A conceptual appraisal towards the contextualization of product and process innovation in clothing manufacturing

Duncan Kariuki Ndwiga, Lucy Wanjiru Ciera and Geoffrey Ngugi Mokabi
Department of Fashion, Clothing and Textiles, Technical University of Kenya, Nairobi, Kenya

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Abstract

Purpose – This study aims to address the aspects of product and process innovation strategies and their determining factors to understand their characteristics in clothing manufacturing and contribution for a successful and competitive clothing industry.

Design/methodology/approach – This general review is based on literature data of previous studies on innovation that transcend and cover the aspects of innovation applicable in the clothing industry. Although the scope of discussion is theoretically broad, it focusses on the context of innovation strategies in clothing manufacturing and the determinant factors indicating the acquisition and implementation of product and process-related innovation activities, simultaneously exploring and linking their implications for adopting, managing and integrating enterprise activities to the values of desired innovation novel models.

Findings – Based on theoretical background and pragmatic generalizations, product and process innovation strategies in clothing manufacturing firms tend to incline more towards computer-integrated technologies and concepts meant to promote product development, process optimization and organizational integration. Industry, technological and R&D factors tend to significantly determine innovation capability of a clothing firm.

Originality/value – This review generates integrated conceptual frameworks for product and process innovation strategies applicable in clothing firms and their determinant factors as prelude to empirical validation.

Keywords Product innovation, Process innovation, Clothing industry, Innovation strategy, Clothing manufacturing, Innovation determinants

Paper type General review

1. Introduction

Though varied, the definitions of innovation surround an element of novelty that add commercial value into a business enterprise (Narvekar and Jain, 2006). Today, innovation is key to success of every enterprise, contributing an added value in the market through new products and processes focussed towards customer satisfaction (Jain and Sundström, 2021).

According to Van de Ven (1986), innovation of an enterprise is acquired through a network-based effort focussing on the creation, adoption and sustained implementation of varied ideas of "a better worth". These developments are pegged on innovation pillars such as supporting technologies and infrastructures, new skills and training, R&D activities, financial services and a favourable government regulatory framework that encourages innovations (Foresight Horizon Scanning Centre, 2010). In the context of an enterprise

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innovation system, innovation is characterised as an interactive process of the firm's operational activities entrenched within the overall enterprise structure (Audretsch, 2014).

Thus, to have a better understanding of the nature of innovation performance in an enterprise, the management of market information on current and future customer demand and its subsequent adoption within the enterprise operational activities is crucial (Cillo *et al.*, 2010). As such, innovation symbolizes a learning organization embracing continuous change beyond the activities within the innovation pillars to also include continuous improvements in product design and quality, changes in organisation and management system, creativity in marketing, modifications of production processes that increases efficiency and speed to market bringing down production costs and ensure environmental sustainability (Mytelka and Farinelli, 2000).

Therefore, the purpose of this review is to explore and harmonize applicable innovation strategies worth implementation in any clothing manufacturing firm and their determinant factors. Innovation strategies increases firm's competitive advantage enhancing productivity and efficiency, thus reducing the cost of production while improving on products (Kaliappen and Hilman, 2017). In this context, innovation strategy refers to the structural support and tools for innovation which enables a firm innovation capability, thereby influencing its performance to effectively innovate and sustain competitiveness based on the degree of product and process innovations (Salisu and Bakar, 2018). Thus, an industry requires to define its innovation strategies which can only be achieved through the management of firms' resources in acquisition and implementation of innovations (Abdulla and Kumar, 2021). Likewise, innovation determinants factors influence and/or indicate innovation adoption in a firm thus its innovation capability. According to Nieto *et al.* (2022), country factors raging from institutional to industry factors are key innovation determinants that have significant effects on innovation strategies of a firm. This paper therefore adds knowledge by:

- identifying the current nature of innovation strategies and their determinants towards product development and production process innovations in clothing manufacturing;
- identifying the potential future innovation directions in the clothing industry; and
- by underlining the system of innovation towards the values of desired innovation models applicable in innovation research studies in the clothing industry.

