# The application of big data in fashion retailing: a narrative review

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**The Application of Big Data in Fashion Retailing: A Narrative Review**


## Abstract

Big Data continues to disrupt the fashion retail industry and has revolutionized traditional business models. Today, both leading fashion brands and new start-ups are using Big Data analytics to improve business operations and maximize profitability. The current paper aims to take stock of the literature on Big Data in fashion and concisely summarise the fashion industry's current position. We uncover five main reasons that are driving the utilisation and application of Big Data analytics in the fashion industry. These are (1) trend prediction, (2) waste reduction, (3) consumer experience, consumer engagement and marketing, (4) better quality control and the need for a world with fewer counterfeits, and (5) shortening supply chains. We also identify key challenges which must be overcome as the most fashionable industry now seeks to model the fashion market and consumer behaviour with Big Data.



**Keywords**: Big Data; fashion; fashion industry; retail; trend forecast; consumer experience; review.

## 1 Introduction

As one of the most sought-after research topics (Acharya et al., 2018), Big Data continues to attract the interest of all industries across the globe. The fashion retail industry is no exception with the unprecedented competition, emerging technologies and the ongoing COVID-19 pandemic (BOF, 2020; Jin and Shin, 2020; van Lier, 2019) accelerating digital disruption. Accordingly, social media platforms are abuzz with likes, comments, tweets, and pins as more than 59% of the world is now online (Statista, 2020a; Sharma, 2017) and thus, further contributing to the generation of Big Data in fashion. Some stakeholders have recognised Big Data as the future of the fashion industry (Swayne, 2014) whilst others as the hot new fashion trend (Costa, 2016) with Big Data ending up being the buzzword among practitioners in the fashion industry (Greene, 2018).

However, despite its apparent popularity, Big Data does not have a universal definition (see Hassani and Silva (2015; 2018) for a discussion). Rather, the concept of Big Data has evolved considerably over the past 20 years (Lee, 2017). Initially, Doug Laney defined Big Data based on volume, variety and velocity (3Vs) (Smallwood, 2019) but over time this definition has evolved into the creation of 5Vs, 7Vs and 10Vs which include veracity, validity, vulnerability, volatility, visualization, and value (Firican, 2017). Alongside the emergence of Big Data, there has been a growth in the need for Big Data analytics which refers to the technologies and architectures that can extract value from structured and unstructured Big Data by enabling high-velocity capture, discovery, and/or analysis (Feblowitz et al., 2013). According to the "Management Tools & Trends" survey carried out by the management consulting firm Bain & Company, companies around the world have in recent years widely adopted and embraced digital tools such as advanced analytics to improve operations and ultimately profitability (Rigby and Bilodeau, 2018).

The potential impact and usefulness of analysing different types of data are rather apparent and obvious in the traditionally numerically driven fields of finance, insurance and healthcare, and it is therefore not surprising that companies in these sectors have been early and enthusiastic adopters of Big Data (Alton, 2018). In the fashion industry, many actors traditionally relied on intuition and creativity when making important decisions regarding, for instance, designing, buying and merchandising. However, there are signs that this industry is now increasingly relying on Big Data for insights with real-time analytics (Ferguson, 2014; New Gen Apps, 2017; Landmark and Sjøbakk, 2017; Morache, 2017). Today, consumers view fashion not only as a simple wearable but also as an experience (Flacandji and Krey, 2020; Zoghby, 2018) and Big Data is being exploited to turn this experience into a journey (Sharma, 2017). Whilst the fashion industry is no stranger to data analytics as it has a long history of using spreadsheets for analysing sales information, the biggest change is in terms of the size and growth of unstructured data that needs analysing (Murray, 2016). Accordingly, fashion retailers are now relying on data science with both predictive models (statistics) and prescriptive (user recommendations) data analytics for planning their operations (Shah, 2020; Fox et al., 2018; Zoghby, 2018; Chapman, 2017; Beck, 2017). Statista (2020b) estimates that the number of digital buyers worldwide (which was 1.66 billion in 2017) would rise by 28% to 2.14 billion by 2021, and this statistic gives an indication about the potential future growth of Big Data in fashion. With COVID-19 forcing consumers to shop online in most parts of the world, the number of digital buyers would likely be higher than the previous estimations with brands accelerating digital innovation and e-commerce for survival (Silva and Gee, 2020). This, in turn, implies that Big Data in fashion will only get bigger, at a faster rate than ever seen before. Therefore, it is prudent to acknowledge and prepare for a future where Big Data

will continue to disrupt the $3 trillion global fashion industry which accounts for 2% of the world's GDP (Fashion United, 2018).

Big Data can be useful for the fashion industry in many ways. New Gen Apps (2017) asserts that the fashion industry can use Big Data for market identification, trend analysis, understanding the consumer, converting high ticket purchases, lifting new designers, measuring influencers' impact and improving cross-selling, and sustainability as pointed out by Christopher Wylie (Styles, 2019). Trend prediction is very important in fashion, and Big Data can aid by charting cyclical fluctuations and give an indication about the general trends that may materialise (Alton, 2018). Moreover, Big Data in the form of Google Trends can also be value-adding if exploited correctly (Silva et al., 2019a). Numerous opportunities are waiting to be exploited as fashion brands begin to engage with and exploit Big Data.

The entire fashion industry is slowly beginning to embrace the potential of Big Data coupled with artificial intelligence (AI) (Byers, 2020; Gupta, 2020), virtual and augmented reality (McDowell, 2020; Rogers, 2020). However, applying analytics to fashion is an arduous task (Fox et al., 2020; Murray, 2016). This is partly due to garments having different names in different countries and regions, with experts believing data analytics cannot entirely replace human insights into fashion (Murray, 2016). Fashion companies like Macy's (one of the largest department stores in the US) use Big Data from out-of-stock rates, price promotions, sell-through rates, visit frequencies, sales to style preferences and online and offline personal motivations to create customer-centric assortments and customized incentives at checkouts (van Rijmenam, 2014). Interestingly, Big Data analytics has led to a 10% increase in Macy's store sales, which is significant considering that in 2011 Macy's was relying on Microsoft Excel for insights (van Rijmenam, 2014). Another keen exploiter of Big Data has been fashion brands looking to penetrate the wearable smart fashion market via tracking health and fitness performance. Wearable smart fashion not only generates more Big Data that needs analysing but also has brands like Ralph Lauren, Samsung and Athos (https://www.liveathos.com) investing further to create innovative products which track body heat, record heart rates, and charge via solar power (Hastreiter, 2016).

