). The sector gathers over 32 thousand companies, of which more than 80% are small and medium-sized confections in the national territory. According to the Brazilian Institute of Industrial Studies and Marketing (IEMI), the sector directly employs about 1.7 million

Brazilians and generates more than 4 million direct and indirect jobs (IEMI, 2021). Of those, 75% of the employees work in confections, and 70% are women.

In line with the above, the main goal of this research is to examine knowledge management processes and their impacts on innovativeness and product innovation in the Brazilian textile sector. The research method has a quantitative approach with a descriptive objective.

2 THEORETICAL BACKGROUND AND HYPOTHESES

2.1 Knowledge management and innovativeness

Considering the changing customer preferences and dynamic business environment, organizations must acquire knowledge from employees, customers, and suppliers to continuously improve their products and services (Qasrawi, Almahamid, & Qasrawi, 2017). Knowledge acquisition will also enable firms to capitalize on their strengths and review their weaknesses (Albort-Morant, Leal-Rodríguez, & De Marchi, 2018). The acquired knowledge must be shared with colleagues, particularly those occupying positions in relevant departments (Jarrahi, 2018).

Learning organizations encourage their employees to participate in different organizational issues actively. Employee participation enables the management to analyze problems from different perspectives and helps in proposing viable solutions. Finally, the acquired and shared knowledge must be applied in the relevant areas to improve the processes (Abbas & Sağsan, 2019).

Organizations may use the acquisition to obtain knowledge about current interests hidden in the market (Gold, Malhotra, & Segars, 2001; Hoe & Mcshane, 2010; Huber, 1991).

Companies acquire external knowledge by building alliances, hiring people, creating partnerships with suppliers, and interacting with customers (Huber, 1991). Regarding innovativeness, establishing relationships with external agents to understand their current and latent pretensions is an essential resource (Adler & Shenhar, 1990; Guan & Ma, 2003; Martinez-Cañas, Saez-Martinez, & Ruiz-Palomino, 2012).

Knowledge acquisition is linked to the abilities and capabilities of creating internal knowledge and absorbing external knowledge (Lichtenthaler & Lichtenthaler, 2009).

Consequently, new knowledge helps renew the company's knowledge base (Yu, Dong, Shen, Khalifa, & Hao, 2013) and promotes new ideas (Hsu & Sabherwal, 2012).

Innovative companies have physical and intellectual assets that identify and select prosperous innovation opportunities (Adler & Shenhar, 1990; Lawson & Samson, 2001; Martinez-Cañas *et al.*, 2012). The company's internal knowledge can be acquired through employee training and continuous education (Rusly, Corner, & Sun, 2012). Therefore, innovative companies seek to financially support and develop research and training activities (Guan & Ma, 2003; Hii & Neely, 2000; Lawson & Samson, 2001; Martinez-Cañas *et al.*, 2012).

The internal acquisition may be used to strengthen research and development and qualify the people in a company, expanding their knowledge base (Rusly *et al.*, 2012). Competitive success arises from a dynamic process of capability building. Knowledge acquisition, organization, integration, and use are processes that collaborate to build innovativeness, while new combinations of knowledge result in new products and processes (Yu *et al.*, 2013). These processes influence the firm's innovativeness, as they facilitate control of changes in the market, management of the company's knowledge base, contact and cooperation between internal and external agents, and search for new and existing knowledge at the company's base (Yu *et al.*, 2013). Knowledge acquisition has a positive relationship with innovativeness for three reasons: i) new knowledge allows innovations creation; ii) the higher the knowledge, the greater the possibilities of combinations, which would contribute to creativity; iii) by acquiring knowledge, a firm can reduce uncertainties and risk aversion (Kör & Maden, 2013). The acquisition process is positively associated with innovativeness, which, in turn, is positively associated with innovation performance, just as the knowledge management process is positively associated with innovation performance. Consequently, innovativeness mediates the relationship between the knowledge management process and innovation performance (Yu, Chen, & Nguyen, 2014).

Knowledge management has changed its nature from the theoretical concept of an instrument that helps innovativeness. The analysis of knowledge management and the understanding of its practices are essential in the search for innovation. The existence of knowledge management in policies and strategies is positively related to innovativeness, as well as the existence of knowledge management in leadership is positively related to innovativeness (Bidmeshgipour, Omar, & Khairuzzaman, 2012).

