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Towards Sustainable Fashion: The Role of Artificial Intelligence — H&M, Stella McCartney, Farfetch, Moosejaw: A Multiple Case Study

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Abstract

Throughout history, technology has undoubtedly changed many aspects of humanity, and more recently, artificial intelligence has certainly created a significant impact on people, industry and the planet. Parallelly, there is another factor which affects Earth and people lives: the harmful footprint that is generated within the whole fashion system. From production to consumption, fashion creates a vicious cycle where unsustainable behaviours are repeatedly practised. On the other hand, an increasing concern is rising about these kinds of damaging approaches, demanding for a more sustainable fashion system. In this scenario, could artificial intelligence have a role in building a sustainable fashion system? This essay tries to answer this question examining how artificial intelligence can be implemented to gain sustainable solutions within the fashion production and consumption. More specifically, the research is developed through the multiple case study methodology. For this reason, four fashion brand cases are analysed in order to underline the sustainable benefits gained from each strategy: H&M, Stella McCartney, Farfetch, Moosejaw.

Keywords: Sustainable; Fashion; Artificial Intelligence; Technology; Case Study.

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Introduction

Artificial intelligence (AI) and sustainability are two topics which became highly popular within society. AI turned out to be part of consumers' daily life, representing an essential instrument for industries and customers, thanks to its ability to ease decisions and simplify economic processes. Parallelly, sustainability is an urgent need that governmental organisations, industries, and society are trying to implement and reach.

Indeed, one of the industry sectors which aspires to embrace the concept of "sustainability" is the fashion industry. Surveys and market research followed one another in recent years: a clear sign that the attention about sustainable fashion is increasing in the whole society.

In January 2019, the multinational professional services network KPMG released a market research which investigated the relationship between people and sustainable fashion: the "Sustainable fashion-A survey on global perspectives". The study was carried out in Hong Kong, London, New York, Shanghai and Tokyo, with at least 1.000 people polled in each city. Even if the survey underlines differences in consumers' perception regarding the topic, it shows an evident interest in sustainability. The percentages of respondents who declared to support sustainable fashion were as follow: in Tokyo 49%, 55% in New York, 54% in London, 71% in Hong Kong, and 90% in Shanghai.[1]

Along with KPMG, also McKinsey has certainly conducted one of the recent and most relevant questionnaires. In 2020, the American management consulting firm disclosed data collected from 6.000 participants: English, French, Spanish and German consumers. 16% of them desire to see products with sustainable credentials, 20% believe this year they will spend less than their average annual expenses, and 45% would have a more positive perception for those fashion businesses that communicate profound values rather than low, convenient prices.[2]

However, despite this emerging attention towards sustainability, the fashion system is still unprepared and unsustainable from any points of view. Nevertheless, in this contemporary scenario, AI can have a crucial role in creating a more sustainable fashion system. Indeed, when AI is used to realise a more noble purpose within sustainable approaches in the fashion industry, it achieves one of the most valuable applications of itself.

AI has different definitions, and the scholars Kok, Boers, Kosters, and Van Der Putten[3] underlined the multidimensional concept of this technology. One of them categorises AI as a field within computer science, which is able to replicate human-like thoughts, optimising them in the learning process and self-correction. Another identification of AI is the capability of the machine to improve their learning, self-correction process, etc., emulating human intelligence. AI is also defined as "an extension" of human intelligence through the use of the computer. In the technical language, it is the study that aims to create more efficient use of computers by improved programming techniques. These definitions identify AI as a computer system which can act and reason like humans.

It is possible to classify AI in five categories based on different adoption of technology: machine learning, decision support system, expert system, optimisation, and image recognition and vision.[4] Each of these categories has the potential to increase efficiency and sustainability within the fashion supply chain. Machine learning is used to forecast, understanding future sales, colour and demand, but also predicting fabric behaviour using mechanical properties and detecting possible fabric defects. Decision

1. Felix Chung Kwok-pan, Zhang Huifeng and Pat Woo, "Sustainable fashion-A survey on global perspectives", *KPMG* (January 2019): 1.

2. Brooke Roberts-Islam, "Social Sustainability, Overstock And 'Greenwashing': How COVID-19 Is Changing The Fashion Industry", *Forbes*, (July 06, 2020), https://www.forbes.com/sites/brookerobertsislam/2020/04/21/social-sustainability-overstock-and-greenwashing-how-covid-19-is-changing-the-fashion-industry/.

3. Joost Nico Kok, Egbert J. Boers, Walter A. Kosters and Peter Van der Putten, "Artificial intelligence: definition, trends, techniques, and cases" in *Artificial intelligence*, ed. Joost Nico Kok, (Oxford, UK: Eolss, 2009), 1–21.

4. Chandadevi Giri, Sheenam Jain, Xianyi Zeng and Pascal Bruniaux. "A Detailed Review of Artificial Intelligence Applied in the Fashion and Apparel Industry". *IEEE Access*, vol. 7, (July, 2019) :95381, doi: 10.1109/access.2019.2928979.

support system optimises the decision-making process concerning fashion managerial strategy, pursuing the main objective to reduce the overall cost and increase efficiency in the fashion supply chain.

