

Fashion Supply Chain: a literature review to define the trends of research (2012-2019)

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Abstract: Due to the high challenges to face and the current market evolution towards an ever faster fashion, the fashion supply chain has been the subject of several studies proposed in literature, with different facets and topics treated. In order to identify the main trends and issues of research, since the aspects at stake are several and different, the aim of this study is to present results from a literature review carried out in 118 scientific papers published between 2012 and 2019 resulting from a very simple query with a unique search term: “fashion supply chain”. Descriptive statistics (i.e. year of publication and country of the study) and qualitative aspects (i.e. category of topic and keywords’ analysis) were investigated. Sustainability, as well as the development of models aiming at different optimizations methods and the implementation of Radio Frequency Identification (RFID) tools turned out to be much debated within the field in question, whilst enabling technologies resulting from the Industry 4.0 paradigm appear as less common, probably due to the time span under investigation.

Keywords: Fashion supply chain; literature review; frequency-persistency keywords analysis; textile industry.

1. Introduction

The fashion industry and more in general the fashion supply chain (FSC) has shown a trend of accelerating development over the past decades (Niu et al., 2018). Among the attributes associated to the changes involved, the main ones are fast, agile, quick; all terms recalling a certain speed aiming at promptly respond to a customer increasingly demanding and with high expectations.

Fast because nowadays the FSC has to deal with the renowned fast fashion, which represents together an industrial practice (Choi et al., 2014) and a business model (Caro and Martínez-de-Albéniz, 2015) whose central idea is to offer to the customer a continuous stream of new merchandise in the market which reflects the latest fashion trend and capture the hottest design that the market most prefers, at affordable prices.

Agile because the FSC is considered to be an agile supply chain (SC), or at least aspires to be. Agility in this case focuses on responsiveness: conventional SCs have been lengthy with long lead-times and hence have been forecast-driven and consequently inventory-based; agile SCs are shorter and seeks to be demand-driven and information-based (Christopher et al., 2004).

Quick because one of the most widespread systems within the FSC, developed right in this field, is that of Quick Response (QR), a practice aiming at enhancing inventory management by reducing lead time, matching in this way the market demand faster (Choi, 2013).

We could also talk about the changing in consumers’ habits shifting towards e-commerce services, thus undermining logistics and transportations systems (fashion products are the most sold via web - Eurostat, 2020); we could also talk about the sustainability perspective, since the textile industry is among the world’s

most polluting (Boström and Micheletti, 2016; Bottani et al., 2020); we could also talk about the labour exploitation or the common trend due to globalization of shifting production sites to emerging markets and developing countries (Warasthe and Brandenburg, 2018), thus complicating the management of SCs.

Surely, all the above-mentioned issues can offer several research insights, and actually this is what they did, since literature in the field of FSC is extremely copious and various. However, a study which tries to resume and delineate the main recent trends of the fashion industry is actually missed, and this is the gap intended to be filled with this paper. In line with this aim, the chosen approach for carrying out the study is a literature review on 118 scientific papers published between 2012 and 2019 dealing with works carried out worldwide within this specific field. Both descriptive data and qualitative parameters considered worth of attention will be discussed.

The remainder of the paper is as follows: section 2 outlines the methodology followed, as well as the aspects investigated; in section 3 the literature review results are presented and discussed; section 4, finally, presents conclusions and future research directions.

2. Methodology

A query on the Scopus database (www.scopus.com) was carried out in February 2020 with a unique and simple keyword: “fashion supply chain”. The only constraint set was on the time span; indeed, only papers published between 2012 and 2019 were included. The reason why the previous period was excluded has to be found in the aim of the study itself: as the trend of research and the developments of the last years wanted to be defined, only the most recent literature could be useful and deserved attention for this purpose. Moreover, the term Industry4.0

firstly appeared in 2011, and since it was estimated that this event could affect the recent research, it was decided to set the time span starting from the subsequent year, in which first studies on this topic could be potentially published. No constraints were instead set on the document type.

