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Using Martech for Sustainable Fashion Retail - A Bibliometric Approach

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Abstract

The present study aims to analyse the current research trends trying to capture the patterns and themes that connect Martech and Sustainable Fashion retailing; to identify the directions for further research in this specific area. The PRISMA model was utilized to identify the 255 articles between 1996 to 2024 from Web of Science. Further Bibliometric analysis was conducted using VOSviewer software and R Bibliometrix package through Biblioshiny interface. Co – occurrence keyword analysis led to the identification of four clusters and bibliometric coupling analysis led to identification of five clusters. Thematic analysis revealed various emerging themes for future research. In the future, the authors' framework "Martech Conjunction with Sustainable Fashion" can guide further research regarding Martech's use in sustainable retail.

Keywords: Marketing Innovation, Sustainability Marketing, Fashion, Retail, Bibliometric Analysis, PRISMA model

1. INTRODUCTION

Since, the dawn of the 21st century a lot of advancement has been experienced in the production of apparels and textiles. This, has led to the decrease in the overall production cost of the apparels [1]. Furthermore, these low-cost apparels led to the emergence of fast fashion. On an average, in US, a particular person wears a specific apparel only for eight to ten times before it is thrown away (approximately 11 million tons of apparels are discarded every year in US alone) [2]. These discarded apparels often end in landfills where they cause further pollution, since they contain harmful chemicals like lead, pesticides, fertilizers etc, and remain in the soil for several decades [3].

Other than Environmental implications, many fashion companies were pointed out by the NGOs for not working towards social sustainability. 'Gucci' was accused of labour

abuses and unsympathetic working conditions [4]. ‘Chanel’ was also accused of not taking any steps to reduce its environmental footprints or to improve its labour’s working conditions [5]. Rana Plaza incident in Bangladesh remains a dark example of labour abuses for apparel production in Third world counties [6].

Marketing strategies adopted for selling environmentally friendly products to the previous generation might not be effective for Gen Z consumers [7]. In addition to this, Gen Z are already aware of the environmental and social problems around them; as they read, see and analyse their surrounding and follow global trends regarding the same [8]. Martech can be an effective tool for connecting with this young generation. Further, Martech can also be useful in decreasing the attitude-behaviour gap of common masses regarding sustainable fashion [9].

Although there are several reviews on Sustainability, Sustainable Fashion, or Martech, there is dearth of any reviews combining these terms together. Moreover, most of the reviews focus on manufacturing and supply chain of fashion industry with few taking up consumers point of view. It serves as an important knowledge gap which need to be addressed since, consumers today are aware of environmental and social costs of fashion industry and also are tech savvy. Thus, for fashion brands it becomes absolutely necessary to inculcate Martech in their communication strategy to directly address their intended audience.

The present study incorporates the Bibliometric and Thematic approach for shedding the light on the convergence trends between the Martech and Sustainable Fashion, particularly the use of technology for communicating sustainability in fashion industry to the consumers. Since, the body of knowledge comprising of Martech and Sustainable Fashion is broad and diversified, Bibliometric analysis was conducted to get a glimpse of past, present and future of the topic. It is especially useful for getting a bird’s eye view of the research domain since it is systematic, transparent, replicable and comprehensive [10].

Table 1. Past reviews on Sustainable Fashion and Martech in Fashion Industry

Authors (Year)	**Review Type**	**Review Focus**
Sustainability		
Khalek and Chakraborty [11]	Systematic Review	Adoption of Shared Consumption Practices
Pendse et al. [12]	Bibliometric Analysis	Progress of Greenwashing Practices and Behaviour as a subject of scholarly interest
Sustainable Fashion		
Harsanto et al. [13]	Systematic Review	Present state of Sustainability (Product Innovation, Process Innovation & Organisational Innovation) Innovation in Textile Industry
Di Vaio et al. [14]	Systematic Review	Role of Responsible Innovation (RI) for promotion of Ethical Corporate Behaviour (ECB) in Asian Fashion Industry
Sinha et al. [15]	Systematic Review	Consumer Awareness and Acceptance regarding Sustainable Fashion (SF)
Dabas and Whang [16]	Systematic Review	Evolution of Sustainable Fashion Consumption (SFC) from a product-based phenomenon to gradually include broad sustainable fashion practices
Islam et al. [17]	Systematic Review	Consolidation of Sustainable Manufacturing Practices across Textile, Apparel and Fashion (TAF) industries and developing a framework for the same
Mukendi et al. [18]	Systematic Review	Defining and conceptualisation of Sustainable Fashion over the years
Thorisdottir and Johannsdottir [19]	Systematic Review	Impact of Corporate Social Responsibility (CSR) on the Sustainability implementation with Fashion Industry
Thorisdottir and Johannsdottir [20]	Systematic Review	Implementation of Sustainable Practices into Business Models and how to measure it

Authors (Year)	Review Type	Review Focus
Sustainability		
Tey et al. [21]	Vote Count Analysis	Factor's affecting Consumer's Willingness to Pay a premium for Sustainable apparel
Desore and Narula [22]	Systematic Review	Major driver's and barriers across textile firms supply chains for sustainability implementation
Karaosman et al. [23]	Systematic Review	Framework for integrating Environmental and Social Sustainability Practices in Fashion operations (product, process and supply chain levels)
Martech		
Singh and Basu [24]	Systematic Review	Technology Acceptance by consumers for online shopping
Jadhav et al. [25]	Systematic Review	Impact of digital marketing implementation on SME firm's performance
Ghorbani et al. [26]	Systematic Review	Development of a model for Consumer's Perception of Digital Brand Personality
Using Martech for Promotion of Fashion Products		
Noor et al. [27]	Systematic Review	Use of Artificial Intelligence (AI) for optimising manufacturing and retailing of Apparels
Using Martech for promotion of Sustainable Products		
Cano et al. [28]	Bibliometric and Systematic Review	Role of E-marketplaces and open innovation in the achievement of Sustainability
Using Martech for the promotion of Sustainable Fashion Products		
Mesjar et al. [29]	Systematic Review	Role of Technology in the Supply Chain of Fashion industry to attain Sustainability

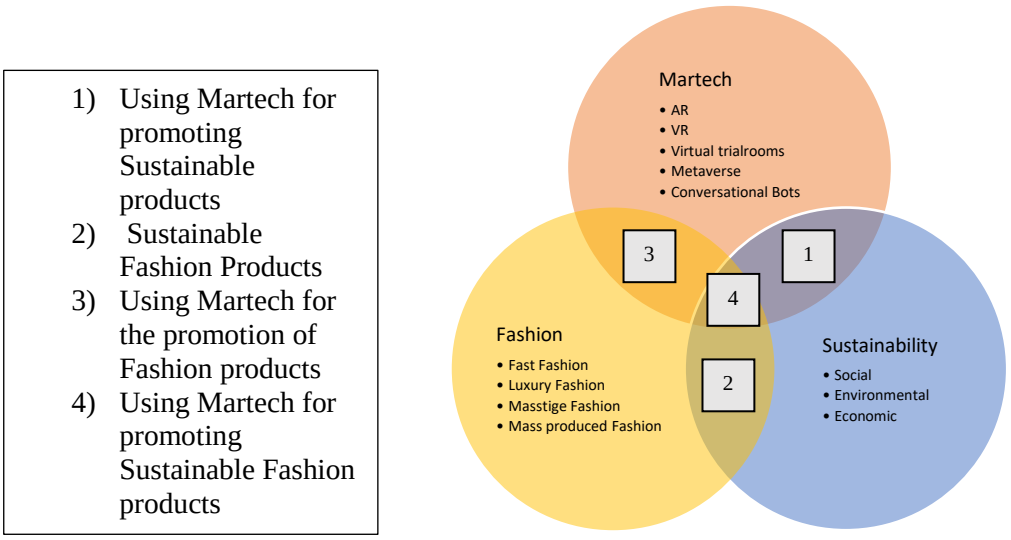

Figure 1. Venn Diagram for Martech Conjunction with Sustainable Fashion

In view of above background, the present study focuses on the given research questions–

Q.1 – What is the trajectory of research related to Martech with respect to Sustainable Fashion?

