Chapter 7
Business Aspects of Textile Design

Mohanapriya Venkataraman and Jiří Militký

7.1 Introduction

The clothing industry has constantly been evolving by introducing new business concepts, the invention of new materials, design methodologies, innovative manufacturing processes, and marketing strategies. Creative ideas of the design process influence the work of fashion designers. New consumer patterns have risen, showing a bias toward e-commerce instead of traditional "Brick and Mortar" models. Globalization has influenced the industry's supply chain, marketing, and sales aspects. Recently, pandemic like COVID-19 has impacted consumer buying capacity and behavior. Awareness about the environment has increased focus on a circular economy with sustainable business models. In this chapter, we will be reviewing factors that influence the business and marketing of design and light.

7.2 Business Models

The clothing industry is continuously evolving based on the changing dynamics of economics, global politics, and customer preferences. The industry needs to adopt a business model that enables it to be profitable and sustainable. The business models are designed to derive economic value from technological inputs. The main elements of a business model are given in Table 7.1 (Chesbrough, 2007).

M. Venkataraman (✉) · J. Militký
Department of Material Engineering, Faculty of Textile Engineering, Technical University of Liberec, Liberec, Czech Republic
e-mail: mohanapriya.venkataraman@tul.cz

J. Militký et al. (eds.), *Fibrous Structures and Their Impact on Textile Design*,
https://doi.org/10.1007/978-981-19-4827-5_7

Table 7.1 Elements of business model

Business model element	Description
Value proposition	The value offered by the product to the end user
Market segment	Types of customers with different needs
Value chain structure	The structure within which the organization fits and the value added by them
Revenue generation and margins	Customer engagement channels to generate revenue profitably with the profit margins
Value network position	The placement of the company in the value proposition chain to the customer
Competitive strategy	A strategy to remain competitive and to gain a competitive advantage

Adapted from Chesbrough (2007)

7.2.1 Perspective and Constituents of a Business Model

Different authors and business theorists have differently interpreted the word "business model" or proposed different meanings of the word. It also is confused with business terminologies of strategy, business concept, economic model, revenue model, etc. (Morris et al., 2005). Authors provide broad and often contrasting explanations about the constitution of the business model (Amit & Zott, 2001; Bohnsack et al., 2014; Chesbrough, 2007; Magretta, 2002; Mason & Spring, 2011; Osterwalder & Pigneur, 2010). Morris et al. (2005) have reviewed different perspectives of the business model. The context provided by different researchers and the focus on specific components has been reviewed in detail, focusing on the nature of data used to arrive at the perspectives.

The business model provides a holistic framework that can be applied within the context of the industry. Understanding and application of a suitable business model are essential for the clothing industry. Chesbrough (2007) highlights the combination of clothes, design, and its function as a significant value proposition to the customers. The potential customers are identified by using the scientific method to identify market segments that would use the outputs of the clothing industry. The efficiency of the value chain would result in the company achieving its business objectives comprising of usage of raw materials, innovative production techniques, customer value creation, and being sustainable. Some of the significant factors that influence the outcomes are cost optimizations, competitive strategy, and the business's unique value proposition. Having a suitable business model enables companies to deal with textile products and solutions (Table 7.2).

Table 7.2 Perspective on business models

Source	Specific components	E-commerce/general
Afuah and Tucci (2001)	Customer value, scope, price, revenue, connected activities, implementation, capabilities, and sustainability	E
Alt and Zimmerman (2001)	Mission, structure, processes, revenues, legalities, and technology	E
Amit and Zott (2001)	Transaction content, transaction structure, and the transaction governance	E
Applegate (2001)	Concept, capabilities, and value	G
Betz (2002)	Resources, sales, profits, and capital	G
Chesbrough and Rosenbaum (2000)	Value proposition, target markets, internal value chain structure, cost structure and profit model, value network, and competitive strategy	G
Donath (1999)	Customer understanding, marketing tactics, corporate governance, and intranet/extranet capabilities	E
Dubosson-Torbay et al. (2001)	Products, customer relationships, infrastructure and network of partners, and financial aspects	E
Gartner (2003)	Market offering, competencies, core technology investments, and bottom line	E
Gordjin et al. (2001)	Actors, market segments, value offering, value activity, stakeholder network, value interfaces, value ports, and value exchanges	E
Hamel (2016)	Core strategy, strategic resources, value network, and customer interface	G
Horowitz (1996)	Price, product, distribution, organizational characteristics, and technology	G
Linder and Cantrell (2000)	Pricing model, revenue model, channel model, commerce process model, internet-enabled commerce relationship, organizational form, and value proposition	G

(continued)

Table 7.2 (continued)

Source	Specific components	E-commerce/general
Markides (1999)	Product innovation, customer relationship, infrastructure management, and financial aspects	G
Petrovic et al. (2001)	Value model, resource model, production model, customer relations model, revenue model, capital model, and market model	E
Rayport and Jaworski (2001)	Value cluster, market space offering, resource system, and financial model	E
Timmers (1988)	Product/service/information flow architecture, business actors and roles, actor benefits, revenue sources, and marketing strategy	E
Viscio and Pasternak (1996)	Global core, governance, business units, services, and linkages	G
Weill and Vitale (2001)	Strategic objectives, value proposition, revenue sources, success factors, channels, core competencies, customer segments, and IT infrastructure	E

7.3 Design

Business is driven by the ability to garner a competitive advantage over its competition. In the textile industry, which is driven by innovation and creativity, design plays a major role. There is an increased interest in furthering the envelopes of design which will ultimately lead to competitive advantage and business profitability. The design process contains the sub-discipline of textile design, and it is essential to evaluate the attitude and values that drive the innovation process (Valentine et al., 2017).