At first, the query returned a total of 153 papers. After a careful preliminary analysis, papers not in English, without the authors’ list and off topic according with a screening of title and abstract were removed; the final set of the papers consists of 118 manuscripts. Specifically, the sample includes 82 journal articles (among which 3 literature reviews and 3 articles in press at the time of the query), 22 conference papers, 2 editorials and finally 12 book chapters. For those interested readers the full list of the screened documents can be provided.

With the support of Microsoft Excel™, both descriptive and qualitative parameters were evaluated; specifically, at first the sample was categorised according to the topic treaded based on a classification drawn up by the authors, and in some cases further deepened in micro-categories; then the evolution over time was defined, both in terms of the absolute number of papers and related to the topic treated; the geographical origin of the studies according to the affiliation of the first author was determined in order to identify more productive countries; a keywords’ analysis was finally carried out, allowing to inspect their frequency related to their persistency during the aforementioned time frame.

3. Literature review results

3.1 Classification by topic

In this section, the classification of the 118 screened papers resulting on the basis of the topic treated in each document is presented. According to the general contents and the experience of the authors in the field, 4 different main arguments were identified:

1) Analysis and models for the FSC, including those papers whose aim is to present results from analyses or development of models intended to solve a specific issue. Quite often, the structure of these studies at first presents analyses carried out by applying formulae and theorems, and according to the relating outcomes next proposes the development and implementation of the proper model. Sometimes, the model’s results are compared with specific standards found in different studies or publications.

2) Management of the FSC, where the general topic of managing operations, relations among the different actors of the whole FSC or problems are concerned (e.g. the relationship between manufacturer and retailer is much debated within these studies).

3) Sustainability in the FSC, including studies whose main aim is to deepen the sustainability perspective of the FSC, both from an environmental and economic point of view, as well as social. Quite often these three aspects are not considered separately, but in relation with at least one of the other two.

4) Technologies and innovations for FSC, where different tools and applications are debated together with their benefits in terms of efficiency and effectiveness’ improvements in the FSC.

Moreover, exception made for the second category which turned out to be very poor in numeric terms, the other three classes were further divided into micro classes according to more specific peculiarities. Specifically, below the more in-depth classification for the first class is provided:

1A) **Analytical models**, following a strict and rigorous mathematical procedure;

1B) **Empirical models**, starting from the direct observation of phenomena;

1C) **Multi-attribute models**, considering different variables of a given process/phenomenon in order to select the best combination;

1D) **Simulation models**, which adopt a simulation strategy to reproduce a specific process with the aim of assess or foresee its behavior under certain conditions; they are quite useful at the stage of initial development, as they can highlight weaknesses to be improved.

Quite simply, instead, the subdivision of the third topic, which recalls the three perspective of sustainability (i.e. economic, environmental and social) and the cases in which they are considered together.

As far as the last class referred to technologies and innovations, the subdivision into micro classes is the following:

4A) **Radio Frequency Identification (RFID)** tools implemented for the FSC; as the name of this micro class suggests, the aim of these papers is to illustrate the adoption of RFID tools, its impact on processes and operations, the achievable benefits and practical case studies. It was decided to dedicate to this topic a specific micro class due to the numerousness of papers in order to stress its relevance.

4B) **Industry 4.0 technologies for the FSC**; this micro class includes studies analysing technologies brought from the fourth industrial revolution.

4C) **Other technologies**, a micro class which simply includes the remaining papers not belonging to the previous two.

The resulting subdivision is below illustrated, in Table 1.

Table 1: Classification by topic results.

Category	Micro-category	Number of papers
Analysis and models	-	60
	Analytical	44
	Empirical	7
	Multi-attribute	6
Management	Simulation	3
	-	4

Sustainability	-	32
	Economic	4
	Environmental + Economic	3
	Environmental + Social	5
	Environmental	15
	Environmental + Economic + Social	4
	Social	1
Technologies and innovations		22
	RFID	12
	Industry4.0	8
	Other	2
TOTAL	-	118

As it can be easily deduced from Table 1, the most debated topics are for sure that of analysis and models related to the FSC, and its sustainability aspect.