There is also evidence of a new market for support services in fashion Big Data analytics. Companies like Holition (https://holition.com) are creating software which allows for visualisation of Big Data (Arthur, 2014). Edited (https://edited.com/) and Worth Global Style Network (WGSN, https://www.wgsn.com/en/) are also noteworthy as they use Big Data from different sources to evaluate the potential success of new merchandise and identify successful pricing models (Hastreiter, 2016). Edited aggregates fashion trends and sales data from all over the globe and makes it accessible in real-time with its data set estimated to contain a minimum of 53 billion data points (Noyes, 2014). It also covers over 1000 retailers and holds 15 million high-resolution images (Noyes, 2014). In 2013, Edited's Big Data services were credited by ASOS for the 33% increase in its sales during the fourth quarter (Gupta, 2015; Noyes, 2014). On the other hand, the most prominent fashion forecasting firm WGSN's 'Instock' is a retail analytics service with more than a million products and 11 million stock keeping units (SKUs) each day from more than 10,000 global online brands and retailers (Noyes, 2014; The Economist, 2017). Instock tracks the online shoppers' clicks as they browse and buy items and uses this information to inform retailers on the styles or brands that are fast-selling and when to discount (Murray, 2016).

### *1.1 Purpose and Research Approach*

This paper aims to narratively review (Baumeister and Leary, 1997; Ferrari, 2015) the literature

on the use and application of Big Data in the fashion industry. As Ferrari (2015) points out, narrative reviews are used to describe and appraise existing studies and are especially useful to contribute to general debates in the research literature and assess the current state of knowledge. Therefore, we argue that a narrative approach is appropriate given our aim of surveying the current state of knowledge in this emerging and rapidly developing field, and to concisely summarise the fashion industry's position. Narrative reviews are also useful for providing rationales for future research (Ferrari, 2015), and our article can motivate and guide researchers into exploiting the vast amounts of data generated by the fashion industry for improving its planning, production and decision-making capabilities. Recently, there have been some publications dealing with aspects of the use of Big Data in fashion (Madsen and Stenheim, 2016; Jain et al. 2017; Jain & Kumar, 2020; Silva et al., 2019b) whilst the book by Marr (2016) describes and explains how some fashion companies (like Amazon and Ralph Lauren) have successfully adopted Big Data.

Yet, in comparison to other industries, there exists minimal applied academic research about the use and application of Big Data in fashion, and therefore, most of the work that is reviewed in the current paper relates to industry and market research. Such literature reviews can be very useful for the future developments within the related field, as evidenced through the recently published, heavily industry-based academic review for the petroleum and petrochemicals industry by Hassani et al. (2017). Furthermore, the exploitation of Big Data in fashion is still in its very early stages, and it is only through extensive research and analysis that new concepts can be introduced and existing products and services can be improved (Alton, 2018). Hence, this paper seeks to concisely summarise the existing applications of Big Data in the fashion industry and act as a point of reference for researchers, consultants and fashion industry professionals alike as they endeavour to take fashion companies into the next stage of Big Data analytics. This paper expands on some of the themes initially explored in a short paper written for a practitioner-focused journal (Silva et al., 2019b), but differs by going much more in-depth and having a sharper focus on the latest academic research and industry applications.

The narrative literature review approach has some limitations that should be noted upfront. Ferrari (2015) points out some typical limitations of narrative reviews, such as little knowledge about the researchers' assumptions and planning as well as selection and evaluation biases. Since our review focuses on pivotal studies and is not meant to be an exhaustive literature review, it may be potentially biased in terms of selection of studies and our interpretation of the findings. Moreover, since Big Data is still a relatively new topic in the context of the fashion industry, much of the reviewed literature is based on industry and market research, some of which may not be as methodologically rigorous as peer-reviewed scholarly research.

The remainder of this paper is organised such that Section 2 is a detailed review of how big data from social media and Google Trends is influencing the fashion industry. Then, in Section 3 follows a discussion of how Big Data can be useful for the fashion industry whilst the paper concludes in Section 4 by summarising the key findings, practical implications, as well as a brief discussion about the challenges associated with the implementation of Big Data in fashion.

## 2 How is Big Data from Social Media and Google Trends Influencing the Fashion Industry?

It is well-documented that the structure and dynamics of the fashion industry have changed considerably over time (Djelic and Ainamo, 1999; Taplin, 1999; Bhardwaj and Fairhurst, 2010; Aspers and Godart, 2013). The changes have been particularly noticeable during the last two-three decades, with the competitive landscape of fashion markets dramatically changing as a result of societal mega-trends such as internationalisation, globalisation, digitalisation and automation (Hines, 2012; Jin and Cedrola, 2016; Keller et al., 2014; Nayak and Padhye, 2018; Bertola and Teunissen, 2018). This inevitably means that fashion companies can no longer operate in isolated silos but must take into account that they are operating in an interconnected world and are embedded in increasingly complex global supply chains (Christopher et al., 2004; Sen, 2008). However, the increased collaboration with multiple sources and partners also has advantages in that it leads to the accumulation of more Big Data which can help provide a much broader and holistic view of the entire fashion industry (Alton, 2018; Cooper, 2017).

The emergence and growth of social media during the last 10-15 years has been a formidable source of disruption in the fashion industry (Baraglia, 2016; Kontu and Vecchi, 2014, 2016; Mohr, 2013). Given the increasing importance of social media in the form of Instagram, Pinterest, Snapchat, Facebook, and Twitter for fashion brands, we find it pertinent to briefly discuss the role played by social media in transforming fashion in the age of Big Data. Social media was ranked as the number one influencer of fashion purchases for women aged 18-24 in the US (Mintel, 2017) whilst Joyce (2020) suggests that social media is a place for celebrating sustainability in fashion. Nevertheless, most companies are yet to exploit Big Data analytics for tracking their supply chain data that can help create more sustainable operations (Kwan, 2020).

However, social media is not the only disruptor of fashion in the age of Big Data. Another evolution which is most worthy of discussion is Google Trends (https://trends.google.com), and its impact on the fashion industry (Silva et al. 2019a). As evidenced by the review which follows, it is clear that both these factors will remain key for the survival and growth of fashion brands today and in the future.

### *2.1 Social Media as a source of Big Fashion Data*

It is no secret that internet penetration usage is accelerating across the globe with individuals using social media to express their views and opinions (Jain et al., 2019), thus rapidly contributing to the continued growth of Big Data. According to Trites (2013), social media is the fashion industry's source of Big Data, and recent research has shown that enormous amounts of knowledge about fashion can be harvested and extracted from social media (Ma et al., 2019). Poorthuis et al. (2019) support this view as they refer to the fashion industry as an attention-based economy and notes the importance of social media as a unique space within which fashion knowledge is created and shared. Meanwhile, Hsiao et al. (2019) discuss the importance of social media marketing in the fashion industry, whilst Cabiddu et al. (2019) study social media communication strategies in the fashion industry. Social media is famous for making it easier for retailers to see what is hot and trendy (Bloomberg, 2020) and COVID-19 has increased social media usage and related sales (Gonzalo, 2020; Bianchi et al., 2020). It is safe to say that the impact of social media on the fashion industry is beyond comparison. The hashtag #fashion on Instagram has recorded 13 million monthly mentions globally (Facebook, 2017a), and Instagram is widely recognised as the number one platform for fashion product discovery (Facebook, 2017b). As a result, celebrities, fashion bloggers and individuals are now key influencers of fashion trends across the globe (Davies, 2016).