Textile design process thinking is guided by emotive, haptic, sensorial, and tactile qualities (Valentine et al., 2017). Due to the traditional and ancient roots of the textile industry, designers have followed the same methodology with very minor deviations introduced organically. However, this has changed in the digital age with the invention of smart materials (Worbin, 2010) and changing fashion and quality trends of consumers. The necessity for sustainability also increased the changing landscape of textile design (Thackara, 2013). Textile designing has even adopted an "open-source" approach, probably borrowed from Information Technology practices. An ETextile Summercamp's Swatchbook Exchange is an open-source platform where the designers freely share the physical work ETextile samples (ETextile, 2021).

7.3.1 Understanding of the Design Process

Design is a continuously evolving process. Design improvements drive its evolution or address the changing demands. The demand is the constant inventions of new materials, innovation of production methodologies, and changing global politics. The demand is influenced by the customers who have varied needs which change with contemporary trends.

The strategy of companies drives the design process. It is increasingly considered a multi-disciplinary activity that involves organizational structures (Bertola & Teixeira, 2003). This has been dealt with in detail in the study of design management (Libânio & Amaral, 2017). Design management is a holistic umbrella that integrates design, development, implementation, and execution to achieve business objectives.

7.3.2 Levels of Design Management

Researchers have endeavored to develop models that adequately represent the design management process. They developed new models or improved on earlier models by incorporating the changing environment. It can be said that the design management process is divided into three different levels by different researchers.

- Strategic
- Tactical
- Operational.

Borja de Mozota (2003) defines design as a core competency to a company's strategy while being an administrative competence tactically and economic competence operationally. Best (2006) provides an alternative perspective where tasks, plans, and global policies are defined strategically, teams, processes, and BU systems tactically, and the physical and tangible products, services, and experiences operationally. Wernerfelt (1984) describes strategic resources for value creation as an interplay between tangible and intangible assets like people, process, technology, organizational structure, brand, etc.

7.3.3 Models of Design Management

As described earlier, the design management process cannot exist in a vacuum. It is driven by the collaboration between individuals, teams, and organizations. This collaboration should be supported by a strong process and technology for sharing the knowledge. Such integrated systems will contribute to the success of the design outcomes. The factors that influence a design professional are:

1. Leadership (Lee & Cassidy, 2007)

2. Decision-making autonomy and design competencies (Kang et al., 2015)
3. Knowledge sharing (Kleinsmann & Valkenburg, 2008)
4. Entrepreneurship (Gunes, 2012)
5. Communication, integration, and teamwork (Girard & Robin, 2006).

7.3.4 Design Management Modes

Design management modes have also evolved over a while. Claudia and Alexander (2014) have compared different modes of design management (Table 7.3). It fundamentally compares the four modes by differentiating by different parameters like goals of the design management process, mode/attitude of the design management process, organizational processes that support the design process, capabilities to design, people talent and leadership, and value creation through corporate strategy.

Lucerne Design Management Model provides a detailed relationship between multiple levels and related activities (Claudia and Alexander 2014). This model

Table 7.3 Comparison of design management modes

DM modes	Simple mode (1)	Integrated mode (2)	Dynamic mode (3)	Entrepreneurial mode (4)
Goals	Management of project to realize the design	Relationship between functional touchpoints	Gain competitive advantage through the interplay of internal and external factors	Taking advantage of new opportunities
Mode/attitude	Using design selectively	Integrating the design	Transformational design	Leverage design
Organizational processes	The single project connected to corporate activities	Customer experience is the major focus	Process design and change management integrated with strategy	Strategic design management
Design capabilities	Design project management	Planning, coordinating, aligning, infusing design	Rearchitect capabilities	Opportunity evaluation and exploitation
People	Marketing, design, and product teams	Design managers	Design leaders and senior management	Design leaders and line managers
Contributions to corporate strategy	Product improvement	Positioning	Competitive advantage	New business

Adapted from Claudia and Alexander (2014)

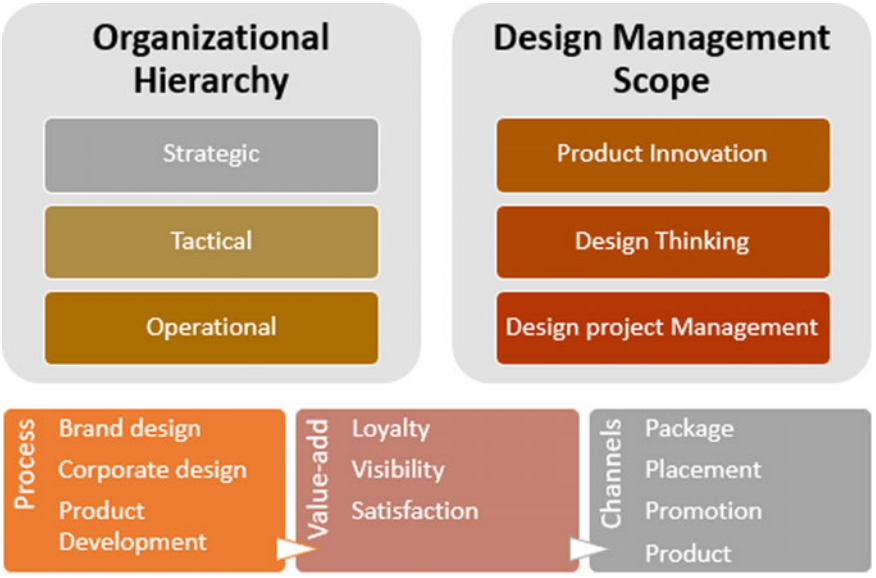

Fig. 7.1 Integrated design management model. Adapted from Claudia and Alexander (2014)

contains intrinsic details of essential processes, control tools, stage gates, and key performance indicators (Fig. 7.1).

