

Supply Chain Risk Assessment in the Fashion Retail Industry: An Analytic Network Process Approach

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Abstract

In today's global markets, characterized by extremely fast changes in technology and customer's demand, and by product life cycle getting shorter and shorter, a single firm has not the ability to be competitive if it is not included in a network that, operating as a single entity, is able to react to demand dynamism and volatility. Therefore, existing supply chains, structured in a global sourcing view, are highly vulnerable to perturbations resulting from a strong dependence on other network's players, such as suppliers or logistics providers. In this complex and competitive context, properly assessing and managing risks connected to the different stages of the value chain, as well as external and not directly controllable risks, means being able to ensure continuity in supply. This paper focuses on the particular field of the fashion retail industry since its highly unpredictable demand and extremely short life cycle make it very important to analyse risks connected to the supply chain. The particular case we are referring to is represented by a fashion company that manages an extended network of wholesalers, direct operated stores, franchising mono-brand stores and factory outlet stores main aim of the presented work is to prioritise the list of identified risk factors by adopting the Analytic Network Process approach. This method is, in fact, more suitable for real complex problems that cannot be completely represented through a simple hierarchical structure. The obtained results show that supply chain efficiency, in terms of correct management of both material and informative flows, is considered the most crucial part also for a demand-driven supply chain as the fashion industry one which, in addition, is constantly seeking for customer tastes and always changing trends.

Keywords: Fashion Retail, Clothing Industry, Risk Assessment, Risk Management, Analytic Network Process, Supply Chain, Prioritization

INTRODUCTION

The increasing trend towards globalization and outsourcing is leading many industrial sectors to entrust relevant parts of their business to suppliers often located in developing countries. These phenomena are causing loss of control and of full visibility of the supply chains, thus increasing risks connected to any possible changes or disruptions. Risk sources do not exclusively reside in the effects of external events, such as

legal restrictions or natural disasters, but also in the impact of internal changes of strategies, business models and interaction with the actors of the supply network (Tang, 2006).

To assess the risk profile for a company, it is useful to highlight the main risk sources within the supply chain that can be grouped into five categories, as shown in Figure 1 (Mason-Jones and Towill, 1998; Fera et al., 2017; Christopher and Peck, 2004):

1. Risks external to the main company and internal to the Supply Chain :

- a. Supply Risk: which include those elements disturbing material and information flow between main company and upstream enterprises (Zsidin, 2003). They depend on the structure of the supply network since risks increase if the company is dependent from few key suppliers, if it works in a global sourcing perspective, etc.;
- b. Demand Risk : which include any possible interference to the material and information flow between central company and the market, across all the other enterprises between them (Svensson, 2002). Typical risks are connected to the volatility of demand or bullwhip effect.

2. Risks internal to the main company and to the Supply Chain:

- (a) Process Risk : process refers to the sequence of managerial and value added activities internal to the company. These processes are directly dependent on company's assets, on reliability of transports and communications; therefore the connected risks refer to the interruption of these processes.
- (b) Control Risk: control systems are the set of procedures that rule the processes and the relationships with other network's actors. These risks are internal to the company and are related to procurement, production or inventory policies.

3. Risks external to the Supply Chain:

- (a) Environmental Risk : is related to external factors which result from economic, socio-political, technological or natural events.

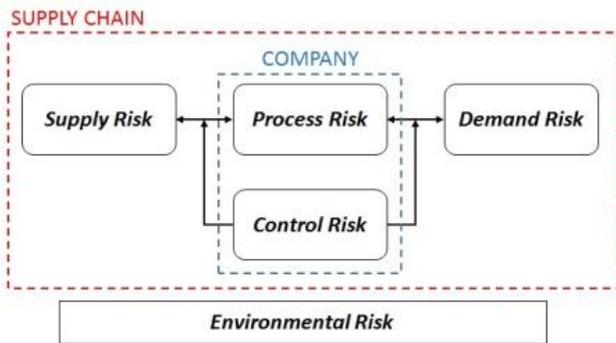


Figure 1: Risk sources in the Supply Chain

It is important for managers to understand that the risk profile is directly influenced by strategic decisions. Therefore, rather than catalogue every possible risk, the first step of a proper risk management is the analysis of internal processes in order to isolate most critical and relevant weakness factors. After that, it is possible to monitor external environment in order to detect warning signs and, consequently, develop mitigation plans or alternative strategies. Main purpose is to strengthen the resilience of the operational structure, which is the ability to quickly recover after an adverse event which disturbs or interrupts the normal activity of the supply chain.

