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CREATIVITY AND INNOVATION: THE USE OF ARTIFICIAL INTELLIGENCE IN THE FASHION SECTOR

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Introduction

The fashion market is one of the most dynamic and creative sectors in the economy and is characterized by various peculiarities, such as the continuous change of trends and consumer needs. In recent years, the sector has seen several evolutions driven by technological, cultural, environmental and consumer changes. Sustainability is one of the most important themes, demonstrating a growing environmental awareness among consumers, who demand transparency and ethical practices from the sector.

In recent years, artificial intelligence (AI) has been transforming the fashion market in many ways, improving efficiency, personalizing the customer experience and opening up new creative possibilities. AI analyzes huge amounts of data from social media, online searches and past sales to identify emerging trends, machine learning algorithms can predict which colors, styles or materials will be popular, allowing brands to plan their collections in a more targeted way. Through AI-based tools, designers can create new collections or explore design variations. For example, generative design algorithms can propose unique models based on specific inputs, or creative applications (such as DALL-E or MidJourney) can inspire new visual concepts. AI also allows for tailor-made products to consumers, in fact, there are recommendation systems based on purchase data and user preferences and customizable products, such as clothes or shoes, created through online configurators that exploit algorithms. The use of augmented reality (AR) and AI allows customers to try on clothes virtually, improving e-commerce, virtual try-ons through apps that use AI to adapt clothes to the user's body shape and personalized avatars to simulate realistic looks. AI improves logistics efficiency, reducing waste and costs, inventory optimization to avoid surpluses or stockouts and more accurate demand forecasts thanks to the analysis of historical and real-time data. Many companies use AI to reduce their environmental impact, identifying sustainable materials and optimizing the production process, or for the analysis of the ecological footprint through data on the entire production chain. AI enhances customer interaction through advanced Chatbots to quickly answer questions or offer assistance, personalized advertising campaigns based on user tastes and behaviors. AI can help identify counterfeit products by analyzing images, materials and product details to ensure their authenticity, analyze online reviews and comments

to understand consumer preferences and dissatisfaction, providing valuable insights to improve products and services. The use of AI in the fashion industry not only improves the competitiveness of companies, but also promotes a more responsible and customer-centered approach. The objectives pursued by this work lie in identifying the spaces in the fashion industry that allow the replacement of human work with AI; the implications on the quality of the service offered and on competition and future trends. The thesis intends to offer an analysis of these aspects and does so in three chapters. The first chapter aims to describe the fashion market, its evolution and its trends; the second explores the role of artificial intelligence in this market and, finally, the third offers an analysis of an empirical case, that of the H&M brand, which is having very positive results precisely with the adoption of AI.

CHAPTER I
THE FASHION MARKET

Premise

The following chapter describes the fashion industry, its current dynamics and the issue related to the quality of materials. This last aspect is addressed by highlighting the impact of new materials used in the fashion industry, whose adoption is based, above all, on the need to be sustainable. In fact, the sector is characterized by producing a significant impact and the latest trends show a response to ecological demands. Finally, the chapter aims to investigate the spaces offered by the fashion industry in which artificial intelligence can be introduced.

1.1 The international fashion market

The international fashion market is one of the most dynamic and globalized sectors of the world economy, and is characterized by a complex network of production, distribution and consumption. It is influenced by several factors, including ongoing cultural trends, technological innovation, demographic changes and global economic policies. The global fashion market has a significant economic value, in 2023 it involved trade in related industries equal to 1.7 trillion dollars, with forecasts of constant growth thanks to the increase in demand in emerging countries, such as China, India and Brazil[1]. The main segments present in the sector refer to clothing, footwear, accessories, which are expressed in various forms: sports fashion, luxury and fast fashion. Another characteristic of the sector is that the production of fashion goods is highly fragmented and widespread at a global level. Countries such as China, India, Bangladesh and Vietnam are important clothing producers due to the relatively low labor costs that have led, over the years, many Western brands to entrust their production[2]. The fashion market segments can be summarized as follows: “Luxury”,

[1]Data published by Confindustria, 2024

[2] In recent times, there has been a growing attention towards sustainability and reshoring (relocation of production closer to consumer markets).

think of brands such as Chanel, Louis Vuitton, Gucci that dominate the designer sector, which represents a significant part of the global fashion market, especially in Asian markets; " Fast Fashion" **:** with brands such as Zara, H&M, Primark that lead the segment characterized by rapid production and low costs (this model is currently under scrutiny for its ethical and environmental implications) and " Sustainable Fashion": segment that has spread with the increase in environmental awareness, which has imposed low-impact solutions also to the fashion sector. One of the most evident innovations in recent years has concerned the introduction of ecological materials, low-impact production processes and circular economy models. The fastest growing regions are China and India at the forefront where the growing middle class and urbanization have been key factors in the development of the sector. Europe remains home to many of the most famous luxury houses, such as those in France and Italy, a creative and productive epicenter recognized globally. The US market is one of the main consumers of fashion, with New York as the hub for business and emerging designers. Finally, expanding markets that show a growing interest in international fashion, with the potential for rapid growth are those in Africa and South America.

1.2 Current Trends

The growing concern about climate change and the pressure on brands to reduce their environmental impact are two factors that are leading to a greater emphasis on sustainable practices that are translating into the spread of recycling, ethical fashion and transparency in the supply chain[3]. Another sector innovation concerns its digitalization, namely the shift to e-commerce, accelerated by the COVID-19 pandemic, with platforms such as Farfetch, Zalando and Amazon that have increased their market share. Furthermore, digitalization has paved the way for new business models such as direct-to-consumer (D2C) which involves selling clothes directly to the public without the intermediation of the store. A very evident trend is also that regarding the influence of social media, social platforms, in particular Instagram,

[3] Alan TL Chan, Eric WT Ngai, Karen KL Moon, *The effects of strategic and manufacturing flexibilities and supply chain agility on firm performance in the fashion* industry European Journal of Operational Research, 2016, p. 34.

TikTok and YouTube, which are playing a crucial role in defining global trends. Influencers and celebrity endorsements have become fundamental for fashion marketing that directly addresses famous and popular faces to have their clothes worn. Other innovations concern the use of 3D printing, smart materials, augmented reality (AR) and the metaverse that are transforming the way consumers interact with fashion, enabling immersive and personalized experiences.

1.3 The fashion industry supply chain

The fashion supply chain represents the entire process of production and distribution of clothing and accessories (from the creation of raw materials to sale to the final consumer) and includes several interconnected phases that involve various actors along the way. The initial phase concerns the " Production of raw materials " and involves, above all, the processing of raw materials to obtain yarns and fabrics. The Spinning and weaving phase involves the generation of yarns and fabrics while Dyeing and finishing consist of coloring and providing specific qualities to fabrics such as, for example, water repellency and softness. This is followed by Product Design and Development which takes into account trends, consumer needs and available materials, while Packaging involves the transformation of fabrics into clothing items (or shoes, bags, accessories) followed by their Distribution , which takes place using physical stores, clothing chains, luxury boutiques and e-commerce platforms. The retail phase sees products being sold to consumers through various channels: single-brand stores, department stores, e-commerce, outlets, followed by the post-sales phase and the management of waste produced. Below is a summary table of the phases described [4].

[4]Foglio A., *Fashion Marketing*, Milan, 2001, p. 109.

Tab. 1: The stages of the garment manufacturing process

PHASE	Description
Raw Material Production	Involves growing and harvesting natural fibers (eg, cotton, wool, silk, flax) or producing synthetic fibers (eg, polyester, nylon).
Spinning and Weaving .	The raw materials are processed into yarns and then woven or knitted into fabrics.
Dyeing and Finishing	Fabrics are dyed, printed, or treated to enhance appearance and characteristics like water resistance or softness.
Design and Product Development	Designers and fashion houses create collections and develop clothing items, focusing on trends, consumer demands, and material availability.
Garment Manufacturing	The designed patterns are cut and sewn into finished garments in factories or artisanal workshops.
Distribution	Finished garments are distributed to retailers through global supply networks, including physical stores and e-commerce platforms.
Retail	Products are sold to consumers through various channels like flagship stores, department stores, online retailers, and outlets.
Post-Sale and Waste Management	Includes recycling, waste management, and sustainable fashion initiatives to reduce environmental impact and promote reuse.

Source: Personal processing on various sources

Those described are of the "macro functions", within these phases, in fact, there are others, in fact, the production process for a piece of clothing is a sequential set, which

goes , as has been said, from the design of the product to its production and distribution. Each phase is crucial to guarantee the quality, efficiency and conformity of the item to the desired specifications and, upstream, places attention on market trends and fashions. "Market research and analysis" is a function that overrides all the others and is present in every company that deals with fashion. Before starting production, companies, in fact, conduct research to identify trends, consumer tastes, innovative materials and other needs expressed by the public, this step helps to define the type of clothing to produce and to develop an adequate strategy that is more in line with demand[5]. In the design phase, we move on to the Design care and sees the designers create sketches and conceptual models of the garment using drawing software (CAD) to obtain technical models, as well as details such as cuts, stitching, decorative details and accessories (often, several iterations are made to perfect the design until obtaining what is sought). There is also a function that deals with Selection of materials and that involves a series of choices: Choice of fabrics, yarns, accessories (buttons, zippers, etc.) and finishing details. Materials must be chosen based on the desired properties such as quality, comfort, resistance and cost and, at the end, preliminary tests are planned to verify their technical characteristics (elasticity, resistance to washing, etc.). Another sub-function of Design is Prototyping, or the creation of the prototype of the garment based on the final design that allows to evaluate the fit, the quality of the fabric and the overall design. In general, the prototype can undergo changes until it satisfies all the criteria set in the design. The Development of the Model (Modelling) is, instead, a phase that involves the creation of the paper pattern , which is the full-scale representation of the various parts that make up the garment that is created with digital or manual tools and, subsequently, through the "gradation", we move on to the creation of variants of the model (different sizes). The Producing a sample with final approval ends the ideation phase of the garment, allowing us to check whether the garment meets the required design and quality standards. Samples are quality checked before being approved for production, after which mass production begins. This phase takes up most of the creative operations: Cutting: fabrics are cut according to the pattern; Sewing and Assembly **:** the various parts of the garment are sewn together, a

[5]Foglio A., *Fashion Marketing* , cit., p. 111.

process that can be done by hand or using industrial machines and Finishing: the addition of details such as buttons, zips, labels and decorative stitching. As for Quality Control, this involves checking each garment to ensure there are no defects in the fabric, stitching or details. Correct sizing, fit and compliance with brand standards are also checked. After quality control, the garments are ironed to give them a finished, ready-to-sell look and are then packaged individually or in stock for shipping. The finished garments are distributed to physical stores, e-commerce platforms or wholesalers, such distribution can also include warehousing, inventory management and shipping to customers. At this stage, very important are the collecting customer feedback for future improvements and managing product returns, repairs or defects. This process may vary slightly depending on the type of production (custom, limited series, etc.)[6].

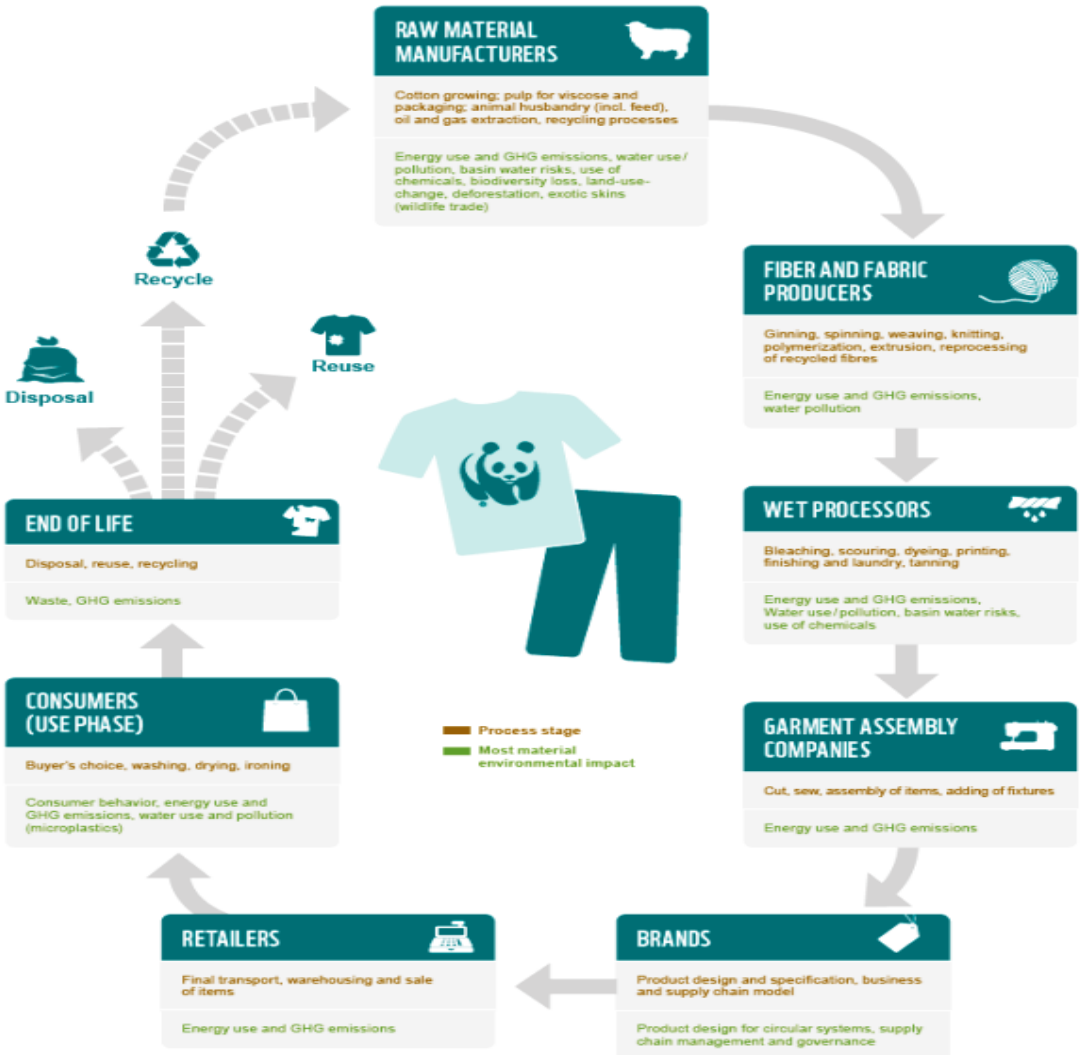
1.4. Environmental impacts of fashion

The production process of a garment, described in the previous pages, causes environmental impact in every single phase that characterizes it.
Specifically, the production process is characterized by a significant "Consumption of resources", which is inherent in the use of textile fibers, the fuel used to transport and operate the machines used for production. Among the resources most used in the sector, there is also the significant consumption of water and electricity as well as the "Emission of greenhouse gases" which is strongly connected to fuel consumption. Also the "Generation of solid and hazardous waste" which occurs in each phase of the manufacturing process, continuing in the one concerning consumption and ending with the end of the life of the good, or with its elimination and destruction. The "Pollution of air and water" is a typical impact of this process, causing the acidification of the air caused by the emission of sulfur oxides (SOx), fossil fuels and nitrogen oxides (NOx). This impact occurs, in particular, in conjunction with the production of electricity used in the production phases of fashion garments.