The expert system can work without human intervention, and it results implemented in fashion manufacturing and production for reducing pollution, choosing the right processes and resources to decrease the environmental impact. The expert system also aims to reinforce customers' satisfaction building recommendation engine in fashion retailing.

Evolutionary algorithms are one form of optimisation search, and one type substantially used in the fashion industry are genetic algorithms. These resolve scheduling and design layout issue related, and it is additionally applied to improve the fitting service.

Besides, the fashion industry utilises image recognition and vision to automate different industrial applications such as inspection or process control, but it is extensively used for content-based image retrieval system, virtual try-on and augmented reality.

The afore mentioned classification of areas of action regarding AI is then developed through specific techniques and methods, which the most popular implemented within the fashion industry result to be the genetic algorithm, artificial neural network and fuzzy logic for predictions, evaluation and forecasting.[5]

It is highly evident how AI is indeed performing an outstanding and conspicuous presence within the fashion system, and it is not tricky understanding the crucial potential and impact that it can have in terms of sustainable practices. From decision making concerning production system to customers' communication, AI can shape a new and more responsible fashion era, where design, production and customers search for the same value: sustainability.

Understanding what AI is and what it can do, there is a shred of undoubted evidence that AI can be an efficient tool to fight unsustainable practices in the fashion industry.

Indeed, there are emerging cases where AI is a well-grounded positive technological support which enables fashion to be more sustainable. The application can start from the source of the raw materials to the whole supply chain system, until the interaction with consumers.

For example, in recent years, H&M invested widely in AI to reduce the overstocking. In this case, AI enables H&M to forecast demand and trends, drastically reducing the amount of unsold clothing that would end up in a landfill.[6]

Even the well-known luxury fashion brand Stella McCartney, famous also for its commitment to sustainability, started to recognise the powerful impact that AI can have on fashion. Indeed, in 2019 Stella McCartney partnered with Google, focusing together on one big issue: the environmental impact of cotton and viscose. On June 10 2020, Google also began another collaboration with WWF Sweden with the hope and goal to create an environmental data platform, to improve more circular and sustainable supply chain decision. The focus of this new cooperation is specifically on textile raw materials.[7]

Furthermore, the usefulness of AI is disclosed when the data are gathered and shared among consumers who check fashion products: it is the case of Farfetch. The latter is an online luxury fashion platform which informs online users about the footprint of fashion products. This technological approach allows consumers to be aware of the environmental impact that is generated by the fashion industry.

5. Giri, 95383-95384, 95388.

6. Emma Thomasson and Anna Ringstrom. "Back on-trend? H&M makes AI, loyalty drive to ride fashion cycle", Reuters, (April 17, 2019), https://www.reuters.com/article/us-h-m-strategy-ai/back-on-trend-hm-makes-ai-loyalty-drive-to-ride-fashion-cycle-idUSKCN1RT1U7.

7. Google Cloud, "WWF and Google Partner", Google Cloud, (June 10, 2020), https://cloud.google.com/press-releases/2020/0610/wwfandgoogle.

Instead, the harmful clothing returns from online purchases are tackled by the outdoor recreation company apparel and gear for activities like rock climbing, snowboarding, camping and hiking Moosejaw. AI can reduce drastically returns, avoiding all its collateral environmental impact.

In this essay, therefore, there will be a focus on sustainable fashion, AI and examples of how AI can strengthen sustainability within the fashion system. The aim is to show and explain realistic and concrete solutions which could, if implemented correctly, improve the fashion industry, driving it towards a less harmful product life cycle.

Sustainable Fashion & Artificial Intelligence: Research Objectives and Methodology

The objective of this article is to analyse and evaluate four different fashion companies that, to practice sustainability, are implementing AI. Questioning various methods of AI applications, new and innovative strategies are revealed, underling the effects.

The research is developed using the case study analysis, examining different and heterogeneous sources, such as reports, the official companies' websites, academic journals, books and periodicals. The case study analysis allows researchers to have a holistic understanding of complex phenomena[8] and to build a structural analysis that explains the "why" and "how" of particular circumstances.[9] Specifically, this article is built using the multiple case study methodology, which enables the researcher to analyse data and phenomena within single cases and across situations, evaluating the significance of findings. Another strong advantage of multiple case study is that different analysis of several realities can reinforce empirical evidence for a more convincing theory.[10]

In particular, this research aims to underlying specific unsustainable issues related to the fashion industry and their harmful consequences. Subsequently, it is explained how some companies shaped AI tools in order to improve the fashion system, gaining sustainable practices. Adopting this strategy of analysis it is possible to have a clear and comprehensive view of how fashion companies are reacting to fashion sustainable issues, and how much AI can be effective in helping them to transform their traditional business models to innovative and more sustainable ones.