1.1 Overview of innovation studies in the clothing industry

The clothing industry is one of the world's most global industries and historically recognised as the incubator of innovation and a pillar towards industrial revolution (Alam *et al.*, 2019). Even though the clothing industry is characterized by low R&D activities and dependence on innovation knowledge (Giannini *et al.*, 2019), it has high-value added segments where product design and R&D are important competitive factors. Also, it is a sector where relatively adaptable modern technological innovations can be adopted even in developing countries (Byrne, 2000). Such technology advancements have enhanced sustainability of this industry through new functional products and production mechanisms by installing and adopting new advanced systems and equipment (Kozlowski *et al.*, 2016; Varukolu and Park-Poaps, 2009; Hoque *et al.*, 2021).

Although Au and Yeung (1999) argues that the low technological nature of clothing manufacturing has led to clothing production remaining in low-cost countries with little or no innovation, the past two decades has seen adoption of new innovations leading to some of the developing countries experience very high output growth rate (e.g. Bangladesh,

Vietnam) (Alam *et al.*, 2019). Furthermore, the importance of speed-to-market has resulted to new structural changes leading not only to innovative products and processes but also to new market and organisational methods along the global fashion supply chain (Des Rosiers *et al.*, 2011). Accordingly, has seen increased outsourcing more so by developed countries due to connectivity of the supply chain though to the detrimental of their industry (Kincade and Annett-Hitchcock, 2021), prompting developed countries and subsequently their developing counterparts approach varied innovative strategies to remain competitive.

For example, in developed countries, innovation studies in European Union (EU) on clothing production firms focused on technological change, particularly the use of just-in-time (JIT), quick response (QR) and computer systems for designing, cutting and finishing (Taplin, 2006). In Italy for instance, clothing manufacturers did industrial upgrading seeking to compete on the product basis of design, quality and fashion thus remaining in high value-added market segments (Taplin, 2006). In Germany, local clothing producers besides enhancing technological use also brought innovative strategies to respond to international price competition (Adler, 2004). Despite Giannini *et al.* (2019) claiming that the EU innovation model for the clothing industry has low investment in R&D, and little capabilities for autonomous innovation still acknowledges that these firms managed to acquire transversal innovations from unrelated industry variety which have had a greater impact towards their innovative performance.

On the other hand, the fashion global outward processing and supply chain network have also showed high innovation and learning levels in developing countries. The trickle down effects through vertical knowledge flows from foreign clients and suppliers have influenced clothing firms to highly innovate in the developing countries (Wadho and Chaudhry, 2018). For instance in Asia, there is increased use of JIT and other QR techniques to meet shorter lead times, coupled with systematic use of teamwork and multi-skilling to improve on both productivity and quality (Taplin and Winterton, 2004). China in particular has been in the forefront in promoting innovation activities in clothing manufacturing through its National Innovation Platforms rising to become the world leading exporter of clothing (Li *et al.*, 2011; Gracie, 2011). Furthermore, global integration of the supply chain has motivated clothing firms in China to upgrade through learning and adoption of technological innovation capabilities (Zhang *et al.*, 2016). Thus, for the clothing industry to remain competitive, it ought to continuously innovate, enabling high productivity through efficient processes and feasible strengths in product developments (Byrne, 2000).

2. A study framework for product and process innovation appraisal

This paper drew on existing innovation research from which varied innovation literatures and frameworks are integrated to underline the context of innovation strategies in clothing manufacturing. Thus, defines innovation strategy on a concept that embodies two dimensions of innovation in the form of products and processes, coupled with their determinant factors which characterizes a competitive clothing industry.

Due to the pragmatic nature of innovation, an extensive desktop research approach was used to review various innovation literature from sources such as journal publications, books, agencies and industrial reports and working and conference papers. The inclusion and exclusion criteria of literature was primarily based on the type of study thus focused on product and process innovation literature specific to clothing manufacturing. However, it was also selectively expanded to capture other transversal innovation strategies developed and applied in rather different sectors but adoptable into the clothing industry. The sourced literature was evaluated to develop innovation conceptual frameworks as a prelude to

empirical validation, following a rationale that focuses on the need to re-evaluate the aspects of product and process innovations in clothing firms.