Textile design requirements need to consider emotive, comfort, haptic, sensorial, and tactile qualities. It is progressively being referred to as "smart" in the context of new inventions and techniques (Igoe, 2010). The factors associated with design (Fig. 7.2) have been outlined in the mapping of parameters that define the relationship between design and designers (Eckert, 2014).

7.3.5 A Framework for Training and Integration of Design Management

Apparel product development requires an integrated and multi-disciplinary approach to result in professional designs. Libanio and Amaral (2017) provide a framework that can be used for the learning and development of design management stakeholders. They proposed a framework of competencies and evaluation mechanisms for design management. This approach may be emulated by organizations specializing in apparel. Their conceptual model illustrated (Fig. 7.3) shows complex relationships among individuals, teams, and organizations. It showcases the scenarios of the external environment influencing the organization's structure.

Fig. 7.2 Factors associated with considerate design. Adapted from Eckhert (2014)

Fig. 7.3 Training and integration framework for apparel industry. Adapted from Libanio and Amaral (2017)

Table 7.4 Determinant phase activities (DPA)

Determinant phase activities (DPA)	Description
DPA1	Strategies and guidelines are defined and aligned to the organizational strategy, culture, and values. Definition of planning and supply are also pursued
DPA2	Research of trends, review of past work, concept finalization, and choice of raw materials
DPA3	Modeling and development of a prototype, technical drawings, and specifications are created, and prototype production is initiated
DPA4	Teams with the necessary expertise are assembled to brainstorm and validate the proposed collection
DPA5	Promotional activities within the external and internal stakeholders are started Information is created and propagated to managers, vendors, retailers, and sales personnel
DPA6	Market scan to understand the acceptance of the product by the consumers. Analysis of the data is expected to be reflective of the potential success of the final collection

Adapted from Libanio and Amaral (2017)

The development of new collections consists of six phases according to the framework proposed by Libanio and Amaral (2017). They are known as determinant phase activities (DPA) (see Table 7.4).

Libanio and Amaral (2017) defined a framework of phases and professional design activities related to product development and have mapped the key stakeholders, from the perspective of the apparel industry. Borja de Mozota (2003) recommends methods for the integration of design across the organization. Kotler and Rath (1984) encourage the participation of designers in all stages of product development.

7.4 Competing in a Globalized World

The ultimate success of the products that undergo the detailed design process is to stand the scrutiny of the end customer. In recent times, consumer trends have been influenced by the concept of globalization which has completely changed the dynamics of supply and demand. Any customer from any part of the world has to access the products produced in another corner of the world. World economics is driven by the consumers' need for the best products and the providers' ability to provide the same. Global policy-making bodies have recognized this need and have encouraged trade agreements and free trade zones that allow unhindered business across the world. To compete in this world economy, having a well-defined competitive strategy becomes imperative. Different researchers have listed sets of criteria that

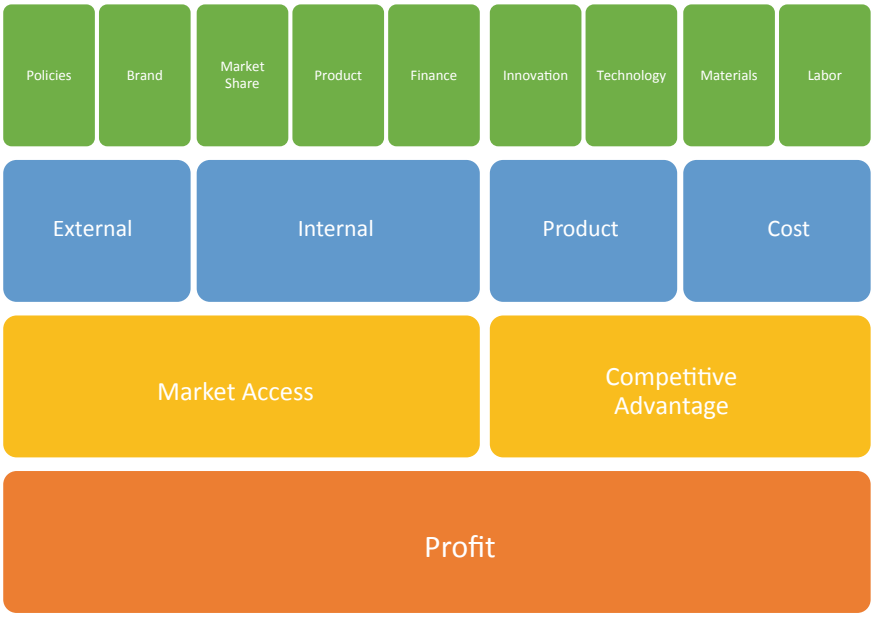

Fig. 7.4 Resources as a basis of profitability. Adapted from Grant (1991)

enhance competitive strategy. Being competitive is a necessity for textile companies to derive profitable and sustainable growth. While Hill (2000) identified manufacturing as a competitive strategy, Grant (1991) describes competitive advantage as a balance between the resources and capabilities of an organization (Fig. 7.4).

Textile companies can derive competitive strategies through various means. Depending on the priority of the organizations, the strategy can be deployed in different contexts. Table 7.5 contains different categories proposed by various researchers.

For the textile companies to be successful in a globalized business environment, they have to build competitive advantages that will help them to navigate the competition that is not limited by geographical boundaries.