Facebook is also disrupting fashion trends on social media and can provide Big Data analytics on most mentioned fashion items by country, based on Facebook status updates (Facebook, 2017a). Interestingly, with only a fraction of social media content being generated by the brands themselves (Baraglia, 2016), the consumer is at the forefront dictating what brands must offer to remain competitive. Social media has undoubtedly transformed the role of the consumer and today, the fashion consumer is in the driver's seat.

Moreover, it is no secret that fashionistas who used to await the latest edition of Vogue for fashion trends are now increasingly turning to social media instead (Greene, 2018). The traditional fashion runway shows are now disrupted by social media. Today, runway shows continue to be fun and exciting but have lost their status as the exclusive first look at fashion's elite (Trites, 2013). Instead, social media has taken over, as evidenced through Burberry's Tweetwalk which shared backstage pictures via Twitter before models hit the runway whilst brands and designers have resorted to Instagram for exclusive line releases with Michael Kors teaming up with Pinterest to build a fashion week hub (Trites, 2013). Social media has also transformed the way fashion is communicated and disseminated; from print-media (magazines and newspapers) to more direct and frequent communications and interactions between brands and consumers (Davies, 2016) leading to more crowdsourcing of new fashion ideas (Mehtälä et al. 2016). Edited's Social Monitor feature is a sound example which demonstrates the core importance of social media for Big Data in fashion. Social Monitor aggregates social activity by more than 800,000 fashion influencers and experts (Noyes, 2014) enabling brands to uncover new insights and the latest trends. Fashion companies like Macy's rely on Big Data from social media as one of the essential components in their marketing strategy, which enables them to target consumers in a better and more advanced way (van Hooijdonk, 2017).

Big Data via social media sentiments allow for gauging customer engagement, purchasing times, and touchpoints which can then be used to build detailed customer segments enabling more efficient marketing campaigns (Greene, 2018). Such analysis also enables brands to get their designers, marketing teams and consumers to co-create fashion designs and marketing campaigns through the analysis of consumer engagement online. More recently, research by Choi (2018) evaluated the impact of social media observations when combined with demand forecasts for a boundedly rational retailer. Choi finds that good social media comments on the product play a key role in determining the value of quick response supply chains (Choi, 2018). In the UK, one of the fastest-growing fashion brands (at that time), Pink Boutique takes design inspirations from social media (Burton and Espiner, 2017).

Brandwatch provides research on luxury fashion brands and compares their performance on social media in the form of a social index leader board (Joyce, 2017). They considered factors such as social visibility, general visibility, net sentiment, reach growth, and engagement and content and concluded that Chanel was on top of social media. Brandwatch also provides Big Data analytics using Twitter fashion data. Brandwatch tracked mentions of the New York Fashion Week (NYFW) on Twitter in 2016 and identified the top 10 accounts (#NYFW tweeters) gaining the most impressions in the conversation (Joyce, 2016). Influential accounts included those belonging to Rihanna, Kylie Jenner and Tommy Hilfiger. Brands can perform similar analysis on tweets about their products and those of their competitors for improving their product offerings. The insights from such analysis can truly redefine fashion brands. For example, an analysis of tweets on the NYFW 2016 showed that dresses were in trend even though it was an autumn/winter show (Joyce, 2016).

More recently, Big Data analytics on Twitter data, enabled Poorthuis et al. (2019) to uncover several interesting aspects of the fashion industry. First, that the attention paid to fashion is highly uneven and varied cross-industry functions, national origins, and companies, even though there are a series of important global fashion capitals. Second, attention to fashion does not always correlate to where fashion products are sold. Third, that attention to fashion is a market-making mechanism and an indicator of wider social and cultural processes of tastemaking and identity formation.

### *2.2 Google Trends and Fashion Consumer Behaviour*

Internet culture shapes luxury fashion consumer habits (Yotka, 2019), and in fact, online searches are referred to as the new personal shopper (Duarte and Thomson, 2019). Google Trends is an analytical tool that can be used to analyse Big Data on web searches across the world (Choi and Varian, 2012). Google Trends has become more powerful as a result of the emergence and proliferation of Big Data and recent advances in Big Data analytics. Since social media is becoming increasingly important in fashion, it is not surprising that Google Trends is identified as one of the six trend-tracking tools to know (McDowell, 2019) and is likely to be extremely useful as companies across the globe are forced into zero-based budgeting following the COVID-19 pandemic. Yotka (2019) asserts that the next great fashion movement will start online, further emphasising the importance of incorporating Google Trends for fashion business analytics. As Boone (2016) points out, fashion consumers actively use Google to look for ideas and find the best designs, which they may buy with the tap of a button. Since it collects and harvests all these data, Google already knows the next big fashion trend (Bain, 2016). Google's Online Retail Monitor indicates that in 2018 fashion has seen the highest growth in search boosted by overseas shoppers (especially from EU) seeking access to UK brands online (Jahshan, 2018). Such trends are favourable for the fashion industry in the UK which is experiencing uncertainties with Brexit looming on the horizon (Hantzsche et al., 2019). Boone (2016) analysed search patterns and geographic factors driving the biggest fashion trends in 2016 and found that Google Trends can show which styles are catching on with fashion consumers. For example, Google Trends for bomber jackets grew 297% YoY in the UK and 612% YoY in the US, which also illustrated the shift towards genderless fashion (Boone, 2016). Besides, fashion companies can monitor and track Google search behaviour to identify purchasing decisions and quickly meet that demand (Hastreiter, 2016).

Other fashion brands are also increasingly using Google Trends to improve their competitive position. One such example is Miinto (https://www.miinto.no/) a leading Norwegian fashion retailer that created a fun nostalgia-based quiz using Google Trends to enable consumers to be fashion-forward (Armstrong, 2016). Another example is the partnership between Google and the online fashion platform Zalando in the creation of Project Muze. Project Muze applies machine learning (Neural Networks) to the field of fashion and exploits data contained in Google's Fashion Trends report to create designs based on the interests fo users (Think with Google, 2017). Gap Inc. too mined Big Data from Google Trends and other sources to inform the next season's assortment (Israeli and Avery, 2018). While some have been critical of the process (see, for example, Perez (2016)), there is little doubt that more in-depth research and development can further increase fashion companies' ability to utilize the outputs from this type of use of Big Data analytics.