H&M Case — Unsustainable Practices & Unsold Clothing: Circular Design and Forecast Demand

Among fast fashion brands, H&M started to pragmatically focus its attention on AI during 2018 when it created an AI department in the company. The innovative section has the goal to help H&M to implement more sustainable business decisions, and from then until now it is studying and building new AI strategies to gain sustainability in H&M, with particular regard for the design and production process.[11]

In fact, one determinant aspect of fashion sustainability lays in the product design and how it is made. The supply chain is developed into different stages for production, distribution, use and end-of-life management of the energy-related product.These phases often inevitably do not consider waste generation, irresponsible resources consumption and use of nocive substances. For example, the design phase of a product is one of the foremost decisive for its environmental impact, which amounts to over 80%

8. Kahirul Baharein MohdNoor, "Case Study: A Strategic Research Methodology", *American Journal of Applied Sciences*, vol. 5, (2008): 1602.

9. Leonard-Barton, Dorothy. "A Dual Methodology for Case Studies: Synergistic Use of a Longitudinal Single Site with Replicated Multiple Sites". *Organization Science,* vol.1, (August, 1990): 248–266.

10. Gustafsson, Johanna, *Single Case Studies vs. Multiple Case Studies*, (Halmstad, Sweden: Halmstad University, 2017), 3.

11. H&M. "Sustainability Report", 2018, 1–109.

of all product-related environmental footprint.[12] The Swedish company H&M seems to be aware of this issue, stating that it is creating standardised circular principles to apply during the design process. Circularity principles, in this case, are developed through the use of AI, data analysis programmes and 3D visualisation. These *miscellanea* of technologies help to reduce production waste, save materials, time and energy through the design process. H&M stated that its main sustainable purpose is to create products with quality and durability, using safe chemical input, evaluating materials and production processes, and AI is seen as a valuable tool for reaching this goal.[13]

Along with the supply chain's environmental impact, another worrying issue is the overstock that too often leads to the so-called "deadstock". Frequently, fashion companies burn their unsold product: in 2017 Burberry burnt clothing worth £28.6 million, and the BBC reported that from 2013 to 2017 the company destroyed products with a total value of £90 million.[14] Burberry justified it stating that the energy generated from its burning practice was capture, considering the act environmentally friendly. However, in September 2018, Burberry declared that it ceased burning stock immediately, and it would instead donate, repair, reuse or recycle unsold stock.[15] In 2017 also H&M ended up with being in the spotlight: a Danish tv, Operation X, alleged that the company had been accused of burning 12 tonnes of unsold but usable clothes. In the same year, Bloomberg as well reported that H&M was destroying discarded clothing with recycled wood and trash in the city of Västerås, as part of the project to help a Swedish power plant to convert from oil- and coal-fired generation, to become a fossil fuel-free facility by 2020. H&M, in its defence, declared to Forbes that rarely the company destroys clothing, assuring that it is always the last option and only for those garments that cannot be reused or recycled.[16]

These are only two of the foremost famous example of burning unsold overstock clothing over the last decade, but beyond the reasons that push fashion companies to burn their products, there are significant environmental drawbacks of incinerating garments. As reported by the UK House of Commons Environmental Audit Committee's in February 2019, even if the incineration of unsold stock recovers some energy from the product, it inevitably worsens the climate impact of the item, generating further emissions and air pollutants. Plastic microfibres may be released in the atmosphere from burning synthetic clothes, and the CO_2 emissions of a product would be doubled if generated not only during its production, but also from its destruction. Hence, the UK Committee suggested and encouraged instead reuse and recycling practices, and governmental ban of burning or landfilling unsold stock that can be reused or recycled.[17]

Therefore, given these downsides of destroying unsold clothing, usually, there are different solutions suggested: governmental bans, recycling, reusing, repair. However, AI can even empower fashion companies to reduce and minimise unsold clothing through forecasting demand. In the case of H&M, it uses predictive AI tools to match demand with production, as accurately as possible. Data analytics allows placing the right product at the right place at the right time with an accurate forecast, avoiding unsustainable overproduction and rationalising resources.[18]

12. EU Science Hub - European Commission, "Sustainable Product Policy", EU Science Hub - European Commission, (December 13, 2018), https://ec.europa.eu/jrc/en/research-topic/sustainable-product-policy.

13. H&M. "Sustainability Report", 2019, 38.

14. BBC, "Burberry burns bags, clothes and perfume worth millions", BBC, (July 19, 2018), https://www.bbc.com/news/business-44885983.

15. Elizabeth Paton, "Burberry to Stop Burning Clothing and Other Goods It Can't Sell", The New York Times, (September 06, 2018), https://www.nytimes.com/2018/09/06/business/burberry-burning-unsold-stock.html.

16. Heather Farmbrough, "H&M Is Pushing Sustainability Hard, But Not Everyone Is Convinced", Forbes, (April 14, 2018), https://www.forbes.com/sites/heatherfarmbrough/2018/04/14/hm-is-pushing-sustainability-hard-but-not-everyone-is-convinced/.