In the highly dynamic context of the Fashion and Apparel Industry (Lanzilotto et al., 2014), the proper assessment and management of the supply chain risks can be crucial for its efficiency. For example, due to the adoption of traditional long-term demand forecasts, any change or fluctuation may lead to over-stock producing excessive quantities that quickly become obsolete or out of fashion or stock-out undersizing actual sales volume resulting in an image damage and lost sales. Another possible risk is given by the offshoring trend which, from one side, ensures a substantial cost advantage but from the other, contributes to lengthen geographical distances and lead-time. This leads to the extension of replenishment times and consequently to the difficulty of quickly respond to any delay along the chain or change in market demand.

Despite fashion retail is receiving increasing researcher's attention, in particular concerning supply chain management (Ngai et al., 2014; Iannone et al., 2015; Brun and Castelli, 2008) literature does not show relevant studies related to risk assessment and management. Only few works have been proposed in last few years:

- Venkatesh et al. (2015) that use the Interpretative Structural Modeling (ISM) to establish the interdependencies between the risks associated to the apparel retail supply chains in India;
- Shen et al. (2014) and Chiu and Choi (2013) that only focus on the financial aspect of risk management;
- Khan (2013) that, through a case study, explores how design is used as a strategic tool for managing risks in fashion retail;

- Xiaofen and Wei (2012) that identifies four main risk areas related to external environment, customer and suppliers cooperation and to the enterprise itself;
- Liljander et al. (2009) That relates product quality to functional and financial risks which cause a reduction in store brand value;
- Aghekyan-Simonian et al. (2012) that analyse the perceived risks connected to online purchases which are mainly related to brand image and online store image;
- Chen and Xiao (2015) that evaluate how the entity of the disruption risk influence outsourcing strategies;

Other research works, then, analyse risks connected to outsourcing (Hon Kam et al., 2011), those risks related to social and environmental aspects (Freise and Seuring, 2015) or risks that a company may encounter when implementing green initiatives (Wang et al., 2012b).

It is clear that none of them proposes a detailed and structured analysis of all the risk factors connected to each supply chain process. Then, based on these considerations, this paper wants to fulfill this gap and become a reference framework for future risk assessment and management studies in this field. The present paper aims, in fact, at identifying all the main risk factors connected to each process and to each objective of a typical Fashion supply chain, by defining a complete and general map.

The authors aim at addressing this apparent gap in literature and, thank to a deep analysis of both current practice and literature, first identifying and after, through the use of the Analytic Network Process (ANP) approach, prioritizing the risk factors connected to the fashion and apparel retail supply chain.

The rest of this paper is organized as follows. Section 2 describes the research methodology with particular attention to the ANP approach and all the necessary steps. In Section 4 we will discuss results and future developments of the research.

RESEARCH METHODOLOGY

The main purpose of this paper is to assess and prioritize the main risk factors related to each working phase of a fashion company that manages an extended network of wholesalers and stores.