Gucci was reported to be the most popular Google search for fashion brands in 2017, followed by Louis Vuitton in second place (Bobila, 2017). However, more recent analytics

through Google Trends show that this Gucci's leading position has changed with Louis Vuitton reaching similar popularity levels in terms of search trends since September 2019 (see, Figure 1). These insights can be useful for fashion companies in several ways. For example, it provides information about the effectiveness of their online marketing campaigns and their online presence (e.g. websites, social media) when it comes to customer engagement. Moreover, these data can also be used to map the market and analyse competitors. Companies can quickly and easily identify who the most important competitors are and how these companies are engaging their customers online. In turn, companies can use insights from such analyses to improve their existing practices. The simple example in Figure 1 also clearly illustrates how, except for Gucci and Louis Vuitton, the other luxury brands analysed in this example do not have an optimal online presence and footprint. More recently, Duarte and Thomson (2019) discussed how Google Trends can help understand what consumers want to buy and wear. For example, 45% of dress searches refer to occasions with weddings, formal events, graduations, parties and summer being the most popular. Moreover, Google Trends can also help identify regional differences in demand for clothing, the most sought after colourways, and interestingly, the findings in Duarte and Thomson (2019) indicates that consumers are now less willing to compromise comfort for style.

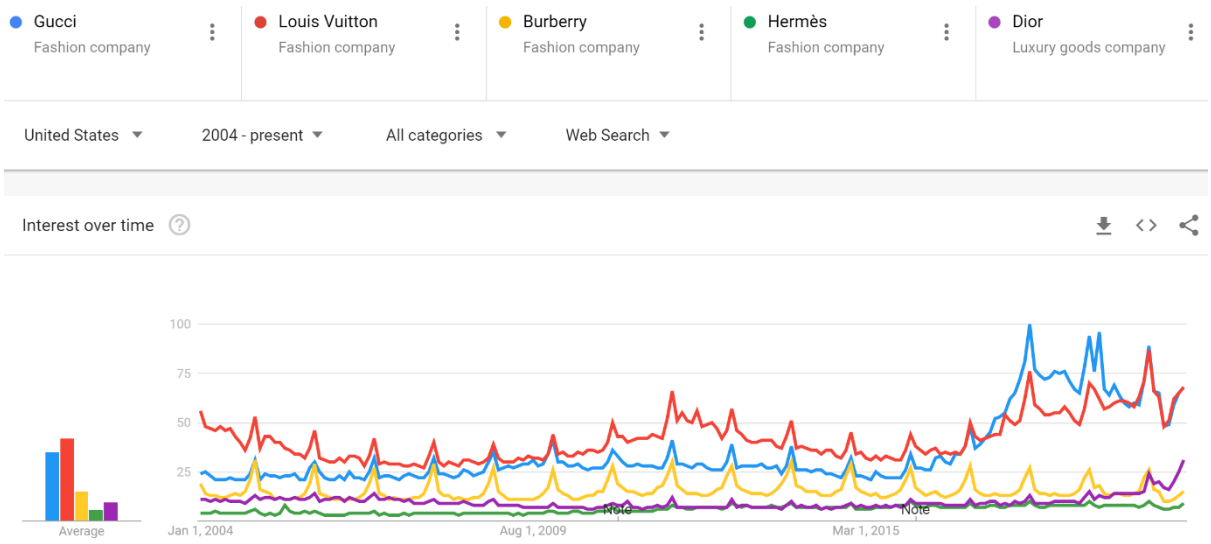


*Figure 1: Google Trends for selected luxury fashion brands (January 2004 – July 2020) (Data source: https://trends.google.com, retrieved 11 July 2020).*

Future research could consider whether Big Data in the form of Google Trends for fashion can help predict actual sales for brands. This could be the case since existing research suggests that Google search activity can be useful in the prediction of other types of economic activities such as, for example, real estate sales and prices (Wu and Brynjolfsson, 2015). Likewise, there could be several alternate research avenues that can be explored from different perspectives (e.g. fashion design, buying, merchandising and management).

## 3 How is Big Data Useful for the Fashion Industry?

In this section, we seek to outline the need and usefulness of Big Data in Fashion. At a time when the highly volatile economic conditions are threatening the survival of fashion retailers, Big Data can provide a needed competitive edge to get ahead in the market. Having identified

the opportunities, fashion companies have started exploiting Big Data for improving business operations (Thomassey and Zeng, 2018; Zaki et al., 2019). In brief, Big Data allows retailers and designers to make smarter decisions based on new datasets (Hastreiter, 2016). Recently, Acharya et al. (2018) investigated four fashion retailers and found that Big Data can assist in knowledge co-creation leading to evidence-based, improved decision making, and ultimately better business returns. Also, the exploitation of Big Data through Big Data analytics can help fashion companies reduce waste and enable mass production like never seen before (Costa, 2016) whilst creating new avenues for revenues that were unthinkable a decade ago (Brownlow et al., 2015). Gap Inc. is another example of a fashion company that exploited Big Data to better understand consumer behaviour and translate this understanding into better customer experience (Israeli and Avery, 2018).

In the following, we identify five areas where the application and exploitation of Big Data have large potential usefulness for the fashion industry: 1) trend forecasting, 2) reducing wastage, 3) analysing and enhancing consumer experiences, 4) better quality control and fewer counterfeits, and 5) shortening supply chains.

### *3.1 Trend Forecasting*

Fashion trend forecasting 'refers to the profession of envisioning future trends in style and foreseeing consumers' desires' (DuBreuil and Lu 2020, p. 68). Today, Big Data is used for trend forecasting purposes in a variety of industries (Hassani and Silva, 2015). Discovering and developing trends is the lifeline of the fashion industry, and this means that using Big Data for trend forecasting has a natural application in fashion. In the past, human-based processes (DuBreuil and Lu, 2020) and historical sales alone have been the determinant of trend popularity (Hastreiter, 2016), but nowadays, looking at historical sales is insufficient as consumers are increasingly expecting and demanding highly personalised shopping experiences. Therefore, it has been observed that in recent years the fashion industry has also started using Big Data for trend forecasting purposes.

According to Alton (2018), Big Data analytics on purchasing behaviour from past seasons can help find out which fashion qualities or elements shoppers may respond to in the future. For example, researchers from Penn State attempted to identify a network of influence among major designers, analysing data from 6,629 runway reviews of 816 designers from Style.com (now, https://www.farfetch.com/uk/) (Swayne, 2014). The same approach can redefine the way retailers source their merchandise via aiding in the identification of new and promising designers popular with consumers, but who have not yet signed with major fashion brands (Hastreiter, 2016).