17. House of Commons Environmental Audit Committee. "Fixing Fashion: Clothing consumption and sustainability". UK, London, 2019.

18. Alison Clements, "H&M puts AI forecasting at the heart of its supply chain sustainability", Retail Connections (January 31, 2020), https://www.retailconnections.co.uk/articles/hm-puts-ai-forecasting-at-the-heart-of-its-supply-chain-sustainability/.

The risk of having overstocked products is drastically reduced aligning demand with supply chain, because AI calculates the probability to sell a product rather than another one, and, with this strategy, it is possible not only to avoid unsold items, but also to invest and consume only the necessary amount of energy and other sources that are needed. Hence, integrating AI, H&M is able to maximise the probability of a product to be sold, eliminating useless and damaging waste. Indeed, overall stock amounts and prediction errors can be reduced respectively to 20–50% and 50% through AI.[19]

In this case, the fact that fast fashion is one of the most harmful fashion business models on the planet, the necessity of finding new and highly efficient methods to reduce its impact is urgent more than ever, and AI is demonstrating to be consistent and effective in this context.

Stella McCartney Case — Harmful Environmental Impact of the Supply Chain: From the Environmental Profit and Loss Tool to Google for Sustainable Fashion

Adopting sustainable practices is high-priority also within the fashion system for many reasons. UN underlined that this industry has a tremendous environmental impact on the planet: it is able to use 93 billion cubic metres of water every year and 2.000 gallons of water to make a pair of jeans, reaching 20% of global wastewater; besides, every second the equivalent of one garbage truck of textiles is landfilled or burned. Clothing and footwear production generates up to 8% of global greenhouse gas emissions[20] and part of these global emissions come from the irrigation system for cotton crops, oil-based pesticides, the machinery of harvesting and transport.[21]

The fashion supply chain has, without the shadow of a doubt, a relevant environmental impact that needs to be assessed and decreased significantly. For this reason, it is crucial to measure the environmental footprint that this kind of production generates, creating new and innovative solutions to solve and eradicate this harmful system.

In this problematic scenario, in recent years, technology is proving to be a highly powerful tool that, if used fairly, can provide notably positive results. For this reason, one of the most sustainable oriented luxury fashion brands, Stella McCartney, started to use the "Environmental Profit and Loss" breakthrough decision-making tool, created by the international group specialised in luxury goods Kering, supported by PwC and enriched by the collaboration with sustainability experts from academia and business.

The fashion company has been using the Environmental Profit and Loss tool since 2012, because it is a technology that measures the impact of the whole supply chain, from the raw materials to the selling phase of the clothes. The tool uses welfare economics to place a monetary value on the change to the environment caused by a business. In order to do so, it finds the environmental valuation coefficient for 6 impact areas (greenhouse gas emissions, water use, water pollution, land use, air pollution and waste), for 16 process steps (such as extraction, production, processing, etc.), 102 raw materials and104 countries.[22] The Environmental Profit and Loss tool combines both primary and secondary data. The primary evaluated data are as follow: material data that describe which kind of material is used, also considering its quantity and its source; financial data that show the spending with the suppliers; and the environmental data from the suppliers' sites and all the other managerial places. The secondary data

19. McKinsey, "The State of Fashion", 2018.

20. UN, "UN launches drive to highlight environmental cost of staying fashionable", UN News, (March 25, 2019), https://news.un.org/en/story/2019/03/1035161.

21. UN Environment Programme, "UN Alliance For Sustainable Fashion addresses damage of 'fast fashion' ", UN Environment Programme, (March 14, 2019), https://www.unenvironment.org/news-and-stories/press-release/un-alliance-sustainable-fashion-addresses-damage-fast-fashion.

22. Hatim Bennis, "A Deep Learning Approach to Develop Your EP&L, Inspired by Kering", Medium, (October 01, 2019), https://medium.com/@hatimbennis1/a-deep-learning-approach-to-develop-your-ep-l-inspired-by-kering-533a0d84bb17.

instead derives from Life Cycle Assessments, Environmentally-Extended Input-Output models and industry statistics. Furthermore, Stella McCartney, through this technology, has been able to evaluate not only the environmental impact but also the social one. Indeed, the tool enables the company to estimate the change in wellbeing that is caused by the emissions generated by its production and resources used (regarding, for example, health impacts or access to clean water).

Since when, in 2012, Stella McCartney adopted the Environmental Profit and Loss tool, there has been a visible reduction of its environmental impact year after year. In 2014 the technology revealed there was evidence that the raw material stage of cashmere caused 42% of the total environmental impact. The extrapolation of this data allowed the company to decide to stop using virgin cashmere and instead to choose reengineered cashmere yarn. This strategy was effective, because, by 2016, the environmental impact generated by this fibre was reduced to 11%.[23]

Stella McCartney continued to strengthen the relationship between advanced technology and sustainable fashion throughout time; in fact, later, the brand collaborated with a giant technology company: Google. The latter, after enrolled the help of "Current Global", a consultancy which guides fashion companies to be more sustainable, hypothesised that cloud-based data collection, analysis and machine learning tools could help fashion company to provide a more detailed and informed system for industry.[24] However, it needed to experiment with this thesis empirically, partnering with a fashion brand. Therefore, Google decided to collaborate with a fashion company which best matches sustainable values.