Operational risk is defined as the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events (Saaty and Vargas, 2006). Then, in this context, the authors adopted the Analytic Network Process (ANP) approach (Saaty and Vargas, 2006) as a tool for risk prioritization based on experts' decision. The ANP represents a generalization of the Analytic Hierarchy Process (AHP) (Saaty, 2001). Many decision problems, in fact, can not be hierarchically structured because they involve interactions and interdependencies of several elements of different levels. The applied method, through a network-decision structure and not a simple hierarchy, can handle complex problems providing an easy and accurate way to analyse tangible and intangible factors. All the research work was conducted in cooperation

with a team of experts composed by 10 managers from 3 different companies operating in the Italian Fashion and Apparel Industry. In addition, the study is supported by a deep literature analysis involving more than 60 papers from the most important journals dealing with the topics of supply chain risk management, retailing and operations management in the fashion and apparel industry (e.g. Int. J. of Production Economics, J. of Retailing and Consumer Service, European J. of Operational Research, Int. J. of Logistics Management, etc.). The process flow of the adopted methodology is shown in Figure 2.

In order to better understand the context and the problem, first step of the work was the Process Analysis (ref. Section 2.1) also including material and informative flows typical of a fashion retail supply chain.

The second step, where the ANP approach starts, is represented by the Main targets identifications (ref. Section 3.2) which allowed us to select the focus and overall objectives of the entire supply chain.

Thank to the results coming from these first two steps, we were able to break this complex system into its constituent parts and to perform the Risk factors identification step (ref. Section 3.3). More than 90 risk factors were identified and classified according to both targets and processes. Given the high number and according to ANP approach, all the risk factors were grouped into clusters (Clusterization ref. Section 3.4) according to similarity criteria. Then, the Network Definition step (ref. section 3.5) allowed us to determine interdependencies between factors, including inner (within the same cluster) and outer (among different clusters) relationships. While a hierarchy is a linear to down structure, a network instead develops in all directions and may show cycle between different clusters and loops within the same cluster. In the end, all the clusters and all the connected risk factors are compared (Pairwise Comparison ref. section 3.6) thank to a questionnaire survey based on experts' decisions in order to determine relative priorities among elements.

Final goal of the ANP approach is then reached with the Prioritization (ref. section 3.7) of the list of potential risk factors based on their relative importance in the organisation.

PROCESS ANALYSIS

First step of our approach was the definition of all the processes and material and informative flows typical of the fashion industry.

In this particular study, we are referring to companies that operate with an extended network of:

- wholesalers : they are supply chain actors that directly buy products from the main company during the sales campaign and then sell them to multi-brand stores. They represent an intermediate ring between producers and market;
- franchising stores : they are mono-brand stores not directly managed by the Figure 2: Process flow representing the research methodology company. They are allowed to use company's brand and distribute its products by directly

buying them. It means that all the risks connected to under- or over-stocks are borne by the store itself;

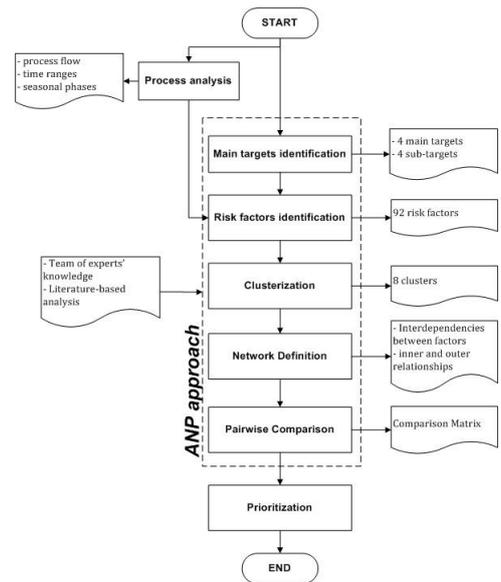


Figure -2

- direct-operated stores : they are stores directly managed by the main company. It means that all the decisions, and consequently the risks connected, on purchasing and distribution are centralized;
- factory outlet stores : in these direct-operated stores, the company sells previous season's unsold stocks at significantly discounted prices. They allow to absorb the risk of overstocks.

All the main processes performed in a typical Fashion Retail Supply Chain are listed and described in detail in Table 3. We also reported the indicative time range during which each of these processes is performed for the two traditional selling seasons: Fall Winter (F/W) and Spring/Summer (S/S).