Large trend forecasting firms such as Edited (https://edited.com/) and WGSN (https://www.wgsn.com/en/) have also disrupted the fashion retail industry considerably in recent years and have developed advanced Big Data analytics applications. However, as shown by Silva et al. (2019a) using several examples from the fashion industry, Google Trends can be a useful and beneficial tool for trend forecasting in fashion retail and can complement existing tools and efforts. Using Google Trends for "nowcasting" (predicting the present or very near future) has sizeable untapped potential and could be the next buzzword in the application of Big Data analytics in the fashion industry. To this end, MakerSights is an analytics platform known to combine factors such as search queries, social media activity, e-commerce sell-throughs and consumer feedback for trend prediction (Mc Dowell, 2019).

Zara (https://www.zara.com/) mines Big Data daily to analyse and understand exact consumer demands. These insights are then translated into tangible designs - daily, which

enables Zara to remain at the forefront in terms of catering to consumer expectations and demand for the latest fashion trends (Varma, 2017). Moreover, there are increasing consumer demands for the latest designs from catwalks to be available in-store instantly. This “fast fashion” trend was initially supported by the first wave of Big Data analytics, which helped meet the demands in terms of enabling fashion companies to make the right decisions concerning pricing, inventory, discounting, colours, and sizing (Murray, 2016). Initially, fast fashion was mainly associated with companies like H&M, Topshop, Benetton, and Zara producing 10-15k new items per annum (Costa, 2016; Sull & Turconi, 2008). Today, the “second machine age” (Brynjolfsson and McAfee, 2014) is enabling agile retail companies to produce 50-100k new items per annum via efficient Big Data analytics (Costa, 2016).

Agile retail is another result of the use of Big Data in fashion and relates to companies that rely solely on Big Data analytics and only sell through online channels (Costa, 2016). ASOS is a prime example of a successful agile fashion retailer. As Brownlow et al. (2015) assert, ASOS reaps financial benefits by using Big Data and its extensive product range to predict trends and give customers what they demand. In a similar vein, Topshop uses predictive analytics to determine emerging fashion trends, drawing on freely accessible Big Data harvested from fashion blogs and social media platforms. Chen and Luo (2017) experimented over an online clothing shopping dataset using discriminative mining to show how it could uncover useful clothing consumption trends and profitable clothing features. Thailand-based Pomelo Fashion keeps up with fashion trends via the use of Big Data for analysing social media trends to better understand the consumer’s rapidly changing tastes, needs, interests, and preferences (Chia, 2019). Alibaba used Big Data to help designers identify fashion trends and then coupled this with AI to shape New York fashion week looks (Livni, 2019). Recently, the denim mill Panther Denim also reported that it started using Big Data during the coronavirus crisis to determine trends (Sourcing Journal, 2020). Heuritech, a personalized market intelligence platform is another example, they use AI and Big Data analytics to create accurate trend predictions and sales forecasts for efficient stock planning (Segura, 2020).

Another example of how Big Data can provide better fashion forecasts is through the use of Google Trends (Silva et al., 2019a). There is considerable untapped potential to analyse Google Trends for a particular product category (e.g., bomber jackets). When this information is considered in a multivariate framework, there is a potential for extracting useful insights from this trendline for enhancing company-specific marketing strategies (Levy, 2014). Stitch Fix, the US-based online retailer, employs 75 data scientists and exploits Big Data analytics on consumer-style profiles to send shoppers a box of five items that have been selected by an algorithm (Murray, 2016). True&Co, ThreadMason, Stantt and Stich Fix provide customised garments using data on budgets, lifestyle and body scans (Gupta, 2016). The power of Big Data has become so great that for some retailers, fashion weeks are no longer the key source of information about fashion trends. For example, online clothing retailers such as Lesara (https://www.lesara.com/) (discontinued) moved away from relying on its designers going to fashion weeks, and instead, planned their product lines via the use of Big Data analytics to identify consumer trends (Costa 2016).

Technology is also playing a key part in Big Data analytics for fashion trends with firms like SAP (https://www.sap.com/) offering high-speed analytic capabilities (Sharma, 2017). Technology in the form of cognitive computing which relies on data mining, helps retailers simulate human thought processes and discover consumer needs via pattern recognition and natural language processing leading to faster insights into fashion trends (Murray, 2016). To this end, H&M has used AI and Big Data, and as a result, ended its long-standing practice of

stocking stores in different countries around the world with the same type of merchandise (Chaudhuri, 2018). Moreover, Big Data technology-based IBM's Cognitive Prints is aiding fashion designers with ensuring the novelty aspect of their designs by analysing vast amounts of image data looking for similarities (Kovacevic, 2018). Those interested in research into the use of AI in fashion are referred to Thomassey and Zeng (2018). Insights from Big Data analytics revamped H&M's fashion offering in its Stockholm Östermalm store which now gives prominence to female consumers and higher-priced items including floral skirts in pastel colours as opposed to basics for men, women and children (Chaudhuri, 2018).

However, as Silva et al. (2019a) note, trend forecasting with Big Data is not without its inherent problems. Forecasting with Big Data can be challenging for several reasons which include technical skills, signal to noise ratios, hardware and software, and architecture of algorithms, among others (Hassani and Silva, 2015). In the context of the fashion industry, there are, for example, concerns over the loss of creativity in fashion because most retailers rely on similar trends. This is where other Big Data technologies could similarly complement trend forecasts as IBM's Cognitive Prints does, by aiding fashion designers with ensuring that their designs are novel via the analysis of vast amounts of image data looking for similarities (Kovacevic, 2018). Also, predicting trends can be challenging due to a mix of complicating factors such as objective design issues and the cyclicality of fashion (Alton, 2018; Cooper, 2017). Big Data has struggled to process and understand societal attitudes, movements in politics, ethics, emotion, and aesthetics that influence fashion trends (McDowell, 2019). To help resolve these issues firms like Edited collect data for trend forecasting, housing the largest repository of fashion trend data containing 53 billion data points (Gupta, 2015). Yet, the actual effectiveness of Big Data tools at predicting fashion trends remains largely unknown (Sun and Zhao, 2018). The success of Big Data algorithms at predicting fashion trends depend on its capabilities at predicting the three most critical components for trend forecasting, colour; pattern; and design details (Blaszczyk and Wubs, 2018). Recently, Zara’s hot polka dot dress was in the news as a success story for old-school trend spotting versus Big Data (Felsted and Halzack, 2019). Whilst there are related theoretical advancements, empirical research using real data is still lacking (DuBreuil and Lu, 2020). Nevertheless, advocates of Big Data-based trend forecasting believe it to be capable of helping to improve the accuracy of trend forecasting (Chaudhuri, 2018).