It was during the 2019 Copenhagen Fashion Summit that Google announced a pilot in collaboration with Stella McCartney, which implied the utilisation of Google Cloud technology, that is able to illustrate a more deep description of the entire supply chain. Through this advanced technology, it is indeed possible to measure more precisely the environmental impact that fashion supply chain has, analysing data regarding raw materials and resources used. Stella McCartney has been the first fashion label to test it, and the brand has been extremely crucial and useful to improve and to refine the platform.

In this project, Google and Stella McCartney are highly conscious about the greater use of cotton in the fashion industry, which accounts for 25% of all fibre utilised, and viscose, whom the demand is growing and that implies the destruction of forests, which are vital for decreasing carbon emissions. Therefore, the pilot is centred on testing the efficiency of the AI tool on these heterogeneous raw materials, with the aim to expand the analysis into a more comprehensive and diverse kind of textiles[25]. Furthermore, the technology is capable of understanding the different environmental footprint depending on the geographical territory where production is installed.[26]

Stella McCartney is well known for being a fashion company which is actively committed to sustainability, and this last innovative strategy is undoubtedly one of the most avant-garde and experimental methods that have ever been implemented before for gaining sustainability, especially at the raw materials stage in the production process chain. Because, in order to produce responsibly, it is necessary to obtain profound and detailed measurements of the consequences of every business choices. Once this knowledge is refined and completed, it is possible to decide which kind of strategy is the most sustainable one.

23. Stella McCartney, "Measuring our impact", Stella McCartney, (n.d.), https://www.stellamccartney.com/experience/it/sustainability/themes/measuring-our-impact/.

24. Nick Martin, "Google's new pilot aiming to measure the environmental impact of the fashion industry", Google Cloud, (May 15, 2019), https://cloud.google.com/blog/topics/inside-google-cloud/googles-new-pilot-aiming-to-measure-the-environmental-impact-of-the-fashion-industry.

25. Caroline Donnelly, "Stella McCartney and Google Cloud start machine learning and fashion-focused sustainability push", Computer Weekly, (May 15, 2019), https://www.computerweekly.com/news/252463377/Stella-McCartney-and-Google-Cloud-embark-on-machine-learning-and-fashion-focused-sustainability-push.

26. Nick Martin, "Google's new pilot aiming to measure the environmental impact of the fashion industry", Google Cloud, (May 15, 2019), https://cloud.google.com/blog/topics/inside-google-cloud/googles-new-pilot-aiming-to-measure-the-environmental-impact-of-the-fashion-industry.

Farfetch Case — Lack of knowledge about sustainable fashion: Fashion Footprint Tool

The concept of "sustainability" requires the participation of the whole society, engaging governments, private and public sectors, companies and, last but not least, civil society.[27] If on the one hand, recent data show an increasing customers' concern about sustainability in the fashion system, on the other hand, people still tend not to possess adequate knowledge on slow fashion to adopt a more conscious behaviour.[28] Hence, there is still a problematic lack of knowledge that distinguishes public opinion. For this reason, a systematic education on which are the most responsible consumer behaviours, and precise communication on the impact of fashion consumption is critical to gain sustainability.

Nowadays, it is widely known that customers can use online stores to research and find out information in different ways, for example, through computers, tablets and mobile phones. By exploring user-friendly apps, customers can now visit these sites. Modern technology and online experiences make it easier now for customers to research and view products. And academic literature says that technology, along with interactivity, can now influence more easily the customers.[29] Also, this interactivity certainly influences the trust and the attitude that a customer will have towards the brand.[30] Therefore, if it is possible to influence consumers' behaviour within the online channel, it is worth trying to affect customers positively, in order to educate them for more sustainable fashion consumption.

In this case, to reinforce customers' awareness of sustainable fashion, recently Farfetch has released the "Farfetch fashion footprint tool" on its official website. In this way, AI builds interactivity with online users, attracting them in a participatory attitude towards sustainability, calculating and showing scientific data about how much specific materials impact on the planet.

The footprint of linen, cotton, viscose, polyester, nylon, wool, silk and leather is precisely described in terms of carbon emissions and water usage as follow:

1 kg of linen = 15 kg of carbon, 2,067 litres of water

1 kg of polyester = 21 kg of carbon, 78 litres of water

1 kg of nylon = 24 kg of carbon, 78 litres of water

1 kg of cotton = 28 kg of carbon, 10,000 litres of water

1 kg of viscose = 30 kg of carbon, 3,829 litres of water

1 kg of wool = 46 kg of carbon, 2,237 litres of water

1 kg of silk = 25 kg of carbon, 58,153 litres of water

1 kg of leather = 19 kg of carbon, 17,093 litres of water

Besides, after informing the environmental impact in terms of carbon emission and water usage, the AI tool suggests customers what kind of textile is more sustainable compared to the traditional ones. Organic, vegan, recycled or responsibly sourced textiles are described as materials which reduce the environmental impact and, in addition, examples of textile certifications are displayed in order to guide customers better.