[6] Marchi G., *Market knowledge for product innovation. The paths of fashion companies between creativity and marketing* , Bologna, 2008, p. 89.

"Polluting emissions", in general, have impacts on drinking water, air and soil with toxic chemical sediments produced by factories or with the use of chemical substances in crops (cotton, hemp *in particular*) as defoliants or pesticides. "Biodiversity loss", on the other hand, occurs with intensive cultivation in different areas of the globe and consists in the destruction of natural *habitats* to create artificial cultivation conditions. The following diagram, created by the WWF, reconstructs the production process of the sector, associating, for each phase, the environmental impact caused.

Fig.1: The production process of the fashion sector and its impacts



Source: WWF: Full report 2015

Fair Trade and *Greenpeace* [7]have often denounced the impacts caused by the production of the textile/clothing sector, proposing some *best practices* that require *managers* to invest in environmental initiatives[8].

The entire supply chain is under accusation, even if the focus of the problem is on the use of "polyester", the most used fibre in the manufacturing industry, which is a petroleum derivative and uses an *energy intensive process* that releases millions of tons of carbon dioxide.

The other aspect on which the complaints have focused is the excessive use of water: just think that the growth of cotton requires over 2 thousand litres to produce a basic model t-shirt[9].

The *carbon footprint* [10]of a *t-shirt* has been estimated at 15 kg, or twenty times its weight.

To transform raw materials into textiles, an estimated 8,000 different synthetic chemicals are used, most of which are discharged into drinking waterways. The azo dye, nonylphenol, phalates and ethoxylants (NPEs) used in the industry are bioaccumulative chemicals that can pass to humans through the food chain. In particular, growing cotton requires 10% of all pesticides used worldwide, approximately 2.6 billion per year, and 25% of all insecticides in the global total[11]. The entire textile industry uses 378 billion liters of water each year, and textile dyeing and related treatments contribute to up to 20% of water pollution worldwide. Synthetic fibers also use petroleum, a non-renewable natural resource. In recent years, voluntary initiatives aimed at changing environmental policies have convinced companies in the sector to publish their annual Sustainability Reports, describing their environmental and social impact and the initiatives launched to resolve the damage[12]. Pressure from environmental organizations has also contributed to producing this change; for

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[7] *Fairtrade* is the certification mark of fair trade, and its aim is to guarantee better conditions for agricultural producers. Greenpeace is an NGO that aims to defend the environment.

[8]Ciasullo, MV, S. Cardinali and S. Cosimato, *A Strenuous Path for Sustainable Supply Chains in the Footwear Industry: A Business Strategy Issue,* Journal of Global Fashion Marketing, Taylor & Francis Journals, vol. 8(2), 2017, p.162.

[9]Ibid.

[10]This is a parameter used to estimate the greenhouse gas emissions caused by a product, a service, an activity carried out by an organization, an event or an individual, expressed in tons of CO2 equivalent.

[11]https://fashionunited.it/statistics/statistiche.

[12]Henninger CE, PJ Alevizou and CJ Oates, *What Is Sustainable Fashion?* .Journal of Fashion Marketing and Management, n. 4, 2016, pp. 400-416.

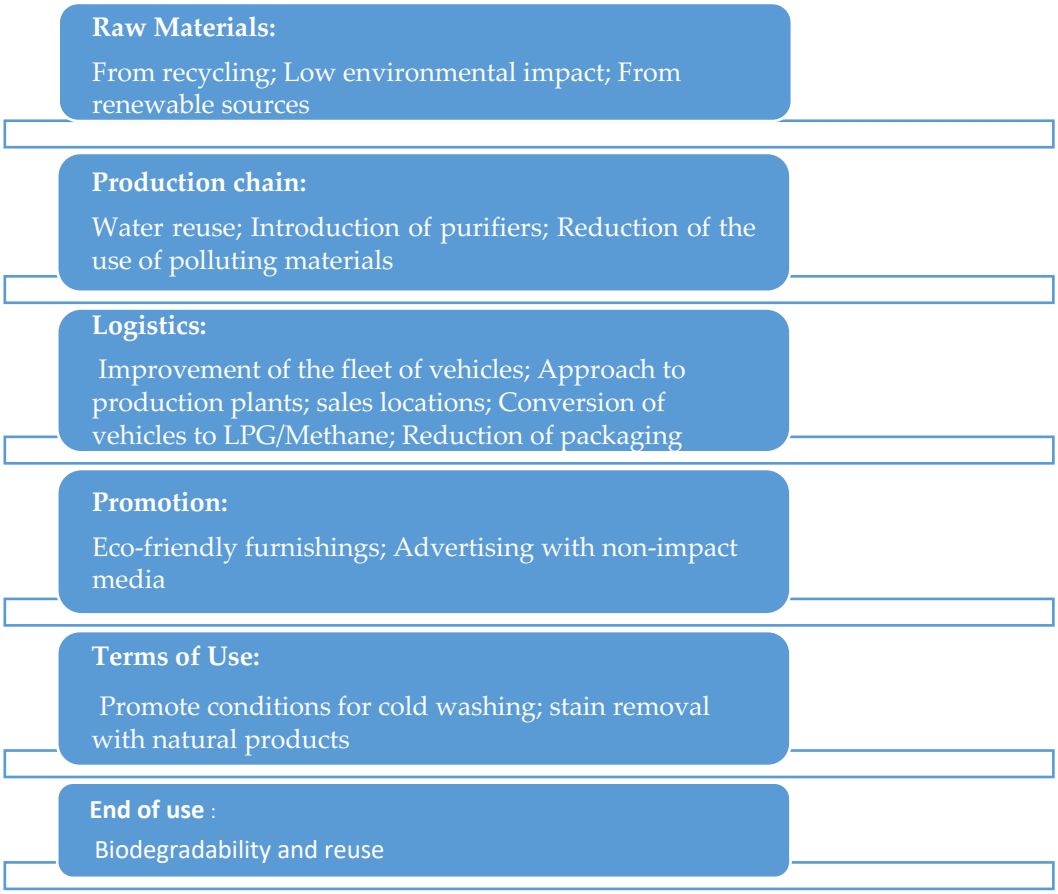
example, in 2018 the WWF *Deeper Luxury Report* considered that fashion *brands* should become more sustainable for a number of reasons and through various methods: improving operational efficiency; improving relationships with employees, motivating them with an increase in *loyalty* and streamlining *performance* at the *customer service level* ; introducing innovations that improve competitive advantage; creating *networks with non-profit* associations that help *brand image* and, with it, improving financial credit[13].

Various strategies aimed at containing the impacts described have been spread in the sector and, among the principles adopted, the three Rs have prevailed: "Reuse, Saving, Recycling".

Reuse refers to the reuse of waste but also to the spread of used clothing, such as *vintage* ; Saving concerns the use of efficiency, innovations in the *supply chain* and the use of inexpensive materials and finally Recycling concerns the recovery of production waste in view of their use in the production process. Based on the three Rs, the adoption of sustainable practices can concern all phases of the process, in which it is possible to observe some specific interventions, aimed at reducing the impacts described. The following diagram describes them by reporting the summary aspects for each phase.

[13]Frisa M, Frisa ML, *The beautiful and the good. The reasons for sustainable fashion. Venice* , Marsilio, 2011, p. 109.

Tab. 2: Practices for sustainability



Source: Personal elaboration on Montera R. (2011)

One of the aspects that contributes to characterizing these companies as sustainable is certainly identifiable in the "traceability" or in the reporting of the origin and of the people responsible for the operations[14]. In general, the sector has responded to environmental demands by introducing a series of innovations in the supply chain. Below, an analysis of them.

[14]Montera R., *The sustainable internationalization of multinational companies: Myth or reality?,* L'industria, Rivista di economia e politica industriale 37, n. 1, 2016, p. .22

1.5. Recent innovations in the fashion supply chain

In recent years, precisely as a result of the complaints described, there has been an increase in the attention of companies towards ensuring sustainability in every phase of the fashion supply chain. This involves the spread of the use of ecological materials, the reduction of waste, the promotion of recycling and the adoption of ethical production processes that respect the environment and workers.

In general, in recent decades we have witnessed an innovative process that has involved the entire sector, motivated by various needs, almost always linked to market changes or technological transformations.

As we have seen, environmental issues can also be included among the "market transformations" and impose production changes.

The origins of innovation can be exogenous or endogenous, in the first case the mechanism is called in literature as *demand pull* , that is driven by the pressures of demand , in the second case it is the offer that drives innovation: companies are dominated by the *technology-push,* they dictate technological progress and seek, in investment, innovative solutions. The *technology push perspective* pushes for the continuous valorization of technological capabilities, innovating and developing them[15].

The sources of new ideas almost always come from the company system itself, but they can also come from universities, consumers, *competitors* , or from the creativity of individual employees. In all companies, in a *Total quality perspective* , the contents of innovation are shared with the *marketing management* which, going back to the real needs of the market, makes them known. To go back to these needs, various tools are used, for example, *Focus groups* which These are meetings in which a group of participants, representing "typical customers", are asked to explain the required contents of the products, as well as the characteristics that act as a deterrent to their consumption.

Often, targeted, individual interviews are used, in which the consumer is invited to describe his/her experience in using the product, or, through the so-called ' *Empathic*

[15]Simone C., The *resource based view and the knowledge based view. From the atomistic to the interactional perspective* , Aracne ed., 2004, p. 72

Design ' which takes into account the *lead user's behaviour*[16] (a particularly competent and innovative consumer who develops, in complete autonomy, new solutions that he often talks about in the media and on dedicated pages). Equipped with a high level of *expertise, leading* consumers anticipate the need in the market long before it manifests itself, confirming the possession of a *forecasting ability*[17]. In recent years, a corporate function has spread that deals with encouraging, collecting and sharing knowledge, both for its use in the production sector and to grasp market trends, *Knowledge Management* , which today plays a crucial role with respect to innovation, making cultural resources manifest and valorizing them.

This function stimulates ideas, for example, through *brainstorming,* through which discussion groups are created on a problem, seeking a shared solution.

Among the techniques that help to find the desired solutions, which often turn out to be innovative, is that of the *6 thinking hats* , in which a hat is assigned to each participant in the discussion, inviting them to embrace the role associated with it; for example, if one receives the policeman's hat [18], one will have to contribute a normative vision, if, instead, one receives the priest's hat, one will have to think about the ethical aspects of the issue, and so on [19]. Through this technique, the group moderator aims to avoid rigid attitudes by inviting the adoption of other ways of thinking.

The *5 Technique why,* instead, (*Why, When, What, Who, Where*) consists in asking specific questions to find the solutions to the problems[20]. The technique of *provocation and movement* is based on making unusual, even illogical, statements to stimulate the search for possible solutions. For example: *Escape* , a technique that denies usual and obvious solutions; *Inversion,* which involves the inversion of roles or sequences that one is used to performing; the *Exaggeration and illusion technique* encourages the adoption of variations of *focus,* from the real to the fantastic.

The ideas that are formed, thanks to these techniques, tend to be creative and, therefore, innovative. The techniques described must, in any case, always be channeled into a

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[16] Reinach S, *A world of fashions. Globalized dress* , Rome-Bari, 2011, p. 51

[17]The *reason why* is another aspect that must be considered and represents the credibility of the product that must be evaluated with respect to the satisfaction of the consumer's needs. Innovating a product means making an improvement that the consumer must know.

[18]In real cases, rather than assigning a hat, it is preferable to assign a role, or a symbolic color.

[19]Denicolai S., *Economics and management of innovation. Governance and intermediation of knowledge as a lever of competitiveness* , Bologna, 2020, p. 70.

[20]Ibid., p. 72.

consumer insight perspective, which aims to understand the needs of customers through specific market research[21]. In the fashion sector, what has been highlighted takes on particular importance as it is a sector that requires continuous innovation.

The fashion market differs from others in that it is *multi-oriented*: it presents itself as an *"accessible market"* because, with *ready-to-wear*, the offer is aimed at everyone and not at niches, making it open to all tastes.

This requires the need to present many proposals, so that each consumer can find the product that best suits their needs. The market in question is also a *dynamic market"* being a reflection of society which, by definition, is continually changing.

Based on this characteristic, fashion must respond to global needs, which vary from country to country, by adopting differentiation strategies.

Fashion is also a "*gradual market*", since it does not allow radical changes to the leaders having to limit themselves to following the determined rhythms of social change. If one decided to revolutionize the wardrobe continuously, it would produce a crisis in the consumer who is willing to add only a few items per season.

The fashion market is, then, a "*segmented market"* outlining an offer aimed at very different categories of consumers, among which niches creep in. Even if the innovations of the lines do not appear to be particularly differentiated for each season[22], the market in question is proposed as dynamic and inclined to continuous experimentation.

In this sense it is also considered a "*Current Market"* having to keep up with the changing tastes of consumers which, once detected, requires that the product launch takes place in the shortest time possible, its success being linked to the immediate response to the need[23].

Fashion is also a "*conditioned market"* as it is affected by changes in society**,** in their cultural, political, technological, social, etc. meaning, characterising itself as a *consumer-oriented sector*.

As regards the production aspects, the "fashion product" can be obtained through one of the following cycles[24]:

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[21] Segre Reinach S., *A World of Fashions. Globalized Dressing* , Laterza-Bari, 2011, p. 112.
[22]Designers' collections always look very similar
[23] Segre Reinach S., *A World of Fashions. Globalized Dressing* , cit. p. 33
[24]Ibid.