### *3.2 Reducing Wastage in Production, Returns & Excess Inventory*

Fashion has a waste problem (Cernansky, 2020). Returns and excess inventory continue to be a severe financial challenge for the fashion industry. A study by IHL found that global returns of clothing and footwear total $642.6bn per year and that approximately 10% of these returns are a result of poor fit (Palmer, 2016). More recent evidence indicates that the value of excess inventory from spring/summer 2020 collections alone is estimated at €140 billion to €160 billion worldwide (Gonzalo, 2020). A former CEO at ASOS noted that a 1% reduction in returns can add $10 million to ASOS profits (Thomasson, 2013). One factor driving returns and depressing online purchase rates are concerns about the fit. In Germany, 35% of online shoppers aborted potential purchases because of concerns about fit (Thomasson, 2013). Initially, data analytics was able to show the fashion industry the scale of waste in the business (Bridgewater, 2019). But now, not only can Big Data analytics help minimise returns and improve purchase rates, but it can also improve purchasing and manufacturing decisions via data-driven insights into return/refund data (Hastreiter, 2016).

The Hong Kong Polytechnic University developed ‘WiseEye’, an intelligent fabric detection system built via Big Data analytics and deep learning (Tao, 2018). It not only helps detect defects instantly but also contributes to substantial reductions in loss and wastage in production with results indicating the system can reduce 90% of the loss and wastage in a fabric manufacturing process. Dong et al. (2020) exploited Big Data to propose an interactive, knowledge-based design recommender system (validated through several successful real design cases) that can interact between virtual product demonstration and the designer’s professional knowledge to find the best existing design solution, thereby helping to reduce unnecessary wastage through non-optimal processes. Gonzalo (2020) asserts that the best-performing companies enhance decision making by relying on Big Data analytics for simulating dynamic demand scenarios specific to locations and SKUs to synthesize the resulting inventory risk.

One example of Big Data at work to alleviate concerns about the fit was Fits.me (no longer available direct to retailers). This technology exploited data analytics to allow consumers to visualise clothes on different body shapes and was used in online purchases from brands such as Adidas and Hugo Boss (Thomasson, 2013). Similarly, applications such as EyeFitU exploit Big Data analytics to match users' measurements against sizing charts from thousands of brands and filter online shopping results down to the items most likely to fit (Palmer, 2016).

Likewise, overproduction is one of the costliest and most environmentally damaging aspects of the fashion industry (Cernansky, 2020). The problem of overproduction is real with the UK alone sending an estimated £140 million worth of clothing into landfill each year (Bridgewater, 2019). Big Data can help solve the deadstock problem by providing more accurate demand forecasts, which in turn enables companies to optimize production planning (Alton, 2018). In this way, Big Data analytics can reduce excess inventory, which eliminates the need to offload excess inventory to discount retailers like TKMaxx. Selling excess inventory at a deep discount not only has adverse financial effects but could also lead to brand dilution which may have serious (and possibly disastrous) consequences in the long run (Costa, 2016). As Greene (2018) points out, Big Data analytics can enable jettisoning of superfluous stock via the streamlining of product lifecycles. An illustrative example is the case of H&M, a fashion company which is trying to reduce the need for markdowns by reducing the reliance on designers and switching to Big Data analytics and algorithms which analyse store receipts, returns and loyalty-card data (Chaudhuri, 2018). ‘Lovethesales’ (https://www.lovethesales.com/) uses Big Data analytics to help retailers maximize the financial recovery of excess inventory by matching the metadata of overstocked products with consumers actively shopping for products with matching behavioural metadata (Bridgewater, 2019). Recently, Google and WWF Sweden have partnered to create an environmental data platform to help fashion brands source materials responsibly through big-data analysis and machine learning, and WWF’s deep knowledge of assessing raw materials (Frost, 2020; Heathman, 2020).

Efficient pricing is another means of reducing excess inventory. Fashion retailers invest over $1 trillion in markdown programs through a one-size-fits-all markdown strategy that is not optimal for profitability (Saera, 2020). Leading apparel retailers are now exploiting advanced analytics to price smarter (Gerards et al., 2018). BenMark et al. (2017) suggest that a dynamic pricing solution should include five modules of which the elasticity module is based on time series methods and Big Data analytics. The Boston Consulting Group reported their experience with more than 20 projects where smarter discounting decisions with Big Data analytics led to 10-20% boosts in gross margin for in-season and end-of-season fashion sales

programs (Seara, 2020). Jet.com (discontinued following Walmart's acquisition) was an example of a retailer using Big Data and AI for dynamic pricing, whereby automated real-time price changes are used to maintain competitiveness (Medium, 2018). Also, some retailers use Big Data analytics and AI to always sell specific products for 10% less than Amazon's prices for the same items (Medium, 2018).

### *3.3 Analysing and Enhancing Consumer Experience, Consumer Engagement, and Marketing Campaigns*

Nowadays, consumers are increasingly relating fashion to their online or offline experiences. Accordingly, brand experience is now recognised as an emerging area in the field of marketing where the creation of memorable experiences is key for survival and competitive advantage (Kharat et al., 2018). Research by Jain et al. (2018) suggests that as much as 40% of all luxury purchases are influenced by a consumer's online experience. Some authors even suggest that this figure could be as high as 70% (Shonoiki, 2017). Yet, consumer experience is a relatively new construct from an omnichannel academic research perspective (Chauhan and Sarabhai, 2019) in an age where understanding the consumer is crucial for brands (D'Lima and Srivastava, 2019). In the past, smartphones used to be at the forefront of consumer experience, but recently Big Data has become a big game-changer (van Hooijdonk, 2017). Due to the increased competitive pressure within the fashion industry because of, factors such as fast fashion (Bhardwaj & Fairhurst, 2010; Sull & Turconi, 2008), fashion companies are actively searching for new and innovative ways to analyse and enhance the consumer experience and differentiate themselves from other brands. Given the easy access to information in the digital era, how fashion products are priced has a significant impact on consumer experiences both online and offline. H&M is an example of a company that ensures their fashion is priced right by utilizing Big Data analytics on currency fluctuations and raw material costs (Chaudhuri, 2018).

Big Data presents a niche opportunity for brands which are willing to explore and actively engage with it to analyse and enhance consumer experiences. Another example is Macy's which uses Big Data-based trend forecasts by gathering and analysing data on shopping behaviour on social media, the company's website, and store transactions. Macy's also attempts to improve the consumer shopping experience by targeted discounting of products based on tweets (van Hooijdonk, 2017).

Jain et al. (2018) reports that the luxury fashion brand Montblanc collaborated with RetailNext and deployed video analytics in-store to map where consumers spent most of their time. This information was used to make decisions about the placement of products and staff, which led to a 20% increase in sales (Jain et al., 2018). Burberry also has a reputation as a luxury fashion brand which invests heavily in Big Data analytics intending to enhance the customer experience (Marr, 2017; Marr, 2018a).