The processes are then divided into:

- i. Pre-Season phase: as the name implies, this phase involves all the activities performed before the beginning of the real selling season, starting from the creation of the collection from the Styling Office and ending with the deliveries of the finished product to clients and stores;
- ii. In-Season phase: it starts with the first sales recorded in the stores and involves all the selling season including discounts period until the shipment of unsold goods to the central warehouse; Post-Season phase: it involves all the activities necessary for the correct management of the unsold items and their delivery to factory outlet stores.

IDENTIFICATION OF MAINTARGETS

Main critical issue of the fashion industry lies in the ability to promptly capture customers' tastes and transfer them into successful products. This implies trying to meet customer

tastes of a large market share offering a wide variety of products and, at the same time, reducing time-to-market and whole logistics costs in order to avoid a strong price markdown at the end of the selling season due to rapid changes in trends. Based on these considerations, we identified 4 main targets, 2 of which have 2 sub-targets, as following reported:

1. Market driven orientation :

The primary purpose of a supply chain is to satisfy customer’s demand. According to it, the whole fashion supply chain is driven by real and current market needs (Walters, 2006), releasing from the total dependence from demand forecasts. The attainment of this target depends from two sub-targets:

- a. Market sensitivity improvement, intended as the ability to recognise market needs, thank to reliable demand forecasts, and to quickly respond to demand changes;
- b. Brand attractiveness ; it is defined as the intrinsic capacity of a brand to attract market interest. In our context, the company experience this attractiveness through stores and clients network using their ability of attracting customers.

2. Cost reduction :

While the previous target mainly focuses on supply chain effectiveness, the cost and waste minimization refers to the efficiency of supply chain activities. The target of profit maximization from a production/logistics perspective results, in fact, in cost reduction of all the activities along the value chain. This is strictly connected to:

- a. Time management : refers to the correct time management and possible reduction of all supply chain processes, since any delay may cause a late launch of the seasonal collection or late deliveries to stores and wholesalers and the consequent loss of market share;
- b. Material flow management : focuses not only to quantities and types of items in transit along the chain but also to correct data management and exchange between actors.

3. Brand internationalization and market expansion :

It refers to the entry in new foreign market and subsequent expansion, and involves decisions regarding marketing strategy and retail format, product, and service mix appropriate to a foreign country (Picot-Coupey et al., 2014).