7.5 Branding in Textiles

The textile industry does not have many entry barriers. It is fairly low cost, and in a globalized world, textile companies need to establish their presence in the market. Presence in the market is driven by the ability of the consumer to recollect a brand. Keller (2003) provides details of connections between brands and their meanings given in Table 7.6.

Table 7.5 Categories of competitive advantage

Researcher	Categories proposed
Edwards (2001)	Price, flexibility, quality, and dependability
Abernathy et al. (2006)	Price, quality, dependability, product flexibility, volume, and flexibility
Krajewski and Ritzman (1996)	Plant and equipment; production planning and control; labor and staffing; product design and engineering; and organization and management
Glock and Kunz (2005)	Cost—low-cost operations; quality—high-performance design and consistent quality; time—fast delivery time, on-time delivery, and development speed; and flexibility—customization and volume flexibility
Valentine et al. (2017)	Cost leadership—competition based on price; differentiation—a unique product that is valued by customers; focus—a niche market for the products developed on cost and differentiation strategy

Table 7.6 Connections between brand and information

Brand information	Description
1. Awareness	Helps categorize and understand the needs satisfied
2. Attributes	Describes the product characteristics
3. Benefits	Value recognized by the consumer
4. Images	Provide visual information
5. Thoughts	Cognitive responses of the consumer
6. Feelings	Affective responses of the consumer
7. Attitudes	Judgments and evaluations triggered
8. Experiences	Consumption behaviors

Adapted from Keller (2003)

Unique brand identity is a necessity for textile companies to compete. A company's brand identity helps its customers to recognize it and get positive associations. That emotional connection ensures customer loyalty and profitability in a competitive marketplace. Textile and apparel companies need to have a well-defined brand strategy supported by its distinct features like vision, mission, and values. It might be symbolic patterns, name, logo, and interplay of graphics and colors. The distinct image elevates recognition and translates into recognition and prestige of a brand in the market, thereby driving market share and profitably (Longwell, 1991). Bruer describes the differentiation strategy in textile and branding in Fig. 7.5.

Fig. 7.5 Branding as a differentiation strategy in the textile and apparel industry. Adapted from Bruer (2005)

7.5.1 Brand Identity

The identity of a company that helps the users to recollect the unique features of a service or product is the first step toward customer acquisition and retention. Leo Bernett has provided five dimensions that influence brand identity (Randall, 2002). It is relevant to all domains including textile and apparel (Fig. 7.6).

Value addition to the brand is based on its classification, market position, type, and other criteria that influence the end customer opinion and experience as given in Table 7.7.

The textile companies competing in such a low-barrier entry industry need to create a niche that will allow their customers to recognize their brand and elevate the opportunities for customer acquisition and loyalty.

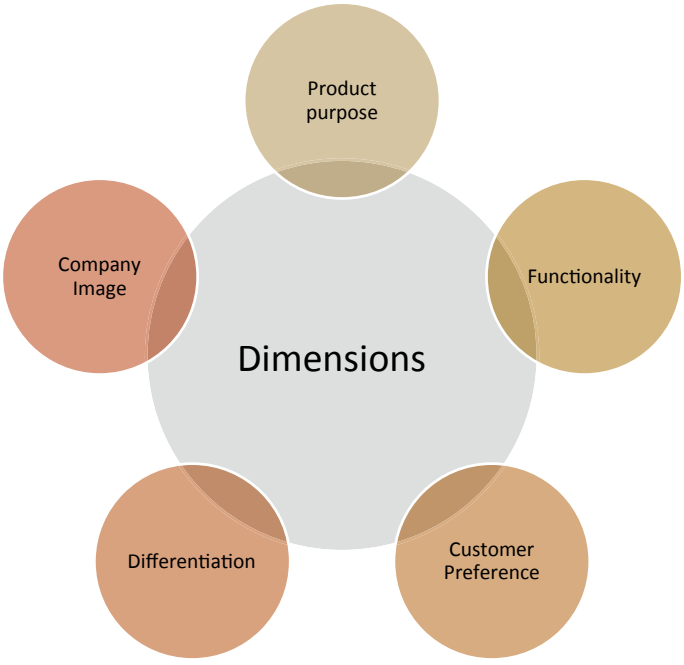

Fig. 7.6 Dimensions of identity adapted from Leo Burnett. Adapted from Randall (2002)

Table 7.7 Value additions to brands

Brand classifications	Brand market positions	Brand type	Other
Corporate House Range Product	Primary Secondary Tertiary	Product Service Personal Organizational Event Geographical	Channel Own Co-branded

Adapted from Bruer (2005)

7.6 Customer Value Proposition (CVP) Using Omnichannel in Textiles

Textile companies, by default, provide value to their customers. To crystallize the value provided to the customer, a strategic tool called customer value proposition (CVP) is used. It helps to communicate the exact value proposed by the company and derived by the customer. The life cycle of CVP is provided in Fig. 7.7 (Payne et al., 2017).