Classic cycle: which does not allow excesses, think of jeans, white shirts, sheath dresses, etc.

Interrupted cycle: which occurs when the head proposed it is not accepted by the market;

Rapid cycle: whose duration is limited to the season;

Cycle within the cycle: which sees continuous modifications to the characteristics of the products which, thus, are continually re-proposed[25];

Recurring cycle: which sees past garments being revitalized.

With respect to the market, it is possible to decide to address a specific segmentation, identifying narrow areas of offer: by geographical areas, by demographic and social typology (age, sex, income, level of education), aimed at specific levels of awareness (informed/uninformed consumer, standard of living, behavioral nature, focusing on the advantages sought), by attitude (positive, negative) or, finally, by *brand loyalty*[26].

Market segmentation can be further specified where the company focuses on a single line: *Men's clothing, Women's clothing, Children's clothing.*

Italian men's fashion is known worldwide for its style and quality, having various requirements that can be summarised as [27]: *Fashion value,* who sees the p roduct stands out for its aesthetics, originality, reference to a specific status, attractiveness and elegance; *Styling* , whose value is the *design* , the fabric, the colors, the line and the packaging; *Innovation* , which refers to the continuous updating of the product portfolio; *Brand and notoriety,* which requires that the product is identifiable by the consumer. Also the *availability of complementary accessories* , which give the product that desirable added value and the fine *fabric* they underline the quality of the garment. In the industry, it is the use of fine fabrics and designs that allow products to be sold at higher prices [28].

Marketing function is responsible for presenting the garments to the market by orienting the *perception of their durability*, enhancing its packaging, materials and

[25]Think of the classic little black dress: over time the materials, shapes and details have changed but the "little black dress", the term with which it was presented, persists.

[26]Henninger CE, PJ Alevizou and CJ Oates, *What Is Sustainable Fashion?* . cit., pp. 400-416.

[27] D'Avolio, Romeo E. Bandinelli R., Rinaldi R. **,** *Towards PLM maturity assessment in the fashion industry,* XX Summer School "Francesco Turco", Industrial Systems Engineering, 2016, p.67

[28] The cult of the image has also strengthened the role of the concept of the *silhouette* which identifies the aspects that enhance the body, the wearability of the garment.

colours even if the stylists also participate in the construction of the product's identity[29]. In the sector, the following stand out: the *corporate stylist*, employee and, usually, creative director; the *producer stylist,* who follows the *brand.* both as a stylist and as a manager [30], the *professional consultant stylist* , who works for multiple companies[31].

Another characteristic of the 'fashion' sector is that it is based on a specialized supply chain, which sees the innovation process involve multiple players in the *supply chain.* At the 'downstream' end of the chain are Small and Medium Enterprises (SMEs) that produce yarns and fabrics, which are further divided into companies specialising in products made from wool, cotton, silk and so on.

In a 20017 study, still current, Brusco and Paba identified some characteristics that typify the Italian supply chain[32]:

"*• high specialization in a specific manufacturing sector or production sector which in the Italian case concerns the so-called "Made in Italy", that is, the set of industrial sectors mainly linked to the fashion sector, and extensively to all other sectors in which the immaterial component of the products plays a strategically relevant role*

• a large population of small and medium-sized enterprises which represent the predominant business typologies of the Italian industrial fabric;

• a breakdown of production processes into different phases characterised by reduced optimal dimensions, according to which each company present in a given district territory, in accordance with its own distinctive skills, takes charge of the creation of a specific segment of the value chain;

• the development of subcontracting contracts and cooperative behaviors between local businesses, which, more often than not, are the real driving forces behind local entrepreneurship".

If we look at the size of the companies operating in the supply chain, they appear larger and more capitalised the further away we move from the production areas where fabric

[29]Coviello M., *Rhetorical Figures & Advertising* , F. Angeli ed., Bologna, 2009, p. 12
[30]An example of this type of designer is Giorgio Armani
[31] An example of this form of collaboration is given by Karl Lagerfeld for Chanel and Fendi.
[32]In: www.itconsult.it

production prevails, reaching, in fact, their maximum size when the *core business* deals with final packaging [33].

The description of the sector helps to understand the ways in which innovation is achieved. First of *all, it tends to accept the induction of the social context, or rather of the prevailing tastes. Furthermore, it is affected by the different forms of organisation of the entire production chain, making different aspects prevail depending on whether the programmed cycle* or *fast fashion*[34] prevails. Innovation, in fact, suffers the consequences of such choices. If you produce by adopting a *scheduled cycle* , the production system is subject to seasonal changes in terms of fabrics, colors, cuts, buttons, zippers, etc., while, in the presence of *fast fashion,* the *supply chain* is characterized by being based on the production of new products or mini-collections that have a very short life cycle. In the *scheduled cycle,* the production area drives the others, acting as *a driver* of the entire supply chain, and, in particular, of the creative area.

In the case of using a cycle based on *fast fashion*, it is observed that the 'guiding subjects' of innovation are the distribution networks[35]. In this latter case, the objective of rapid development of collections pushes towards a simplification of trend analysis and prototyping, which are generally carried out by a *staff* composed of a rather large number of people. Companies with a programmed cycle assign a fundamental role to [36]*Knowledge Management, being called upon to manage the culture of creativity, developing it at the pace required by the market*. A difference can also be observed from an organizational point of view, in fact, compared to traditional companies, where it is preferable to adopt a *routine* capable of ensuring consistency in results, in fashion companies flexibility is preferred, which is functional to creativity [37]. Flexibility, in fact, guarantees better sharing of knowledge and know-how, useful

[33]Montera, R. 2016, *The sustainable internationalization of multinational enterprises: Myth or reality?* cit ., pp. 51-70.

[34] Saviolo S. and Testa S., *The companies of the fashion system* , Rizzoli ed., Milan, 2013, p. 5

[35]The term fast fashion refers to a family of business models, which present different degrees of vertical integration and market positioning, but which have in common the shortening of design times and the elimination of the seasonal cadence of collections in favor of a continuous renewal of products.

[36] D'Avolio, Romeo E. Bandinelli R., Rinaldi R. **,** *Towards PLM maturity assessment in the fashion industry,* cit., p. 99.

[37]On the relationship between creativity and sustainability see: Feng T., L. Su C. Zhu and AS Sohal , *Customer Orientation for Decreasing Time-To Market of New Products: It Implementation as a Complementary Asset* . in Industrial Marketing Management, 2012, p . 98.

aspects for the creation of new collections[38]. In these companies, creativity is present both in its "ideation" phase and in its "design" phase[39]. In an innovative perspective, it is the *management* that provides for the generation of ideas and distributes the competences, defines the agenda, the pace, the roles, etc. [40]Innovation proceeds, in this sector, by involving all the actors, which implies the need to preside over their requests, sharing them[41]. The following table shows the contribution to the innovation process of each actor in the "fashion sector".

Tab. 3: The cognitive activities of the actors in the fashion sector

ACTORS OF THE CHAIN	**COGNITIVE ACTIVITIES**
CONSUMERS	Market knowledge generation
STOREMANAGER	In-store consumer observation; Selection of the most interesting and significant consumers
SALES FORCE	Selection of representative stores; Information gathering; Direct observation of the preferences of consumers who purchase in stores
SALES/AREA MANAGER	Collection and aggregation of collected information; Selection of the most reliable sources
BRAND/PRODUCT MANAGER	Selection of the information collected; Interpretation of the data
STYLISTS	Selection of information received; Use of knowledge in creative function

Source: Personal processing on Marchi G. (2008)

The minimization of the distance between the subjects involved in the innovative activity and the speed of the timing represent the central aspects of the success of the innovation of a “collection”[42]. The novelty that presides over the innovative process in the "fashion" of recent years refers to their orientation towards respecting ESG implications. In fact, whatever the innovated object, it is necessary that it coordinates with ESG instances, which also explains why, more and more often, the reason why

[38]In: Sistema Moda Italia, in: https://www.sistemamodaitalia.com
[39]Ibid.
[40]Volpato G., *Knowledge management as a tool for competitive advantage. An intersectoral comparison* , Carocci ed., Rome, 2007, p. 19.
[41] Alan TL Chan, Eric WT Ngai, Karen KL Moon, *The effects of strategic and manufacturing flexibilities and supply chain agility on firm performance in the fashion industry* , cit., p. 8.
[42] Marchi G., *Market knowledge for product innovation. The paths of fashion companies between creativity and marketing* , cit., p. 74

one decides to innovate is precisely to equip the company with low-impact systems and technologies.

1.5.1 Sustainable business models in the fashion sector

"Sustainable innovation" therefore presents itself as a competitive tool for operating in continuously evolving markets[43].

Today, observing the companies operating in the sector, we are witnessing the spread of responsible *modus operandi*, both nationally and internationally, this happens, above all, among the larger ones[44]. The described orientation is sanctioned by the consideration of sustainability as a fundamental value but, also, the objective of obtaining advantages in terms of energy and water savings, reduction of material waste and the containment of sanctions issued to those who produce without respecting the principles of sustainability[45]. Furthermore, the culture of "efficiency" has spread, given by the correlation between corporate sustainability and economic *performance* that is obtained thanks to the savings obtained by avoiding waste and, in particular, by containing the use of energy and water. Investment in "*green*" technologies and innovations is also establishing itself by virtue of the *performances* obtained, and the acquired [46]*brand image.* With respect to this last point, there are many cases of sustainable initiatives in the sector due to image opportunism alone. Very often, these are initiatives that later turn out to be *greenwashing*, or façade sustainability[47].

:Sustainable innovation in the fashion sector is also necessary to comply with the legislation: each phase of the textile supply chain must, in fact, comply with the *standard* environmental requirements established by the legislator that require each

[43]Cedrola, E. and L. Battaglia, *Country-of-Origin Effect and Firm Reputation Influence in Business-to-Business Markets with High Cultural Distance* , Journal of Global Scholars of Marketing Science 23, n. 4, 2013, p. 394.
[44]Ibid.
[45]Cedrola, E., L. Battaglia and AG Quaranta, *International Entrepreneurship and Performance: What Are the Important Factors in Markets with High Cultural Distance* ? *In The Changing Global Economy and Its Impact on International Entrepreneurship* , edited by H. Etemad, S. Denicolai, B. Hagen and A. Zucchella. Cheltenham: Edward Elgar Publishing Limited, 2016, p. 66.
[46]Ibid.
[47]Boer H. and WE During, *Innovation, What Innovation? A Comparison Between Product, Process and Organizational Innovation.* International Journal of Technology Management 22, no. 1-3, 2016, pp. 82-84

partner in the supply chain to operate in responsible working conditions[48]. The regulatory requirements are due to the fact that the textile and fashion industry has a production process, in all phases of the supply chain, that has a particularly high impact on the environment in terms of intensive use of chemicals, pesticides and large quantities of water. Furthermore, the sector presents critical issues regarding the treatment of workers involved in production, this is due to the fact that the adoption of outsourcing and delocalization strategies in third world countries has led to the use of large amounts of underpaid labor employed in conditions that do not take their rights into account[49]. In addition to these aspects, the complex articulation of the production system, which involves other industries, such as the chemical or agri-food industries, exposes these industries to the risk of failure to comply with the principles of sustainability. Developing sustainable strategies therefore requires a transformation of the supply chain itself, taking care to reduce its impacts on the environment, contain consumption, reduce waste and, at the same time, respect the health and rights of workers and consumers.

In the "fashion" industry it is necessary to intervene in each specific phase of the production process. The following diagram specifies the interventions useful for reducing impacts.

[48]Cedrola, E., L. Battaglia and AG Quaranta, *International Entrepreneurship and Performance: What Are the Important Factors in Markets with High Cultural Distance* ? op. cit., p. 78.
[49]Cedrola E. and L. Battaglia, *Country-of-Origin Effect and Firm Reputation Influence in Business-to-Business Markets with High Cultural Distance,* cit., p. 78.

Tab.4: Impacts for individual processes

Stages of the process	***Interventions***
Supply of raw materials	Low environmental impact; low energy impact; materials derived from recycling, renewable sources; Fair trade and fair trade in general.
Production	Reduction of energy consumption; reuse of water in the manufacturing phases of the process; adoption of low energy consumption technologies; recycling of waste and production leftovers.
Logistics	Rationalization of transport flows; use of low energy consumption vehicles; abolition, where possible, of packaging.
Promotion	Use of eco-friendly furnishings and fittings; low-impact communication tools.
Final life cycle	Recycling; reuse and care for biodegradability.

Source: Personal processing on various sources

The circular configuration of the *supply chain* is the goal to strive for in the long term and aims to achieve sustainability, also by creating value from the waste obtained from the process.

However, these issues are still too deeply rooted in the *marketing* of companies operating in the sector that aim to convey an image of themselves as attentive to the *green economy* to the public, which has become particularly sensitive to the issue in recent years. The *green economy* , or more properly *ecological economy* , is based on bioeconomic analysis where, in addition to the benefits of a certain production regime, *the environmental impact* caused is also taken into consideration, that is, all the damage produced during the transformation cycle of raw materials and can be found already in the extraction phase and, subsequently, in the phase relating to transport and transformation, up to the disposal phase.

The search for a *captatio benevolentiae* sees many companies in the sector communicating *green policies* that have never actually been implemented, or the refusal to use raw materials considered harmful whose use is, in reality, prohibited by law. This is the phenomenon of "*greenwashing*" or the use of a false representation of the facts with the sole purpose of acquiring a *green image* with the public.

Through *Greenwashing,* virtues associated with the *brand are appropriated* by acting on an untruthful communication of the *policies* pursued and translating into *marketing* a much more noble purpose such as reducing the impact on the environment.

The term *Greenwashing* means washing with green and refers to the attempt of these companies to obscure their environmental impact responsibilities by declaring the launch of sustainability initiatives never pursued or results never achieved.

Environmentalists, attentive to the issue, have planned the publication, on an annual basis, of the *Greenwashing Report*[50], which makes public the real corporate policies undertaken by companies and the associated impacts. The *report* has repeatedly denounced the "declarative" abuse in the "fashion" sector, such as the use of false labels describing the use of *green raw materials* that are not confirmed by the analyses carried out on the products.

In many cases, product indications highlight *green aspects* that are required by law, for example, the non-use of CFCs, which are gases banned in the EU since 2003.