Q.2 – What are the emerging themes which can lead to convergence of Martech and Sustainable Fashion?

Q.3 – What are the future research opportunities for Martech adoption in Sustainable Fashion?

2. METHODOLOGY

Bibliometric Analysis is the method of research focused on previous published literature from databases like Web of Science (WoS), Scopus, Pubmed, etc; finding the trends, patterns and relationships between them to identify the sources for new research areas in the future. This method focuses on various keywords, citation analysis, journal data, author data, research domain data etc. It is considered to be more objective in nature being systematic, transparent and replicable and is able to tackle the subjective biases of the researcher [30].

It consists of performance analysis and science mapping. Performance analysis is a method of analysing criteria like authors, publications, evolution, journals, countries, etc using citation received by articles and their publications [31]. On the other hand, science mapping is used to develop relationships among articles based on research constituents [10].

Figure 2. Research Process

The present study was done in accordance with the Preferred Reporting Items for Systematic Reviews and Meta – Analysis (PRISMA) [32] guidelines as shown in Figure 3.

In step 1, various literature reviews were assessed for the identification of appropriate keywords, each for Sustainable, Fashion, Martech and Behaviour [33], [34] and [35]. Finally, the keywords which were used to search the relevant literature are as follows –

“Sustain*” OR "Ethical" OR "Circular" OR "Fair Trade" OR "Responsible" OR "Eco" OR "Green" OR "Environment*" OR "Cradle to cradle" OR "Second Hand" OR "Organic" OR "Recycle" OR "Upcycle" AND

"Fashion" OR "Apparel" OR "Textile" OR "Cloth*" OR "Garment" OR "Outfit" OR "Attire" OR "Costume" OR "Cotton" AND

"Martech" OR "Engineering" OR "Technology" OR "Innovation" OR "IR 4.0" OR "Information and Communication Technology" OR "Internet of Things" OR "Artificial Intelligence" OR "Virtual Reality" OR "Augmented Reality" OR "Big Data" OR "Cloud Computing" OR "Virtual Services" OR "Softbots" OR "Chatbots" OR “Metaverse” AND

"Behaviour" OR "Behavior" OR "Consumer" OR "Consumption" OR "Purchase Intention" OR "Branding" OR "Retailing" OR "Buying".

Further, previously Cano et al. [28] has used the Scopus database to connect E-marketplaces through Open Innovation to Sustainability. Other authors also have utilised the Scopus database extensively for their literature reviews in the past like [25], [14], [23] and other databases like ProQuest [16], [22] and [20]. Thus, we see that there is a lacuna of research conducted specifically using Web of Science database. Therefore, for literature identification, only the research articles appearing reputed peer reviewed journals in Web of Science (WoS) were considered for the review. Furthermore, WoS have a stringent indexing criterion for journals (like SSCI and SCI) than Scopus [36] on the other hand it is also useful for conducting a multi – disciplinary research [37].

In step 2, the cleaning of data was done was on specific criteria. Only research articles which are published in journals, were included for the evaluation and unpublished articles, conference proceedings, book chapters and editorials were excluded. Only the research articles which were in English language were assessed for evaluation, since English has a global appeal. Whereas, it would be very difficult for other languages to get the same meaning after the translation. Further, the research articles which appeared in Management, Business, Economics, Consumer Behaviour and Operation Management categories were included in the evaluation process and other categories like Core Engineering, Medical Sciences, Humanities, Agricultural Studies, etc were excluded from the research.

In continuation, the 'Title, Abstract and Full-text' of remaining 316 articles was evaluated for the eligibility of the articles. Out of 316 articles, only 255 were found appropriate for the final data analysis. 83 articles were excluded because they do not address Martech, Sustainable Fashion and Retailing together. Glänzel and Moed [38] discussed that in a Bibliometric Analysis, a sample size of 100 is deemed acceptable for getting good results.

For step 3, the researcher exported the total of 255 articles in plain text format from Web of Science with full citation records. These were further analysed using VOSviewer software (Visualisation of Similarities) [39] and R Bibliometrix package [40] through Biblioshiny interface for data analysis & findings are discussed in next section. All the data was assessed from Web of Science (WoS) core collection upto 31st December, 2024

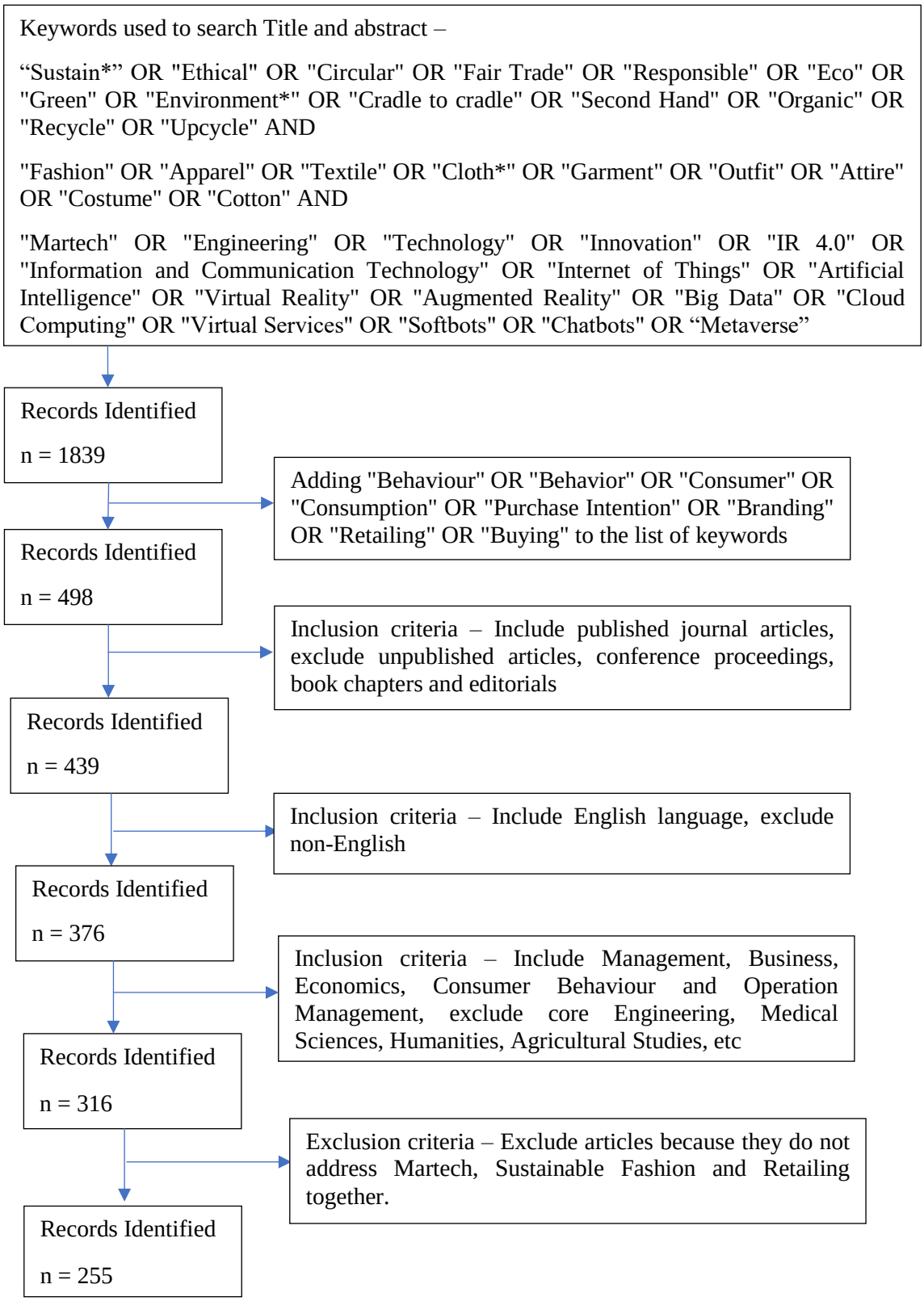

Figure 3. PRISMA flowchart of study (Adapted from Moher et. al., 2009)

3. PERFORMANCE OVERVIEW OF THE PUBLICATIONS

3.1 Evolution of Articles

Figure 4 given below shows the frequency of research articles during the time period of 1996 to 2024. The first article appeared in WoS in 1996 and since then there has been a significant increase in the number of articles. We identified three phases in this evolution – Emergence (1996 to 2010) comprising of 16 articles, Pre expansion (2011 to 2016) comprising of 35 articles and Expansion (2017 to 2024) comprising of 182 articles. The introduction of Sustainable Development Goals (SDGs) in 2015 led to a significant increase in the research interest in the given field. Another considerable increase came during the 2020 due to emergence of Covid – 19. The people were locked inside their homes and became more health and environment conscious while marketers relied on newer technologies to reach out to their intended audience. The authors are optimistic of the growth potential of the domain as it is still in its infancy stage.