3. Innovation strategy theory in clothing manufacturing

3.1 Clothing product development innovation theory

According to Cillo *et al.* (2010), product innovation refers to the degree of newness of a product as compared to previous products commercialized by a firm based on its characteristics or intended use. Thus, provide customers with increased product differentiation and exclusivity reflecting firms' ability to respond to market demand changes. Accordingly, product innovation strategy enables a firm to achieve high competitive advantage while controlling firm processes of developing and delivering new products efficiently (Salisu and Bakar, 2018). These strategies have become critical cross functional activities in clothing manufacturing ensuring flexibility to effectively and competitively respond and adapt to changing market requirements (Calisir *et al.*, 2013).

In clothing manufacturing, product innovations come along the product development (PD) process basically involving all partners of the fashion value chain (Bailey and Seock, 2010). Besides, PD is usually guided by the manufacturing process depending on the business model and product category aligned along the supply chain ensuring a competitive, resilient and responsive supply chain (Khan *et al.*, 2012). The key phases of fashion PD cycle follows the fashion design process which is customer-centered depending with the target market (Munasinghe *et al.*, 2021; RKJ and Rupasinghe, 2016). Thus, revolves around R&D activities within the target market, thereby identifying customer demand and ends in the same market where the customer demand is met, thus cyclical in nature as shown on Figure 1, which reflects the integration of different functions of the PD process.

To enhance fashion products, PD innovation strategies are being adopted within the functions of PD cycle informing on factors involving consumers, product values and dimensions and other PD theories (Sameti, 2022). This makes the flexibility of the PD process and its capacity as the mainstay for survival and growth of fashion enterprises

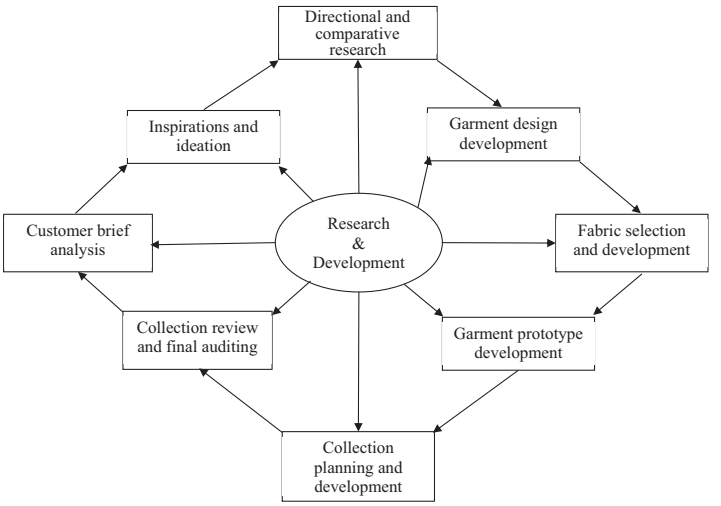

Figure 1.
Fashion PD cycle

Source: Author

(Brooks, 2019). Hence, knowing what promotes and inhibits the outcome of new product developments (NPDs) based on the agility of the PD cycle is paramount.

As a result, innovative NPD models have been developed implying how PD teams collectively decide along the phases of a product line (Nayak and Padhye, 2015), ensuring quick launching of new products and quality management from the sourcing point (Fairhurst, 2008). Various transversal NPD models being adopted in the clothing industry includes: systematic NPD model with flexible distinct integral stages of the PD process; sequential NPD model meant to rationalize and identify the interrelated process activities for product design and development; supplier-integrated NPD model meant for supplier integration at various points of the PD process; new product design and development model detailing each activity of a NPD process from design to delivery; and Electronic-NPD model indicating information interdependency using electronic communication technologies along a product value chain (RKJ and Rupasinghe, 2016).

The cohesion between the NPD models involves extensions of one model to the other thus their insight may not significantly vary. For instance, the NPD models have led to the development of No-interval Coherently Phased Product Development (NICPPD) model, which identifies inherent qualities of clothing on a six phase clothing PD process (May-Plumlee and Little, 1998). NICPPD is part of the Proactive Product Development Integrating Consumer Requirements model, which captures consumer requirements along the apparel PD process (May-Plumlee and Little, 2006), thus a progression of other. Same applies to Functional Expressive Aesthetic (FEA) NPD model which also identifies consumer needs along the fashion design process (RKJ and Rupasinghe, 2016). Nevertheless, NPD models have become significant, as they recognize the changes in market demand and prerequisite technologies while involving supply chain partners, thereby meeting customer expectations and gaining market advantage (Wijewardhana *et al.*, 2021).