27. Jeffrey Sachs, "From Millennium Development Goals to Sustainable Development Goals", *Lancet*, vol. 379, (June, 2012): 2210.

28. Sanjukta Pookulangara and Arlesa Shephard. "Slow fashion movement: Understanding consumer perceptions — An exploratory study", *Journal of Retailing and Consumer Services,* vol. 20, (March, 2013): 204.

29. James Coyle and Esther Thorson, "The Effects of Progressive Levels of Interactivity and Vividness in Web Marketing Sites", *Journal of Advertising*, vol.30, (October, 2001): 65–77.

30. Bill Merrilees, "Interactivity Design as the Key to Managing Customer Relations in E-Commerce", *Journal of Relationship Marketing*, vol.1, (2002): 111–127.

Along with the education regarding the environmental footprint related to fashion production, it is crucial to underline the existence of second-hand items, as one of the leading sustainable fashion practices within the market. In fact, in 2011, an academic study showed that the majority of participants bought apparel from second-hand sources because of environmental reasons.[31] Another survey of 3,000 consumers who have purchased at least one pre-owned item in the last year across the UK, US and China, displayed that 57% overall of second-hand purchases, prevent to buy something new.[32] Other studies assert that when customers understand the impact and environmental consequences of clothing consumption, they try to change their behaviour decreasing clothing waste, for example, buying second-hand clothing.[33]

Therefore, informing consumers about alternative forms of fashion consuming which are more respectful towards the environment, can push them to acquire pre-owned fashion items, avoiding the consumption of new fashion products which indeed have a greater environmental impact.

On the Farfetch's official website, the AI fashion footprint tool advises shopping consciously, and it even drives customers towards purchasing pre-used fashion items. Indeed, the AI tool illustrates the environmental benefits that derive from second-hand fashion, writing for each pre-owned garment bought how much carbon, water and waste can be saved as follow:

One coat = 30 kg of carbon, 1 m^3 of water, 1 kg of waste

One dress = 15 kg of carbon, 1 m^3 of water, 0 kg of waste

One denim = 8 kg of carbon, 3 m^3 of water, 0 kg of waste

1 top = 6 kg of carbon, 1 m^3 of water, 0 kg of waste

One skirt = 5 kg of carbon, 1 m^3 of water, 0 kg of waste

One leather bag = 5 kg of carbon, 4 m^3 of water, 0 kg of waste

This simple, direct and straight forward method has the merit to communicate and underline the importance and the evident difference in buying a new single item of clothing, compared to acquiring a pre-owned one. If producing only one kg of wool requires the consumption of 46 kg of carbon and 2,237 litres of water, it is easy to imagine the environmental consequences that even few winter coats made with wool can generate. By contrast, one single second-hand dress can save up to 15 kg of carbon, also avoiding the consumption of a significant quantity of resources.

Consequently, the tool represents the acquisition of second-hand clothing as a more ethical choice, since it clearly explains the environmental reasons to behave consciously, learning about the outcome of encouraging a certain method of production, rather than driving the fashion consumption towards personal attitudes that positively affect the planet.

This technological tool undoubtedly instils hope that in the future customers could be more active in behaving responsibly. However, it is necessary to highlight the fact that the AI tool is not well-positioned within the website. Indeed, it is much easier to access to the https://www.farfetch.com/uk/fashionfootprinttool web page from the Google search, taping "Farfetch Footprint Tool", rather than from the official website. If the tool were put in a more visible and accessible place for online users in the Fartetch's website, it would be much more effective and useful in gaining consistent communication about sustainability.

31. Kim Y. Hiller Connell, "Exploring consumers' perceptions of eco-conscious apparel acquisition behaviors", *Social Responsibility Journal*, vol.7, (March, 2011): 69.

32. Farfetch, "Understanding the environmental saving buying pre-owned fashion, Farfetch Displacement Research — Report", 2019, 6.

33. Kim Y. Hiller Connell and Joy M. Kozar, "Environmentally Sustainable Clothing Consumption: Knowledge, Attitudes, and Behavior", in *Roadmap to Sustainable Textiles and Clothing. Textile Science and Clothing Technology*, ed. Senthilkannan (Singapore: Springer, 2014), 52.

Moosejaw Case — Negative Environmental Impact of Online Returns: Data-driven Personalisation Platform

Customers are increasingly buying fashion products from online channels; in 2018, only in Russia, which is part of BRICS, online sales accounted for more than 10% of all apparel sales in the market.[34] However, online platforms still have some significant limits due to the lack of physical customers' experience.