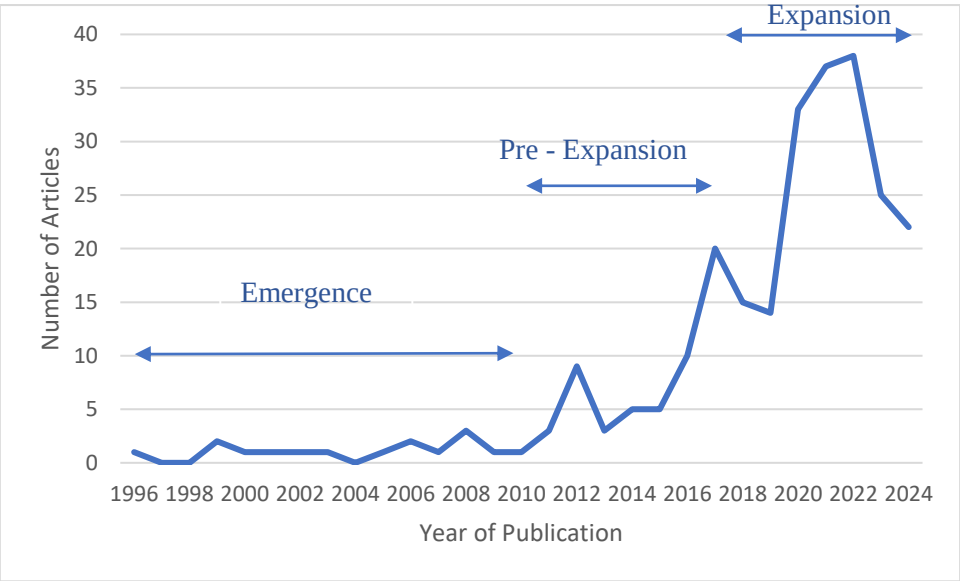

Figure 4. Evolution of Research Articles

3.2 Performance and Citation Trends

The trends for citations and publications related to Martech convergence with Sustainable Fashion is provided in the Table 2.

Table 2. Publication and Citation metrics for the given research domain

Panel A: Publication Metrics	**Statistic**
Total Publications (TP)	255
Total Cited Publications (TCP)	245
Article	242
Review	13
Number of Active Years (NAY)	28
Productivity per Active Year (PAY)	9.11
Panel B: Citation Metrics	**Statistic**
Total Citations (TC)	9783
Total Citations per Publication (TC/TP)	38.36
h – index	37
g – index	11
Panel C: Co - authorship Analysis	**Statistic**
Number of Contributing Authors (NCA)	682
Number of Unique Authors (excluding repetitions) (NUA)	564
Authors of single-author publications (ASA)	32
Authors of co-authored publications (ACA)	650
Single-authored publications (SA)	33
Co-authored publications (CA)	222
Collaboration Index (CI)	2.67

Here, Panel A shows the metrics related to Publications with 255 as total number of publications (TP), out of which 245 are cited which is 96.08% of the total publications. Out of 255, 242 are classified as articles (conceptual or empirical) in WoS and rest 13 are review articles (critical or systematic). The research domain is active for last 28 years from 1996 (NAY) having a mean of 9.11 articles per year (PAY). Panel B shows the metrics related to Citation with total number of citations (TC) received by the research domain, with each article receiving an average of 38.36 of citations (TC/TP). The h-index and g-index of the research domain is 37 and 11 respectively which shows the impact and influence of research activity in the field, where h-index shows h number of publications which are cited h times and g-index shows the "g" number of articles having "g2" number of citations. Panel C shows the metrics related to Co – Authorship Analysis with a total of 682 authors contributing to the field. 564 were unique authors, with single authored publications (SA) contributing 12.94% of total publications and a large number 87.06% were co-authored (CA). Each lead author collaborates with a mean of 2.67 authors for the development of field which is shown by Collaboration Index (CI) (NCA/TP).

3.3 Top 10 Most Prolific Authors contributing to the field

The top contributing authors to the field are shown in the Table 3.

Table 3. Top ten prolific authors for the given research domain

Author	TP	SA	CA	NCA	CI	TCP	TC	TC/TP	h	g	Start PY
Ko E	7	1	8	12	1.71	7	141	20.14	4	3	2015
Choi TM	6	0	6	17	2.83	6	145	24.17	5	4	2011
Chan HL	5	0	5	16	3.20	5	189	37.80	5	5	2016
Lee SH	4	0	4	4	1.00	4	56	14.00	4	3	2016
Caniato F	3	0	3	8	2.67	3	113	37.67	3	3	2017
Caridi M	3	0	3	8	2.67	3	113	37.67	3	3	2017
Cheng H	3	0	3	3	1.00	3	18	6.00	2	2	2020
Danese P	3	0	3	8	2.67	3	113	37.67	3	3	2017
Jin BE	3	0	3	4	1.33	3	77	25.67	3	3	2020
Parker CJ	3	0	3	4	1.33	3	83	27.67	3	2	2016
Vinelli A	3	0	3	8	2.67	3	113	37.67	3	3	2017

(Abbreviations include CA (co-authored publication), CI (collaboration index), g (g index), h (h index), and NCA (number of contributing authors). SA refers to a publication with only one author. Start PY represents the publishing year start, TC represents total citations, TC/TP represents average citations per publication, TCP represents total cited publications, and TP represents total publications.)

It shows that E. Ko is top contributing author with 7 publications followed by TM Choi and HL Chan with 6 and 5 publications respectively. Only E. Ko has contributed with single sole authored article, rest others have relied on collaboration to contribute. TM Choi has the longest run of articles starting from 2011. In terms of citations, HL Chan has maximum number of citations with 189 and also has the maximum of both h-index and g-index. In terms of average citation also, HL Chan leads the way with an average of 37.80 citations coming from 5 publications.

3.4 Top 10 Most Prolific Journals for the given research domain

The top journals having the publications related to the research field are provided in the Table 4.

Table 4. Top ten prolific journals by productivity for given research domain

Journal Title	TP	TC	CABS rating	ABDC rank	WoS JIF	Scopus h-index
Sustainability	38	461	NA	NA	3.9	136
Journal of Cleaner Production	16	463	2	A	11.1	268
International Journal of Retail & Distribution Management	13	257	2	A	4.74	94
Sustainable Production and Consumption	9	325	NA	NA	12.1	60
Journal of Fashion Marketing and Management	8	126	1	B	4.18	61
Journal of Business Research	7	148	3	A	6.33	229
Asia Pacific Journal of Marketing and Logistics	6	59	1	A	4.64	57
International Journal of Consumer Studies	4	78	2	A	7.1	88
International Journal of Production Economics	4	126	3	A	12	214
Journal of Retailing and Consumer Services	4	114	2	A	10.4	120

(Abbreviations include ABDC rank (Journal Quality List ranking in 2022 by Australian Business Deans Council), CABS rating (Academic Journal Guide ranking in 2021 by Charted Association of Business Schools), WoS JIF (Web of Science Impact Factor in 2024 by Clarivate Analytics), Scopus h – index (h – index provided by Scopus in 2024), TC represents total citations and TP represents total publications.)

Sustainability and Journal of Cleaner Production come out as top productive journals for the given research domain with 38 and 16 publications respectively. Most of the research journals have a h-index of greater than 100; mostly are ranked “A” by the Australian Business Deans Council and are rated as “3”, “2” and “1” by the Charted Association of Business Schools. This shows that the given research field is welcomed by the journals of international repute with diverse fields.