Knowledge transfer and creation require organizational trust, which results in innovations. Therefore, trust must be perceived as critical to innovativeness (Sankowska, 2013).

Knowledge storage is related to the abilities and capabilities to integrate, absorb, transform, and connect knowledge (Lichtenthaler & Lichtenthaler, 2009). These processes facilitate the

distribution of knowledge in a company in which employees become aware of the existence of the knowledge base (Yu *et al.*, 2013).

Innovative organizations have physical and intellectual assets to manage the creation of innovations, and their storage process improves knowledge retention, standardization, and reuse (Hii & Neely, 2000; Martinez-Cañas *et al.*, 2012). Therefore, these processes help organizations reuse knowledge quickly to facilitate knowledge communication without losing its consistency and the occurrence of its fragmentation (Zack, 1999).

By establishing the storage, companies intensify knowledge identification, localization, and transmission, whether explicit, through documents and manuals, or tacit, generated by individuals or groups (Alavi & Leidner, 2001). Hence, these processes positively impact innovativeness and facilitate the development of interconnected management (Adler & Shenhar, 1990; Guan & Ma, 2003; Hii & Neely, 2000; Lawson & Samson, 2001). Knowledge storage is linked to activities of knowledge conversion (Nonaka *et al.*, 1994; Nonaka & Takeuchi, 1995), organization, integration, combination, structuring, coordination (Gold *et al.*, 2001), accumulation (Lee, Lee, & Kang, 2005), presentation (Bhatt, 2001), stocking, retention, and memorization (Alavi & Leidner, 2001).

Knowledge practices, such as knowledge storage and transfer, positively and significantly affect innovation results. Thus, a culture oriented towards innovation and knowledge management is relevant in improving a firm's technological results efficiently (Donate & Guadamillas, 2010).

Storage may impact a firm's innovativeness as it centralizes and facilitates access to its knowledge base (Sáenz, Aramburu, & Blanco, 2012). Moreover, practices and procedures formalization is relevant to improving innovativeness, facilitating the diffusion and reproduction of the capability (Esterhuizen, Schutte, & Du Toit, 2012). A firm's progress in codifying, organizing, storing, and retrieving knowledge will lead to the availability and easiness of access to knowledge, thus accelerating the ability of the organization to perform the management of innovation projects that contribute to innovativeness (Sáenz *et al.*, 2012).

Influential knowledge storage should positively encourage innovativeness. This occurs because the more the knowledge is available and its access is agile, the better the application of new ideas and creativity will be. Also, exploring new ideas involves dealing with unknown situations, which may trigger risk perceptions and inhibit the company from trying new ideas. Knowledge application induces people to internalize available knowledge (Huang & Li, 2009; Nonaka & Takeuchi, 1995) and makes knowledge more active and relevant (Gold *et al.*, 2001; Huang & Li, 2009). These processes are conducted to incorporate specialties into processes

(Chen & Huang, 2009; Sarin & Mcdermott, 2003). Knowledge application makes it possible to boost innovation through practice (Hsu & Sabherwal, 2011; Johannessen *et al.*, 1999), and frequent exchanges with knowledge lead people to greater understanding or mastery over knowledge (Chen & Huang, 2009; Gold *et al.*, 2001).

As knowledge is put into practice, the company internalizes it and starts understanding new ways to use it, improving innovativeness (Yu *et al.*, 2013). Therefore, knowledge application is linked to abilities and capabilities to combine knowledge with activities and products (Lichtenthaler & Lichtenthaler, 2009). People, in turn, specialize in the knowledge they practice, and integrating different specialties generates new ideas and complex knowledge (Hsu & Sabherwal, 2012).

Innovative organizations own intellectual and physical assets, which allow innovation construction and flow (Guan & Ma, 2003; Hii & Neely, 2000; Martinez-Cañas *et al.*, 2012). When the company establishes the application, it tries to hasten learning by experimenting with practicing and reproducing knowledge application (Hsu & Sabherwal, 2011). Knowledge application focuses on putting knowledge into practice to exploit its potential (Aboelmaged, 2014; Gold *et al.*, 2001). Therefore, as companies use knowledge, they increase their understanding of its application (Gold *et al.*, 2001), helping them become creative and agile in developing returns to changes in the market (Aboelmaged, 2014; Nonaka & Takeuchi, 1995). Hence, creativity is an essential attribute of business innovativeness in companies (Huang & Li, 2009).