The growth of fast fashion models, which emphasizes convenience issues, has made it urgent to respond to the requirements of sustainability, paying attention to aspects such as the exploitation of natural resources (such as water) or the use of chemical products in production processes. *Fast fashion* has also generated problems in terms of *waste management*[51], leading some companies to reflect on the longevity of clothing items from the moment they are designed. In addition to these issues, attention is also paid to the social dimension linked to *offshoring* that characterizes the fashion sector, and which highlights the loss of rigor in *outsourcing policies*[52]. But it is not only the phenomenon of *fast fashion* that is affected by the dimension of sustainability, but the entire fashion system, even the one that uses careful and selected processes[53]. In general, today, luxury companies are called to develop and consider sustainability as one of the *drivers* of their offering[54]. These concerns have arisen from controversies

[50]Montera R., *The sustainable internationalization of multinational companies: Myth or reality?,* cit., p. .88

[51]Di Tullio, P., D. Valentinetti and MA Rea, The *Competitiveness of Firms through the Sustainable Business Model: A Decade of Research* , L'industria, Journal of Industrial Economics and Policy 39, no. 3, 2018, pp. 357

[52]As is evident, for example, in the choices made by some international brands in their sourcing policies following the Rana Plaza incident in Dhaka, Bangladesh.

[53]Frisa ML, *The Beautiful and the Good. The Reasons for Sustainable Fashion,* cit., p. 88.

[54]Ibid.

that have developed following the knowledge of some widespread practices in the "luxury" sector, involving the destruction of unsold clothing items. In this cultural context, sustainability and sustainable innovation have assumed a particular importance for the "fashion system", becoming a source of innovation for business models. Literature has introduced the notion of *sustainable fashion* to indicate the diffusion of a heterogeneous series of entrepreneurial initiatives that make sustainability the central element of the value offered. The *business model* is conceived as the ability of the company to provide value to the market by translating it into profits where the value proposition can refer to both the resources and skills of the company as well as to relationships with third parties[55]. Co-creation with other subjects also assumes a particular importance in the sustainable context, constituting a ground for sharing between the company and other *stakeholders* with a view to producing new value propositions. In literature, there is also growing attention on how sustainability can impact the issue of the *business model* of the fashion sector[56]. Todeschini et al. (2017) have explored the topic in depth, focusing on the possible *model of business* that can be adopted in the "fashion" sector, highlighting some macro trends present in the sector. In the opinion of the two authors, it is necessary to set up the *model of business* paying particular attention to "communication to consumers" about the measures adopted to make fashion sustainable. Furthermore, *business models* in the fashion sector must place emphasis on the adoption of a circular economy for clothing and on the diffusion of *Corporate Social Responsibility practices* that are hoped to be extended to the entire fashion system. A *business model* suited to the demands of sustainability must also take into account the affirmation of the *sharing economy* and the opportunities that can arise from the adoption of new, less impactful technologies. Innovation through sustainability is a *driver* of business development that should not be underestimated, as the market recognizes this as a potential source of value, in particular, the new generations are showing greater attention to these issues, given that the ethical dimension of the *brand* is believed to reflect the personality of consumers[57].

[55] Di Tullio, P., D. Valentinetti and MA Rea, The *Competitiveness of Firms through the Sustainable Business Model: A Decade of Research*, cit., p. 87.
[56] *Ibid.*
[57] De Brito, MP, V. Carbone and C. Meunier Blanquart, *Towards a Sustainable Fashion Retail Supply Chain in Europe, Organization and Performance,* International Journal of Production Economics 114, no. 2, 2008, p. 533.

The role of conscious consumers has been the subject of various sector studies in which attempts have been made to trace their influence on sustainable policies[58]. Moreover, since the beginning of the diffusion of *pret a porter* , clothing lines have often been designed paying attention to the needs of the public, trying to anticipate their tastes and more and more consumers seem to appreciate themes such as " *slow fashion* " [59]which promotes " *ethical conduct, reduced fashion production and purchasing quality over quantity clothing* " [60]. Although sustainability is a pervasive theme at the level of consumption, there remains, however, as reported in some contributions in the literature, a gap between the appreciation of sustainable *brands* in fashion and real purchasing behavior[61]. In any case, in response to these growing demands for sustainability, the need to rethink the company [62]*business model emerges. With reference to the fashion system, sustainability, therefore, constitutes a central component of the business* model of companies, these are aspects that have a particular criticality as there is a contrast between economic *performance objectives* and orientation towards sustainability[63]. Transparency in Corporate Social Responsibility (CSR) practices, in fact, can impact economic and financial [64]*performance,* so it follows that the diffusion of sustainability occurs at different levels and with different practices in *fashion companies*. For example, some practices concern the assortment offered. The large *fast fashion companies* have, in fact, developed and produced *sustainable collections with the integration in the offer of collections produced with the use of new materials, with organic materials or with* [65]*fair trade certified* [66]materials. In general, in the fashion system we are witnessing processes of *brand extension* on sustainable collections that seek above all the appreciation of the new

[58]Lee MY and J. Sung, *Sustainability and Management in Fashion, Design and Culture* . Journal of Global Fashion Marketing 7, no. 2, 2016, p. 45.
[59]Cedrola, E. and L. Trabaldo Togna, *Italian Excellence. Internationalization and Eco-Sustainability of the Biella Textile District* , Milano.Trino, 2020, p. 107.
[60]De Brito, MP, V. Carbone and C. Meunier Blanquart, cit., p. 501.
[61]Ibid.
[62]Cedrola, E. and L. Trabaldo Togna, *Italian Excellence. Internationalization and Eco-Sustainability of the Biella Textile District* , cit., p. 502.
[63]Ibid.
[64]Ibid.
[65]Lion A., L. Macchion, P. Danese and A. Vinelli, S *ustainability Approaches within the Fashion Industry: The Supplier Perspective* . Supply Chain Forum, An International Journal 17, no. 2, 2016, pp. 95.
[66]Ibidem.

generations[67]. There is no lack of examples of companies that, based on the principles of the circular economy, have increased the use of recycled products or started the collection of used garments directly in their stores[68].

It is also possible to identify companies that have redesigned their entire *business model* with sustainability in mind.

The Stella McCartney *brand, a well-known designer* of luxury models, is considered one of the main *leaders* in sustainability[69]. The *People Tree brand* , on the other hand, is known for embracing the principles of the *World Fair Trade Organization* (WFTO), the association that deals with fair trade. WFTO was founded in 1989 and over 60 countries participate in it and its aim is to help disadvantaged producers, offering assistance and services to improve their knowledge of world markets, establishing contacts with international trade organizations to induce them to adopt fair rules in commercial exchanges.

1.5.2 The new materials

In addition to providing procedural responses, innovating processes, systems and company protocols, many companies active in the sector have begun to use new materials that are replacing the traditional fabrics used in packaging up to now. These are innovative materials, the result of research aimed at creating non-impact fabrics and, at the same time, capable of enabling their performance. The following table describes the most widespread innovative materials and fabrics in recent years.

[67]Ibidem.
[68]Cedrola, E. and L. Trabaldo Togna, *Italian Excellence. Internationalization and Eco-Sustainability of the Biella Textile District* , cit., p. 503.
[69]Ibidem.

Tab. 5: New materials

Newcell Fiber	Textile fibre derived from cellulose recycling
Eco-friendly	Ecological fabric obtained from recycled nylon
Orange Fiber	Innovative ecological fabric obtained from waste from the orange supply chain
Soybean Protein Fiber	Innovative textile fibre derived from soy
Bionic Yarn	Yarn obtained from the recycling of plastic bottles
Crabyon	Ecological fabric from crustacean shells
Corn Fiber	Derived from a natural polymer with insulating properties
Organic Wool	In respect of the animals that produce it
Organic Cotton	Textile fibre with low water consumption
Lyocell	Innovative ecological fabric derived from eucalyptus wood
Wine leather	Eco-friendly clothing fabric derived from wine production waste
Pinatex	Textile fiber obtained from pineapple waste
Recycled cotton	Which is interwoven with other fibres
Regenerated wool	Recovered from old clothes
Biosteel	Innovative clothing material that can be considered a vegan silk

Source: Personal processing from Cedrola, E. and L. Trabaldo Togna (2020)

Newcell Fiber is a material obtained by creating a pulp from the transformation of fabrics that contain high quantities of cellulose. Once the pulp is created, it is reintroduced into the yarn manufacturing process, a system that guarantees the obtaining of high quality ecological fabrics, particularly resistant, both in the wet and dry state. Furthermore, *Newcell Fiber* has the characteristic of guaranteeing rapid absorption of the dye as well as high resistance to abrasion. The strong point of this fabric is recycling and the ability to transform into new sustainable material. The first

dress obtained with this system appeared in 2014 at the fashion festival in Gotland, Sweden, and, subsequently, at the Berlin fashion week in 2016[70].

Econyl is, instead, a fabric derived from the recycling of *nylon* . Its production is achieved through a process that allows the green yarn to be reused infinite times.

Nylon from end-of-life fabrics (especially carpets, as well as clothing, nets and even building materials) is separated from the other materials it is combined with, then cleaned and shredded. Once the pulp is obtained, it is sent to the depolymerization plant and finally taken to production plants that transform it *into Econyl*.

In addition to obtaining clothing, the finished product can be used for textile flooring (*carpets*) and for the production of swimwear.

The new fabrics do not come only from the plant world but can also be obtained from waste from the food industry, for example, Orange *Fiber* derives from the transformation of materials from the citrus fruit supply chain.

Orange waste is rich in cellulose and is produced, above all, in the juice and air freshener industries, whose waste is collected and, once the cellulose has been extracted, transformed into spools of thread. *Soyebean Protein Fiber* is, instead, a botanical textile fiber from post-oiled soybeans. The process involves extracting it from distilled soybeans by refining its basic protein.

This, which comes in liquid form, is polymerized by modifying its structure and then cooked, a process that makes a wet yarn that is thermoformed. The resulting waste is used as feed. The final fabric is characterized by its softness and shine, as well as its air permeability and low moisture absorption.

Bionic Yarn is a derivative of recycled plastic that is wrapped in polyester fiber. The process begins with the collection of plastic bottles that are melted and reduced to tiny polymers that are spun together to create the "Yarn-core"[71].

The latter is a yarn that is distributed in different types, a soft one that is obtained by combining recycled plastic with natural textile fibers and a less refined one that is obtained from completely recycled plastic, heated and spun. This material was launched in 2009 and, today, is also used by important *brands* known in the world of

[70]Di Tullio, P., D. Valentinetti and MA Rea, T *he Competitiveness of Firms through the Sustainable Business Model: A Decade of Research,* cit., p. 102.

[71]That is, the center of the yarn.

international fashion, in addition to the *low-cost companies* that use it for denim garments, tracksuits, bags and shoes.

Even from shellfish waste, yarns can be obtained by extracting chitosan, an element that derives from chitin, a substance that serves to protect shrimp shells.

Chitosan, combined with natural fibres such as linen, cotton and wool, allows us to obtain an ecological fabric with various properties, being anti-allergic and 100% biodegradable[72].

Crabyon is the final fabric obtained with this methodology and which is permeable to air and able to absorb humidity, prevent dehydration and protect against allergies. Furthermore, it is suitable for the production of all types of clothing, especially underwear (for adults and children), medical fabrics and mattresses.

From particular processes of sugar extracted from corn, starches and some legumes, it is possible to obtain polyactic acid PLA, a polymer that, once spun, makes *Corn Fiber*, a material with high humidity absorption, particularly breathable, shiny and with high resistance to heat and UV rays. For its transformation, the machines emit low levels of CO2 and it has the advantage that the residues can be recycled and transformed into fertilizers.

The materials obtained with these operations have the defect of being very delicate, however, the high insulating capacity of *Fiber Corn* makes it also useful in the construction field, in ventilated roofs and in cavities[73].

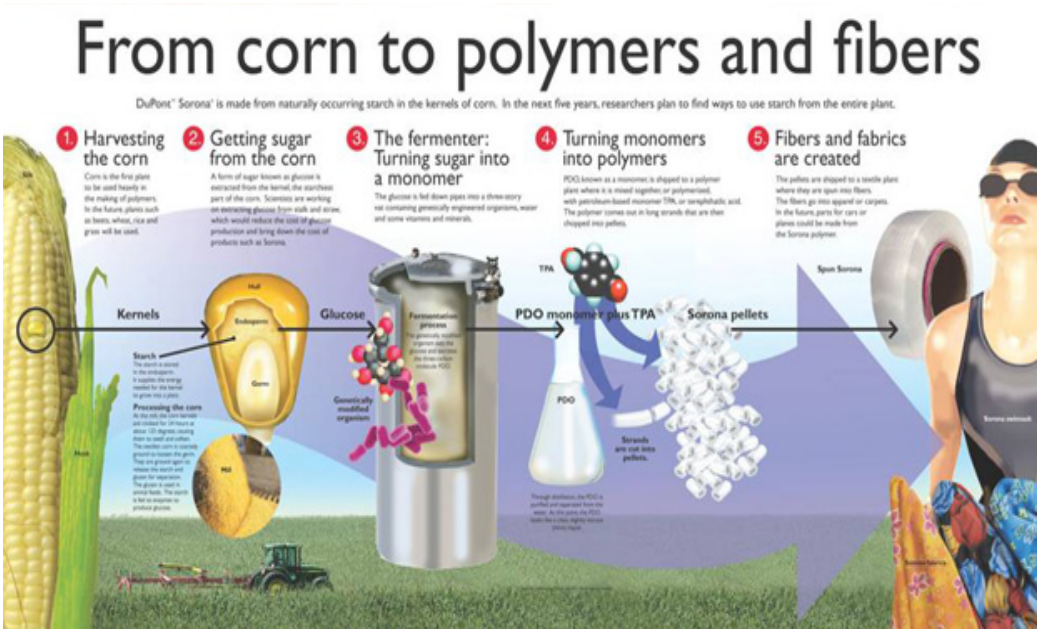
Clothes of all kinds and stuffing of mattresses, cushions and sofas are suitable for its use.

Below is the process for obtaining *Corn fiber*.

[72]Silvestre, BS and DM T, îrcă , *Innovations for Sustainable Development: Moving toward a Sustainable Future,* Journal of cleaner production, 2019, p. 91

[73]Di Tullio, P., D. Valentinetti and MA Rea, *The Competitiveness of Firms through the Sustainable Business Model: A Decade of Research* , op. cit., p. 103.