4. INTELLECTUAL STRUCTURE

The Intellectual Structure helps to uncover the major themes which emerge in the given field of research. Science Mapping is used to uncover this intellectual structure with techniques like Co – occurrence Analysis and Bibliometric Coupling [10].

Figure 5 show the collaboration among countries for the given research domain. The blue colour indicates the productivity rate of research articles with dark blue indicating higher productivity. The pink lines depict the collaboration among authors of different countries. Most of the research is occurring in the big apparel markets and apparel producing areas like USA, UK, South Korea, China and India. Research collaboration among USA and China is most prominent.

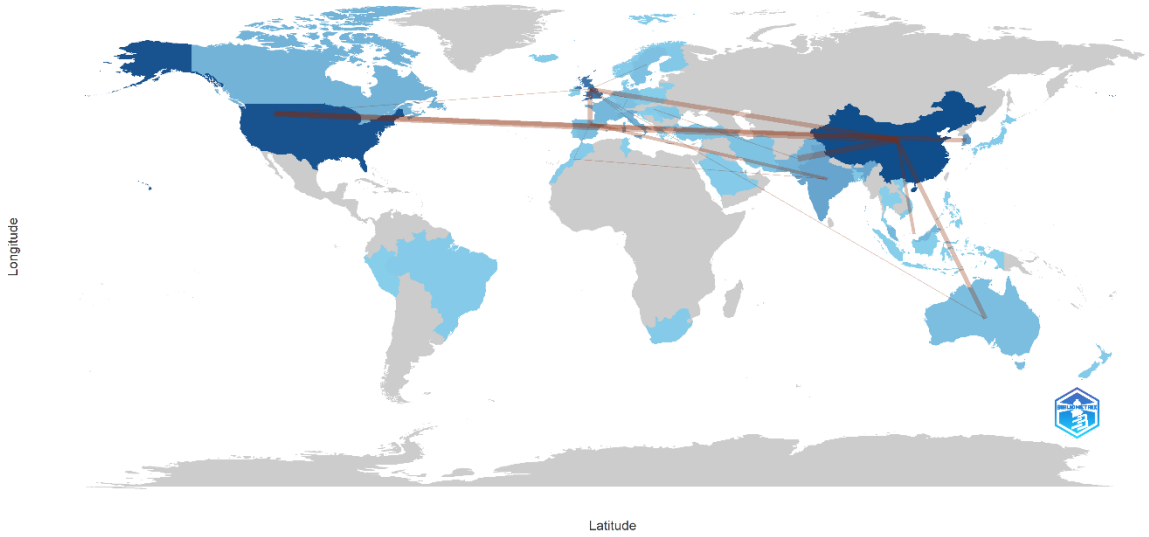

Figure 5. Country Collaboration Map

Overall, there is a lot which is still left to be explored. The researchers should also focus on Africa, Latin America and Central Asia and collaborate with the authors of those areas also. Pollution and climate change are global phenomena and directly associated with sustainability; if one region is also left out it would be quite decremental for overall sustainability efforts.

4.1 Keyword Statistics

This section helps us to identify and determine the important keywords which authors and publishers are focusing. As per bibliometric data, the authors focused on 872 keywords while publishers indexed these research paper with 731 keywords. The Table 5 provides a list of authors keyword and publisher indexed keywords with descending order of their occurrence.

Table 5. Top 10 author keywords and indexed keywords

Author Keywords	Occurrences	Indexed Keywords	Occurrences
Fashion Industry	31	Management	37
Sustainability	27	Model	36
E – commerce	15	Performance	34
Innovation	15	Impact	32
Supply chain Management	8	Innovation	31
Virtual Reality	8	Technology	26
Technology	6	Design	19
Augmented Reality	6	Online	14
Social media	6	Consumption	14
Sustainable Development	6	Experience	13

The Table 5 shows that the authors have used Fashion industry, Sustainability, E - commerce and Innovation most frequently, on the other hand indexers have used Management, Model, Performance and Impact most frequently. This helps us to validate the search strings which we have used. The authors have focused on achieving sustainability in fashion industry with the help of Martech tools specifically Virtual

Reality (VR), Augmented Reality (AR), E – commerce, social media and development of innovative technologies for the same. While, indexers focused on broader perspective like management, model and performance of Martech tools. In doing so, sustainability is sidelined by the indexers. So, authors' keywords were used for further analysis, since they are given by the authors themselves and they better specify the contents of the documents.

Fig. 6 shows the occurrence of authors keywords over years. It is seen that most keywords appeared around 2015 with the development of Sustainable Development Goals (SDGs) by UN. Over the years they have grown, with main keywords like Fashion and Sustainability leading the growth. Innovation previously followed them, but now keywords like Augmented Reality and E – commerce has overtaken it, showing newer dynamics of research in this field.

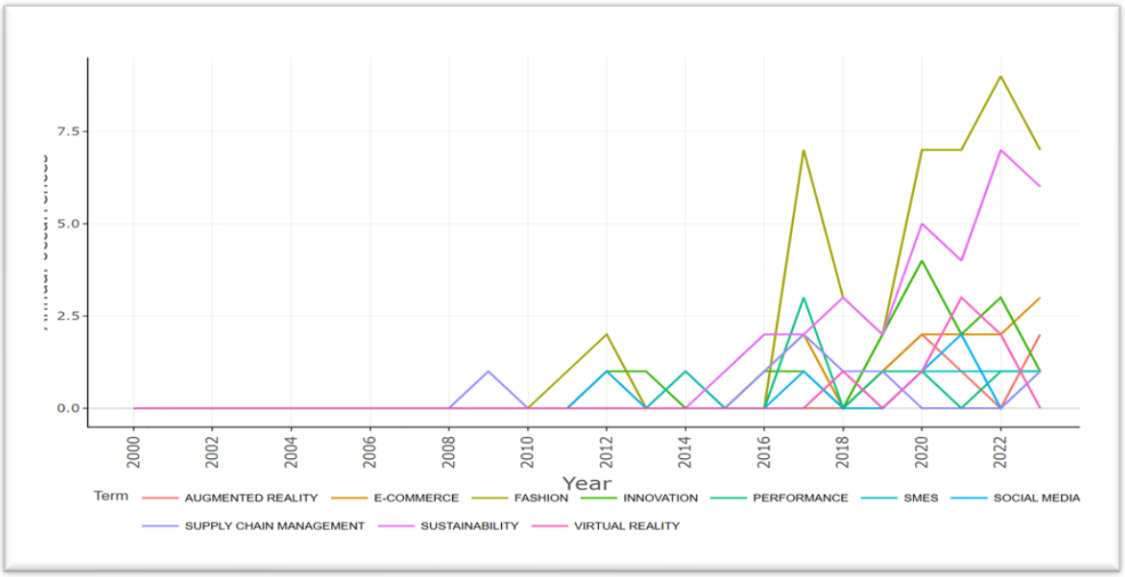

Figure 6. Evolution of Authors keyword over years

4.2 Keyword Co - occurrence Analysis

Keywords hold an important place in providing the detailed information about the present and central trends in a research domain. In this section, we develop and analyse network on the basis of author's keywords. Further, VOSviewer was used to decipher the keywords co – occurring together. Figure 7 provides the clusters based on keyword co – occurrence analysis.