A vital step to improving a firm's innovativeness is institutionalizing current practices and procedures related to this capability, carried out with the repetition and experimentation of practices and procedures incorporated in activities performed by people (Esterhuizen *et al.*, 2012). The application process is positively associated with innovativeness and innovation performance. Thus, innovativeness is very important in the relationship between the knowledge management process and innovation performance (Yu *et al.*, 2014).

The application has a positive relationship with innovativeness for two reasons. First, as people master knowledge, they start perceiving contextual and causal relations that involve that knowledge. Second, mastery of knowledge by the process of a gradual application implies that the potentials of knowledge are declared with the repetition of the process itself, and each potentiality allows synergy with previously established knowledge, generating creativity and the emergence of new ideas (Yu *et al.*, 2014).

The fast technological and economic development in the world economy and the development in the systematic and complex nature of innovation processes require specific innovation

policy activities, such as access to new knowledge through networking (Kuştepelı, Gülcan, & Akgüngör, 2013). People and organizations may become aware of new technologies and information, as each industrial activity has certain types of innovation logic, innovative processes, and innovation results. Besides, knowledge generation, diffusion, application, and exploitation are closely related to a region's ability to produce innovation (Kuştepelı *et al.*, 2013). Knowledge management capacity positively influences product and process innovations of SMEs and intellectual capital. It also directly impacts firms' innovativeness (Al-Tal & Emeagwali, 2019).

Three external knowledge sources constitute the three indirect market players that are not common in the literature (consultant, new employees, and workshop). The knowledge inherent in these three sources is essential to the firm's innovative capabilities (Medase & Abdul-Basit, 2020). Mehrabani & Shajari (2012), Kör & Maden (2013), and Trivedi & Srivastava (2022) provided empirical evidence of the positive relationship between knowledge application and innovativeness. Based on that, the following hypothesis is suggested:

H1: Knowledge management has a positive impact on innovativeness.

2.2 Innovativeness and product innovation

New products, services, processes, business models, or management practices correspond to innovation types (Birkinsha, Bouquet, & Barsoux, 2011). On the other hand, innovativeness corresponds to changes in business practices, working styles, and external relationships (Ganter & Hecker, 2013). Innovativeness is an organization's ability to successfully acquire or launch ideas, processes, or products (Hurley & Hult, 1998). Thus, companies that innovate assimilate novel creations, adapting to external changes. Besides, companies that work on innovations guide their efforts to create new possibilities and conditions (Damanpour & Wischnevski, 2006).

Innovative firms offer an array of unique abilities and capabilities balancing innovation admission and generation (Damanpour & Wischnevsky, 2006; Lawson & Samson, 2001) and a resource base that supports identifying, selecting, and producing innovations (Martinez-Cañas *et al.*, 2012). In turn, companies that develop innovativeness establish a vision, strategy, and cultural values directed towards innovation, which stimulate responsibility for risks, creativity, learning, and interaction of experiences (Hii & Neely, 2000; Lawson & Samson, 2001).

Innovativeness may be classified as technical or administrative, representing the difference between technological and social structures (Gopalakrishnan & Damanpour, 1997). Technical innovations are changes in an organization's operations and basic activities (Damanpour & Evan, 1984; Gopalakrishnan & Damanpour, 1997), while administrative innovations are changes in complementary activities of the company's social system (Santos-Vijande, López-Sánchez, & González-Mieres, 2012).

In regions with different knowledge bases, where there are different deficiencies in the innovative performance, regional development success is related to the presence of territorial agglomeration of clusters of interrelated companies. The significant means for development is the capability and potential of the companies and other regional parties to have access to knowledge and to create innovation through learning (Gülcan, Akgüngör, & Kuştepel, 2011). An important element in innovation processes is creative minds, organized in groups, teams, or themselves. Professional R&D employees are the innovative entity in industrial innovation processes, searching for and recombining existing knowledge to develop innovative products (Broekel & Brenner, 2011). As a result, all innovation processes depend on the capability of players to cooperate and interact (Iivonen, Kyrö, Mynttinen, & Kahiluoto, 2011).