As e-commerce increased and so had fashion consumption through online channels, the environmental impact created due to transportation, packaging and returns is worrying. Indeed, the online environment, when shopping, is still not entirely reliable. Online engagement, safe payment and free returns lead to rising online fashion consumption, but on the other hand, people still find difficulties and physical barriers to choose the right size, style or fit which eventually increase return rates.

Only from 1999 to 2009, the miles driven by package carriers rose to 40%, which was partially linked to the rise of online shopping. These delivery vans often produce a high volume of carbon emissions: in 2009, some scholars wrote that those last-mile deliveries in e-commerce retailing account for 32% of the whole energy usage.[35] And if fashion e-commerce has its environmental footprint when it delivers its products once ordered online, it has even greater impact if consumers' return the fashion item. It indeed depends on which kind of return method the customer selects. The package carrier altering their normal delivery route to collect packages emits 362 g CO_2, but when the customer goes to the offline retailer location to return the product, the carbon emission becomes 4.455 g CO_2, based on an average round trip of a customer to go shopping. When instead, the customer delivers the returned item through mail, package delivery service increases the miles they drive per item.[36]

Up to 40% of online purchases are ultimately returned, and one of the main reasons why a fashion item is usually returned is because of the poor fit, as cited by 60% of US consumers, according to Detecon USA consulting. When approaching in buying a fashion product online, surely the online user has to face many variables regarding clothing's characteristics. For example, globalisation allows buying clothing from different part of the world, but it even confuses customers due to the highly visible differences in sizes and measurements among brands and from country to country.[37] In 2018 the technology company Optoro estimated that 5 billion pounds of waste are generated every year through returns, creating 15 million metric tons of CO_2 emitted during the return process[38] and $390 billion worth of merchandise returned.[39] It is clear that fashion e-commerce has a substantial environmental issue.

In this case, the outdoor recreation retailer Moosejaw implemented AI to tackle the problem. The apparel company noticed that a significant percentage of online customers were buying more sizes sample of the same clothing to try them on, and choose the one which fit the best. And this was a data also detected by the University of Gothenburg, which showed that the online consumers' behaviour recently switched from buying one item and returning it if it was not right, to order a lot of size and colour variations of the same fashion product, trying to find those they like the most and returning the others.[40] This customers behaviour phenomenon is called "sized sampling".

34. McKinsey, "The State of Fashion", 2020.

35. Christopher Weber, Chris Hendrickson, Scott Matthews, Amy Nagengast, Rachael Nealer and Paulina Jaramillo, "Life cycle comparison of traditional retail and e-commerce logistics for electronic products: A case study of buy.com",*2009IEEE International Symposium on Sustainable Systems and Technology*, (June, 2009): 1–6.

36. Rose Francoise Bertram and Ting Chi, "A Study of Companies' Business Responses to Apparel E-commerce's Environmental Impact", *International Journal of Fashion Design, Technology and Education*, vol.11, (2018): 258.

37. True Fit, "The State of Returns — Foot & Apparel — A special Report", 2018.

38. Harriet Constable, "Your brand new returns end up in landfill", (February 15, 2019), https://www.bbcearth.com/blog/?article=your-brand-new-returns-end-up-in-landfill%2F.

39. Optoro, "2018 Optoro Impact Report", 2018.

40. RosieFrost, "Is our obsession with online returns damaging the environment?", (April 09, 2020), https://www.euronews.com/living/2019/11/13/is-our-obsession-with-online-returns-damaging-the-environment.

In fact, Moosejaw, specifically working with"True Fit" the data-driven personalisation platform for footwear and apparel retailers that uses rich, connected data and machine learning to enable personal experience for fashion retailers, discovered that almost 15% of its returned online purchases could be attributed to size sampling. Along with size sampling, there was happening that consumers returned a product because of the wrong size and re-ordered a different size: it was a sequential size sampling. This consumers behaviour led inevitably to a significant rate of returns. Therefore, Moosejaw decided to improve and refine its customer analytics and data, to satisfy and fit online customers' needs from their physical dimensions to their favourite style.

Thanks to AI, when a shopper places multiple sizes of the same item in the shopping cart of the fashion company's website, a suggestion to create a "True Fit profile" appears on the web page. When the online user fills the data required, True Fit can match the information regarding the customer with the True Fit's "Fashion Genome", in order to recommend the best fit.The Fashion Genome is an organised, and comprehensive data collection about apparel and footwear industry gathered from consumers, brands and retailers. It allows the system to study and find the best style and fit because of its high numbers of information.[41]

The adoption of AI within the company's strategy allows reaching a reduction of size sampling by 24% over one year period, and in the same time span34% drop in size samplers and sequential size sampling was reduced by 18%.[42]

Discussion & Conclusions

The overall analysis allows the design of different AI adoption in the fashion industry. Two main factors drive AI to build sustainable fashion: concern and knowledge.