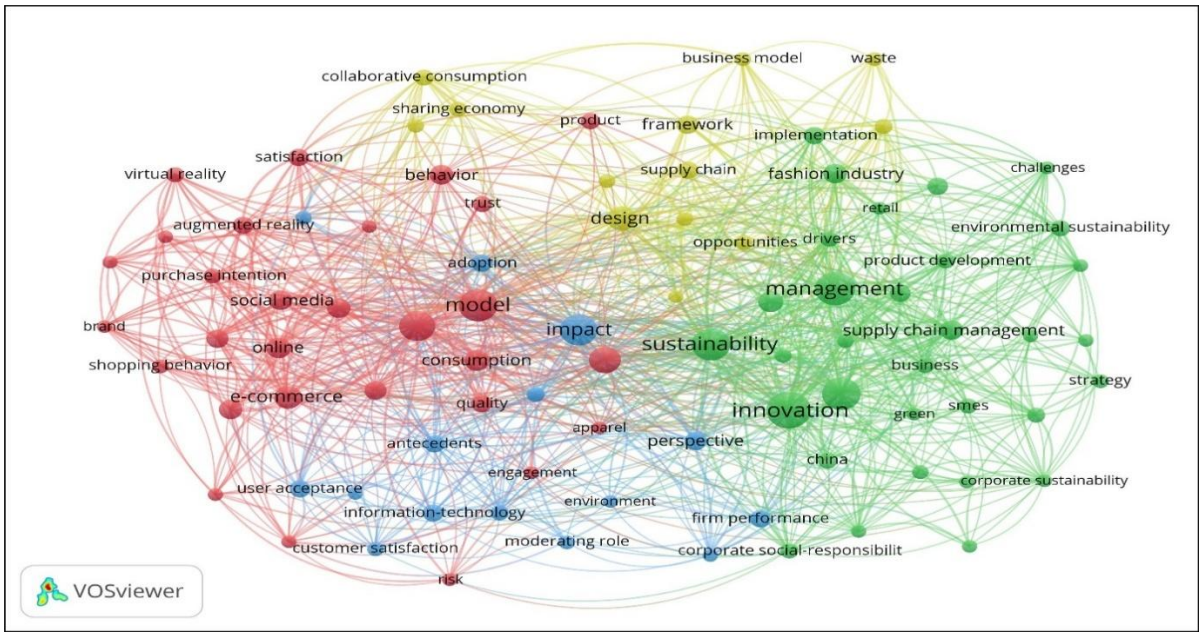

Figure 7. Co - occurrence Analysis

Sustainability and Innovation in Fashion Industry (Green Cluster with 32 Items)

Subthemes –

Using the items, we identified various sub themes within the cluster such as Sustainability Implementation which aligns with the topics like Sustainability, Drivers [41], Challenges, Environmental Sustainability, Collaboration, Green, Social Responsibility, Corporate Social Responsibility, etc. This cluster identifies with the difficulties, methods, models and motivation for sustainability implementation in apparel industry. [42] studied CSR's impact on sustainable purchase intention, [43] discussed the Sustainability challenges in Fast Fashion context. Environmental Sustainability is most discussed form of sustainability in terms of Corporate Environmental Sustainability [44]; firm's Voluntary Environmental Behaviour [45]; Collaboration [46]; etc followed by Social Responsibility in terms of Social Capital [47], Fast fashion [48], maximising Social Responsibility through Weighted Goal Programming [49].

Another important sub theme identified within the cluster is Organisational Capabilities which aligns with the topics like Innovation, Performance, Industry, Implementation, Textile Industry, Retail, Product development, Strategies, Supply Chain Management, Competitive Advantage, Knowledge Management, Smes, etc. This theme deals with the business entity and its potential to achieve operational excellence in both the production and promotion of Sustainable Fashion with the help of Martech applications. Innovation is discussed in terms of Product Innovation [50]; Business model innovation [51]; Innovation within Small & Medium Enterprises (Smes) [52]; Process innovation [53], Supply chain innovation [54]. Knowledge management is linked to Sustainable Performance of the firm [44]. Financial performance of firm's Sustainability adoption is studied via Stakeholder's Theory [55].

Martech within Fashion Industry (Red Cluster with 29 Items):

Subthemes –

Using the items, we identified various sub themes within the cluster such as Martech Tools, Medium of Interaction and Experience with Martech Tools. Martech Tools is identified with use of keywords like Model, Technology, Virtual Reality, Augmented Reality. This theme deals with the types of Martech tools and technology used within the Fashion industry and their implementation (Petit et al., 2019). Augmented Reality is used to increase a business entity accord with customers and online systems [56]; for Virtual Try On (VTO) [57] and in evaluation of a garment's features and style by consumers [58]. Virtual reality is used in terms extending the brand store reach in terms of Virtual Stores [59], use of VR in Luxury Fashion context [60] and designing VR stores [61]. They are used in conjunction to increase the shopping experience of consumers [62], to enhance multi-sensory experience [63], etc.

An important sub theme identified within the cluster is Medium of Interaction which have the keywords like Interactivity, Internet, social media, Online and E – commerce. This theme deals with the source through which the consumers interact with Martech tools. Interactivity is utilised as mobile phone touch points [64] and virtual try – on when touch points are not available [65]. Social media can be used to increase this interactivity in GenZ [66] and Millennials [67], [68] in enhancing Luxury experience in phygital world [69].

Another important sub theme identified withing the cluster is Consumer's Experience with Martech tools which have keywords like Motivation, Satisfaction, Trust, Consumer, Experience, Risk, Perceptions. This theme deals with consumer's emotions and feelings towards the Martech tools employed by the fashion industry. Hedonic and utilitarian motivations of consumers are having an effect on affective response towards augmented reality [70] while another study debunks this [71]. Trust was studied as a concept for Brand Trust [42] and trust related to Martech tools and platforms [72], [46]. Consumers are now looking forward to new Martech tools being used and have trust in them.

Sharing & Collaborative Consumption (Yellow Cluster with 13 items)

Subthemes –

The given theme give rise to various sub themes which are identified as follows – Personalisation and Waste Management. Personalisation is identified using keywords like - Mass Customisation, Information, Supply chain. This theme deals with the use of Mass Customisation for providing consumers with more sustainable choices. The researchers' emphasis on Manufacturing Flexibility (MF) for achieving this customisation [73] and can Mass Customisation really increase the sustainability quotient of apparel firms [74].

Another important sub theme identified within the cluster is Waste Management through keywords like - Waste, Circular Economy, Sharing Economy. This theme deals with addressing the issue of increased waste production due to fast fashion and increasing in the recycling behaviour of consumers. The researchers discussed about the changes need to be made in apparel supply chains bring down waste production [75]; Circular Fashion and Shared Fashion in form of renting and second - hand clothing is also showing good

response from consumers and may be useful in reducing the waste production [76]. They also explored the importance of Martech tools in the promotion of Circular Fashion practices among consumers [72]. In this cluster, [77] focused on Game theoretic approach for waste reduction and circular fashion.

Consumer Motivations & Outcomes (Blue Cluster with 15 items)

Subthemes –

The given theme give rise to various sub themes which are identified as follows – Change in Consumer & Consumer Decision Making. Change in Consumer is identified with the keywords like Impact, Adoption, Intention, User Acceptance, Customer Satisfaction. This cluster helps us identify the final outcome of a firm's efforts to promote Sustainable Fashion through Martech applications. User acceptance of new Martech tools and apps [78] like Blockchain – Enabled E – commerce Platforms (BEEP) [76] and if consumers are satisfied with these tools during their shopping journey [79] for Augmented Reality and for Virtual Fittings are discussed [62]. Consumer Satisfaction also helps Fast Fashion to better showcase their sustainability efforts to consumers [43]. Adoption is discussed in terms of apparel firm's adoption of Sustainability in their Supply chains and models [80], [81]; Stakeholders' influences on it [82] and implementing Martech tools in Luxury Fashion [83] & Consumers' adoption of Martech tools [84] and green practices [85].

Another important sub theme identified within the cluster is Consumer Decision Making through keywords like Decision Making, Information Technology, Antecedents, Determinants, TAM, Capabilities, Firm Performance, Perspective. This theme helps us to identify the intervention concepts and models that help in consumer decision making. Decision Making theories [86] helps in taking decisions for Sustainability initiatives implementation [87] and Martech tools adoption within the firms [88]. Authors have also discussed the Millennial shopper's decision making in an online world using cues like Martech tools and social media [68]. Technology Acceptance Model given by [89] is most preferred model used by authors to identify the consumers' acceptance of firms' sustainability efforts [90] via Martech tools [91]. Various antecedents like technology related (perceived interactivity, perceived autonomy, performance expectancy, facilitating conditions, perceived risks, perceived benefits) [92]; fashion related (visual aesthetics, functionality, fashion consciousness, personal innovativeness) [93]; psychographic antecedents (self - congruence, lifestyle congruence, environmental attitude, social pressure, environmental awareness, perceived ecological importance) [43], [94], [95]; buying motives (economic motives, hedonic motives) [76]; sustainability related antecedents (transparency of sustainability efforts, organisational flexibility, perceived channel integration) [96], [43] are identified during the course of study in research domain.