As far as the first category is concerned, models such as that of QR (e.g. Choi, 2017) or the buy-back contract (e.g. Niu et al., 2017) are common, as well as theoretical models to be implemented in specific cases and developed *ad hoc* under specific circumstances. For instance, examples of interesting models are provided by Bottani et al., (2019), who developed and implemented an analytic model for assessing the economic and the environmental sustainability dimensions of a specific fashion company and its supply chain; Ren et al., (2017) instead proposed a comparative study of models for demand forecasting in the fashion industry with multiple sources of uncertainty in order to identify the fastest and consequently the best; Battista and Schiraldi (2013) described the structure of the logistic maturity model (LMM) and showed the potential improvements achievable by using this model in terms of the identification of the most appropriate actions to be undertaken for increasing the performance of the logistics processes in a fashion company. Many other studies could be mentioned, and what they all share is the common aim to make more efficient parts of FSC thanks to techniques, strategies or models both already existing or novel.

The second most spread topic is that of sustainability. What emerges from the majority of papers is that FSCs are moving to a cleaner production and in general less impactful operations in order to comply with regulations (and so avoiding penalties), and above all in order to improve their images in the eyes of consumers. Among customers, in fact, there is always more and more awareness and interest in rewarding those companies which expend themselves for sustainability (Bottani et al., 2020).

As already stressed, the RFID technology earned a dedicated micro class, with its 12 papers. This does not surprise at all, since in the logistics field, heart of the FSC, RFID tools are quite spread.

An interesting point to notice is that only few papers (8), compared to how the issue is spreading in other contexts, consider Industry4.0 technologies. The reasons are reflected right in these papers, as what emerges is that

among the main barriers we find huge costs, bureaucratic issues, the requirement for updating or even completely change software already in adoption, changes in working habits and high expertise required. However, among these eight, it is worth mentioning Nayak and Padhye (2018) who examined the applications of artificial intelligence in the fashion field, or Banica and Hagi (2016) who instead dealt with the use of big data analytics to improve the decision-making process in the FSC.

Finally, note that very few contributions come from the topic of management of FSC, as well as from the adoption of other technologies or innovations (so not deriving from the Industry4.0 paradigm).

3.2 Evolution over time

The second aspect investigated refers to the evolution in time of the published documents over the eight years under investigation. Specifically, 17 papers were published in 2012; 14 in 2013; 15 in 2014; 9 in 2015; 12 in 2016; 15 in 2017; 20 in 2018 (most productive year); 16 in 2019. Exception made for 2015 in which it is noticed a trough (9 papers specifically), in the remaining seven years publications are quite steady with an average of 15 papers per year.

Figure 1 below, proposes the evolution over time according to the topic treated.

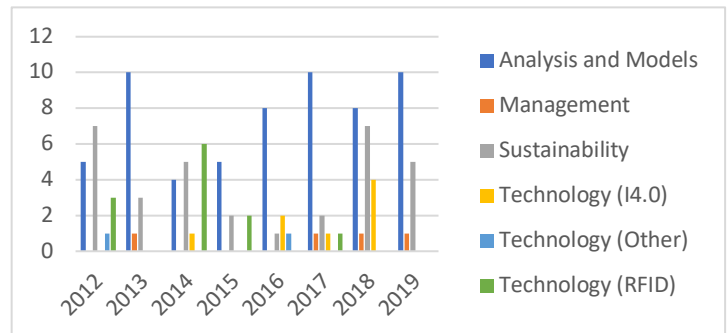


Figure 1: Number of papers published per year according to their topic classification.

The topic of analysis and models of the FSC is homogeneously distributed over the whole time frame, and same reasoning holds true for the sustainability class (with a peak of 9 documents in 2019), confirming the high number of contributions in these themes. Regarding the RFID technology, it firstly appeared in 2012, and most of the production is up to 2015; indeed, from 2016 to 2019 only one paper was published. Surely, we cannot say that this technology is saturated, but it is probably mature and debated in other fields; this is probably the reason why the attention was shifted to different topics. Indeed, the four years in which only one RFID paper was published, are the years in which most of the paper dealing with Industry4.0 technologies were presented.

3.3 Geographical distribution

A third interesting parameter analysed is the geographical origin of the studies, determined according to the affiliation of the first author. Note that for 23 papers it

was not possible to trace this information, and accordingly they were excluded from this analysis.