As such, PD innovation strategies have mainly embraced technological adoption to enable clothing firms achieve sustainable success in frequently changing and competitive market (Shan and Jolly, 2013). For example, Wijewardhana *et al.* (2021) identified the implementation of technological strategies such as 3D prototyping, cloud computing, Internet of Things (IoT), big data analysis, virtual reality, augmented reality, advanced colour matching, simulation and cognition as some of the key Industry 4.0 (I4) technologies being used in clothing PD. These new PD technologies more so virtual human body modelling using body scanners; virtual designing, fitting, animation and prototyping using 2D and 3D computer-aided design (CAD) linked with computer-aided manufacturing (CAM) systems; textile CAD systems and product data management systems have significantly improved efficiency of the fashion PD process (Nunes *et al.*, 2017; Hoque *et al.*, 2021; Nayak and Padhye, 2015).

Quality management is also an integral part of PD process enabling translation of customer demands into product specifications. By using strategic innovative conceptual tools and technologies such as electronic data interchange (EDI), Kano model, quality function deployment (QFD), house of quality (HOQ) and analytical hierarchy process (AHP) has linked consumers requirements with the PD process technical specifications (RKJ and Rupasinghe, 2016). These quality tools are specifically being implemented to develop marketable products with quality attributes as specified by customers. The overall integration of clothing PD innovation strategies of quality management, NPD and technology is as shown in Figure 2, indicating how they are symbiotic with each other.

However, it is worth noting that clothing PD models are characterized by repetitive tasks (Bandinelli *et al.*, 2013) hence ought to be optimized through innovation strategies to clearly interpret and satisfy customer requirements. Also, their sequential order with only a

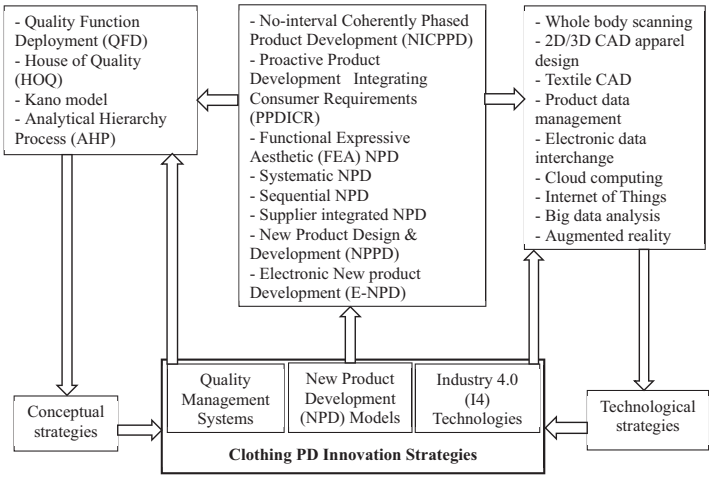

Figure 2.
A framework for clothing PD innovation strategy

Source: Author

forward movement of functions (Malhotra *et al.*, 1996) maybe ineffective toward flexible manufacturing. Thus, should focus on adaptable PD strategies which enhances the success of the PD process according to consumer preferences and insights of the PD team (Sameti, 2022), and also accommodate the rapid changes where varied product developments are simultaneously manageable without repetitive wastages. As RKJ and Rupasinghe (2016) observes, characterizing systematic clothing NPD models leads to acceptable clothing products in the market hence requires appropriate innovation strategies.