Table 6. Major co-word (thematic) Clusters for the given research domain

Cluster	**Themes**	**Topics**	**Sub Themes**	**Topics**
Green	Sustainability and Innovation in Fashion Industry	Sustainability, Management, Innovation, Performance, Fashion Industry, Implementation, Textile Industry, Retail, Drivers, Challenges, Environmental Sustainability, Product Development, Conceptual Framework, Strategies, Collaboration, Supply Chain Management, Textile, Firm, Efficiency, Business, Strategy, Green, Smes, Social Responsibility, China, Financial Performance, Corporate Sustainability, Competitive Advantage, Knowledge Management, Corporate Social Responsibility	*Sustainability Implementation*	Sustainability, Drivers, Challenges, Environmental Sustainability, Collaboration, Green, Social Responsibility, Corporate Sustainability, Corporate Social Responsibility
			Organisational Capabilities	Innovation, Performance, Industry, Implementation, Textile Industry, Retail, Product development, Strategies, Collaboration, Supply Chain Management, Financial Performance, Competitive Advantage, Knowledge Management, Smes
Yellow	Sharing & Collaborative Consumption	Design, Barriers, Opportunities, Collaborative Consumption, Sharing Economy, Information, Mass Customisation, Supply chain, Business Model, Circular Economy, Waste, Sustainable Development	*Personalisation*	Mass Customisation, Information, Supply chain
			Waste Management	Waste, Circular Economy, Sharing Economy

Cluster	**Themes**	**Topics**	**Sub Themes**	**Topics**
Blue	Consumer Motivations & Outcomes	Impact, Intention, Adoption, User acceptance, Customer Satisfaction, Information Technology, Decision Making, Antecedents, Technology Acceptance Model, Capabilities, Firm Performance, Moderating role, Environment, Perspective, Determinants	*Change in Consumer*	Impact, Adoption, Intention, User Acceptance, Customer Satisfaction
			Consumer Decision Making	Decision Making, Information Technology, Antecedents, Determinants, TAM, Capabilities, Firm Performance, Perspective
Red	Martech within Fashion Industry	Model, Technology, Fashion, Virtual Realty, Augmented Reality, Motivations, Interactivity, Satisfaction, Trust, Internet, social media, Online, E-commerce, Shopping Behaviour, Consumers, Experience, Quality, Apparel, Perceptions, Engagement, Risk, Consumer responses	*Martech Tools*	Model, Technology, Virtual Reality, Augmented Reality
			Medium of Interaction	Interactivity, Internet, social media, Online and E – commerce
			Experience with Martech Tools	Motivation, Satisfaction, Trust, Consumer, Experience, Risk, Perceptions

4.3 Bibliometric Coupling

It works on the references of an articles to undercover emerging themes in the given research domain to guide future research works [12]. In this, the relationship is stronger if the number of references cited in common in two publications [40]. The Bibliometric Coupling analysis resulted in following five clusters as shown in Figure 8.

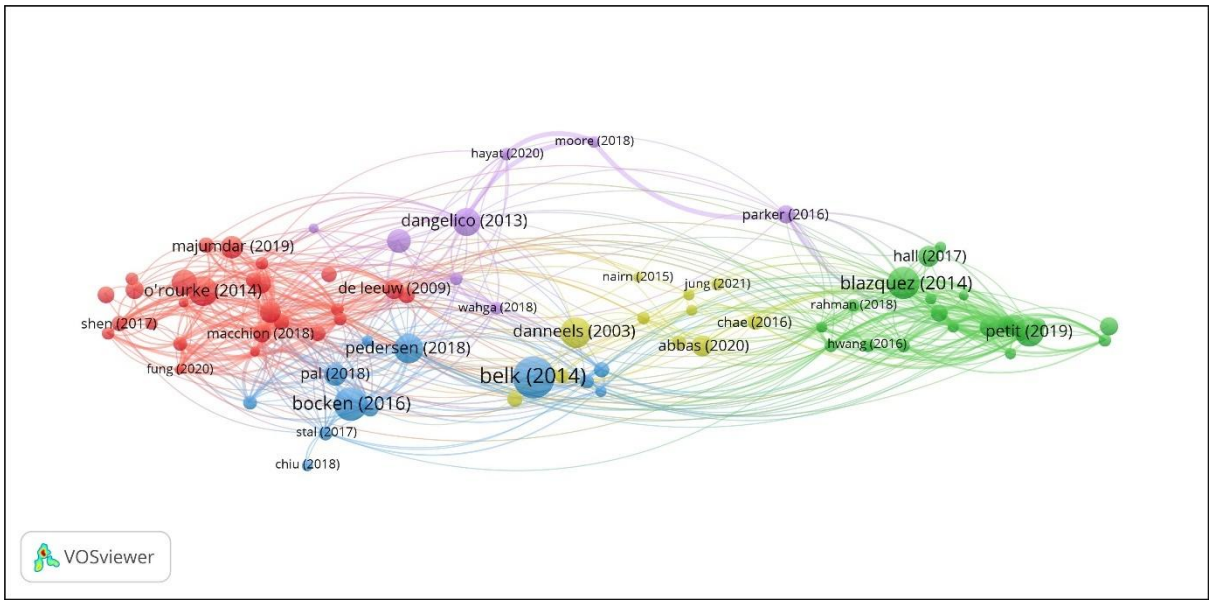

Figure 8. Bibliometric Coupling Analysis

Green Supply chain in Fashion Industry with CSR – Upon analysis, this cluster (Red) is able to generate a total citation (TP) of 1442 from 26 articles having an average of 55.46 citations per article. The oldest article from this cluster is published in 2009. This cluster sheds light on how to make the supply chain and operations within Fashion industry more sustainable and greener [81] and how CSR is affecting the greening of Fashion supply chains [21]. The journals in this cluster also focus on productions and operations research like Sustainable Production and Consumption, Journal of Cleaner Production, International Journal of Operations & Production Management, Production Planning & Control, etc.

Innovative Sustainable practices Adoption by firms - Upon analysis, this cluster (Blue) is able to generate a total citation (TP) of 1112 from 12 articles having an average of 92.66 citations per article. The oldest article from this cluster is published in 2014. This cluster sheds light on the Innovation which is being undertaken by firms, especially textile and apparel firms, to bring about sustainable changes throughout their organisation [97]. It also focuses on use of new technologies and models to implement these [98]. The journals in this cluster also focus on innovations, sustainability and adoption - Environmental Innovation and Societal Transitions, Journal of Business Ethics, Sustainable Development, Business Horizons, etc.

Sustainability as growth drivers for Small & Medium Enterprises (Smes) - Upon analysis, this cluster (Purple) is able to generate a total citation (TP) of 456 from 8 articles having an average of 57 citations per article. The oldest article from this cluster is published in

2012. This cluster sheds light on the use of Sustainability by Smes for gaining a competitive advantage using them in Fashion Industry [99]. The journals in this cluster also focuses on Sustainability, Fashion, Entrepreneurship and Strategy – Journal of Fashion Marketing and Management, International Journal of Entrepreneurial Behaviour & Research, Business Strategy and the Environment, etc.

Martech as growth drivers for Small & Medium Enterprises (Smes) and Luxury Fashion brands - Upon analysis, this cluster (Yellow) is able to generate a total citation (TP) of 564 from 11 articles having an average of 51.27 citations per article. The oldest article from this cluster is published in 2003. This cluster sheds light on the use of Martech by Smes and Luxury companies for gaining an edge over their competitors [60], [83]. The journals in this cluster also focuses on retailing and strategy management - Strategic Management Journal, Journal of Business Research Technology Analysis & Strategic Management, Journal of Retailing and Consumer Services, etc.

Using Martech to gain Customer Engagement - Upon analysis, this cluster (Green) is able to generate a total citation (TP) of 1159 from 21 articles having an average of 55.19 citations per article. The oldest article from this cluster is published in 2001. This cluster sheds light on the use of Martech by Textile and Apparel firms to gain customer engagement [100]. It also talks of various new engagement methods and technologies coming like Virtual Reality (VR) [101]; Augmented Reality [56], [58], [70] and RFID [102]. The journal in this cluster also focuses on Fashion, Retailing, Technology and Marketing - International Journal of Electronic Commerce, Journal of Interactive Marketing, International Journal of Retail & Distribution Management, Clothing and Textiles Research Journal, Fashion and Textiles, International Journal of Consumer Studies, Journal of Fashion Marketing and Management, etc.