Textile companies have typically marketed their products through traditional marketing channels. Off late, there is a need to adopt digital channels to reach customers. The recent pandemic has accelerated the need to adopt digital channels because of the movement of the potential customers from visiting "Brick and Mortar"

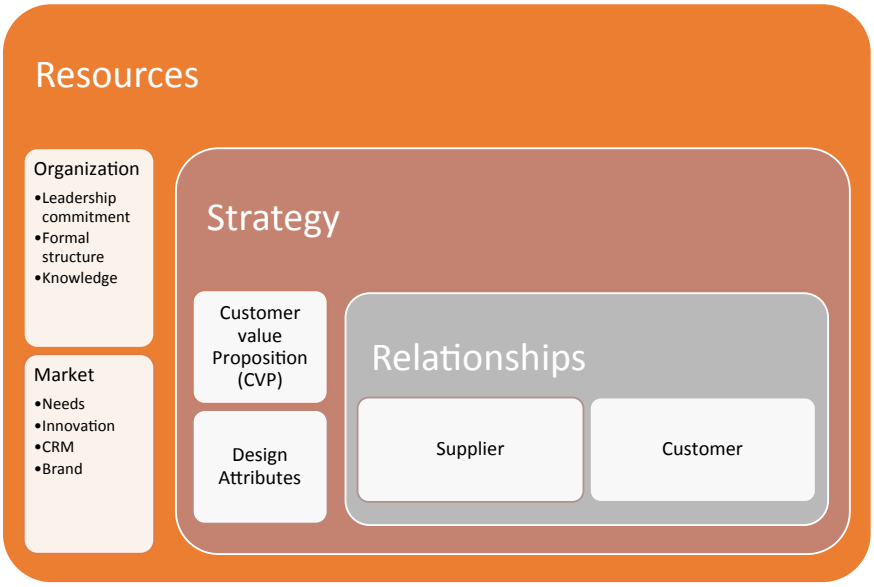

Fig. 7.7 Customer value proposition (CVP) life cycle. Adapted from Payne et al. (2017)

Table 7.8 Types of buyer profiles (Spanish Observatory Report, 2016)

Traditional buyers	Nearly 60% who do not seek online experiences
Digital buyers	Nearly one-fifth who are pragmatic and opportunistic buyers
Mixed buyers	Nearly one-fifth who like to research and explore alternatives

shops to online malls. There is increased adoption of an omnichannel model to develop a competitive advantage. There is the continued integration of multiple channels into a centralized, optimized omnichannel to provide unique user experiences, both online and foot sales. The companies strive to develop strategies that would improve the consumers' online experiences and encourage the personal participation of their consumers and their continued engagement with the company (Lorenzo et al., 2020). Omnichannel provides up to 40% of the business for this sector. There are three buyer profiles (Table 7.8) identified in Spanish Observatory Report (Spanish Observatory Report, 2016).

In recent times, fashion consumers prefer to research and compare multiple channels to access a brand before making a purchase decision (PWC, 2016). The sources of the information search are:

- Brand's website
- Online store
- Recommendations from friends and family
- Forums and blogs.

According to PwC, while physical stores continue to be the preferred destination of consumers, the percentage of omnichannel is continuously increasing. Consumers prefer more access to the brand. Spanish Fashion Observatory (Spanish Fashion Observatory, 2016) has found that more than 80% of online shoppers consult brand websites and apps and more than 50% refer to social networks.

7.6.1 Managing Customer Relationships

Managing relationships with the customers is the foundation of any business that intends to remain profitable in business. In the connected world, we live in, word-of-mouth, social media chatter, forums, and blogs play a major role in influencing the purchasing decisions of the customers. So, the business has an excellent motivation to pursue different means to manage those relationships. Adoption of CRM provides the following benefits to the organizations:

- Identification of the right customers (Ellatif, 2007)
- Integration of CRM into business processes
- Use CRM to gain a competitive advantage

- Focused on marketing campaigns
- Understand and serve customer needs
- Development of the right product and service
- Individualization of customer support
- Increasing reach through omnichannel
- Track customer behavior and preferences
- Constantly improve quality of product.

Farhan et al. (2018) investigated and defined the critical success factors (CSF) in the implementation of a CRM (Table 7.9). The CSFs need to be considered to automate CRM activities and thereby achieve company objectives.

Heiskanen and Jalas (2003) has referred to a new called product service systems (PSS). PSS is used for the cohesive delivery of products and services by an organization. A PSS typically utilizes the concept of operational improvements rather than capital inputs. It focuses on not just finances but also improvements of existing products and services through iterative developments. It is aimed to reduce consumption of natural resources while increasing product quality and customer satisfaction (Heiskanen and Jalas, 2003). Due to the larger objective of PSS to reduce environmental impact, clothing is certainly an area of interest. It is likely to face challenges of trust deficit, ease of use, and price (Armstrong et al., 2015). Three types of PSS can be considered in the context of textiles. Based on the types, we can imagine various scenarios that apply to the textile industry (Table 7.10).

- Product oriented (PO)
- User oriented (UO)
- Result oriented (RO).

Overall, the textile industry has an opportunity to balance customer relationships with its social responsibility. Considering new business models like PSS enables it to attract customers who value the responsible approach of the businesses. Automating CRM further strengthens the bond between the company and the customer.

7.7 Technology as an Enabler

Technology is speeding up the evolution of business across all industries. The innovations in the technology domain have created opportunities to improve efficiencies and cost optimization. In a competitive textile market, any possible optimization can provide a competitive advantage. The concept of Industry 4.0 can bring about revolutionary changes to the industry. Based on Kearney's definition of Industry 4.0, there are four key technologies namely (Hidayatno et al., 2019).