3.2 Clothing manufacturing process innovation theory

According to *Oslo Manual* (OECD, 2005, 2018), process innovation is the implementation of new or significantly improved production or delivery methods. Through constant process innovation strategies that enable modifications on firms' production methods, firms can maintain quick and flexible responses to the ever changing market demand (Salisu and Bakar, 2018). Process innovations strategies ought to uplift production and delivery techniques of a firm by reengineering and advancing its operation procedures and capacities (Ajayi and Morton, 2015; Yu *et al.*, 2016). Key to process innovation strategies in clothing production is maintaining a balance between enhancing manufacturing performance and the cost incurred from using technology, thus achieving adequate competitive firm performance (Yan and Fiorito, 2002). As such, new technological improvements are continuously being recognized as significant innovation strategies depending on the firms' internal characteristics through mechanical engineering, computer technology, production systems and artificial intelligence thus changing the production methods and scope of clothing firm activities (Varukolu and Park-Poaps, 2009).

Today, varied disruptive technologies have become strategic towards the transformation and adoption of I4 into the clothing production process. These ranges from mini factories for personalized production from cutting to shipping; purchase activated manufacturing for handling material inventories according to actual customer demand; active tunnel infusion allowing change of color in each article of clothing; automated apparel systems for controlling the process of garment assembly; real time process tracking for monitoring the

progress of the manufacturing process; and social manufacturing uniting the consumer with the production system through customized clothing (Bruno and Pimentel, 2016; Jayatilake and Peter, 2016). The wide recognition and implementation of I4 concept is essential for the future of clothing manufacturing enabling intelligent and flexible manufacturing where cyber–physic system has led to advanced industrial production systems and applications while integrating IoT and Industrial IoT in connecting process operations as well as information sharing (Chen and Xing, 2015; Jayatilake and Peter, 2016).

Also, the integration of computers has become crucial in process and organizational optimization. This is by acquisition of computerised manufacturing technologies in fabric preparation, cutting, fusing, sewing, pressing, garment dyeing and printing; by integration of computerized systems for management, materials handling and team working; by adoption of flexible manufacturing systems implemented through improved training and expert systems (Hoque *et al.*, 2021; Nayak and Padhye, 2015); and by application of artificial intelligence methods such as machine learning, expert systems, decision support system, optimization and image recognition and computer vision (Giri *et al.*, 2019).

In addition, introduction of innovative bespoke systems and mass customization of fashion products through CAD/CAM has responded to consumers requirements, thereby offering effective production while ensuring process efficiency and quality products (AlMond, 2011; Nayak *et al.*, 2015; Yan and Fiorito, 2007; Watcharapanyawong *et al.*, 2011). For example in modular production system, processes are grouped into a module and integrated with varied computer technologies to enhance team work and information sharing, whereas the unit production system has automated conveyor system where computers plan, control and direct the flow of work through the system (Ferdous and Kabir, 2015), thus enabling lean manufacturing and simultaneous production of continuous product varieties with short development cycle.

Apart from technology, production management tools have as well been paramount towards clothing production process innovation strategies. Tools such as JIT have enabled adapting the variations in manufacturing plans and time schedules while eliminating waste in the production process (Singh and Ahuja, 2012; Iqbal *et al.*, 2020). To speed up information and inventories flow, QR tools such as Global Quick Response has been established ensuring cost and scale efficiencies when sourcing globally with quick and accurate market response (MacCarthy and Jayarathne, 2010). Also, the use of EDI systems has streamlined the supply chain processes allowing automated exchange of information (Mossinkoff and Stockert, 2008). Even though EDI had challenges due to ever changing fashion, and inability to increase efficiencies when linked with internal information systems or with suppliers (Riddle *et al.*, 1999), it has been restructured creating strong linkages between apparel manufacturers and customers while supporting accurate demand forecasting and fast product delivery maintaining optimal inventories (Masudin and Kamara, 2017).

Other tools enabling lean and flexible manufacturing includes enterprise resource planning system for identifying and planning firm's resources towards sourcing, producing and distribution of customer orders; customer relationship management system for managing customer data, customer service and support and business partnership; supply chain management system for managing material sourcing, production and management; and total quality management meant to improve the functioning of the clothing production system continually, on all its levels using all available resources (Zhang *et al.*, 2016; Kale, 2016; Colovic, 2011; Jahed *et al.*, 2022). Figure 3 shows how various clothing production process innovation strategies have been integrated based on varied technologies and production management tools/systems.