Firstly, the concern is needed in order to drive the change, looking for new and more sustainable fashion business models, which embrace a genuine interest in solving unsustainable issues. Most of the time, it is not possible to always prove if the fashion industry is truly moving towards more sustainable practices due to the widespread lack of transparency.However, AI appears to have a significant impact on helping fashion companies to be more sustainable thanks to some tangible data; therefore, new AI implementations for shaping sustainable fashion are desirable.

Once the fashion business model, pushed either by the awareness of existing unsustainable consequences of fashion activities, or the increasing customers' demand or the willingness to be more sustainable, switches towards innovative AI tools, it is possible to gain more advanced, and comprehensive knowledge that enables the fashion industry and customers to make more sustainable decisions.

As previously described, H&M decided to adopt AI within its product design phase because better methods of production are required, reducing resources waste. Furthermore, forecasting demand helps the fast-fashion company to decrease overstock and deadstock drastically, avoiding harmful waste and rationalising resources. Knowing all the variables related to a product possibility to be sold or not and in which place, allows the company to assess the production and distribution phase.

These actions are significantly required in such a problematic and controversial fashion business model that is the fast fashion.

Furthermore, if on the one hand, it is important to know if it is worth producing an item based on its forecast demand, on the other hand, it is extremely crucial being aware of its supply chain impact. Certainly, it is not simple to thoroughly understand the environmental footprint of the fashion supply chain, due to its complex nature and the many factors involved in the process. In this case, the AI project between Stella McCartney and Google is pivotal, because it allows gathering an enormous quantitative

41. True Fit, "True Fit®: Consumer Fit & Style Data Platform for Fashion Retail", (n.d.), https://www.truefit.com/products/genome.

42. True Fit, "Case Study — Moosejaw", London, UK, (n.d.).

of data that otherwise would have been, if not impossible, extremely difficult to obtain for companies. The collaboration, measuring the impact of cotton and viscose and underling the water consumption, is able to give precise data on which production method is less or more sustainable than another: AI reinforces the knowledge related to heterogeneous material and resource invested, raising awareness. The fashion industry, through this method, could arise its responsibility for its actions, adjusting and improving its supply chain looking for the most sustainable way to produce.

Secondly, knowledge is crucial in the fashion industry as well as in public consciousness. Engaging online customers through the interaction with an AI tool which masters the information related to the environmental footprint of consumers' behaviour, could empower people to have a positive impact on the planet through their choices. The Fertfitch fashion footprint illustrates the environmental consequences generated by different kinds of textile and the environmental benefits of buying second-hand fashion products. Such AI communication tool, having the potential to inform better and educate people, could strengthen the concept that when all the different players, from industry to people, behave more responsibly, it is possible to gain real sustainability.

Alongside with forecasting sales, measurement of the supply chain environmental impact and AI communication tool, it is furthermore necessary to introduce an AI system to regulate and decrease the adverse effects produced by the growing fashion e-commerce. In this case, Moosejaw implemented AI for analysing and building better size and style recommendation, that reduced not only the financial cost generated by a significant quantity of sample sizes of clothing returns but also the environmental impact.Contemporary society increasingly relies on online fashion shopping, often practising harmful consumerism without knowing the consequence of these actions; AI strategy guides online consumers towards less damaging behaviour through more consistent suggestions.

All these AI implementations have a positive impact within the fashion system indeed, and even if its application for building sustainable fashion it is relatively new, it is already demonstrating to bring significant results in terms of sustainability.

For this reason, more AI technique adoptions are suggested within the fashion industry for revolutionising some damaging traditional business models. A possible limitation of AI adoption for sustainability is the fact that it could be financially costly, especially for small and medium enterprises, furthermore, it required skilled people in the field who can utilise AI and make responsible decisions within the company. In addition, there is a high competition of many fashion companies, which still operate without caring about sustainable values, focusing on a compulsive rush in proposing the lowest price in the market. This trend must be taken into account to create instead a robust, attractive and reliable brand image which corresponds to real and practical sustainable principles.

Therefore, last but not least, the company has to be genuinely interested to use AI for responsibly creating sustainable fashion, and sincerely striving for sustainability within its corporate social responsibility, in order to orchestrate the whole core business towards sustainable actions.

Limitations and further research

The main limitation of this research is the absence of more complete internal data of the fashion companies analysed, which would have enriched the study. Indeed, it is relatively seldom that fashion companies are willing to share precise information regarding their sustainability performance, due to the delicate topic. They are still adjusting their models, previously many of them have committed several unsustainable mistakes, and a number of those who are willing to change are still learning. Usually, companies are also concerned about their brand image, because they probably are afraid to lose credibility and to be criticised for not being either sincerely or utterly sustainable in their operations. However, transparency and share of further information on their sustainability activity would also credit the commitment of the fashion businesses that are genuinely investing in the change. Lastly, being AI for sustainable fashion a relatively recent technological phenomenon, further research is suggested, in order to understand the long-term impact of AI on building sustainable fashion and its future fast evolution.

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