In the relationship between portfolio management governance, portfolio innovativeness, and firm performance, portfolio management for product innovation is essential when considering portfolio management governance to explain the higher innovation outcomes (Urhahn & Spieth, 2014). Therefore, formality and explicitness, information support, and partial review frequency impact the innovativeness of a firm's product portfolio and, consequently, higher technology and innovativeness drive a firm's performance (Urhahn & Spieth, 2014).

The synergy effects of innovation exist and can be changed depending on the innovativeness levels and industrial categories (Lee *et al.*, 2019). Both must have a positive relationship from the definition of innovativeness and product innovation. Companies with innovativeness develop and accept new products, aiming to increase profitability and expand markets. The positive relationship between innovativeness and product innovation was empirically confirmed by Urhahn & Spieth (2014), who guided the following hypothesis:

H2: Innovativeness has a positive impact on product innovation.

Figure 1 shows the theoretical model suggested in this research.

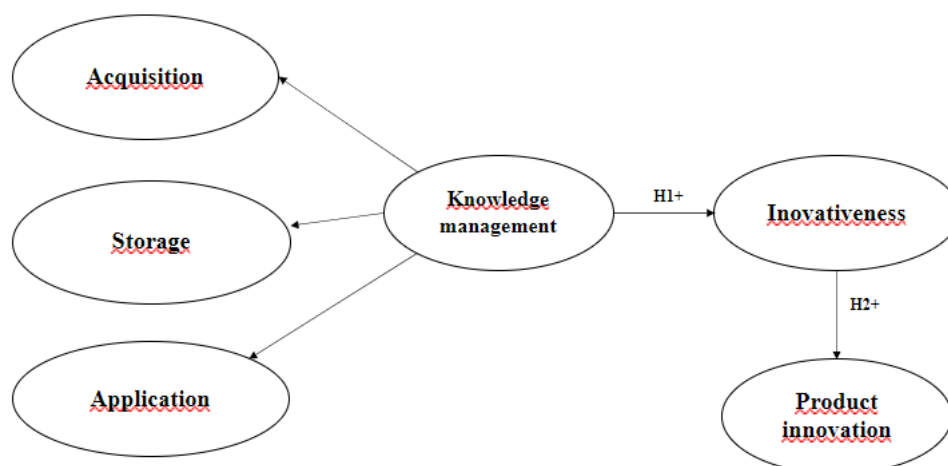


Figure 1. Proposed theoretical model.

Source: Elaborated by the authors.

3 RESEARCH METHOD

This research has a quantitative approach, applied through a cross-sectional survey. As for data analysis, the structural equation modeling technique was used to validate and evaluate the intrinsic relationships of the theoretical model and its hypotheses (Byrne, 2016; Kline, 2015).

The data collection instrument was composed of variables validated in previous studies and adapted to the context of this research. Concerning the knowledge management process construct, the scales proposed by Gold *et al.* (2001) were used for knowledge acquisition and knowledge application, and the scale proposed by Donate & Guadamillas (2010) was used for the knowledge storage process. Finally, for the innovativeness construct, the scale was based on Calantone, Cavusgil & Zhao (2002), and product innovation was based on Darroch (2005). All scales were measured on a seven-point Likert scale, varying from 1 (I completely disagree) to 7 (I completely agree). The scales used in the study are presented in Appendix A. The study object was composed of Brazilian industries in the textile sector, registered in the Sector Report of the Brazilian Textile Industry - Brazil Textile 2014 - and associated with the Brazilian Association of the Textile and Clothing Industry (ABIT). According to the Institute of Industrial Studies and Marketing (IEMI), the industrialization process in Brazil began with the textile industry. Its history and roots predate the arrival and occupation of the Portuguese, as the Indians who inhabited the country already carried out craft activities and used primitive techniques such as the manual interweaving of vegetable fibers to produce coarse canvas, with the primary purpose of body protection (IEMI, 2021). The textile industry is one of the

most widespread globally, constituting an essential income and employment generation source for several developing countries (IEMI, 2021). The research sample comprised 157 industries registered with IEMI, 2014 edition, from 377 companies registered in the rectilinear knitting and weaving sector.

Data collection occurred from September 2015 to April 2016 in five waves of research. One of the researchers contacted the organizations by phone to speak with the marketing manager. When it was impossible to talk to the manager, we requested an e-mail to send the questionnaire. At each contact, the researcher provided a brief explanation of the theme and relevance of the research, the importance of participation in the study, and the questionnaire application.