Fig.2: Obtaining Corn Fiber



Source: Di Tullio, P., D. Valentinetti and MA Rea (2018)

Today, textile industries that use new materials can be classified into four categories: industries that use organic fabrics; i. ecological fabrics; i. recycled fabrics and i. recyclable fabrics. Among the first are those that use organic cotton and organic wool (the 2017 *Textiles Exchange Report* has officially stated that the quality of the former is significantly superior to standard cotton). The greatest advantage of these productions is summarized in the reduced water consumption.

Organic wool is that obtained from animals that live in freedom, feeding on organic food and undergoing manual shearing that eliminates any form of violent shearing. Ecological textile fibers are based on the use of elements taken from nature such as, for example, eucalyptus wood which makes it possible to produce *Lyocell* , an artificial cellulose fiber with a low environmental impact. Fibers obtained through recycling are increasingly widespread and, in recent years, the one based on pineapple waste (*Pinatex*) has also been developed. Among the innovative fabrics, recently, recycled cotton has also been proposed which, once mixed with other fibers, becomes sustainable. Regenerated wool, on the other hand, is produced using ruined wool, or old garments or scraps.

Among the innovative recyclable textile fibres, cotton waste should also be mentioned.

There are plans to develop fabrics based on *Biosteel* , a synthetic silk of vegan origin, which is inspired by spider webs. It is a 100% biodegradable product. Finally, as an alternative to animal leather there is *Wineleather* , produced with the skins, seeds and stalks of grapes[74].

The environmental and social responsibility of companies operating in the "fashion" sector has spread, capillary, also following the complaints regarding its impacts which have meant that, in the annual reports, the references to sustainability have more than doubled. Even activists like Greta Thunberg have launched messages of denunciation against the "fashion system", industry, accused of being unethical and "green". The *BoF Sustainability Index*[75], fashion sector, has repeatedly urged the industries of the sector to commit to limiting the damage from the lack of attention to the environment, in particular for climate change, also urging the introduction of social protections for workers.

Business of Fashion Index considers over 5,000 data points relating to each company monitored, and uses 338 metrics divided into six categories to measure the achievement of 16 environmental and social objectives[76].

The average score was 36 out of 100, which means a positive commitment to the topic of sustainability but also a spread of *greenwashing* which occurs when companies declare that they have achieved much more than the concrete actions they have implemented. Initiatives in support of transparency, the reduction of emissions and water pollution, as well as the containment of water waste, use of chemical products, consumption of raw materials, production of waste and even the adoption of rights and measures in favor of workers are often described, which are implemented only in marginal aspects or which cannot be demonstrated. The practice of *greenwashing*, or of boasted or distorted declarations regarding initiatives in favor of sustainability, is carried out with various intentions, *first of all*, to convey an image of holding values that enhances the *brand*. It is a real image policy aimed, in particular, at *Millennials*, the young consumers who, in recent years, have acquired a greater awareness of sustainability. Attention to the diffusion of a “green” image is also directed to investors

[74]This is a product that, launched by Italian factories, has obtained unanimous recognition at an international level.

[75]BoF Sustainability Index is concerned with evaluating the sustainability index of major brands.

[76]Gherardini A. and Pessina G., *Riding the Wave of Change. The Industry 4.0 Plan Put to the Test by Districts* . L'industria, Journal of Industrial Economics and Policy 41, no. 2, 2020, pp. 191-214.

and politicians who tend to pay attention to the industrial sector to avoid financial risks and negative repercussions on the electorate.

Sustainable investment has become "*mainstream*", that is, a central element of corporate policies, in almost all production sectors, not only in textiles/clothing, also following the introduction of regulations aimed at imposing the adoption of sustainable business processes[77].

In many countries, sustainability criteria are becoming increasingly stringent and the circumstance that many fashion companies have a multinational nature requires an adaptation to these new measures which prohibit, among other things, starting from 2023, the destruction of remaining stocks and unsold goods.

France has approved a bill to fight the climate crisis, including requiring all consumer products to be labeled with information about their carbon footprint.

In this climate, textile companies are applying labels that are particularly rich in information on the origin of the materials, the emissions produced and the impacts caused.

Promotional messages also tend to exalt initiatives undertaken in this direction. However, within these initiatives the practice of boasting about the adoption of choices that, in reality, are not very *green* or very distorted is spreading. Before the Covid-19 pandemic, many fashion brands denied the payment of wages to workers operating in important production countries such as Bangladesh and Cambodia, subsequently, with the return of orders, they moved on to requesting a reduction in prices, which increased the pressure on those who work in garment factories. The worsening of working conditions did not emerge in their official statements which, on the contrary, boasted of having undertaken socially sustainable initiatives, thus carrying out *greenwashing practices* . The fashion industry, in fact, continues to release large quantities of CO2 into the atmosphere, to release chemicals into waterways, to generate increasing volumes of waste, describing themselves to the public as active in the adoption of sustainability policies.

The answer to the accusations raised by BoF is that the methodology adopted is binary in nature, with a yes-no answer, to evaluate what companies have done in terms of

[77]Ibid.

environmental and social sustainability. This makes it difficult to report on the initiatives that, instead, are rather versatile and difficult to delineate.

On November 21, 2021, the order of the Court of Gorizia intervened with a historic decision in which precautionary protection was decided in the fight against façade environmentalism by shifting the paradigm from the search for compensation to the prevention of damage. The company in question, Miko, was accused of having spread untrue sustainable information about its textile product, or rather, unverifiable on the content of recycled material. The order[78] saw the judge order the company to cease the dissemination of the following *claims*: "100% recyclable", "Reduction of energy consumption and CO2 emissions by 80%", "The first sustainable and recyclable microfiber", "Friend of the environment", "Natural choice" and "Ecological microfiber", as they were not verifiable.

Concluding considerations

The chapter highlighted that the fashion sector is not static, but dynamic, aimed at modifying central aspects, such as materials or the processes themselves, in order to adapt to the demands of modernity. In this sense, the use of new materials, increasingly less impactful, and the openness towards innovation, constitute important open doors to technologies such as artificial intelligence that can help in managing these changes and in offering increasingly complete services to customers. The following chapter will offer an overview of these services, highlighting their contribution within the production process.

[78] RG 2021/712

CHAPTER II
ARTIFICIAL INTELLIGENCE AND FASHION

Premise

Artificial intelligence is making huge contributions in every field and sector and fashion is no exception. Before analyzing the ways of using AI in the fashion sector, an overview of its potential and how it works will be provided. A description of recent uses in the fashion sector and the various advantages for consumers will follow.

2.1.Artificial Intelligence and its Application Areas

Artificial Intelligence (AI) is a new form of solution generation that combines computer science, mathematics, and neuroscience to create systems that can perform tasks that require “human intelligence.” These tasks include image recognition, language understanding, the ability to learn from data, solve complex problems, make decisions, and even adapt to situations in real time.

AI can be divided into two main categories: weak or *narrow AI.* which concerns systems designed to perform specific tasks, such as voice assistants or facial recognition, which are characterized by not having a "consciousness" or a general understanding of the world [79]. Strong AI or general AI is theoretical and is able to understand, learn and perform any human cognitive task that is currently being developed but is not yet accessible. Artificial intelligence uses techniques such as machine *learning*, *deep learning (deep neural networks) and fuzzy* logic algorithms to simulate human cognitive processes, making machines able to "learn" from data and improve over time. AI is rapidly spreading in many sectors, helping to improve efficiency, automation and personalization of various services but also in the production of material goods. In healthcare, for example, AI is used for various purposes, such as medical diagnosis , with algorithms used to analyze medical images (x-rays, MRIs) and recognize diseases, such as tumors, with a precision similar to or greater than that of humans. In Personalized Medicine, large amounts of genetic and medical data can be analyzed to provide personalized care for the patient; in Surgical

[79]Chowdhary KR, *Fundamentals of Artificial Intelligence*, Springer, 2020, p. 77.

Robotics, advanced systems such as the Da Vinci allow AI-assisted interventions, which are improving precision and reducing the risks of interventions. In the Automotive Sector , examples of applied AI can be seen in Autonomous Driving, such as those of Tesla that uses algorithms to interpret the surrounding environment, make real-time decisions and reduce accidents, while, in Predictive Maintenance , AI-based analysis helps prevent breakdowns and improve the efficiency of vehicles.
In Finance, Automated Trading is very popular, with AI algorithms analyzing huge amounts of market data and enabling trading decisions in milliseconds. In Fraud Detection, banks use AI to detect suspicious activity and prevent fraud in real time.
In Marketing, AI enables Personalized Advertising, through systems that analyze the behavior of online users to propose targeted ads and increase the conversion of need into demand.
Chatbots and virtual assistants use AI to answer customer questions, improving the user experience and reducing support costs, while in the entertainment and media sector, *AI* is used mainly for *streaming* and recommendations (services such as Netflix and Spotify use it to suggest content based on users' tastes and habits)[80]. In the fields of art, music and design, using tools capable of generating works of art, music tracks or even screenplays, AI is establishing itself internationally. The use of AI is also increasingly widespread in Industrial production, more precisely, in Automation. It is, in fact, widely used in robotics used in production, improving efficiency and reducing costs. As in the automotive sector, AI is also used to analyze data from industrial machines and prevent their failures. AI continues to evolve rapidly and is expected to have an even greater impact in the coming years in sectors such as advanced robotics, space exploration, precision agriculture.

2.2. AI in the fashion industry

The fashion cycle describes the process by which new styles and trends are created, adopted, and ultimately abandoned. In recent years, artificial intelligence has begun to play a significant role in all of the stages described, changing the way fashion is developed, produced, and consumed. In the phase of the introduction of the garment,

[80]Chowdhary KR, *Fundamentals of Artificial Intelligence*, cit., p. 79.

designers and fashion houses introduce new trends, styles or collections, usually through catwalks, fashion events or private *previews* highlighting innovation and often involving high-priced products with limited availability. In this phase AI can be used to help designers create new ideas or styles by analyzing millions of past models and proposing new combinations of materials, colors and shapes. Some AI software, such as Deep Learning or GANs (Generative Adversarial Networks), are among the most widely used systems today to generate innovative designs[81]. AI can also analyze data from social media, online searches and consumer purchases to predict which styles are likely to be successful (in practice, big data analysis tools allow you to identify emerging micro-trends). In the growth phase new styles start to gain popularity and the media, *influencers* and consumers talk about them and the demand gradually increases. AI helps companies develop personalized marketing strategies based on consumer behavioral data, algorithms can personalize advertising campaigns and suggest products individually, maximizing engagement *and* sales. AI technologies can also be used to create "virtual try-on" experiences where customers can see how certain garments or accessories will look on them using augmented reality (AR). In the maturity stage new styles reach their peak popularity, products become widely available in a range of outlets and at varying prices, and mass consumers adopt them. At this stage AI can be used to improve efficiency in production and distribution, by analyzing demand and market dynamics, algorithms can predict the optimal amount of product to produce and distribute, reducing waste and minimizing costs. AI is also used to automate different stages of production and logistics, from warehouse management to automation in fabric production. In the decline phase, which occurs after the period of maximum success, fashion trends begin to lose popularity, demand drops and prices tend to fall, while new styles begin to emerge and replace previous ones. AI can help in Product repositioning, helping brands identify new markets or segments in which to reposition products that are losing popularity. Data analysis algorithms can identify geographic areas or demographic groups where certain trends may still be successful. In addition, AI helps optimize the management of out-of-date

[81] Mola L., Russo I., Giangreco A. & Rossignoil C., *Who knows what? Reconfiguring the governance and the capabilities of the supply chain between physical and digital processes in the fashion industry, Production Planning & Control.* The Management of Operations, 2010, p. 11.

stocks, suggesting liquidation strategies or personalized discounts to reduce the remaining inventory. In the replacement phase, which occurs when new emerging trends spread, often in response to cultural, social or technological changes, the use of AI can be used to generate p review of new trends by analyzing historical, behavioral and social data. This, in short, allows designers to better anticipate changes in consumer preferences. AI can also promote more sustainable fashion, helping to reduce material waste and proposing circular solutions, such as transforming old garments into new ones through creative recycling or upcycling.

As described, AI is profoundly changing every phase of the fashion cycle, improving efficiency, creativity and personalization, from trend forecasting to *supply chain management,* it allows brands to quickly adapt to market changes and offer increasingly engaging experiences to consumers.

2.3.Tailoring and Artificial Intelligence

Tailoring is a function that refers to an artisanal use of skills being based on the experience gained and the *know-how* acquired over time, however, in recent years, AI has found an increasing use in the fashion sector, also revolutionizing the aspects described [82].

Designers can use AI algorithms to generate new design ideas, with AI analyzing past trends and consumer data to suggest patterns or even generate digital prototypes of clothes, complementing the creativity of tailoring, allowing artisans to explore new shapes and styles. Tailoring is a strong point in the creation of made-to-measure garments, and AI can be used to gather body information through 3D scanners or smartphone-based apps[83].

AI also analyzes the aesthetic preferences of the customer, proposing styles that suit their personal tastes, furthermore, by analyzing large amounts of data from social media, past sales and consumer behavior, it is able to formulate suitable proposals.

[82] Mola L., Russo I., Giangreco A. & Rossignoil C., *Who knows what? Reconfiguring the governance and the capabilities of the supply chain between physical and digital processes in the fashion industry, Production Planning & Control.* The Management of Operations , cit., p. 15.

[83] This allows you to create clothes that are perfectly tailored to your proportions without the need for multiple fittings.

This analytical capacity allows tailors and brands to anticipate emerging trends and prepare collections that respond to market demands. Large-scale tailoring can also benefit from automation and AI to improve production processes, for example, it can optimize the use of materials by reducing waste, suggest more efficient cutting methods or manage the supply chain more intelligently, making the process more sustainable and less expensive. AI combined with augmented or virtual reality technologies, allows tailors to create virtual prototypes of a garment, meaning that a customer can "try on" a dress in a virtual environment, visualizing how it will fit their body before it is even physically produced. High fashion brands and tailors can use chatbots and virtual assistants to improve customer interactions, recommending items, providing style suggestions, or personalizing shopping experiences based on users' preferences, AI analyzes behavioral and shopping data to create more engaging and tailored experiences. In short, AI in tailoring does not replace craftsmanship, but enhances it, helping tailors work more efficiently and innovatively, combining tradition with technology and creating a future in which tailoring craftsmanship is enriched by high-level digital tools.