	Time range		Process	Description
	F/W	S/S		
PRE-SEASON	Sept to Dec	Mar to Jun	Market trend Forecasting	Fashion products are characterized by high volatility and unpredictability [23] and their consume is highly impulsive and subjective [24]. In this step, several professional profiles are involved: fashion designers, style consultants, cool-hunters, fashion bloggers and reporters. Their main task is to analyse and forecast market trends for the following season according to main fabrics fairs, emerging street style and movie or pop star trend.
	Oct to Jan	Apr to Jul	Creation of Seasonal collection	It is a highly time-consuming activity and provides as output a wide variety of clothing items but not all of them will be then produced [25]. It is a process that can be hardly rationalised from a management perspective since the company needs to offer a wide variety to customers during the sales campaign.
	Feb to Mar	Aug to Sept	Definition of main assortment	It is the stage of selection of the items that mainly express the mood of the seasonal collection and that will be surely recommended to the wholesalers and shown in the most representative stores. This selection is responsibility of the Commercial Department and Styling Office.
	Feb to Apr	Aug to Oct	Collection presentation and beginning of sales campaign	The collection is presented in the most important sector fairs (Milano Fashion Week, Premiere Vision in Paris, etc.) and after that, the sales campaign can start. In this period, the company can record orders from wholesalers. All the clients undergo a financial assessment and then their orders can be approved after the solvency check. Most of these orders may be affected by some changes even after conclusion of this campaign.
	Mar to Jun	Sep to Dec	Production orders launch	This phase is almost contemporary to the previous one. Orders already forwarded to production for which there is an insolvency problem, are hold as “suspended orders”. They will be not delivered to the client but will be made available for other clients’ orders even during the selling season.
	Apr to Jun	Oct to Dec	Materials procurement and dispatch to production plants	In this study we suppose that supply of fabrics and accessories is directly borne by the main company. It may happen that this process is, instead, performed by suppliers according to customer’s specifications. In this phase, often material do not pass through the central warehouse but are directly delivered from fabric’s suppliers to producers.
	Jun to Aug	Dec to Feb	Finished products receiving	When receiving finished products in the central warehouse or logistic center, two main checks are performed: (i) <i>quantity check</i> : delivery notes must match with items actually received; (ii) <i>quality check</i> : through a random check warehouse staff is able to identify possible defects on an entire batch of items. Specific defects on a single item, such as a missing button, can only be found in stores, thus increasing the possibility of returned goods. In addition, since loading/unloading processes are not automated in most cases, during this phase warehouse manpower can be overloaded, thus leading to a lengthening in material handling operations and possible delays in deliveries to customers.
	Jul to Sep	Jan to Mar	Deliveries to customers and stores	The personalized kits of items to send to stores and clients are prepared by warehouse staff or, in some cases, by producers themselves. From one side, it results in a leaner material handling process, but on the other, it leads to not optimised transports, since some packages are half-empty.
IN-SEASON	Sept to Feb	Mar to Aug	Sales to final customers	It is the actual selling season. During this period no other production orders are launched. In order to meet actual demand, company can ship to stores on-hand inventories, such as those items stuck in the warehouse due to the “suspended orders”. In addition, movements of clothing items from one store to another are also allowed.
POST-SEASON	Mar to May	Sep to Nov	Returns of unsold stock from stores and clients	At the end of the selling season, the central warehouse receives unsold stocks both from stores and wholesalers according to specific commercial agreements. This step is similar to the “Finished products receiving” one since both quality and quantity check must be performed and the same overloading problems may arise.
	Jun to Jul	Dec to Jan	Outlet assortment preparation	Returned items must be refurbished and priced with outlet discounts. In some cases, in order to offer a wider assortment and attract customers, the company launches a specific production of items destined to outlet stores, using left-over fabrics and simple manufacturing.
	Jul to Sep	Jan to Mar	Deliveries to outlet stores	This step is similar to the “Deliveries to customers and stores” one even if quantities to handle are significantly lower.

Figure 3: Main processes in a Fashion Retail Supply Chain

Table 1: Literature confirmation for the selected supply chain targets

Target		Reference
Market driven orientation	market sensitivity improvement	Cillo and Verona (2008) Carniene and Vienazindiene (2014)
	Brand attractiveness	Heuer and Brettel (2015) Tajuddin et al. (2014)
Cost reduction	Time management	De Toni and Meneghetti (2000) Heckmann et al. (2015)
	Flow Management	Marufuzzaman and Deif (2010) Tang and S.N. (2011)
Brand internationalization and market expansion		Guercini and Runfola (2010) Caniato et al. (2014)
Environmental sustainability		Li et al. (2014) Caniato et al. (2012) Yonggjian et al. (2014)

The expansion process is pursued in already consolidated markets as well, trying to control a wider market share.

4. Environmental sustainability :

Fashion and apparel companies recognized as big source of pollutants and the growing number of environmental conscious consumers are raising the attention on environmental sustainability and corporate social responsibility aspects. This is leading companies to use recycled fabrics and to adopt new programs for monitoring environmental impact of production and distribution.

Our choice for the above mentioned targets has been confirmed by literature, as shown in Table 1, which reports the references for each of the selected supply chain targets.

IDENTIFICATION OF RISK FACTORS

The core of the present research work is the identification of the risk factors for all the supply chain processes. They are characterized in reference to each company's target previously introduced and described in detail as follows.