China turned out to be the country with the highest number of documents (26 overall), almost all belonging to the first class (22 papers), at the expenses of other topics (only 4 studies deal with sustainability); this confirms the interest of Chinese authors for continuously improving their efficiency in processes for becoming more competitive in the fashion world. Hong Kong as well turned out to be active in this field of research, but on the contrary, the topics treated are quite well shared among the various classes. Note that 5 papers deal with sustainability issues, probably due to the fact that this country is considered one of the most polluted regions in the world, with several deaths due to pollution as reported in several studies (e.g. Wong et al., 2002). In this sense, researchers carried out studies analysing the European behaviour, in order to take a cue. Italy as well takes care of the FSC; in fact, the Italian fashion is popular worldwide, and the contribution of the academic world does not lack. It is interesting to note that in the UK sustainability stands out (5 papers out of 9), where several efforts are made to implement the concept of Corporate Social Responsibility (CSR) in SCs, and in this case specifically in the FSCs. Despite being one of the most influencing countries in the world, compared to the other states, the USA are quite poor in terms of published papers.

We also recorded 4 contributions from Portugal, 2 from South Korea, Spain, Sweden and Vietnam while from other minor countries only one document was published.

3.4 Keywords' analysis

Probably the most interesting result is presented in this subsection, and it is that of the keywords' analysis. After having excluded papers not having keywords (4), adjusted synonyms, acronyms (e.g. Corporate Social Responsibility sometimes indicated with CSR) and spelling, considering only those having frequency equal or greater than 2 we find 75 keywords overall. The choice has fallen on a frequency-persistency analysis; frequency refers to the number of mentioning of a keyword in the sample of papers reviewed, while for persistency it is meant the number of years of presence of the keyword in literature, computed considering the first and the last years of appearance. Thanks to a scatterplot built on an Excel spreadsheet it was possible to analyse the relationship between these two parameters and according to the quadrant to which they result to belong keywords were divided into four groups:

- **Well-established topics:** high frequency and high persistency, meaning the topic they represent is widespread and popular, as well as studied and well-established in literature (4th quadrant);
- **Trendy topics:** high frequency but low persistency, meaning that the topic could be at the dawn (3rd quadrant);
- **Intermittent topics:** low frequency but high persistency, probably due to the fact that they were popular in a determinate period (2nd quadrant);

- **Emerging topics:** both frequency and persistency low, which could be due to the novelty of the topic, as well as its poor interest among researchers (1st quadrant).

Note that the values for determining the quadrants were set at 2 for frequency (corresponding to the median value) and at 4 for persistency (half of the time-span under investigation). For those interested readers the scatterplot can be made available, as in such reduced space it is difficult to read and understand.

3.4.1 Well established topic

Among the well-established topics, we found keywords such as “fashion supply chain”, “supply chain management”, “fashion industry”, “fashion”, “fast fashion” etc.; this does not surprise as they generally define the main argument of all the papers in the sample (note that also the keyword used in the original query is here included). Other two popular topics, supported by the fact that these keywords are in this fourth quadrant, are sustainability and RFID. Quick response appears as well; indeed, as already stressed, this strategy is almost vital in the FSC, and for this reason several studies focus on it (mainly belonging to the Analysis and models topic, as it will also emerge in the final section of the keyword analysis related to the topic). Another very popular keyword, dealing with sustainability issues, is that of closed-loop supply chain. Always related to sustainability among the well-established topics Corporate Social Responsibility fits, considered a real strategic tool above all in the fast fashion field e.g. Zara, H&M or Gap are trying to implement it (Li et al., 2014). Other interesting keywords are outsourcing, very common within the FSC, key performance indicator or mean variance analysis, above all in papers presenting analysis or models.

3.4.2 Trendy topics

In this group we found a quite recent keyword (less than three year its first appearance), but with a high frequency: it is the only case of the word retailer; two interesting examples of its usage are provided by Cagri et al., (2018) who analysed the retailer relation with the other actors of the SC, or by Martino et al., (2017) who instead proposed a framework to be implemented when evaluating specific key performance indicators related to the Omni-Channel Retailing, i.e. including e-commerce and online purchasing.