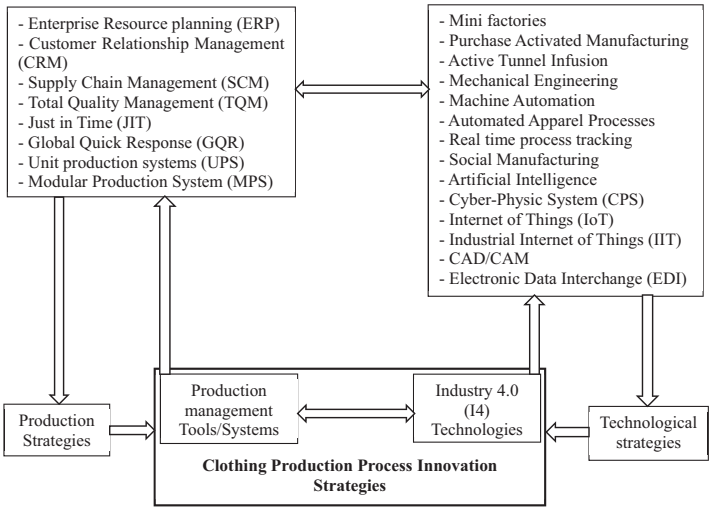

Figure 3.
A framework for clothing production process innovation strategy

Source: Author

3.3 Determinants of product and process innovations in clothing firms

Within product and process integration, the complexity of new products and firm technological level determines how the innovating enterprise acquires and handles innovation (Robertson, 1974). This indicates firms' innovation capability and strategies. Romijn and Albaladejo (2000) refers to innovation capability as major improvements and modifications on existing technologies; as new technologies created on process and product technology; and as internal and external activities of the firm in which production is organized and managed. Innovation capability enables a firm to identify, absorb, adapt, transform and maintain innovations (Zawislak *et al.*, 2012; Romijn and Albaladejo, 2000).

As such, firm innovation determinants are drivers and indicators of innovations capability in a firm thus can be distinguished as firm's innovation propensity reflecting its likelihood of being innovative; firm innovation intensity indicating the level of innovation adoption (Tavassoli, 2015). The interaction and integration of product and process innovation activities can be summarized in Figure 4 portraying how various innovation determinants give forth innovations besides acting as indicators of innovations, leading to an innovation active firm. It also symbolizes how new products developments results to new production processes and vice versa. The best product and process development practices are founded on the coordination and integration of both product and process innovations, each influencing the other (Raymond and St-Pierre, 2010).

While identifying the innovation determinants, various sources such as Community Innovation Survey, Organization for Economic Co-operation and Development, *Oslo Manual* (AG, 2006; OECD, 2005, 2018) and other innovation literature explored in this study pointed on certain determinant factors that may indicate innovation capability of a clothing firm. This review therefore refers to these factors from which an integrated product and process innovation determinants model was developed as shown on Figure 5. The inferred Innovation capability determinants applicable to clothing firms were categorized as: industry factors, R&D factors and technological factors:

- The industry factors are considered as characteristics that influences and determines how a firm carries out its business activities. According to Vasconcelos and Oliveira (2018), these factors are measured by the degree of sectoral innovation, thus attributed to structural performance and behavioral factors of a firm which increase its propensity to acquire innovation (De Fuentes *et al.*, 2015). They are either internal or external factors which indicate innovation possibilities of a clothing firm, thus centered on government policies, firm size and location, company's management, skilled labour and enterprise market orientation (Bhattacharya and Bloch, 2004; Vasconcelos and Oliveira, 2018; Abdu and Jibir, 2018). Government policies dictate the environment a firm operates by creating attractive and habitable business conditions with requisite infrastructure leading to a positive effect towards innovation. Favourable government policies and regulations can potentially stimulate significant and fundamental changes in product and process technology (Patanakul and Pinto, 2014).