Moreover, evidence suggests that Big Data is being used to alter the traditional consumer experience concerning fashion runway shows. To this end, Tory Burch delivered an all-new consumer experience when she turned the runway show into a retail store in real-time (Trites, 2013). Furthermore, there are several other Big Data related technologies (e.g., Radio Frequency Identification (RFID), WiFi analytics and Beacon analysis) which can be used to help improve the consumer experience (Salim, 2017). For example, Euclid Analytics uses location analytics through WiFi signals on smartphones to monitor consumer traffic in stores and thereby enables a more personalised service the moment consumer steps into the

store (Murray, 2016). North Face uses IBM's Watson technology to provide personalized winter jacket recommendations whilst Uniqlo approaches personalised consumer experiences by using AI and Big Data analytics when they measure brain signals in kiosks that use neurotransmitters to gauge customers' reactions as they are shown different clothing items (Morgan, 2019).

Another way in which Big Data can enable consumer engagement in fashion is through the design of clothing. Instead of having to follow the traditional high-cost in-house design process, fashion brands can easily outsource fashion design to designers across the globe, and brands can use Big Data to manage the feedback and iteration process (Greene, 2018).

Today, fashion companies operate in the "age of omnichannel retailing" (Brynjolfsson et al., 2013) and sell both online and in traditional brick-and-mortar stores (Bell et al., 2014). The distinctions between offline and online channels are increasingly blurred (Brynjolfsson et al., 2013). The integration of online and offline channels lead to a greater need analyse and enhance consumer engagement. Big Data aids in the analysis and understanding of how the consumer engages with brands, insights which are vital for enhancing brand equity and brand communications (Greene, 2018). The use of Big Data analytics can be crucial for the ability of luxury brands to identify, understand and connect with their customers, which can build long-term engagement. Luxury brands must cultivate long-term customer relationships since 85% of luxury brands sales come from existing consumers already registered in their databases (Jain et al., (2018). Big Data enables brands to improve their consumer engagement as analytics on comments can guide the dissemination of effective content and lead to innovative concepts and ideas (Sharma, 2017). Furthermore, data analytics on consumer shopping behaviour can help improve store management and design. Optimal store layout can have positive effects not only on consumer engagement but also consumer experience (Murray, 2016).

Using Big Data analytics, Burberry found that more consumers engaged with their website than with their brick-and-mortar retail stores around the globe (Jain et al., 2018). Similarly, Chaudhuri (2018) notes that the fashion retailer GAP (http://www.gap.co.uk/) also relies heavily on online monitoring of customer preferences and uses Big Data analytics from Google Analytics (https://www.google.com/analytics/). Liu et al. (2019) used Big Data analytics to investigate how luxury brands social media marketing impacts consumer engagement. Through the analysis of 3.78 million tweets from 15 luxury brands, they found that focusing on the entertainment, interaction, and trendiness dimensions of a luxury brand's social media marketing efforts significantly increase customer engagement, while focusing on the customization dimension does not.

Fashion marketing too has also evolved over the years (see e.g., Jackson & Shaw, 2008) and the marketing of fashion has gotten much more complicated following the emergence of Big Data in fashion. Those readers interested in an in-depth review of the use of Big Data analytics in marketing are referred to Wedel and Kannan (2016). Companies can now gauge consumer reactions to products and marketing campaigns by opinion mining likes, shares and comments on social media platforms such as Facebook, Instagram and Pinterest (Greene, 2018). Burberry has exploited Big Data to map its market, identify the importance of Millennial consumers for its top line and overhaul its marketing department (Jain et al. 2018). Moreover, in the digital era, personalisation and customisation have become key factors for companies operating in the fashion industry. Fashion companies can tailor promotions and special offers in a more effective way since companies can utilize Big Data to identify and understand what the customer needs and wants (Greene, 2018). For example, brands can create highly personalised email campaigns using marketing automation software (Greene,

2018). The enaction of General Data Protection Regulation (GDPR) has made personalisation even more important since consumers may otherwise chose to opt-out of marketing campaigns that are not personalised to their needs.

### *3.4 Better Quality Control and Fewer Counterfeits*

The fashion industry is also home to a $500bn counterfeit industry (Cocking, 2018; Shannon, 2017). According to the Office of the United States Trade Representative (2017), imports in counterfeit and pirated physical products is estimated at around 2.5% of global imports. Therefore, governments and companies are now increasingly utilizing new technologies to fight back against phoney products (Li, 2013). As noted by Kovacevic (2018), pattern recognition in combination with Big Data can be useful to help brands protect their brand integrity via improved quality control and reductions in the dissemination of counterfeits. To this end, image recognition software in combination with Big Data is also recognised as a viable solution for helping companies protect their brands (Coles, 2018). For example, Amazon relies on Big Data-based machine learning as part of its Brand Registry program to remove counterfeit products from its website. Similarly, the Chinese e-commerce company Alibaba has set up a Big Data Anti-Counterfeiting Alliance in partnership with fashion brands such as Louis Vuitton and Swarovski (Bobila, 2017) combining technology and Big Data to fight counterfeits (Coles, 2018).

Liang and Gai (2015) proposed a novel Big Data-based mechanism to proactively prevent counterfeits in the Chinese context and found that it was successful when tested in four cases. Marr (2017; 2018a) notes Burberry's efforts at fighting counterfeits using and exploiting Big Data in the form of AI-powered image recognition from Entrupy (https://www.entrupy.com/) which can spot a counterfeit with 98% accuracy.

Interestingly, the exploitation of Big Data to fight counterfeits is not limited to fashion brands. Leung (2018) reports that Hong Kong customs is using a Big Data Analytics system to sift through vast amounts of information found on different social platforms and shopping sites to identify counterfeit goods sellers. Finally, Meraviglia (2018) notes that the role of the consumer is often overlooked in discussions of counterfeiting in the fashion industry and shows that consumers are also increasingly using new technologies to take part in the fight against counterfeiting.

### *3.5 Shortening Supply Chains*

Efficient supply chain management is a key factor in the fashion industry which can make or break any given fashion brand (Brun et al., 2008; Sen, 2008). Big Data can help shorten supply chains and thereby enable fashion retailers to obtain a competitive advantage in the market (Brownlow et al., 2015) by improving the speed, flexibility, cost, and sustainability across supply chains (Gonzalo et al., 2020). Choi and Shen (2016) point out that Big Data technologies can enable a sustainable supply chain and they propose a five-step framework for achieving sustainable fashion supply chain management in the big data era. Choi (2017) conducted a study that showed how Big Data could improve forecasting and enable quick response fashion supply chains.