3.4.3 Intermittent topics

Among the intermittent topics we found those keywords having frequency quite low, but persistency greater than four years; in other word they are used since long time but little. The first keyword we notice is pilot study, probably related to models or tools at their first application in small scale. Analytic Hierarchy Process (AHP) follows, a technique for supporting multi-criteria decisions with independent variables; examples of its application are by Wang et al., (2012) for assessing the risk related to the adoption of green initiative or by Ren et al., (2017) for evaluating this time forecast models. Product design also fits in this class, probably because not directly dealing with the management of FSC, main topic of these papers.

Another interesting word is risk analysis, related to those works analysing possible risks and events which may derive from initiatives aiming at changing processes of the SC (for instance it is again recalled the abovementioned paper by Wang et al., 2012). Another keyword referring to the trend of the field to be customer-driven is mass customization (which could also be related to the keyword customer behaviour), a strategy adopted to satisfy needs of consumers whilst maintaining efficiency of mass production. An interesting intermittent keyword is that of Nash, which recalls the famous Games theory developed in the '50s, used when dealing above all with models; an application example is by Niu et al., (2018) who applied this theory for solving the problem of outsourcing manufacturing. The last two keywords deserving attention are green SC and SC models, referring to a general topic and not to a specific strategy, model or technique.

3.4.4 Emerging topics

Among the emerging topic we find those keywords representing new arguments, as the name itself suggests, which then could be established in the future or conversely could turn out to be of limited interest. The authors care mentioning specifically four keywords which deserve attention. The first is big data, a word belonging to the fourth industrial revolution world which stands for the collection of countless data allowing the enabling of technologies and digitalization. An example within the sample is provided by the already mentioned authors Banica and Hagi (2016). Another interesting emerging keyword is interoperability, expressing the modern concept of allowing the enterprises in supply chains to collaborate in an efficient manner while preserving their own identities thanks to an exchange of information, made available through new tools and the abovementioned big data. Circular fashion supply chain is another topic found in this quadrant of the frequency-persistence analysis; indeed, also due to the replacement speed by customers, the FSC has enormous quantities of wastes (both of finished products and at the production stage), and as already stressed the sustainability perspective is very heartfelt. Actually, to be honest, the term “circular” is not emerging or new, but probably it is sometimes referred with one of its “synonyms”, that is closed-loop supply chain, which is another way to achieve and implement the concept of circular economy. That keyword is in the class of well-established topics, and this is the explanation provided by the authors of the reason why circular fashion was found in the emerging topics. The last word worth of attention is systems of systems, recalling the theory of systems which states that a set of independent systems, which could operate individually, cooperate together and are related with the aim of pursuing a common goal, which is actually a different definition of SC; specifically, this theory is about developing applicable concepts or principles implementable in the whole systems (in this case the SC). This theory as well is not new, but within the sample of screened papers has both frequency and persistency low. An example of its application is by Choi et al. (2019), who proposed some principles for building a sustainable FSC

according to this theory, with a specific framework then applied in the colossus H&M.

3.5 Keywords related to the topic

The frequency-persistence analysis has been carried out as well specifically for each of the four topic classes. Table 2 below presents the main ones associated to the topic treated in the papers. To be short, only well-established and emerging topics are referred in the table, as well as only the most interesting classes and micro-classes.

Table 2: Main keywords related to the topic.

Category	Keywords (Well-established)	Keywords (Emerging)
Analysis and models	SC coordination	Forecast update
	Quick response	Buy-back contract
	Mean variance analysis	Two-period problem
	Closed-Loop SC	Planning and control
Sustainability	KPI	
	Corporate Social Responsibility	-
	Case Study	
Technologies (RFID)	Environmental Sustainability	
	-	Case study
		Pilot study
Technologies (I4.0)		Track & tracing
	-	Interoperability
		eBIZ
		Big Data
		Cloud Computing
		IoT