5. Thematic Analysis

5.1 Evolution of Research domain

The evolution of articles was divided into three periods namely, Emergence (1996 to 2010), Pre – expansion (2011 to 2016) and Expansion (2017 to 2024). The evolution of topics in research domain over time periods and each period was analysed using Biblioshiny interface and specific themes emerging in various periods were identified.

Figure 9 provides the alluvial diagram from the development and changes occurred in themes over the three identified periods. The nodes given in the alluvial diagram represents a cluster and the edges identifies with the temporal evolution track of the theme, which is created using the co – occurrences of keywords from different time periods.

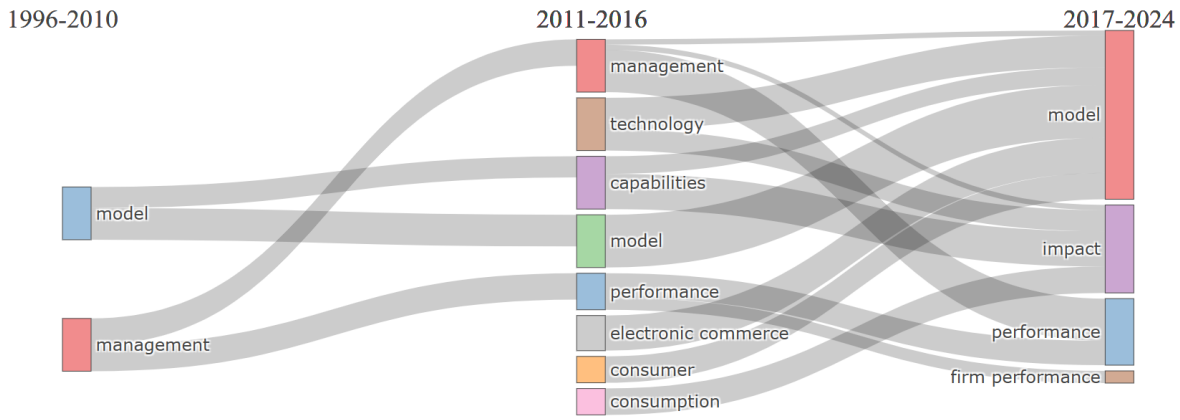

Figure 9. Alluvial diagram for the Martech convergence with Sustainable Fashion

Initially, during the emergence period, two major topics appear which are model and management. It is because initially researchers focus more on the firm side and 'end-of-pipe' solutions for sustainability implementation. This period is known as 'Age of Ecological Marketing' by [103]. In Pre – expansion period, newer topics related to consumers' view about sustainability was explored by the researchers like consumption of sustainability products, electronic commerce and consumer. Previous topics like model and management remained relevant as motor themes and further diversified into topics like capabilities and performance alike. In recent years, the expansion period, the impact of newer technologies and firms' model and capabilities have gain attention from researchers.

5.2 Thematic Mapping

The strategic diagrams for each time period namely Emergence, Pre – expansion and Expansion are shown in Figure 10. The strategic diagram is divided into four quadrants by two axes namely – Density and Centrality. Density refers to the internal strength of themes and centrality refers to the network formation and interaction between different themes [34]. The upper right quadrant having both high density and centrality is known as Motor themes – the driving force of the research domain. On the other hand, lower-left quadrant having both low centrality and density represents the Emerging themes which hold the key to future researches. Upper-left quadrant having low centrality and high density, represents Developed and isolated themes which are not inter-connected with other themes. Lastly, Lower-right quadrant having hight centrality and low density, represents Basic, core and transversal themes that appear across the knowledge field [104].

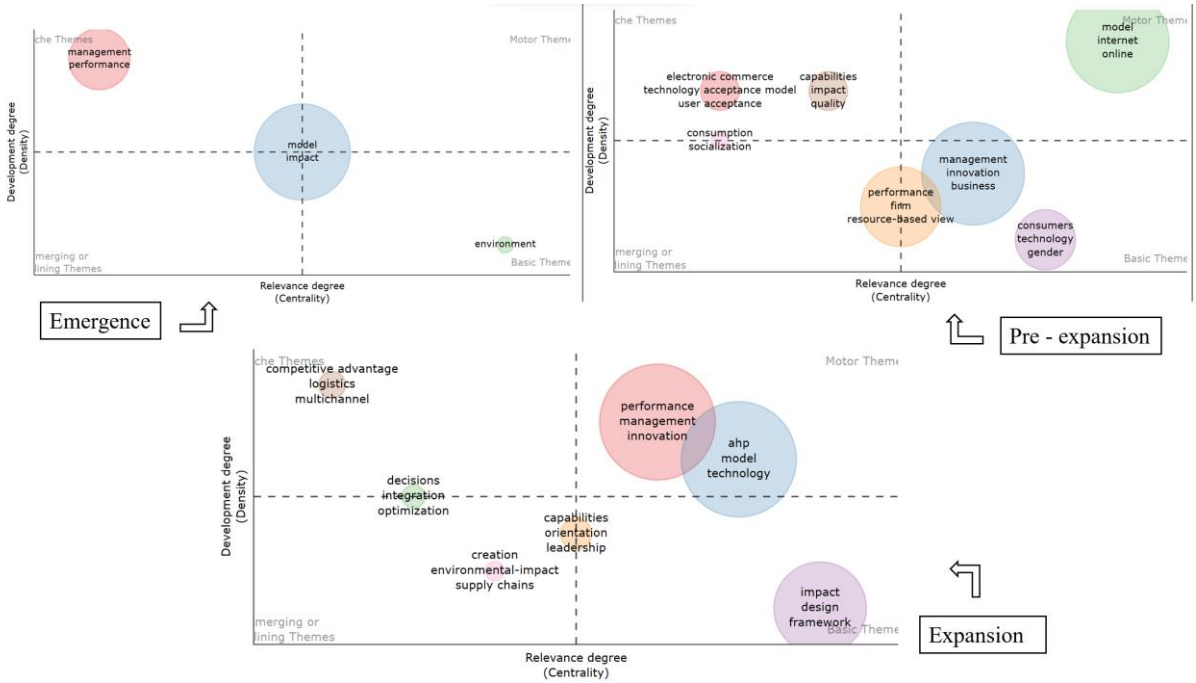

Figure 10. Evolution of research domain across various periods

Emergence Period – In emergence period, keywords are quite vague because it is the period of defining the research field. Model and Impact occupy the central position in the strategic map, neither being a motor or highly developed theme. Authors discussed models like Quick Response [105] & Supply chain models [106]. Environment appears as the basic theme cutting across the various research fields showing the focus of researchers on environmental sustainability in early years. Whereas, Management and performance related terms like firm performance [107] or store performance [108] appear as niche themes [109]. Journal of the Textile Institute is most productive journal during this time period with four articles and USA leading the charge with 10 articles.

Pre – expansion Period – As the research progresses, new themes emerge from the existing themes. Model, internet and online themes appear as motor theme. Consumer and gender appear as basic themes [110]. It indicates the increased focus of researchers on consumers' views of sustainability as also indicated through alluvial diagram. Management moves from niche to basic themes along with innovation and business [111]. This indicates the maturing of theme related to management and now finds itself across different fields in study. Internet and web-based e – commerce [100], [112] finds itself as niche theme along with more consumer-focused research like Technology Acceptance Model (TAM) [113] and user acceptance of sustainable fashion. Another niche group emerges from model, as capabilities, impact and quality [114]. Consumption and Socialization [115] appears as between niche and emerging themes, indicating the new avenues for future research in consumer related themes. Performance, firm and resource-based view [97] appear in between emerging and basic themes. Clothing and Textiles Research Journal is most productive journal during this time period with three articles and USA leading the charge with 11 articles.