Market driven orientation risk factors

The ability to catch customer's tastes is expressed by a reliable demand forecasting process and by a reactive approach to sudden changes in demand during the selling season. Given the need to draft forecasts well ahead of the selling season and given the uniqueness of the fashion products whose success depends on cultural and emotional aspects, elements that may lead to errors and risks are several and mainly related to the Pre-Season phase. These are:

- long-term horizon for the analysis and forecasting process (Forza and Vinelli, 2000), which makes it difficult to predict consumers behavior;
- inefficient item classification : since it is difficult to achieve high forecasting accuracy for single items, it is necessary to group them into product categories (Thomassey and Hapiette, 2007) (for example clothing or accessories) in order to better reflect consumers purchasing behavior;

- unstable demand : purchases are impulsive (Park et al., 2012), driven by emotionality and subjectivity leading to high volatility and unpredictability of demand;
- market heterogeneity, i.e. high consumer segmentation (Brito et al., 2015) for each sales market, for example based on socio-demographic aspects;
- different purchase behavior in each area : given the breadth of the international market, cultural differences between different Countries or even different areas in the same Country (Iannone et al., 2013) may result in a different perception of the brand value;
- competitive initiatives, such as more frequent collection launches or marketing campaigns;
- lack of historical data for fashion items, (Thomassey, 2010) which are new products introduced in the seasonal collection. For these items we cannot draft forecasts according to real historical data since they are not available;
- Absence of in-store marketing analysis, such as consumers interviews, in order to test customer satisfaction and their potential intention to come back (Soderlund et al., 2014);
- No comparison with fabric suppliers to share information on trends for the new season;
- Many actors between company and market : an extended network of wholesalers and distributors makes it more difficult to have quick and reliable feedbacks on final users' purchasing behavior;
- Bullwhip effect, due to poor market visibility, lack of feedback and information sharing between supply chain actors and uncertainties (Miragliotta, 2006). This leads to high inventory levels to cover demand variability;
- on-off purchases , referring to a situation of total absence of logistics-productive integration or cooperation with suppliers, neither in demand forecasting nor in collection design;
- Different contractual terms for returns from wholesalers, which complicates the definition of product assortment to send to outlet stores.

A company reactive to changes in real demand must rely on a flexible suppliers network and must be constantly updated on actual sales status, allowing to promptly identify any possible deviations. These concepts are outlined in the following risk factors:

- lack of information from wholesalers on actual sales status for each item;
- few different suppliers : a broader suppliers network may allow to respond quicker to an order by selecting the appropriate supplier;
- exclusive use of up-front buying, i.e. purchasing and reception of the total product quantity before the beginning of the selling season, by exclusively basing orders on forecasts;
- No use of real demand as replenishment driver : retailers do not usually record invisible demand (Bensoussan et al., 2015) and this does not allow to replenish stores with actually requested products;
- No sold/foreseen deviation analysis, which does not allow to adjust orders and replenishments plans according to actual demand;
- Replenishments solely based on stocks: this implies that no other orders are launched during the selling season but the company responds to any possible change in market demand with on-hand inventories, which may represent orders suspended or returned goods.

From Brand Attractiveness perspective, instead, the proper management of the stores network may determine the success of the commercial campaign and define the reputation perceived by clients. Then, crucial factors are:

- Many new product launches failed, i.e. products designed by the Styling Office that do not meet customers taste;
- Excessive focus on continuative items, implying lack of attention in product innovation (Cillo et al., 2010; Unay and Zehir, 2012) and in following trends. This may lead to always offer similar items over time;
- Customization in international markets, given the important cultural diversity between Countries, characteristics and practices of each Country must be taken into account (Caniato et al., 2014);
- Design of only two collections a year, without infra-seasonal flash collection that may allow to differentiate offer and enlarge product variety (Mehrjoo and Pasek, 2014);
- Poor diversification of sales channels, intended as different kinds of stores, location or purchasing paths (e.g. e-commerce, buy online-pick up in store, buy in store-home delivery, etc.) (Lanzilotto et al., 2015);
- Wholesaler's reputation inconsistent with brand image and unable to attract customers from the target market;
- Deviation between offered and expected product quality, which may lead to customer dissatisfaction;
- Limited On-Shelf Availability, caused by under-estimation of demand, may lead the customer to hopefully purchase another product in the same category (Tan and Karabati, 2013) or may lead to a lost sale ;
- In-store shopping experience, which provides customer with more leisure, interaction with product information and automatic item collocation (Choi et al.,