After cleaning missings and uni and multivariate outliers (through the Z-scores and Mahalanobis Distance), no cases were excluded, and therefore the final sample resulted in 157 valid cases. All analyses were performed with the help of the statistical software SPSS 21 and AMOS 20. Confirmatory factor analyses were performed to assess the quality of the instrument. Then, the structural equation modeling technique was operationalized to test and validate the proposed theoretical model and its respective research hypotheses (Kline, 2015; Byrne, 2016).

4 RESULTS

4.1 Descriptive analysis

The sample was composed of 157 companies, 135 (85.99%) located in Brazil's South and Southeast regions. As for the number of employees, most (52.87%) companies have 100 to 499 employees. Regarding uptime, 85% of the sample has more than 15 years of operation in the market. The results are in Table 1.

Sample Characterization		n	%
Region of Brazil	South	75	47.77
	Southeast	60	38.22
	Northeast	18	11.46
	Midwest	2	1.7
	North	2	1.27
Number of employees	Up to 19 employees	6	3.82
	20 to 99 employees	37	23.57
	100 to 499 employees	83	52.87
	Over 500 employees	31	19.75
Uptime	3 to 5 years	1	0.64

5 to 10 years	13	8.33
10 to 15 years	9	5.77
Over 15 years	133	85.26
Total	156	

Table 1. Sample characterization

Source: data from research.

4.2 Assessment of the structural model

The convergent and discriminant validity were evaluated for the validation of the constructs. In order to verify the unidimensionality, the Exploratory Factorial Analysis (EFA) was performed employing main components and through Varimax orthogonal rotation. Variables with factor loadings lower than 0.5 were removed from the analysis, as recommended in the literature (Byrne, 2016). The final attributes factor loadings varied from 0.635 to 0.908, considered satisfactory (Hair, Howard, & Nitzl, 2020). According to the literature, the variance extracted, composite reliability, and Cronbach's Alpha should present values greater than 0.5, 0.7, and 0.6, respectively, and all were adequate (Hair *et al.*, 2020), indicating adequate reliability. The results are in Table 2.

Constructs	Variable	Factor loading	AVE	CR	α
Knowledge Acquisition	KA01	0.700	0.55	0.93	0.932
	KA02	0.773			
	KA03	0.756			
	KA04	0.766			
	KA05	0.705			
	KA07	0.739			
	KA08	0.730			
	KA09	0.746			
	KA10	0.827			
	KA11	0.693			
	KA12	0.711			
Knowledge Storage	KS02	0.655	0.51	0.86	0.857
	KS04	0.611			
	KS05	0.794			
	KS06	0.832			
	KS07	0.655			
	KS08	0.699			
	AP03	0.791			
	AP04	0.797			
Knowledge Application	AP05	0.825	0.68	0.95	0.949
	AP06	0.837			
	AP07	0.866			
	AP08	0.872			
	AP10	0.817			
	AP11	0.804			
	AP12	0.831			
	IN01	0.886			
Innovativeness	IN02	0.908	0.64	0.91	0.894
	IN03	0.858			

Product Innovation	IN04	0.683	0.53	0.65	0.860
	IN06	0.720			
	IN07	0.712			
	PI01	0.723			
	PI02	0.720			
	PI03	0.792			
	PI04	0.635			
	PI05	0.760			
	PI08	0.714			

Table 2. Convergent validity

Source: data from research.

The discriminant validity was evaluated by comparing the square correlations between the constructs and the average variance extracted for a construct (Fornell; Larcker, 1981). A rule for assessing discriminant validity requires that the square root of the average variance extracted be higher than the correlations between the constructs (see diagonal versus non-diagonal elements in Table 3).

Dimensions	Acquisition	Storage	Application	Innovativeness	Product Innovation
Acquisition	0.58				
Storage	0.47	0.59			
Application	0.73	0.49	0.67		
Innovativeness	0.54	0.40	0.67	0.64	
Product Innovation	0.38	0.30	0.47	0.75	0.60

Table 3. Discriminant validity

Source: data from research.

Based on the results in Table 3, product innovation and innovativeness and application and acquisition presented a higher correlation. Therefore, the additional Bagozzi and Phillips (1982) test was performed to check the differences between the chi-squares for the pairs of constructs, considering the free and fixed models, without and with correlation, respectively. As a result of the differences between the chi-squares, the significance was calculated, indicating significant differences between the constructs analyzed, thus confirming the discriminant validity of the constructs innovativeness and product innovation, and application and acquisition (Table 4).