The size of a clothing firm is a conventional indicator that determines its innovation and performance level. Larger clothing firms are more likely to adopt new

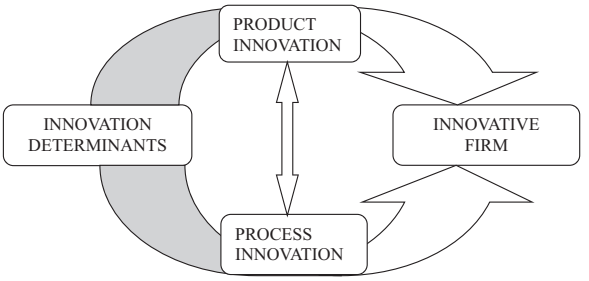

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Figure 4.
Fashion product and process innovation integration cycle

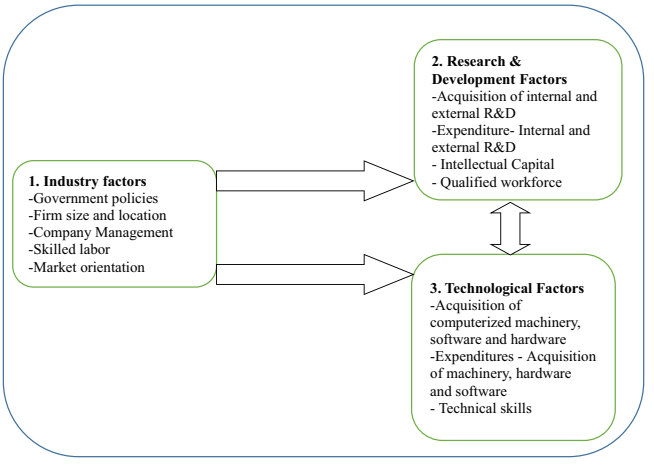

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Figure 5.
Integrated product and process innovations determinants model for clothing firms

technologies than small firms, thus outpacing smaller firms in innovation activities (Zhou and Luo, 2005; Varukolu and Park-Poaps, 2009). Likewise, the location of the clothing firm determines its innovation capability with firms in an industrial district or cluster offering each other opportunities to engage in local linkages between enterprises (Xu *et al.*, 2019). Besides, the linking of education and research institutes with the industry also stimulate learning allowing innovation spillover between firms in the same geographic region (Xu *et al.*, 2019; Mytelka and Farinelli, 2000).

The management team is the central decision-making organ of all enterprise activities meant to bring forth or even implement innovations. The predisposition of the management team tends to impact on the firm's commitment to innovation more so when the values and perceptions of the management are open to technology adoption (Daellenbach *et al.*, 2002). Thus, a rebalance of managerial focus from operational excellence to strategic and change excellence is paramount to effect demand-driven innovations in the clothing industry (Tudor, 2018). In addition, human capital inform of managerial skills and social networks have an indirect positive influence on the innovation capability of a firm and global competitiveness (Chabbouh and Boujelbene, 2020).

The firm's market orientation is also an important determinant of innovation capability enabling clothing firms focus towards identifying and satisfying customers. According to Prifti and Alimehmeti (2017), market responsiveness, as a market orientation component indicates the innovation capability of a firm to acquire market information about customers and competitors. Proactive market orientation has become an important determinant of both innovation and market success of an enterprise with a positive and significant impact on responsive market orientation more so on rapidly changing market environment (Bodlaj *et al.*, 2012). Having challenged a clothing firm manufacturing process, market orientation has been established through technological activities that are significant competitive factors in fashion business for export performance more so in developing countries (Francis and Collins-Dodd, 2000).

- R&D factors are key to acquisition of product and process innovations in manufacturing firms besides being important indicator of technological innovation (Heij *et al.*, 2020). Though the clothing industry may be considered to be a low R&D industry, there are still R&D programs whereby various innovation activities are initiated internally and also acquired externally (Romijn and Albaladejo, 2000). Though R&D data may not necessarily result in the actual product or process innovations, its expenditure can reflect when an innovation occurs since firms need to invest in R&D (Ahmed and Mahmud, 2011).

  In addition, intellectual capital inform of human and external relational capital are seen to have positive influence on knowledge sharing and innovation performance of a firm (Hanifah *et al.*, 2021). R&D activities resulting to intellectual capital like patenting may be considered a measure of an actual innovation when it is ascribed to invention of new products or processes (Barbosa and Faria, 2011). In clothing manufacturing, patenting is usually in form of utility patenting pertaining to functional clothing products; business methods attributed to a production process or selling method; and design patenting which is not usually viable considering the short product cycle of fashion products (Farah, 2012). However, new clothing

product design and styles acquired and guided through the fashion PD process automatically acquire design rights thus a measure of innovation.