(1) Data, computational power, and connectivity
(2) Analytical and advanced intelligence
(3) Human–machine interaction

Table 7.9 CRM success factors

1	Management support and commitment	28	Procedures and policies
2	IT systems management/integration	29	Minimize customization
3	Communication plan for CRM strategy	30	Continuous evaluation
4	Organization culture/culture change	31	Integration of vendor expertise
5	Knowledge management capabilities	32	Design for flexibility
6	Interdepartmental integration	33	Users/employees acceptance
7	Customer information management	34	Wailings to share data
8	Customer contact management	35	Wailings to share the process
9	Monitoring, measuring, and feedback	36	Extensive IT support
10	Motivated and competent staff	37	Size of organization
11	Sales automation	38	Central data warehouse
12	Marketing automation	39	Data mining
13	Services automation	40	Enterprise resource planning (ERP) system
14	Staff commitment/involvement	41	Alignment of business strategy with IT strategy
15	CRM software selection	42	Reward systems
16	Managing change	43	CRM vision and scope
17	Support operational management	44	Realistic expectations/feasibility study
18	Customer involvement/consultation	45	Provide efficient resources
19	CRM mission, objectives, and goals	46	Government
20	CRM processes clearly defined	47	Project cost
21	Project schedule and plan	48	Identify new customers/Keep old customers
22	Customer satisfaction	49	Personalization process
23	CRM championship	50	Long-term orientation
24	Time and budget management	51	Ensure market orientation
25	Process change/structure redesign	52	Customer profitability
26	Creation of multi-disciplinary redesign	53	Benchmarking
27	Customer segmentation	54	CRM benefits

Adapted from Farhan et al. (2018)

(4) Advanced manufacturing methods.

In the example of textiles, Table 7.11 outlines the possible changes that Industry 4.0 can bring.

Papahristou et al. (2017) outline the quantifiable benefits that IoT can bring to the fashion industry. It is expected to bring improved ROI to the business while bringing more value additions to the end consumer (Harrop, 2016). IoT is expected to have a

Table 7.10 PSS scenarios in textile industry

PSS type	Description	Sustainability objective
PO	Repair and redesign	Increase longevity and reduce waste
PO	Take-back	Reduce waste, reuse, and increase revenue
PO	Design customization	Increase product longevity, lifestyle adjustments, and product attachment
PO	Self-creation	Product longevity, product attachment
UO	Expert consultancy	Build for purpose and increase reuse
UO	Renting	Increase reuse and reduce waste
UO	Clothing swap	Increase reuse and reduce waste
RO	Fashion result	Increase product utilization and reduce redundant consumption

Adapted from Armstrong et al. (2015)

Table 7.11 Industry 4.0 scenarios in textiles

Aspect	Artificial intelligence (AI)	Internet of Things (IoT)	Robotics	Wearables/virtual reality/augmented reality	3D printing
People	High accuracy, reduction of effort, and software usage	Minimal monitoring of operators	Reduction of labor for pattern making, cutting, and sewing	Product health control, maintenance, and analytics	Fully automated factory
Process	Self-diagnostic machinery with preventive maintenance; testing	Real-time stock and work tracking	Automated yarn weaving; tension control; pattern making, etc.	Automated real-time production performance; identification and prevention of proliferation	Customization of products and components for embossing, carving, 3D laser cutting, etc.
Product	Waste reduction through computer-controlled knit technology	Annual savings through intelligent automation	Increased productivity and quality	Smart clothing	Rapid prototyping; tailored production

Adapted from Hidayatno et al. (2019)

transformational effect in the short and long term, and its generational evolution is given by Jouriles (2016).

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- Steam—mechanical production
- Electricity—mass production

Fig. 7.8 End-to-end value chain realization of Textile Learning Factory 4.0. Adapted from Küsters et al. (2017)

- Automation—manufacturing automation
- Internet of Things—networked manufacturing.

Some challenges expected in the implementation of technology strategies in textiles (Birnbaum, 2016; Küsters et al., 2017) are:

- Governing laws and regulations for IoT
- Data privacy and protection of individuals
- Uncertainties about financial benefits
- No prior business cases to justify investments
- No coordination across organizational units
- Outdated talent and capabilities
- Strong leadership to encourage radical transformation
- Cybersecurity threats.

In his research, Küsters et al. (2017) discuss a Textile Learning Factory 4.0 experiment that was proposed as a prototype. Its objective was to showcase digital transformation through the adoption of Industry 4.0 solutions. The factory simulated end-to-end value chain from order to delivery. The output was customer-specific textile products (Fig. 7.8).

To help textile companies overcome some of the identified challenges and to create market-ready products and solutions, three key elements to success are (Küsters et al., 2017):

1. Access to state-of-the-art technologies. These technologies should be supported with real business cases that demonstrate possibilities with digital transformation.
2. Access to professional capability building to address gaps in digital competencies.
3. Collaboration among all stakeholders including manufacturers, service providers, and research institutes.

The application of IoT may have a long-ranging impact on the fashion industry. Being able to create prototypes fast enables companies to test and demonstrate the unique characteristics of their products. It makes reconfigurations easier based on the potential buyer preferences. This transformation starting with the product value chain will pervade other new functions (Porter & Heppelmann, 2015).

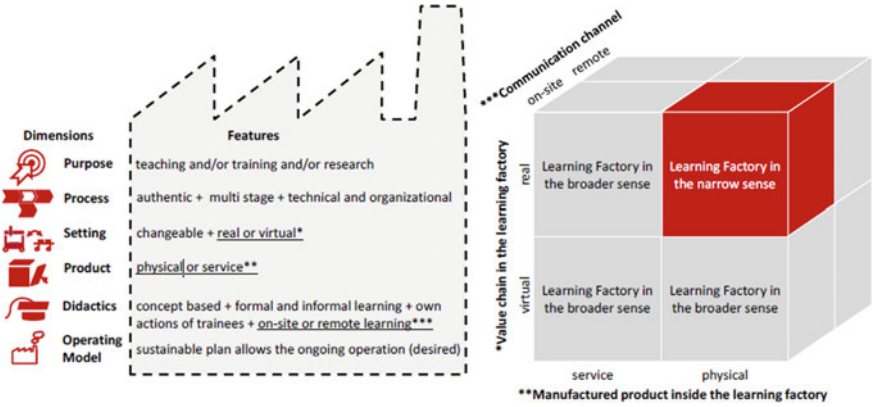

Fig. 7.9 Key features of the textile learning factory (Abele et al., 2015)

Abele et al. (2015) provide a conceptual model of a Textile Learning Factory 4.0 (Fig. 7.9). This is closer to reality than any time in the past due to the leap-frogging innovations in technology.