Expansion Period – More different themes emerge from the existing themes and some new themes are added during this period. Performance, Management and Innovation move to Motor theme from basic themes along with another group with AHP (Analytic Hierarchy Process) [88], Model [116] and Technology, indicating increased focused of researchers on the newer models, technology and processes being implemented by firms [94]. Impact, design and framework appear as basic themes. Capabilities, orientation and leadership appear in between basic and emerging themes, indicating new avenues for future research [117]. Competitive Advantage [118] logistics [119] and multichannel [61], [63], [68] appear as niche themes which require more connection with other themes to gain a better understanding. Multichannel retailing has increased after Covid – 19 times, since 2020, since consumers were locked inside their homes and firms have to improvise on it along with their logistics chain [120]. Creation, environmental – impact and supply chains appear as emerging topics which can be explored in future [54], [80]. Change in firm's supply chain and its environmental impact due to Covid pandemic and the permanent change in consumers due to it are quite interesting avenues [121]. Decisions, integration and optimization lie between niche and emerging themes, in which researchers focus on the integration of latest Martech tools within the firms.

6. Reflections & Future Research: The Road Ahead

The bibliometric analysis was undertaken to map the existing literature on convergence trends between Martech and Sustainable Fashion and uncover the knowledge structure of the domain.

With respect to the RQ. 1, the academic discussion related to Martech conjunction with Sustainable Fashion is growing steadily over the decades. The performance analysis of the research field helped us to identify the major authors, publications and publications trends of Martech convergence trends with Sustainable Fashion. The main contributions came from both the developed countries like USA, UK, Italy, Canada etc, and emerging economies like China, India, Pakistan, Malaysia etc. This shows that most of the research is being conducted in Asian, European and North American countries, both developed and developing.

On the other hand, there is relatively less interaction and collaboration among different authors across the globe. Since, climate change and pollution affect every country in one way or the other, the experts from different fields (like sustainability, technology, marketing, operations, etc) must come together to collaborate to find solutions in this upcoming field.

With respect to RQ. 2, the science mapping revealed the structure of the research area. Management, Supply Chain & Logistics, Economics and Artificial Intelligence & Machine Learning are the major subject areas which are covered by authors from the field. The themes which are uncovered in the study are – Sustainable Innovation models within Fashion Industry, Usage of Martech within Fashion Industry, Sharing, Renting, Second-hand and Collaborative consumption practices and Outcome of Martech and Sustainability practices on consumer behaviour. Using Bibliometric Coupling analysis,

we are able to identify the emerging themes like Small and Medium Enterprises (SMES) and Luxury where Martech like Virtual Reality, Augmented Reality or RFID can be effectively used for Sustainability promotion.

The citation of the research area gained momentum from 2010s, with [122] leading the charge. Empirical articles lead the research landscape in this field with main focus on consumers, CSRs and innovations within industry. Conceptual articles where dominant during the early years of research field.

With respect to RQ. 3, the thematic analysis using the evolution maps and strategic maps helps us to unravel the development of different themes over the decades and identify the scope for future research areas. The future research proposals which can be undertaken in the field of Martech conjunction with Sustainable Fashion are discussed below –

- Positivist approach is the most dominant among the researchers in this field with most using structured questionnaire. Researchers may also go for Interpretivist view to gain novel insights from the research field, since different people, organisations and governments interpret sustainability differently.
- Most of the researchers have focused on environmental facet of sustainability. Future researchers can look into the other aspects of sustainability like Social (sweatshops in fashion industry) or Economic (women community tailoring centres).
- The researchers in this field have concentrated their efforts towards the understanding of individual characters of the consumers. But sustainability as a concept requires participation of whole communities and societies at large. They should try to have more broader mindset at community and societal levels for future research avenues.
- Reputed journals should encourage special editions, include more space in their journals for sustainability as it is a common issue for all people around the globe.
- The research work related to above domain is occurring across Europe, some Asian countries and USA. Since, pollution and environmental degradation is a global occurring phenomenon, so researchers should also focus on Third world countries like African and Latin American countries. These are the countries most affected by climate change and environmental degradation and they do not have any technical know - how and resources to counter this.
- Use of Martech tools like Augmented Reality (AR), Virtual Reality (VR), Artificial Intelligence (AI), etc for increasing the transparency, traceability and accountability in fashion supply chains, provides another exciting avenue for future research. This will help build greater trust of consumers towards sustainability claims of fashion industry.
- Since, climate change and pollution affect every country in one way or the other, the experts from different fields (like sustainability, technology,

marketing, operations, fashion designers, merchandisers, etc) must come together to collaborate to find solutions in this upcoming field. Sustainable Fashion and Martech requires inter - disciplinary research to bring them together and future research should also follow this.

Further, influence of Martech on sustainability of other industries like automobiles, oil & gas, agriculture etc can be analysed. Future researches can also focus on the specific domains within the fashion industry like designing, production, transportation, retailing, etc for example use of Blockchain technology for assessing the Sustainability within the Fashion supply chain.

Figure 11. Integrated Framework for 'Martech conjunction with Sustainable Fashion'

In Figure 11, the authors propose an integrated framework developed using the extensive bibliometric analysis. It helps us by showing the current flow of research related to promoting sustainable fashion using martech tools and its antecedents and benefits. There is lot of complexity surrounding the research domain including such diverse fields like Fashion, Martech and Sustainability; the framework helps to demystify this entanglement.

7. Conclusion

Sustainability is a complex field which has varied meanings for researchers, industry experts and consumers alike. With the increasing global warming and pollution levels, the awareness level of consumers towards environment protection and sustainability issues has increased over the decades [123]. Fashion is one such industry which has a big impact on the sustainability and environmental well-being of our planet [124]. Sustainable Fashion presents such one way to fight the adverse impacts of textile & apparel industries. Furthermore, Martech can be used as an effective tool to promote sustainable fashion and combat greenwashing practices being utilized.

Performance Analysis orchestrated above showed that the field is relatively new and developing; the steady increase in the number of publications and citation impacts is looking promising for the field. The analysis shows that the Eunju Ko, Tsan-Ming Choi and Hau-Ling Chan are the most prolific and influential authors indicating that East Asian authors are leading the research field with their publications; Sustainability, Journal of Cleaner Production & International Journal of Retail & Distribution Management are among the most productive journals in the research field.

Bibliometric and Thematic Analysis was conducted to uncover the intellectual structures and evolution of themes over the time pertaining to Martech and Sustainable Fashion. The study unfolded the present path of the field in which it is moving ahead, who and what is spearheading the convergence trends and finally, what the field might look like in future. This is addressed using the three research questions presented in the study from RQ. 1 to RQ. 3. For the above analysis, the study incorporated PRISMA framework given by [34] which was done to provide a more logical basis to our study.

Various themes were identified from different science mapping techniques like Bibliographic Coupling and Co – occurrence Analysis. The Co – occurrence analysis and resulted in four clusters while Bibliographic Coupling resulted in five clusters. The four major themes emerging from science mapping of the field are namely, Sustainability within Fashion Industry, Martech within Fashion Industry, Consumer Motivations and Outcomes and Shared and Collaborative Consumption practices.

Under the Thematic analysis, longitudinal evolution and strategic maps were created from different periods, emergence period, pre – expansion period and expansion period. The diagram revealed that over years the business model remains the driving theme in the research field, since the implementation of both sustainability and martech requires the considerable inputs from a firm to adjust their model to above practices. It was also

revealed from the diagram that the going omnichannel along with personalized sustainable offerings presents as a scope for future research. The Small and Medium Enterprises (SMES) present an exciting new area of future research as many Smes across the globe are looking forward to implement this sustainability and martech practices.

At the end, we believe that the field of martech, sustainability and fashion will continue to grow together and present new opportunities for all the stakeholders as more and more fashion companies strive to include martech and sustainability practices.

7.1 Limitations

Like all other research, our research also has some evident limitations. Cano et al. [28] used the Scopus database to connect E-marketplaces through Open Innovation to Sustainability. We used Web of Science as our choice of database and focused on connecting Martech with Sustainability within Fashion industry, a specific industry type. Other databases like Crossref, Cochrane, Dimensions, etc can be used to further inculcate other research articles in the present research domain. The research only focused on the English language. While doing so, significant articles which are in other languages might be neglected, which can be included for further research.

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