Construct 1	Construct 2	Chi-square Fix model	Chi-square Free model	Diference	Sig.
APPL	ACQUIS	459.21	456.85	2.36	0.04
INNOV	PROD INNOV	293.208	284.57	8.64	0.00

Table 4. Discriminant validity confirmation

Source: data from research.

4.3 Structural model validation

The development of the structural model validation adopted general guidelines, adapting the constructs and identifying the goodness-of-fit indexes (GOFs). The indexes are classified as absolute fit measures (CMIN/DF and RMSEA), incremental fit measures (NFI and TLI), and parsimonious fit measures (CFI) (Byrne, 2016). The indexes of the proposed model were satisfactory for IFI (0.906) and CFI (0.905), above 0.9. Besides, CMIN/DF (1.709), which presented a value lower than 5, and RMSEA (0.067), which presented a value between 0.05 and 0.08 (Kline, 2015). The TLI index was in the borderline zone, with a value of 0.895, whereas the NFI value was 0.800, unsatisfactory. Table 5 presents the model fit indexes.

Model fit indexes	Values Obtained for the Model Fit Indexes
χ^2/df (CMIN/DF) (< 5)	1.709
RMSEA (0.05 to 0.08)	0.067
NFI (> 0.9)	0.800
TLI (> 0.9)	0.895
CFI (> 0.9)	0.905
IFI (> 0.9)	0.906

Table 5. Model fit indexes

Source: data from research.

Finally, the hypothesis test was performed to examine the significance and magnitude of the estimated regression coefficients (Kline, 2015; Byrne, 2016). Table 6 presents the structural paths, the unstandardized coefficients, the standard errors, the standardized coefficients, and the probabilities.

Path diagrams	Unstandardized coefficients (b)	Standardized coefficients (β)	Std. error	t-value	Sig.	Result
Know_man $\rightarrow$ Innovt	1.112	0.874	0.105	10.625	***	Confirmed
Innovt $\rightarrow$ Produ_inno	0.860	0.840	0.093	9.228	***	Confirmed

Table 6. Hypotheses testing

Source: data from research.

According to the results presented, hypotheses H1 (knowledge management positively influences innovativeness, $\beta = 0.874$, $p < 0.01$) and H2 (innovativeness positively influences product innovation, $\beta = 0.840$, $p < 0.01$) were statistically confirmed. Figure 2 presents the tested theoretical model and the respective standardized coefficients (β s).

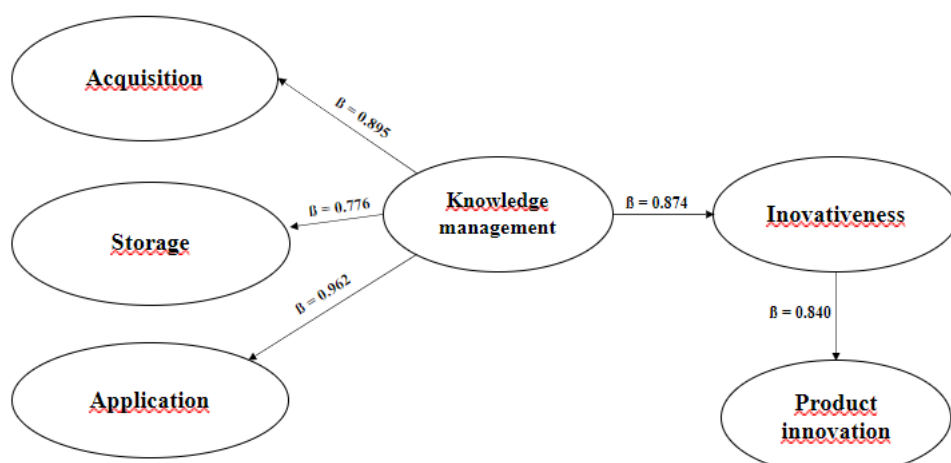


Figure 2. Theoretical model and its standardized coefficients
Source: data from research.