As far as the first category, i.e. analysis and models, as already stressed the QR is a much solid and debated strategy in literature, and all the papers in which this topic is treated present models dealing with different issues, e.g. inventory service target (Choi, 2016) or the impact of risk averse behaviours from the retailer side (Choi, 2017). Same reasoning for mean variance analysis, only found in documents presenting models. Supply chain coordination as well is an evergreen; it is well known, in fact, that competition is no more between single firms, but rather between the whole supply chains, and as a consequence the development of models for managing this issue is vital, as coordination can be very difficult to be achieved. Many papers belonging to this group deal with specific typology of contracts stipulated by different actors (e.g. Wang et al., 2013 or Shen et al., 2014). Closed-loop supply chain, instead, can be seen from a double side; indeed, it is a keyword which recalls sustainability, but more from a technical and an analytical point of view, and this is the reason why in the opinion of the authors it falls among the well-established keywords related to analyses and models; literarily speaking, this keywords in other papers can be replaced from other terms such as circular economy, as already stressed, or simply environmental

sustainability. For concluding with the first category, we also find KPI, whose presence is not surprising since models’ outputs are mainly numerical indicators.

Quite briefly, among the well-established keywords related to sustainability we find CSR which is related to the implementation of sustainability within firms, case study (a quite common investigation method in literature) and finally environmental sustainability, which can be seen as a synonym of sustainability since quite often sustainability is merely associated with the environment.

Finally note that there are no keywords among the well-established for RFID and Industry4.0 technologies, clearly due to the novelty of the topic. As a consequence, emerging keywords for these two groups are not missed: when talking about RFID, we recorded case study and pilot study, since clearly RFID solutions in the fashion field are applications, and the case study (or pilot, similarly), are well suited for these purposes. The attribute pilot, however, stress once again the recent entry within this context. Very easily, track and tracing are their tasks. When talking about Industry4.0, instead, we recorded general keywords such as big data, cloud computing or IoT which are the enabling technologies for digitalization and automation; more interesting instead is the concept of interoperability, already debated in this paper, and above all that of eBIZ. eBIZ is an initiative held by the European Union specifically within the textile industry aiming at enhancing the level of digitalization within the field, and accordingly promoting interoperability and integration. For deepening this project, carried out from a Tuscany university, the authors suggest for instance Bindi et al., (2018).

Since the topic is definitely well-established, in response no emerging trends were found for the sustainability category, confirming its relevance among the scientific world.

For concluding, among the emerging topic related to analysis and models we found the keyword of forecast update, a specific condition which can be assumed for developing models, that together with the information share is essential for managing the inventory (e.g. see Yang et al., 2014); buy-back contract, a specific agreement among supplier and seller providing for sharing the risk due to the market uncertainty (e.g. see Niu et al., 2017) which is not that common in the fashion world, and this is the reason why it falls in the emerging topics. We also find here two-period problem, probably less spread than problems modelled on one single period, and finally planning and control, which is actually not that new in this context, but probably a less common keyword since it recalls a very generic argument.

4. Conclusions and future research

This paper aimed at briefly present the main results of a literature review carried out on 118 scientific documents published between 2012 and 2019 all dealing with issues related to the FSC.

If the initial scope was to define the trend of research of the last years, we can firmly assess that most of the efforts

are primarily towards the development of models for dealing with different issues (from the inventory management to the relationship between actors or to the strategy of QR); secondly, towards the aspects related to sustainability, including green initiatives and the implementation of the concept of CSR. Among the technologies and innovations most investigated or implemented, the only one worth of attention is the RFID, deserving a dedicated class among the topics treated. Quite lacking instead are research related to Industry4.0 concepts.

Surely among the limitations of the study we find the time span; indeed, year 2020 was excluded and could have further increased the size of the sample; the language as well (i.e. English) could have limited results, together with the use of a unique keyword.

In the light of results, for the future surely the literature review will be extended to the following years, as also the recent Covid-19 pandemic could strongly affect research and studies. Moreover, it is in plan to deepen the topic classification: for instance, for the first category it is already though a further classification including a deepening of the aim of the models e.g. for sustainability, for relationship among actors etc. Same reasoning goes for the other categories. Moreover, since the sustainability aspect is much debated, we intend to deepen the topic of green FSC by means of a survey developed for understanding the degree of sustainability of the Italian firms.

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