2.4 The use of Big Data in the fashion industry

The use of big data in the fashion industry is profoundly transforming the way brands operate and make decisions by collecting and analyzing huge amounts of information from multiple sources, such as social media, e-commerce, IoT sensors, and sales data. Big data allows for trend prediction by analyzing user behavior patterns on social media, in particular, online searches and past sales, artificial intelligence and *machine learning* tools studying this data to accurately detect consumer preferences, habits, and comments, as well as to trace product weaknesses[84].

Data on purchasing behavior and preferences allows brands to offer a personalized shopping experience , which is achieved through the practice of companies using algorithms that suggest clothing or accessories based on the customer's tastes and purchasing habits (for example, e-commerce sites such as Amazon or Zalando use big

[84] For example, platforms like Edited and WGSN use big data to predict the most popular colors, styles, and materials in the coming months.

data to suggest products based on the purchase and search history detected). Thanks to the analysis of big data, retailers can also predict the demand for specific products, thus avoiding unexpected stock-outs or excess inventory, which allows for more efficient inventory management and a reduction in operating costs. Zara, for example, uses machine learning models to monitor sales data in real time, adapting production to consumer preferences in near real time. Furthermore, Brands are using their data to segment their audiences and create targeted marketing campaigns, analyzing demographic information, behaviors, and geographic data, and creating personalized advertising messages for specific groups of customers. Today, social media campaigns are almost always optimized by using information about consumer behavior to draw attention to specific products. Among other things, analyzing customer feedback on social media, product reviews, and sales data allows brands to improve the design and features of their products, meeting the demand detected, and also helps identify what consumers like most and what is perceived as less attractive[85]. Big data can also help monitor the supply chain, promoting the traceability of materials and ensuring more sustainable practices, introducing more transparency into the supply chain, an aspect that has become crucial for modern consumers, who are increasingly attentive to sustainability (some brands such as Patagonia use big data precisely to monitor resource consumption and reduce waste in production). Big data also enables the use of dynamic pricing models, which predict that prices will vary based on demand, seasonality, competition and other external factors. This allows brands to optimize prices to maximize sales and profits (many online fashion sites use dynamic pricing to change prices in real time based on consumer behavior, adjusting them in real time without waiting for price lists to change). In short, the use of big data in the fashion industry has revolutionized every aspect of the value chain, from design and production to sales and distribution. Today, the integration of advanced analytics associated with artificial intelligence allows brands to be more agile, innovative and able to adapt quickly to market changes, and in the future it is expected that their use will become increasingly central to anyone who wants to compete effectively in the global fashion market.

[85] Nike, for example, uses big data to gather information about customer tastes and create personalized garments, such as the Nike By You line.

2.5. Traceability through AI

The traceability of a product consists in the identification of all the phases that allowed its creation. With respect to the textile sector, in 2019 the Unece[86], the UN Economic Commission for Europe, developed a preparatory study *Textile 4Sdg* 12 dedicated to *Transparency in textile value chains in relation to the environmental, social and human health impacts of parts, components and production processes* in which the correct traceability is indicated.

The study highlighted the need to make the sector traceable and transparent, which is characterized by a larger than average size of the induced activity, an aspect that prevents the complete collection of information that presides over production. Thanks to new technologies, companies can track data regarding their compliance or employment using mobile devices, which helps to overcome the problem of the extension of the induced activity. Mobile devices, operating at various levels of the supply chain and being connected to each other, allow the identification of the product framework that guarantees transparency or precise knowledge of every aspect of the process.

Companies participating in the supply chain, among other things, should subscribe to *due diligence services* in which they allow third parties access to the processes, determining the possibility of detecting all the qualitative characteristics. Today it is possible to refer to specific internal KPIs (*Key Performance Indicators*) that denote the *performance* achieved by the system, these are indicators that are presented as percentages of impact achieved or consumption of resources[87].

The various KPI indicators refer to the individual phases of the process, making it possible to trace, with greater precision, the specific production implications as well as those responsible for the individual processes. The most well-known fashion *brands* tend to make their KPIs public by offering information about the phases monitored in their supply and processing chains.

IceBreaker, for example, provides, by placing a "barcode" on each product, the traceability of the processing of the merino wool of the garment up to the source, i.e.

[86] United Nations Economic Commission for Europe.
[87] Henninger CE, PJ Alevizou and CJ Oates, *What Is Sustainable Fashion?* cit., p.88.

the sheep farm. *Blockchain* can also be usefully used in the textile/clothing industry to guarantee the traceability of products from their origin, using a shareable system in which, in addition to negotiations, the salient aspects of the production process can be recorded. Furthermore, it is possible to trace the personnel who worked along the production chain, managing to trace those responsible for any critical issues encountered, in order to resolve them.

The traceability of garments through artificial intelligence (AI) represents a major innovation in the fashion and retail sector as it is possible to monitor every stage of the production of a garment, from the collection of raw materials to delivery to the end customer. AI algorithms, combined with sensors and technologies such as blockchain , can create a reliable and immutable traceability system, ensuring that every stage of the production process is recorded and verifiable. AI can thus help companies identify and evaluate the most sustainable and reliable suppliers, reducing the risks associated with unethical labor practices or non-compliant materials. Furthermore, through the analysis of data collected in real time from production sites (sensors, cameras, environmental detectors), it is possible to identify any violations of human rights or environmental issues.

AI can be used to verify the authenticity of materials used in clothing, especially for luxury brands trying to combat counterfeiting, while specific *machine learning algorithms* can analyze images or chemical data of fabrics to confirm their provenance and authenticity. A piece of clothing can be accompanied by a digital certificate that confirms its authenticity and sustainability throughout the production chain and AI can help meet this need in a very reliable way. In the sector, RFID (Radio-Frequency Identification) labels and IoT (Internet of Things) devices are complementary technologies to AI and serve to improve the traceability of garments simply by analyzing the data transmitted (from the aforementioned labels) to monitor in real time the status and position during transportation and distribution. Finally, AI algorithms can optimize the logistics process, monitoring warehouse stock and predicting the most efficient delivery times to reduce waste and delays[88].

[88]Henninger CE, PJ Alevizou and CJ Oates, *What Is Sustainable Fashion?* op. cit., p. 98.

2.6. Transparency and inventory management with AI

Fashion companies are facing increasing pressure to make their production process transparent and demonstrate their commitment to sustainable practices, and AI can play a crucial role in ensuring they meet sustainability requirements across their value chain.

AI, as mentioned, allows you to track the life cycle of a garment, from the moment of production to its eventual disposal or recycling, offering a complete view of the environmental impact of the product. Furthermore, through the use of apps or platforms that use it, consumers can be involved in the traceability process, allowing them to see exactly where the materials come from and where the garment they are purchasing was produced. Finally, AI, as anticipated, is a powerful tool for analyzing huge amounts of data, including customer preferences, past sales and social media trends, also to predict future fashion trends by helping the production process, as well as traceability, since companies can adapt their supply chain more efficiently and dynamically based on the needs expressed by the market[89].

In short, the introduction of AI in apparel traceability not only improves supply chain transparency and efficiency, but can also help companies reduce waste, improve sustainability, and combat counterfeiting. Finally, with the integration of other technologies such as blockchain, IoT, and RFID, AI has the potential to transform the entire fashion industry, making it more ethical and transparent for consumers and the environment[90].

2.7. Taking care of Sustainability in the Fashion Industry through Artificial Intelligence

The growing attention to environmental and social sustainability has led many factories, operating in various fields, to adopt innovative protocols and systems, or production models adapted to new consumer demands. This impulse has been motivated, among other things, by the expansion of markets in the global direction and

[89]Everlane brand has focused on "radical transparency" by leveraging technology to allow customers to see exactly where and how their clothes are made.

[90]Henninger CE, PJ Alevizou and CJ Oates, *What Is Sustainable Fashion?* op. cit., p. 99

the development of an increasingly aware demand. Globalization has required greater attention to the issue of sustainability also in consideration of the profound differences in production methods that have, in fact, imposed monitoring of the practices used in *supply chains*, adapting them to increasingly demanding ESG (Environmental, Social and Governance) regulations[91]. The acquisition of greater awareness by consumers has, instead, encouraged companies to share their needs from a reputational perspective. Among the sectors that have shown the greatest attention to the dynamics described is certainly the fashion sector (in general textiles/clothing). The entire luxury goods sector, which bases its *marketing* on *brand image*, seems to have responded to the required adjustments more incisively than others, which suggests that the cause of the change was due to opportunistic rather than ethical motivations[92]. Italy, known worldwide for its luxury and fashion industry, is among the countries most interested in this transformation, often proposing itself as *a leader* in the acquisition of innovative *know-how* concerning the acquisition of ESG protection tools.

The fashion sector, on a global level, causes significant impacts both because of its size and the production structure it has. It has recorded growth over the last twenty years that, globally, has been equal to average annual increases of +5.3%[93]. The growth in demand has occurred in conjunction with the acquisition of new notions of environmental culture by consumers, increasingly aware of the environmental and social impacts associated with production, to the point that fashion companies have begun to also ask their suppliers to ensure attention to the issue. In addition to ensuring that production activities are carried out with minimal impacts, companies operating in the fashion field have taken steps to publicize their initiatives, in the knowledge that their image will be strengthened.

In the search for the most suitable solutions, these companies have had to face many challenges, having to introduce concrete and distinctive actions, aimed at seizing the opportunities offered by a more careful attention to environmental and social aspects.

[91]Ciasullo, MV, S. Cardinali and S. Cosimato, *A Strenuous Path for Sustainable Supply Chains in the Footwear Industry: A Business Strategy Issue,* cit., pp. 143-162.

[92]On the topic of brand image: Jin BE, E. Cedrola and NL Kim, *Process Innovation: Hidden Secret to Success and Efficiency* . In Process Innovation in the Global Fashion Industry, edited by B. Jin and E. Cedrola. New York, Palgrave Macmillan, 2019

[93]https://fashionunited.it/statistics/statistiche-moda-italia

This attention is also demonstrated by the attribution of specific functions within the company to grasp the pressing needs and transform them into the most appropriate responses. *Risk management*, or the company perspective that aims to prevent problems in the business, has, in fact, made the new instances its own by participating in the search for solutions. These solutions have shaped the entire "value chain", through the introduction of new activities, measures and production protocols. In the textile/fashion sector, technological innovation and the progressive liberalization of international markets have also spread the use of the delocalization of some manufacturing phases to suppliers already operating in emerging economies characterized by less severe environmental and social regulations and, almost always, not subject to controls.

The *Nordic Fashion Council* (NFC) [94]has denounced that fashion is the second most polluting industry in the world, preceded only by oil (as we will see later, the transformation of materials is carried out in a particularly impactful way). Among the *brands that seem to have the greatest impact, fast fashion* houses stand out, presenting up to fifty-two collections a year, one for each week, putting pressure on suppliers, often forced to subcontract, thus creating a widespread production that is difficult to trace [95]. The environmental, social and ethical issues [96]that concern these activities have attracted the attention of the *mass media* to the point that even NGOs (Non-Governmental Organizations) have, on several occasions, denounced the lack of transparency of companies operating in the "fashion" sector.

The acquisition of the described awareness, combined with external pressures, explain, as has been said, the current commitment of the sector to follow a path of 'sustainability in fashion' which includes the adoption of "responsible management" models along the entire "value chain". It often happens that such commitments appear in the form of

[94] The Nordic Fashion Council is an association that shares a unique design heritage and craftsmanship tradition of Nordic countries. NFC has the potential to create competitive advantages and economic growth. Through NFC, the ten largest Nordic fashion organisations aim to intensify strategic cooperation across their regional and organisational borders to exploit the added value of collaborative action.
The main goal of the Nordic Joint Effort is to improve inter-Nordic cooperation to develop a stronger Nordic identity and global positioning, leading to increased export of Nordic fashion brands and products.

[95] Jin BE, E. Cedrola and NL Kim, *Process Innovation: Hidden Secret to Success and Efficiency* , cit., p. 77

[96] With particular attention to the use of animal products.

attention to "Quality" in its meaning of correctness of protocols and which is resolved with the certification of products and company management systems (ISO 14001 of 2015 and EMAS). Certification in the "fashion sector" has existed for decades but, with the growing attention to ESG aspects, it has been enriched with specific protocols addressed, that is, to the sector in a unique manner.

Among the most widespread *standards* in the fashion sector:

• *Oeko-Tex Standard 100* which regulates the production process considering the impacts caused by potentially dangerous substances;

• the '*STeP model'* which offers an analysis of production conditions with particular attention to *environmentally friendly technologies* ;

• the GOTS *Global Organic Textile Standard* which refers to the production of products of organic origin using independent certification bodies (in Italy ICEA) [97].

Among the "minor" *standards* , SA8000 (*Social Accountability*), which certifies social impacts, while the *Fairtrade Foundation assigns a brand to products that demonstrate specific requirements, such as having been obtained using contractual agreements with fair-trade producers. Among other initiatives, the Fair Cotton* logo is worth mentioning, which certifies the origin of the cotton used in the production process, while *Better Cotton Initiative*, a *non-profit organization*, has proposed initiatives to improve the conditions of workers employed in cotton production. *Bluesign* is, instead, a certification that attests that the production of fabrics is sustainable, guaranteeing the total absence of potentially dangerous substances from the initial stages of the production chain. Another type of sector certification is the C2C *Cradle 2 Cradl* , which guarantees the use of a circular economy throughout the entire value chain of the garment[98].

The analysis of the certifications issued highlights the prevalence of their adoption in the basic textile sector and in the production of clothing.

Often the certifications granted have only concerned the product, less frequently, the process adopted. Rarely, companies have thought of certifying the process in conjunction with the product.

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[97] http://www.global-standard.org/

[98] Battaglia M., Testa F., Bianchi L., Iraldo F. and Frey M., *Corporate Social Responsibility and Competitiveness within aspects of the Fashion Industry: Evidence from Italy and France* ", Sustainability, 2014, p. 78

In addition to certifications, which are mostly voluntary, the sector is also governed by European Regulations, such as REACH (EC) n.1907 of 2006 which is, to date, the most complete in this sense, defining some limits in terms of procedures and materials that can be used.

The diffusion of such protocols must also be acknowledged, as anticipated, by the initiatives of NGOs, including *Greenpeace* , which has published some 'reports' denouncing the use of dangerous chemical substances by these companies.