The theoretical model's coefficient of determination (R^2) was analyzed to verify the efficacy of the hypothesis test (Byrne, 2016). The results suggest that innovativeness and knowledge management explained 70.6% of the product innovation variable, a high explanatory power (Tabachnick & Fidell, 2012). It should also be noted that knowledge management, through its formative dimensions, namely, the acquisition, storage, and application of knowledge, explained 76.4% of innovativeness.

5 DISCUSSIONS AND CONCLUSIONS

The main goal of this research has been to examine knowledge management processes and their impacts on innovativeness and product innovation in the Brazilian textile sector. We also expected to contribute to research related to innovation in the textile sector. In the object studied (157 Brazilian industries), the knowledge management processes (acquisition, storage, and application) impacted innovativeness, which, in turn, impacted product innovation. A literature review and quantitative statistical analysis reached the objective of proposing a theoretical model representing the relationship between knowledge acquisition, knowledge storage, knowledge application, innovativeness, and product innovation.

The research results confirmed hypotheses H1 and H2, reinforcing the relationship between knowledge management and innovativeness (Al-Tal & Emeagwali, 2019; Medase & Abdul-Basit, 2020; Mohamad, Ramayah & Lo, 2020; Trivedi & Srivastava, 2022) and product innovation and innovativeness (Lee *et al.*, 2019; Setiyono, Iqbal, Alfisyahr, Pebrianggara, & Shofyan, 2022). This finding also converges with Sáenz *et al.* (2012), who highlighted that a

firm's progress in codifying, organizing, storing, and retrieving knowledge would lead to availability and easiness of access to knowledge. Thus, accelerating the organization's ability to perform the management of innovation projects that contribute to innovativeness. The application process is positively associated with innovativeness and innovation performance. Therefore, innovativeness mediates the relationship between the knowledge management process and innovation performance (Yu *et al.*, 2014). The results also contribute to the findings of Urhahn & Spieth (2014), who identified a positive relationship between innovativeness and product innovation, just as product innovation is a strategic drive to bridge the gap between knowledge management and the performance of specific companies (Setiyono, Iqbal, Alfisyahr, Pebrianggara, & Shofyan, 2022). Knowledge acquisition, application, and protection were positively and significantly related to firm innovativeness (Mohamad, Ramayah & Lo, 2020). Therefore, innovativeness mediates the relationship between knowledge management and organizational performance (Urban & Matela, 2022). Innovative companies develop and accept new products to increase profitability and expand markets.

The confirmation of the relationships between the constructs of the theoretical model contributes by showing that Brazilian textile companies apply knowledge management processes to be innovative and implement their products innovation. Knowledge management, supported by determinants such as collaboration in idea exploration, idea advocacy, and encouraging participation in idea implementation, contributes significantly to the product innovation process (Bratianu, C., Stănescu & Mocanu, 2022). In other words, companies seek to update their product portfolios when launching products according to market trends and based on knowledge acquired, stored, and applied. As a result, they innovate to differentiate themselves from the competition and enhance better market and economic-financial results in the market.

The company sizes influenced the relationships between knowledge management processes, innovativeness, and product innovation. By analyzing the relationship between knowledge management processes and innovativeness, we realized that the relationship between acquisition and innovativeness refers to how the company acquires knowledge. Storage demonstrates the care and the way knowledge is organized to be used and make the company innovative.

The results showed that acquisition is directly related to innovativeness and indirectly related to product innovation. Storage is directly related to innovativeness and indirectly related to product innovation. The indirect effects of the acquisition on product innovation imply that

there may be an investment in acquisition and innovativeness, which meets the company's expectations and needs related to product innovation. Future research could examine this possibility.

Storage is essential for companies to retain their knowledge. Storage and product innovation were positively related and strengthened due to the company's lower investment potential. However, storage may harm innovativeness by making processes bureaucratic and rigid. Such processes form the knowledge management, information management, content, methods, techniques, and management strategies that aim to improve organizational practices, supporting pro-active management of innovation, innovativeness, and product innovation as the result of knowledge management.

The results pointed out that application is directly related to innovativeness and indirectly related to product innovation. These results suggest two aspects: first, as it preserves the effects on innovativeness and product innovation, the application seems to be the first knowledge management process that a company should try to establish; second, even if a company does not have a qualified workforce, it would be appropriate to maintain the application, even when not practiced, in order to prevent the lengthy construction of these processes. The indirect effects of application on product innovation indicate the possibility of a certain level of investment in application and innovativeness so that it meets the expectations of a company regarding product innovation. Therefore, future research could test this possibility.