Brownlow et al. (2015) note how Zara exploits real-time sales statistics, as well as data from blog posts and social media to rush emerging trends to the market. One illustrative example of this is how Zara capitalised on a dress worn by Beyonce on the opening night of

her world tour. By using Big Data analytics, Zara was able to quickly design, manufacture and profit from this social media storm and the general positive buzz before the culmination of Beyonce's tour (Brownlow et al., 2015). In a similar vein, Marr (2018b) finds evidence showing that H&M can create more flexible and faster supply chains using insights from Big Data and Artificial Intelligence. See-to and Ngai (2018) observed Big Data on customer reviews from a major Chinese e-commerce platform at granular, half-daily intervals and found that big data streams of customer reviews contain useful information for better sales nowcasting. In turn, using such data translates into better decision-making about lead and lag times in fashion supply chain management. Choi (2018) studied how the incorporation of social media observations can enable quick response supply chains in the fashion industry. Gonzalo et al. (2020) note three ways in which leading fashion companies are leveraging big data and analytics for supply chain management. First, they exploit radio-frequency identification (RFID) for more efficient product tracking and reductions in in-store merchandising manipulation. Secondly, efficiency (i.e., chances of better product availability, and faster, cheaper, and more accurate deliveries) is increased by automating logistics through digital warehouse design and predictive exception management. Thirdly, AI-powered predictive models are used to stock predicted amounts of inventory in warehouses nearby certain neighbourhoods and cities.

# 4 Conclusion

## *4.1 Key Findings*

This paper begins by giving an overview of the current state of Big Data in fashion. We then consider the influence and usefulness of Big Data from social media and Google Trends on operations within the fashion industry. There is evidence of many fashion brands actively engaging with social media whilst the most proactive fashion brands such as Chanel, Louis Vuitton, Burberry, Michael Kors, and Pink Boutique (to name a few) are seen making the most of their online presence. In terms of the fashion industry exploiting Google Trends, the review suggests that except for engagement with social media, many fashion brands have yet to maximize the opportunities presented via Google Trends. Nevertheless, the review has shown that Google Trends can not only perhaps help in predicting variables of interest for fashion management and help predict fashion trends, but it could also be an active component in future fashion designs.

In terms of how companies appear to be exploiting Big Data to the advantage of their brands, the review uncovered has several areas where Big Data can be applied and exploited: (1) trend forecasting, (2) reducing wastage via production, returns, and excess inventory, (3) analysing and enhancing consumer experience, (4) improvements in quality control and fewer counterfeits, and (5) shortening supply chains. Overall, we find evidence indicating that brands such as Zara, H&M, ASOS, Adidas, Hugo Boss, Macy’s, Montblanc, Tory Burch, GAP, and Ralph Lauren have jumped on the Big Data bandwagon and started experimenting with the utilization of Big Data analytics to improve their operations.

## *4.2 Managerial Implications*

Our review has shown that Big Data can be applied and exploited in a multitude of ways by the fashion industry. However, for fashion companies to be able to fully capitalize on Big Data, they must overcome several technological, human and organizational barriers (Alharthi et al.,

2017). The successful implementation and roll-out of Big Data in the fashion industry are likely to be hindered by several challenges that are worthy of consideration.

First and foremost, GDPR is a major concern for fashion companies that might wish to exploit Big Data in their day to day operations (Adegeest, 2018). The new privacy-related regulations not only hinder how one can use the available data but could also result in companies losing the free access they had to rich consumer data. This ties in with ethics and privacy concerns relating to Big Data and Data Mining which have been problematic since its inception (Rubenstein, 2012; Nunan and Domenico, 2013).

Secondly, fashion graduates (and the next generation of fashion industry practitioners) may lack the technical competence required to make sense of Big Data. This challenge could be turned into an opportunity as it encourages collaborations between fashion industry experts and data scientists but finding the right balance between data science and industry expertise and know-how could prove difficult.

Thirdly, there is an ever-increasing need for fashion graduates to be more data-savvy. This could only be achieved via the incorporation of statistics, machine learning and other data sciences subjects within the fashion degree curriculum. Whilst it is not necessary to delve into the theoretical side of data science, what is perhaps more important is to equip and enable fashion students to make sense of Big Data via the application of data science techniques which are these days are mostly automated. To this end, the Fashion Business School at London College of Fashion (LCF) seeks to cater to this gap in the market by introducing students undertaking its integrated MSc Strategic Fashion Management course to business analytics with R Studio, statistical data analysis (parametric and nonparametric techniques) and the basics of machine learning (linear and logistic regression). Whilst this is a step in the right direction, it would be useful to introduce more data science techniques such as, for example, Neural Networks, Random Forests and Support Vector Machines so that graduates will have a more all-rounded appreciation of the importance and usefulness of Big Data analytics in fashion.

Fourth, access to fashion industry data is rare. In comparison with other industries, it is difficult to gain access to micro-level fashion data and this hinders research and development. Thus, the industry should consider making its data more available for research and development purposes. Finally, as more fashion brands begin to embrace Big Data, they must understand the importance of both AI and human resources. A sound example is the use of Big Data analytics and AI by H&M which saw the algorithm suggesting the retailer promotes Reindeer sweaters in January based on increasing sales in the run-up to Christmas, a flawed insight that would be obvious to a human (Robles, 2018).

In conclusion, it is clear that Big Data will have a lasting impact on the fashion industry, and provides several benefits to fashion retailers which potentially can be exploited to improve performance. Still, the industry has a long way to go in terms of making the most of Big Data in their day to day operations. Therefore, it is encouraging to see private companies such as Edited, WGSN, SAP and Holition (for example) taking the lead in terms of applying Big Data analytics in fashion with academic institutions such as LCF too contributing through the Fashion Innovation Agency (http://www.fialondon.com/). However, more brands should seek to collaborate with and/or learn from these companies in the future. Since the fashion industry has a proud tradition of creating new trends, it is time that they embrace the opportunities afforded by new technological advances and the proliferation of big data about fashion consumer behaviour.

### *4.3 Limitations and Future Research*

Like any piece of research, this study has some limitations. Since we decided to carry out a narrative review, this raises the possibility of biases related to the selection and evaluation (Ferrari, 2015). Therefore, such biases could have affected how we have appraised the selected studies and arrive at our conclusions concerning the state of current knowledge. Thus, our article should be seen as an exploratory first step to build a general overview of the state of Big Data in fashion. In the future, researchers could follow a more systematic review approach, which would entail steps such as using well-defined queries, explicit criteria for the selection of articles, and more stringent procedures and standards for appraisal and synthesis of data (Ferrari, 2015).

In our view, researchers must continue to evaluate this field of research, especially since it is a relatively new area that is still rapidly evolving in different ways. Moreover, the current COVID-19 crisis will undoubtedly change many aspects of business and society (Bapuji et al. 2020), and the fashion industry will not be immune to the changes. For example, the increased use of the Internet and social media for shopping will mean that Big Data will become even more important for fashion companies (Silva and Gee, 2000). Therefore, in future work, researchers could explore in more detail how the COVID-19 crisis influences the need for and use of Big Data in the fashion industry.

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