In particular, the Detox campaign in 2011 [99]and the 'Leaving Traces' of 2016 have focused their attention on the harmful use in the sector of perfluorinated chemicals (PFCs) particularly used in the production of sportswear, urging their reduction. Such pressures have pushed for change, in Italy, in particular, the 'Valentino' group has placed itself among the *leaders of the* change[100]. Another well-known initiative, ZDHC, *Zero Discharge of Hazardous Chemicals* has involved more than twenty global *brands*, which have coordinated to determine new environmental [101]performance *standards*. The National Chamber of Italian Fashion [102]has also conceived sustainability in the sector as a real priority, proposing rigorous standards for the protection of the environment and health. In general, all the initiatives described in the search for the most suitable solutions make use of the satisfaction of some priorities: elimination of environmental risks; minimizing/eliminating pollution and waste production; making the use of resources more efficient; introducing the traceability of the materials used.

Since 2012, there has been, among other things, a “Sustainability Manifesto for Italian Fashion” [103]which dictates the principles to be followed to ensure compliance with environmental standards in the production process.

This is a decalogue that commits the industries in the sector to respect the following points: DESIGN, inviting to design quality products that can last a long time and that minimize the impact on ecosystems; CHOICE OF RAW MATERIALS, suggesting

[99]Through this campaign, most brands were convinced to eliminate dangerous chemicals.
[100]http://www.greenpeace.org/international/en/campaigns/detox/fashion/detox-catwalk/#valentino
[101]http://www.roadmaptozero.com/
[102] The National Chamber of Italian Fashion is an association with the purpose of promoting and coordinating the sector as well as training young Italian stylists. The Chamber was founded in 1958 by SIAM - Italian High Fashion Union.
[103]Decalogue on social and environmental responsibility in the fashion sector, promoted by the National Chamber of Italian Fashion,

the use of raw materials, materials and fabrics with high environmental and social value; PROCESSING OF RAW MATERIALS AND PRODUCTION, committing to reduce the environmental and social impacts of activities and to recognize the contribution of each person to the value of the product; DISTRIBUTION, MARKETING AND SALES, supporting the need to include sustainability criteria along the entire path of the product to the customer; MANAGEMENT SYSTEMS, requesting to commit to the continuous improvement of company performance; FASHION AND COUNTRY SYSTEM, inviting to support the territory and Made in Italy; BUSINESS ETHICS with the integration of universal values in the brand; TRANSPARENCY, which is achieved by communicating to *stakeholders* , in a transparent way, the commitment to sustainability; EDUCATION, achievable through the promotion of ethics and sustainability among consumers and all other interlocutors.
Today, also following the diffusion of the various proposed principles, the "H&M Group", the "Inditex Group"[104], the "The GAP Group", and others, regularly publish their own Sustainability Reports, sharing the results with stakeholders.
The Reports in question provide that even the greenhouse gas emissions released during the processing of raw materials are evaluated in economic terms.
The brands that seem to adopt, with greater vigor, the initiatives described are the larger ones, among the most committed LVMH (Moet Hennessy Louis Vuitton SA), which has adopted the LIFE program with the aim of reducing emissions, 'taxing' them internally. The amounts obtained from the taxes calculated on emissions are reinvested in projects to improve performance in relation to environmental impacts.
"Ermenegildo Zegna", founded the Oasi Zegna[105]a natural park located in the Biella Alps, supporting initiatives aimed at respecting the environment, maintaining places and social education on greenery, while "Tod's" and "Benetton" stand out for their investments aimed at reducing the use of energy resources. ""Fendi" and "Brunello Cucinelli", in addition to adopting eco-compatible processes, regularly finance works aimed at safeguarding our cultural heritage.
AI is also a solution to the issues described, its integration in the fashion sector is having a significant impact on sustainability, helping to transform the industry in a

[104]Owner of several brands including "Zara" and "Massimo Dutti".
[105]The oasis was created with the patronage of the FAI.

more responsible and environmentally friendly way. Fashion, as seen in the first chapter, traditionally associated with waste and pollution, is benefiting from AI-driven innovations that are concretely reducing negative impacts along the entire production chain. AI can be used to improve supply chain management, reducing overproduction and waste of materials, for example, the machine learning algorithms mentioned analyze historical data and trends to accurately predict demand, and this allows companies to produce only what is really needed, thus reducing unsold stock and the amount of fabrics that end up in landfill.

AI can also automate and improve design processes, allowing for the creation of custom-made garments, enabling more efficient production and reducing product returns, a common problem in the e-commerce sector that impacts the environment. In addition, AI-based platforms can suggest more sustainable materials and manufacturing processes with a lower environmental impact, optimizing the life cycle of the product. AI can also help promote the circular economy in the fashion sector, promoting the recycling and reuse of materials, as advanced image recognition and data analysis systems can classify fabrics and indicate the best recycling methods for each garment, facilitating the management of recovery and reuse programs for used clothing and helping to reduce dependence on virgin raw materials. Through AI, as widely illustrated, companies can monitor and track each stage of the supply chain in real time. Data analytics technologies, combined with blockchain, offer the possibility of verifying the provenance and sustainability of materials used, allowing consumers to make more informed choices and rewarding brands that follow ethical and sustainable practices. Thanks to big data analysis, AI is able to identify emerging trends before they become popular, allowing companies to design and produce garments in line with real market demand, reducing the need to liquidate large quantities of excess merchandise, often disposed of unsustainably[106]. Digital fashion, enabled by AI, is also emerging as a promising trend to reduce the environmental impact of the industry. Instead of creating physical prototypes of clothes for collections, designers can use digital simulation tools to create virtual samples, thus reducing the consumption of materials, minimizing the energy used to produce

[106] D'Avolio, Romeo E. Bandinelli R., Rinaldi R., *Towards PLM maturity assessment in the fashion industry,* cit., p. 18.

garments that may never make it to the market. E-commerce platforms that use AI to recommend sizes, patterns and styles to customers based on their past preferences and physical characteristics can help reduce the number of returns, which are a major source of waste in the online fashion industry, as many returned items are not resold and end up being discarded. AI can also improve working conditions in fashion factories by automating repetitive and laborious processes. While maintaining a focus on work ethics, the introduction of AI can reduce reliance on low-paid manual labor in difficult conditions, often prevalent in traditional fashion supply chains. Process automation can free workers from physically demanding and dangerous tasks, improving the quality of their jobs and workplace safety. However, it is crucial to ensure that it is accompanied by retraining programs for workers, so as to avoid job losses and promote a just transition[107]. Advanced analytics also allow the carbon footprint of each garment to be calculated, helping companies reduce CO2 emissions and adopt more ambitious climate goals. Artificial intelligence is therefore transforming the fashion industry towards more sustainable models, reducing waste, optimizing the use of resources and improving ethics along the supply chain. Although there are still challenges to be faced, such as the need to integrate these technologies on a large scale and to ensure that the transition to AI does not compromise employment, technological advances are bringing tangible benefits.

2.8. Brands that adopt AI

Several fashion brands are integrating artificial intelligence (AI) into their creative, production and marketing processes mainly to innovate and improve operational efficiency. Gucci uses it to analyze consumer data and create personalized experiences both in-store and online, for example, using *machine learning technologies* to predict customer preferences and offer personalized recommendations.

Gucci has also experimented with the use of AI and augmented reality (AR) to create virtual fashion shows and immersive content for customers. Nike uses AI to improve product design, especially for the development of innovative footwear, through data

[107] AI can be used to monitor environmental impacts throughout the supply chain, providing real-time data on resource consumption such as water and energy, and enabling companies to adopt strategies to reduce waste and optimize resource use.

analysis, it can predict trends and improve the *sneaker creation process.* Nike has developed the *Nike Fit app*, which uses AI to analyze the shape of users' feet and recommend the perfect shoe size, improving the online shopping experience.

The Inditex group, which includes the Zara brand, uses AI algorithms to optimize inventory management and reduce waste, thanks to the analysis of real-time sales data, it can quickly adapt the production and distribution of items. In addition, Zara uses AI to analyze market trends and quickly adapt collections to consumer demands. The brand Tommy Hilfiger has partnered with IBM and the Fashion Institute of Technology (FIT) to create the *Reimagine Retail initiative,* using AI to analyze global trend data and inspire new collections. This involves analyzing images, colors, and patterns that influence the design of garments. Louis Vuitton uses AI tools to analyze shopping behaviors and improve customer experiences, and has also implemented chatbots for customer service and real-time request management. AI helps personalize products based on consumer preferences by offering tailored options through digital platforms. Burberry uses AI-powered chatbots to offer personalized customer service, improving online and in-store interactions, and uses algorithms to optimize digital marketing campaigns, personalizing content and ads for customers based on their preferences and behaviors. Stitch Fix, a subscription-based clothing service, relies entirely on AI algorithms to offer personalized recommendations to customers, and analyzes data on style preferences, measurements, and feedback to send clothing items specifically chosen for each customer. Levi's uses AI to offer jeans customization services, allowing customers to choose personalized sizes and details, and also analyzes consumer data to adapt production to emerging preferences. Chanel uses AI to improve the customer experience in its stores and online, using intelligent chatbots that offer style and product recommendations based on what the user has previously viewed or purchased. AI analyzes massive amounts of data from social media, runways, past sales and weather forecasts to predict future trends, helping to reduce waste and improve sustainability through optimizing supply chains and on-demand production. Chanel's AI enables the brand to offer more engaging and personalized shopping experiences, both online and in physical stores.

Concluding considerations

The analysis highlighted that, even in the fashion sector, artificial intelligence has taken hold on a par with other areas, contributing to bringing advantages both in production and distribution and in various sales services. The dominant aspect seems to be the one inherent in the search for adherence between offers and market tastes, but also the one relating to warehouse management and correct traceability of products, an aspect considered very sensitive. What emerged is that the quality of the item of clothing does not seem to be affected by the use of artificial intelligence, on the contrary, it can even benefit from it. The following chapter offers a starting point for verifying how artificial intelligence contributes to facilitating the management of very well-known companies such as H&M, an internationally widespread brand that has been using it for a few years.

CHAPTER III

H & M AND THE USE OF ARTIFICIAL INTELLIGENCE

Premise

The chapter describes H&M's activity and the areas in which artificial intelligence is used. In the following chapter, we aim to verify whether the analysis carried out is confirmed. H&M is a brand that adopts artificial intelligence in a widespread manner and this will allow us to verify the different ways in which it can be adapted to the fashion sector, answering the question initially posed about its concrete application.

3.1.The H&M company

H&M is one of the world's largest fashion chains, known for its trendy, fashionable and affordable clothing. H&M was founded in 1947 in Sweden, when Erling Persson opened the first store called Hennes , which means "for her" in Swedish, with the initial idea of selling women's clothing at affordable prices. The first store was located in Västerås, a Swedish city, and was an immediate success thanks to the innovative concept of low-cost fashion. In 1968, Persson purchased a hunting and sports equipment store called Mauritz Widforss, marking the beginning of the sale of men's clothing as well, changing the name of the company to Hennes & Mauritz (hence the name H&M).

In the 1970s and 1980s, H&M began to expand outside of Sweden, opening stores in other European countries, including Denmark, Norway, and the United Kingdom. During this time, the company also introduced children's clothing lines. From the 2000s onwards, H&M accelerated its international expansion, entering the US market and several other countries[108]. Its limited and affordable collections quickly attracted huge crowds, establishing H&M as an innovative fashion company that caters to all budgets. In 2010, H&M began to focus more on sustainability, introducing programs such as the "Conscious Collection," made from sustainable materials, and the clothing

[108] The company became famous for its collaborations with high fashion designers, including Karl Lagerfeld, Stella McCartney, Versace, Balmain, Alexander Wang, and many others.

recycling program, which allows customers to drop off used clothing in stores for recycling. Today, H&M has thousands of stores around the world and a large online presence, and continues to evolve, trying to meet the challenges of the fast fashion market with a greater focus on sustainability and changing consumer habits. H&M has thus grown from a small Swedish women's clothing store to a global fashion giant, always evolving to remain relevant and competitive in the ever-changing market.
H&M uses external manufacturers to make its garments but does so by agreeing on aspects related to the cut, colors, materials and by adopting AI at a group level.

3.1.1 Artificial intelligence at H&M

H&M has, in recent years, begun to integrate artificial intelligence (AI) into various aspects of its business. It is used to optimize business processes, improve operational efficiency and offer a more personalized shopping experience to customers.
H&M AI is also used across the board, i.e. in various operational functions. The specific use is as follows.

3.1.2 AI in management

H&M uses AI algorithms to predict demand for specific items in different geographical locations, allowing the company to reduce waste, better manage inventory and improve product availability in stores and online. AI is used to analyze historical data and trends, allowing for more accurate sales forecasts, which helps H&M make more informed decisions about production and distribution. The AI program is based on trend observations divided into various geographical areas by analyzing aggregated demand collected in big data, specifying the variations that it has undergone over time. This data suggests both quantitative and qualitative variations, thus directing towards the type, color, material, size, etc. In this way, H&M can use AI to offer personalized product suggestions, based on real and current preferences and purchasing behavior demonstrated by consumers. This also translates into an advantage for those who buy by improving their online shopping experience and increasing the probability of conversion and loyalty of customers to the company. In some stores, H&M is experimenting with the use of AI technologies to improve operational efficiency, for

example, to monitor customer flow and optimize store layout or better manage checkout lines[109]. Some H&M stores are integrating the use of AI in fitting rooms to suggest complementary items based on the items the customer is trying on. The company has also introduced AI-powered chatbots to provide customer support, answer FAQs, help find products or manage orders and returns. In a company like H&M, the chatbot performs several functions to support business operations and customer service. First and *foremost*, it offers 24/7 Customer Service and Support, answering FAQs, providing online assistance and managing returns and refunds. A chatbot can provide quick answers to frequently asked questions about shipping, returns, product availability, company policies, etc., helping customers track their orders, change order details or resolve payment issues, and even guiding the process of returning purchased items or providing information on refund policies. It also offers personalized shopping advice, such as product recommendations and outfit suggestions. Chatbot can analyze user preferences and suggest clothing items based on their style, current collections or promotional offers, and in some cases, it can combine items to create complete outfits, improving the online shopping experience.
It also supports promotions and sales by providing information on discounts, special sales, new collections and exclusive offers. It also provides discount codes or personalized promotions based on the purchase behavior or history of the user both recorded. Chatbot takes care of, among other things, inventory management and product availability by checking the availability of a certain product in a specific store or recommending the closest store to the customer that has the desired item. If a product is not in stock, it notifies the user when it will be available again. Chatbot also lends itself to support internal logistics, in terms of monitoring internal processes and supply chain optimization. In particular, it is used to facilitate communication between employees on inventory levels, supplier management or internal delivery tracking, as well as to support logistics departments by providing real-time data or facilitating communications between teams. Thanks to the chatbot, H&M constantly collects feedback, improving its services by being able to ask customers to leave reviews on purchased products or on their online shopping experience and collect feedback directly from its customers after an interaction or purchase, helping the company

[109]H & M, *Annual and Sustainability Report* 2023.

improve its services. Chatbot is also used to answer candidates' questions or to filter CVs in the pre-selection phase, making the recruitment process more efficient[110].