Indirect results of acquisition, storage, and application on product innovation through innovativeness indicated that these processes provide additional benefits since part of the influence of acquisition, storage, and application is connected to the relation between innovativeness and product innovation. As an indirect effect, companies may create acquisition, storage, and application to promote innovativeness, stimulating product innovation. In general, the results of this research do not demonstrate the dynamics in which knowledge management processes should happen to provide product innovation.

Regarding the research limitation, the model resulting from the research is adequate for the relationship between these three constructs, which the particularity of the sample may have determined. Testing the model in samples from different economic sectors is recommended, considering other variables and different constructs. Even though these results refer to the relationship between knowledge management processes (acquisition, storage, and application), innovativeness, and product innovation in the Brazilian textile sector, the

relationships would likely replicate the same performance with other constructs in different contexts. Future research may concentrate on these contributions.

Construct	Variables
Knowledge Acquisition Gold <i>et al.</i> (2001)	KA01- Our company has processes for acquiring knowledge about our customers
	KA02- Our company has processes for generating new knowledge from existing knowledge
	KA03- Our company has processes for acquiring knowledge about our suppliers
	KA04- Our company has processes for distributing knowledge throughout the organization
	KA05- Our company has processes for exchanging knowledge with our business partners
	KA06- Our company has processes for inter-organizational collaboration
	KA07- Our company has processes for acquiring knowledge about new products/services within our industry
	KA08- Our company has processes for acquiring knowledge about competitors within our industry
	KA09- Our company has processes for benchmarking performance
	KA10- Our company has processes for exchanging knowledge between individuals
	KA11- Our company has teams devoted to identifying best practices
	KA12- Our company uses feedback from projects to improve subsequent projects
Knowledge Storage Donate & Guadamillas (2010)	KS01- Organizational procedures are documented through work procedures, written protocols, handbooks, etc.
	KS02- Databases that allow gathered knowledge and experiences to be used later are available in the company
	KS03- There are phone or e-mail directories (referring to departments and sections) to find experts in specific areas
	KS04- It is possible to access knowledge repositories, databases, and documents through some kind of internal computer network (such as an intranet)
	KS05- There are customer databases with updated information about them
	KS06- Databases are frequently updated and information is renewed
	KS07- There are procedural company handbooks about problems and methods that have been successfully applied
	KS08- IT is used to handle, structure, and improve the quality of information and knowledge and encourage communication and accessibility among individuals
Knowledge Application Gold <i>et al.</i> (2001)	AP01- Our company has processes for the knowledge application learned from mistakes
	AP02- Our company has processes for the knowledge application learned from experiences.
	AP03- Our company has processes for using knowledge to develop new products/services
	AP04- Our company has processes for using knowledge to solve new problems
	AP05- Our company combines sources of knowledge to problems and challenges
	AP06- Our company uses knowledge to improve efficiency
	AP07- Our company uses knowledge to adjust the strategic direction
	AP08- Our company is able to locate and apply knowledge to change the competitive conditions
	AP09- Our company makes knowledge accessible for those who need it
	AP010- Our company takes advantage of new knowledge
	AP011- Our company quickly applies knowledge to critical competitive needs
	AP012- Our company quickly connects the sources of knowledge to solve problems
Innovativeness – Calantone <i>et al.</i> (2002)	IN01- Our company frequently tries out new ideas
	IN02- Our company seeks out new ways to do things
	IN03- Our company is creative in its methods of operation
	IN04- Our company is often the first to market with new products and services

Product Innovation - Darroch (2005)	IN05- Innovation in our company is perceived as too risky and is resisted.
	IN06- Our new product introduction has increased over the last 5 years
	PI01-Our company often introduces new ranges of products or services not previously offered by this company
	PI02- Our company often adds new products or services to our existing ranges
	PI03- Our company often improves or revises existing products or services
	PI04- Our company often changes our products or services in order to reduce costs
	PI05- Our company often repositions existing products or services
	PI06-We have launched products new to the world
	PI07- We have launched products new to the firm
	PI08- We have launched new products to existing ranges
	PI09- Our company improves existing products
	PI10- Our company changes products to reduce costs
	PI11- Our company repositions exiting products

Appendix A - Scales

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