7.7.1 Data in Fashion

Data may be considered as unpolished diamonds that can reveal secrets for a business to be successful. The lessons learned by mining the data will allow organizations to relearn, reevaluate, and restrategize continuously to improve their bottom line. Technology plays a major role in helping organizations discover winning parameters from historical data. Big data is the ability to mine huge volumes of data. It has gained significance in recent times. Last decade has seen a huge increase in the adoption of big data (Madsen & Stenheim, 2016; Lim et al., 2009). It can assist to find trends and patterns in fashion data which includes forecasting, raw materials, supply chain management, customer behavior, preferences, and emotions and include all data generated by the fashion industry (Jain et al., 2017). The fashion data can be bucketed into the following categories as in Table 7.12 (Jain et al., 2017).

Jain et al. (2017) proposed (Fig. 7.10) that was a combination of the knowledge-based recommender system and a search engine. This would enable designers to search based on any fashion data criteria and get the best recommendation for the design of their proposed product.

Overall, the introduction of disruptive technology in textiles will provide multifarious benefits including but not limited to better manufacturing techniques, reduced manual labor, improved quality process, cost optimization, and faster prototyping. Adapting technology will enable businesses to become more profitable and sustainable.

Table 7.12 Fashion data (Jain et al., 2017)

Material	Fabric and its characteristics influence the final fashion product
Fashion design	Design of the fashion product
Body data	Body measurement (2D) as well as body scanners (3D)
Color	Human behavior and emotions influence color choices
Technical/production design	Blueprint of technical design

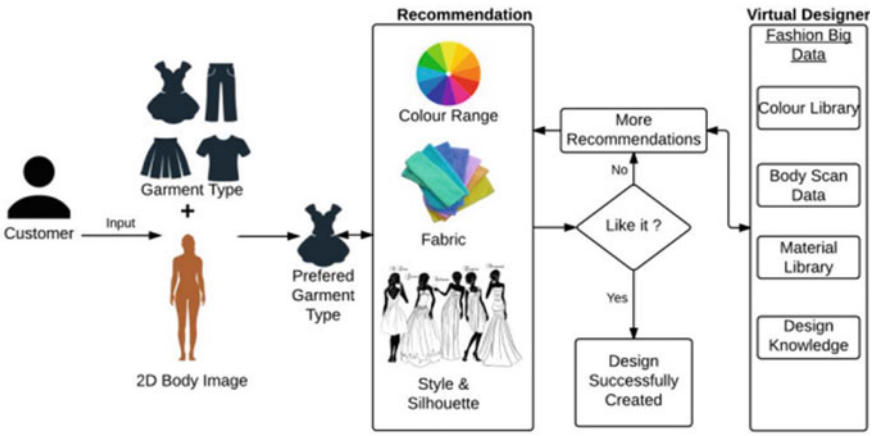

Fig. 7.10 System with search engine and recommender (Jain et al., 2017)

7.8 Circularity for Sustainable Textile Industry

The textile industry is considered to be a top polluting and unsustainable industries impacting our environment (Defra, 2008). There is an increased demand across the globe to implement checks and balances in the industry to reduce further damage to the environment. On the other hand, textile companies also realize the importance of developing sustainable performance and development (Gardetti, 2016). The environmental footprint needs to be evaluated carefully, in terms of water usage (Niinimaki et al., 2020), chemical toxicity (Shirvanimoghaddam et al., 2020), emissions, and energy usage (Muthukumarana et al., 2018). Islam et al. (2020) have mapped environmentally sustainable practices in textiles and associated industries. The textile sector can design transformational innovations by referring to eight archetypes of "Sustainable Business Models (SBM)" referred by Bocken et al. (2014). They describe the underlying mechanisms and solutions. It includes new economic concepts like closed-loop business models, natural capitalism, social enterprises, product service systems (PSSs), etc., and they are as follows (Bocken et al., 2014):

- Maximize efficiency (material and energy)
- Recreate value from "waste"
- Substitution with renewables and natural processes
- Deliver functionality rather than ownership
- Adopt a stewardship role
- Encourage sufficiency
- Repurpose the business for society/environment
- Develop scale-up solutions.

Hemkhaus (2019) has provided different recycling approaches based on the life cycle of textile products. Figures 7.11 and 7.12 contain the recycling processes that would make textile industry to become more sustainable and socially responsible.