Finally, key to R&D innovation capability in a clothing firm is qualified human resources responsible for carrying out R&D activities. Bourouaha and Maliki (2021) found that R&D investment in firms coupled with training are an important determinants of product and process innovation. According to Romijn and Albaladejo (2000), the owners' technical education and working experience, technical skills of the workforce and training is relevant towards acquisition of innovation. Thus, knowledge creation and learning tends improve the innovation absorptive capacity of a firm subsequently enhancing its propensity to innovate (El Elj and Abassi, 2014).

- The technological innovation capability has resulted to adoption of advanced machineries as well as computer integrations as has been discussed on the clothing product and process innovation theory. The acquisition of various I4 technologies, computer-integrated manufacturing technologies and their corresponding costs are indicative of clothing firms' innovation capability towards product development and production processes (Nunes *et al.*, 2017; Hoque *et al.*, 2021; Nayak and Padhye, 2015; Shan and Jolly, 2013; Wijewardhana *et al.*, 2021; Jayatilake and Peter, 2016; Bruno and Pimentel, 2016). Application of these technologies have enabled firms to produce a wider range of products and introduce new products in the market much faster (Wyatt, 1989).

  In addition, market orientation also dictates the adoption of applicable advanced manufacturing technology which positively correlates with export orientation (Mechling *et al.*, 1995), thus a prerequisite for technological innovation development. Similarly, qualified personnel with relevant technical skills positively influence the firm's technology capability by engaging on R&D activities (Leiponen, 2005) besides using the technology.

  Overall, industry factors, firm's technological competences and the cooperation with scientific agents through R&D activities are significant towards product and process innovation capability of a clothing firm (Nieto *et al.*, 2022).

4. Conclusion

The objective of this literature study was to appraise product and process innovation strategies in clothing manufacturing and their determinant factors. The operational definition of innovation used in this study refers to the introduction of a new or improved product and process in clothing manufacturing.

It has been recognized that both product and process innovation systems are symbiotic even though product innovation follows the clothing PD process to design and create new products while process innovations relate to all levels of a clothing enterprise enabling operational efficiency during the production and distribution process. The innovation strategies for both product and process innovations inclines more towards integration of computer technology as a key enabler of PD and production processes. Also, industrial, technological and R&D factors are significant innovation determinants leading to product and process innovation in clothing manufacturing.

However, most of the problems occurring in integrating innovation activities in the clothing industry arise from improper communication of customer demand due to conflicting information and documentation between various technological systems. This

calls for well defined, harmonized and structured innovation platform enabling better integration of information flows, allowing responsive and effective innovation decisions at all levels of clothing manufacturing. Flexible demand led manufacturing concepts and technologies ought to be a prerequisite to innovation capability of a modern clothing manufacturing firm.

5. List of acronyms

Research and Development (R&D), Just in Time (JIT), Quick response (QR), Global Quick Response (GQR), National Innovation Programs (NIPs), Product Development (PD), New Product Development (NPD), Industry 4.0 (I4), Internet of Things (IoT), Industry Internet of Things (IIT), Cyber-Physic System (CPS), Computer-Aided design (CAD), Computer-Aided Manufacturing (CAM), Product data Management (PDM), electronic Data Interchange (EDI), Quality Function Deployment (QFD), New Product Design and Development (NPPD), Electronic New product Development (E-NPD), No-interval Coherently Phased Product Development (NICPPD), Proactive Product Development Integrating Consumer Requirements (PPDICR), Functional, Expressive, Aesthetic (FEA), House of Quality (HOQ), and Analytical Hierarchy Process (AHP), Unit production systems (UPS), Modular Production System (MPS), Enterprise Resource planning (ERP), Customer Relationship Management (CRM), Supply Chain Management (SCM), Community Innovation Survey (CIS), Organization for Economic Co-operation and Development (OECD) .

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Corresponding author
Duncan Kariuki Ndwiga can be contacted at: kariukidun06@yahoo.com