3.1.3. AI in H&M Marketing and Sustainability

H&M also uses AI to segment customers and target more effective marketing campaigns. Shopping preferences, online behaviors, and responses to previous campaigns are used to create more targeted marketing and advertising strategies. As we have seen, the contribution to marketing also comes from the typical functions of AI to optimize production and distribution processes. In fact, by allowing the early identification of items that do not sell well, AI reduces overproduction. H&M is very committed to sustainability initiatives and also uses AI to improve its recycling practices. Through intelligent technologies, the company is able to more efficiently manage used clothing items that are returned to stores for recycling[111].

3.1.4 AI in H&M Design

H&M's AI, used to analyze customer feedback data and market trends, can also assist design teams in creating new collections that are more in line with consumer preferences. In practice, AI offers the company a faster path to adapt detected trends to tailoring formats. AI has enabled a design that proceeds in constantly monitored steps, which include suggestions for cutting, coloring, tailoring and the addition of specific accessories, based on what is extrapolated from big data. This reduces design times and adheres to consumer requests more precisely.

3.2. The benefits of using Artificial Intelligence

The creative process has been accelerated, being able to generate countless ideas and designs quickly, thanks to the simple analysis of past and present trends. This allows designers to save time in the conceptual phase, leaving more room for innovation and experimentation. Another advantage obtained thanks to the adoption of AI is found in

[110]H&M, *Annual and Sustainability Report* 2023.
[111]H&M, *Annual and Sustainability Report* 2023.

customization and made-to-measure design, benefits obtained thanks to the ability of AI to analyze individual data, making it possible to create personalized clothes based on the preferences and needs of individual customers. H&A's e-commerce platforms, for example, use AI to suggest custom clothes, improving the shopping experience and brand image. H&M's artificial intelligence is able to quickly analyze large amounts of data from social media, fashion shows and sales, identifying emerging trends, helping the brand to remain competitive and respond quickly to market demands. In the sustainable field, AI helps optimize production and reduce waste. Thanks to accurate forecasts of consumer demand, the company is able to produce only what is needed, containing the environmental impact. A significant benefit seen in the company has also concerned the optimization of the supply chain, being able to manage logistics and distribution more efficiently, monitoring production, shipments and material consumption. Over time, delivery times and operating costs have been reduced, improving the speed with which products reach the consumer. Regarding Virtual Prototyping and Simulations, through AI and augmented/virtual reality, H&M designers visualize and test their designs in virtual environments without the need to create physical prototypes, thus speeding up development and reducing costs. Another benefit has been the optimization of marketing as AI is helping the brand to personalize strategies, analyzing user data to offer targeted campaigns[112]. By creating smart clothes, H&M is developing garments that react to external stimuli such as temperature or body movements, merging fashion and technology. In general, H&M's AI can accurately predict sales trends and fashion cycles, helping to make more informed decisions about which garments to produce in large volumes and which to limit, as well as what quality requirements to ensure.

Concluding considerations

The chapter confirmed what was stated at a theoretical level, highlighting that artificial intelligence is a versatile and useful tool at a management level, reducing errors,

[112] The effectiveness of advertising campaigns has increased due to increased customer engagement.

promoting perfect adjustments of supply to demand and rationalizing warehouse management.

H&M can be considered a showcase of the future, given that the use of artificial intelligence now seems established and that the advantages drawn could constitute a starting point for the entire fashion sector.

Conclusions

The international fashion market is one of the most dynamic and growing sectors in the world. Globalization has led to the integration of different stylistic cultures, creating new opportunities and forms of consumption. Today, luxury brands such as Gucci, Chanel and Louis Vuitton continue to dominate the market, while “fast fashion” brands such as H&M and Zara are gaining market share with their ability to respond quickly to new trends. Compared to the past, the fashion market shows a growing attention towards ecology, pushing to invest in more sustainable practices. Furthermore, policies that promote diversity in terms of sizes, ethnicities and gender identity are being adopted and, with the advent of e-commerce and the increasingly massive presence on social media, fashion has also become digital, offering increasingly personalized shopping experiences.

The market is characterized by involving a very widespread induced sector, as demonstrated by the fashion supply chain, which is particularly complex and articulated, involving numerous players, from the production of raw materials (such as cotton, wool, polyester) to the creation of garments, up to their distribution and marketing (it can be divided into four main phases: production of raw materials, processing and production of fabrics, packaging and, finally, distribution and sale). The industry relies on a global network involving suppliers, producers and distributors, often with many phases carried out in different countries benefiting from low labor costs. The fashion supply chain is among the most polluting in the world, responsible for approximately 10% of global carbon emissions and consuming large quantities of water, especially in the fabric production phase. “Fast fashion” further contributes to this problem, producing low-cost but short-lived garments, which often end up in landfills after just one season. Sustainable fashion is emerging as a solution to the issues described, leading many brands to commit to reducing their environmental impact through practices such as recycling, the use of eco-friendly materials and the reduction of CO2 emissions. Innovations in the fashion supply chain are, in fact, revolutionizing the sector in terms of efficiency and sustainability. Some of the new sustainable business models include the rental of clothes, the resale of used garments

and recycling, reducing the demand for new products and, therefore, the environmental impact. Recently, research has also focused on innovative and sustainable materials, including fabrics derived from plants such as hemp or pineapple (Piñatex), as well as laboratory-made materials such as mycelium (a fungal structure similar to leather) or fabrics recycled from plastic bottles. Artificial intelligence (AI) is also spreading in the sector, functional to design, production and inventory management, thanks to machine learning algorithms that allow to predict trends, improve operational efficiency and optimize the supply chain. Thanks to AI, it is now possible to create custom-made clothes using software that analyzes the body and suggests perfect cuts and patterns for the customer, improving the fit and reducing fabric waste. Big data, on which AI is based, has become a crucial resource for all fashion brands, which use it to analyze customer behavior, predict trends and personalize shopping experiences (through data analysis, brands can better understand what consumers want and make more informed decisions about production and marketing). AI is also used to improve traceability in the supply chain, ensuring that the materials used come from sustainable sources, and blockchain-based systems allow consumers to verify the origin of the products they buy, ensuring transparency and authenticity. Many fashion brands are adopting AI to improve their operations, for example, Nike does it to analyze customer data and improve future collections, while Zara uses machine learning algorithms to optimize inventory management. H&M uses it at various stages. The company uses external manufacturers to produce its garments and has created a management network that uses AI at various stages. H&M is one of the world's leading fast fashion companies, with a global presence and a strong focus on sustainability. The Swedish company stands out for its ability to offer accessible and up-to-date fashion, thanks to a highly efficient supply chain. H&M uses AI both for inventory management and to improve its supply chain using algorithms that analyze previous sales, current demand and other variables to determine the optimal quantity and styles to produce. AI is also used in H&M's marketing campaigns to create personalized experiences for customers. By analyzing consumer data, AI allows H&M to send targeted purchase recommendations, improving conversion rates and customer satisfaction, and, in terms of sustainability, to monitor the use of sustainable materials and implement greener production practices. AI also supports H&M designers, analyzing global trends and

suggesting new designs and styles based on data collected from social media, sales, and fashion forecasts. AI combined with augmented or virtual reality technologies allows tailors to create virtual prototypes by having the customer “try on” a dress in a virtual environment, so they can visualize how it will fit their body before it is physically produced.

In short, the paper has shown how AI has also entered sectors strongly linked to the artisan tradition, suggesting cuts, colors, shapes, materials, accessories in order to direct towards solutions more suited to market demands, avoiding waste. In short, the paper has shown that even tailoring, a traditionally artisan sector, has received help from AI which, through specific algorithms, allows to guide the cut, create the shapes, make the seams, attach the accessories, etc.

The work has highlighted that the fashion market is characterized by trends that are constantly changing not only in terms of silos but also in terms of operational management methods and materials used. The fashion supply chain highlights the existence of various phases that begin with the choice of materials and continue with production, distribution, retail and waste management. There is an increasingly widespread focus on the environmental impacts of fashion, or the ecological consequences of the industry. In recent years, new sustainable business models and innovative materials have spread, as well as the use of artificial intelligence. AI in fashion can be used for customization and tailoring, the use of Big Data to optimize the sector, traceability and transparency management, and the promotion of sustainability. The paper has offered an empirical case, that of H&M, which uses it for its business management, in marketing and sustainability and in Design. In consideration of the advantages derived from its use, the conclusions that can be drawn from the paper lie in the expectation that the entire sector will equip itself with the artificial intelligence tool without any impact on the quality of the products.

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Bibliography

Alan T. L. Chan, Eric W. T. Ngai, Karen K. L. Moon, *The effects of strategic and manufacturing flexibilities and supply chain agility on firm performance in the fashion industr*y European Journal of Operational Research, 2016

Battaglia M., Testa F., Bianchi L., Iraldo F. e Frey M., *Corporate Social Responsibility and Competitiveness within smes of the Fashion Industry: Evidence from Italy and France*", Sustainability, 2014

Boer H. e W.E. During, *Innovation, What Innovation? A Comparison Between Product, Process and Organizational Innovation.* International Journal of Technology Management 22, n. 1-3, 2016

Cedrola, E. e L. Battaglia, *Country-of-Origin Effect and Firm Reputation Influence in Business-to-Business Markets with High Cultural Distance*, Journal of Global Scholars of Marketing Science 23, n. 4, 2013

Cedrola, E. e L. Trabaldo Togna, *Eccellenze italiane. Internazionalizzazione ed ecosostenibilità del distretto tessile Biellese*, Milano.Trino, 2020

Cedrola, E., L. Battaglia e A.G. Quaranta, *International Entrepreneurship and Performance: What Are the Important Factors in Markets with High Cultural Distance*? *In The Changing Global Economy and Its Impact on International Entrepreneurship,* a cura di H. Etemad, S. Denicolai, B. Hagen e A. Zucchella. Cheltenham: Edward Elgar Publishing Limited, 2016

Chowdhary K.R., *Fundamentals of Artificial Intelligence*, Springer, 2020

Ciasullo, M.V., S. Cardinali e S. Cosimato, *A Strenuous Path for Sustainable Supply Chains in the Footwear Industry: A Business Strategy Issue,* Journal of Global Fashion Marketing, Taylor & Francis Journals, vol. 8(2), 2017

Coviello M., *Figure Retoriche & Pubblicità*, F. Angeli ed., Bologna, 2009

D'Avolio, Romeo E. Bandinelli R., Rinaldi R**.,** *Towards PLM maturity assessment in the fashion industry,* XX Summer School "Francesco Turco", Industrial Systems Engineering, 2016

De Brito, M.P., V. Carbone e C. Meunier Blanquart, *Towards a Sustainable Fashion Retail Supply Chain in Europe, Organisation and Performance*. International Journal of Production Economics 114, n. 2, 2008
Denicolai S., *Economia e management dell'innovazione. Governo e intermediazione della conoscenza come leva di competitività*, Bologna, 2020

Di Tullio, P., D. Valentinetti e M.A. Rea, T*he Competitiveness of Firms through the Sustainable Business Model: A Decade of Research*, L'industria, Rivista di economia e politica industriale 39, n. 3, 2018

Feng T., L. Su C. Zhu e A.S. Sohal*, Customer Orientation for Decreasing Time-To Market of New Products: It Implementation as a Complementary Asset*. in Industrial Marketing Management, 2012

Foglio A., *Il marketing della moda*, Milano, 2001

Frisa M, Frisa M.L., *Il bello e il buono. Le ragioni della moda sostenibile. Venezia*, Marsilio, 2011

Gherardini A. e Pessina G., *Cavalcare l'onda del cambiamento. Il Piano Impresa 4.0 alla prova dei distretti*. L'industria, Rivista di economia e politica industriale 41, n. 2, 2020

H & M, *Annual and Sustainability Report* 2023.

Henninger C.E., P.J. Alevizou e C.J. Oates, *What Is Sustainable Fashion?*.Journal of Fashion Marketing and Management, n. 4, 2016

Jin B.E., E. Cedrola e N.L. Kim, *Process Innovation: Hidden Secret to Success and Efficiency*. In Process Innovation in the Global Fashion Industry, a cura di B. Jin e E. Cedrola. New York, Palgrave Macmillan, 2019

Lee M.Y. e J. Sung, *Sustainability and Management in Fashion, Design and Culture*. Journal of Global Fashion Marketing 7, n. 2, 2016

Lion A., L. Macchion, P. Danese e A. Vinelli, S*ustainability Approaches within the Fashion Industry: The Supplier Perspective*. Supply Chain Forum, An International Journal 17, n. 2, 2016

Marchi G., *Conoscenza di mercato per l'innovazione di prodotto. I percorsi delle imprese moda tra creatività e marketing*, Bologna, 2008

Mola L., Russo I., Giangreco A. & Rossignoil C., *Who knows what? Reconfiguring the governance and the capabilities of the supply chain between physical and digital processes in the fashion industry, Production Planning & Control.* The Management of Operations*,* 2010

Montera R., *L'internazionalizzazione sostenibile delle imprese multinazionali: Mito o realtà?,* L'industria, Rivista di economia e politica industriale 37, n. 1, 2016

Reinach S, *Un mondo di mode. Il vestire globalizzato*, Roma-Bari, 2011

Saviolo S. e Testa S., *Le imprese del sistema moda*, Rizzoli ed., Milano, 2013

Segre Reinach S., *Un mondo di mode. Il vestire globalizzato*, Laterza-Bari, 2011

Silvestre, B.S. e D.M. T, îrcaˇ*, Innovations for Sustainable Development: Moving toward a Sustainable Future,* Journal of cleaner production, 2019

Simone C., L*a resource based view e la knowledged based view. Dall'ottica atomistica a quella interazionedale*, Aracne ed., 2004

Volpato G., *Il knowledege management come strumento di vantaggio competitivo. Un confronto intersettoriale*, Carocci ed., Roma, 2007