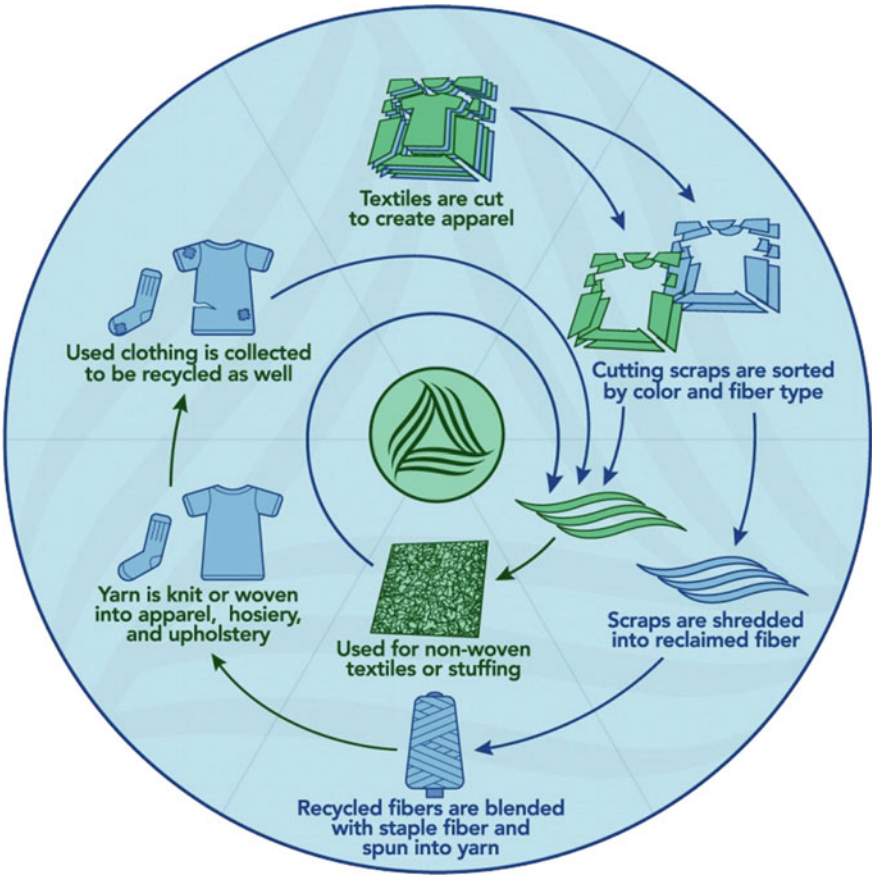

Fig. 7.11 Textile product life cycle and recycling approaches (Image credit: https://etgroup.cz/the-company/)

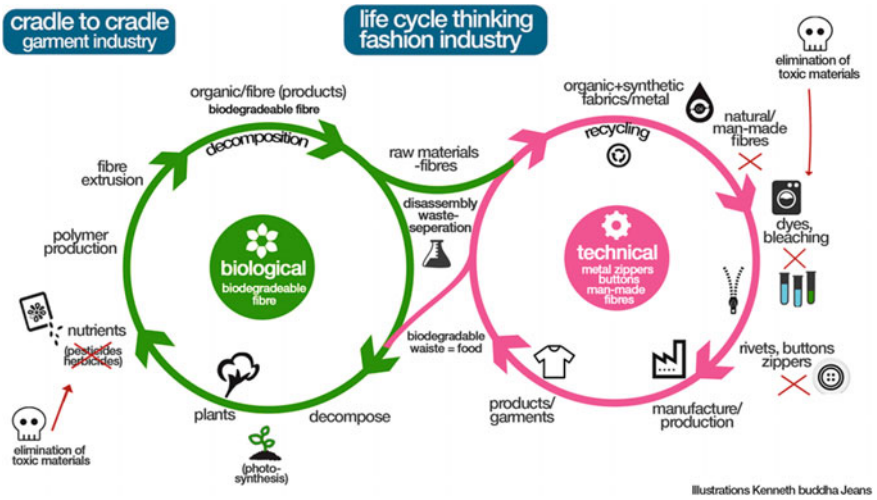

Fig. 7.12 Textile product life cycle and recycling approaches in the garment industry (Image credit: https://buddhajeans.com/encyclopedia/life-cycle-thinking/)

In recent times, there is a paradigm shift toward a circular economy, where waste is considered to be a valuable resource, and elimination of it is considered in designing, disassembly, and recycling (Braungart et al., 2006) (Fig. 7.12). Hemkhaus (2019) has provided a framework of circular business models applicable to the textile industry. The main categories are given in Table 7.13.

Another means to be sustainable is to reuse textile products. In the secondhand clothing sector (Pal, 2015) has listed different resell-based business model types (see Table 7.14).

As the business of textiles is as old as the time when humankind discovered culture, it has become its responsibility to reduce its potential environmental impact. By reducing the environmental footprint, the industry will not only guarantee its longevity but also the end consumers who keep it afloat.

Table 7.13 Categories of circular economy for textile industry

Circular business model	Objective	Description
Circular	Value from waste	Turning waste streams into inputs for other processes
Servitization	Functionality over ownership	Provide services that satisfy users' needs without having to own physical products
Sufficiency	Effective use of resources	Solutions that actively reduce consumption and production

Adapted from Hemkhaus (2019)

Table 7.14 Resell-based business model (Pal, 2015)

Business model	Description
Collection based	Collect used clothes
Direct reselling	Sell to consumers
Business-to-business (B2B) reselling	Sell to resellers
Charities	Collect through charity and resell
Secondhand retailers	Selling used clothes
Redesign brands	Value added to used clothes
Reclaimers	Collect and resell leftovers

7.9 Conclusion

At this moment, the textile industry is at a crossroads of its existence. While there have been multiple inventions and innovations that have driven the industry forward, it is facing headwinds by way of the need to have a sustainable business model. In addition, the recent onset of the COVID-19 epidemic disrupted the industry and has pushed it to the brink. Sustaining the business during adverse economic conditions requires a courageous and innovative mindset. While challenges are multi-fold, equivalent opportunities have arisen in the areas like e-commerce. It is our combined responsibility to look for means to improve the industry, not just for its survival during these challenging times but for its sustenance during the times after.

Acknowledgements This work was supported by the project "Advanced structures for thermal insulation in extreme conditions" (Reg. No. 21-32510 M) granted by the Czech Science Foundation (GACR).

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