- 2015) in addition to other additional services that enhance the shopping experience (eg. restaurant and play areas);
- Lack of key sizes in stores : the absence of the size requested by the customer leads to a dissatisfaction even greater than the total absence of the item itself. Generally demand trend for sizes follows a Gaussian curve centered on a particular size which varies according to the customer target and the reference market;
- Low service level, due to delivery lots with missing items or sizes, caused for example by production defects;
- Limited assortment in outlet stores, in terms of inventory depth and variety breadth, and the mix between basic and fashion merchandise (Rajaram, 2001). This assortment is strictly connected to returns quantity at the end of the season.

Cost reduction risk factors

The Cost Reduction objective can be outlined into two different sub-targets. From a Time perspective, the reduction for the processes of collection development, transports, orders management and material handling, allows to enter the market with the right product at the right time. This factor is crucial in the fashion industry due to the very short product life cycle. Then, factors that may cause a long time to market are:

- Inefficient interaction styling office/marketing office: the styling office must translate market information into the new collection;
- Inefficient interaction styling office/suppliers, that can simplify the process of fabrics selection and guarantee higher product quality;
- Delays in closing sales campaign and increase in distributors orders, may cause delays in production orders launch and lead to errors in dimensioning orders themselves;
- Forecasting error for some items, providing wrong guidelines to the styling office;
- Process misalignment between actors, meaning the difficulty of defining no border connections between supply chain actors, avoiding delays and overstocks;
- Production and delivery of the whole purchase lot before the selling season and Production of more items by a single supplier, which may lead to overload and delivery delays;
- Poor virtual integration between Supply Chain actors without the use of Internet-based technologies and information sharing systems (Bhimani and Ncube, 2006);
- Orders launch close to the selling season, implying that any possible delay from this stage on will cause delays in deliveries to stores;
- Long production lead time, Delivery delays of raw materials and Sole use of foreign suppliers (Macchion et al., 2015), are all factors that may involve an extension in throughput time thus exposing companies to possible disruptions in material flows;
- Wrong delivery scheduling, which may lead either to overload the warehouse or to out-of-stock for deliveries to stores;
- Use of low cost transports mainly for international transports;

- Inefficient item division in warehouse, Limited storage/material handling capacity and No automated warehouse, that may create a bottleneck for product flow causing longer delivery times;
- Short delivery times for foreign clients, which usually require advanced deliveries unlike the national market;
- Urgent deliveries and Frequent replenishments, in order to adapt products availability according to actual demand;
- Long lead time between returns and resending to customers : it is related to defective goods and not to unsold goods. In this case, there is the risk of late resending of refurbished items with a possible rejection by the customer;
- Returns procedures not shared with multibrand customers, which may complicate and delay the management of unsold stocks which require the following activities: receiving, inspection, storage, internal transports and eventual refurbishment (De Brito and de Koster, 2003);
- No Electronic Data Interchange (EDI) system, which makes it difficult to share information in real time with all supply chain actors (Angeles et al., 2001).
- Lost sales due to stock out, for any sudden unpredictable change in trend and/or in weather conditions (Bertrand et al., 2015);
- Items exchange between stores : in order to meet customers request. These additional and possibly unnecessary movements must be always guaranteed in any case;
- Overload at the end of the season, for the reception of unsold goods. It is similar to the pre-season overload due to the reception of production lots;
- Difficult returns identification without a detailed archive and Deviations between delivery notes and actual deliveries, that lead to errors in exactly identifying items and delays in warehouse operations;
- Returns of entire lots for high defective percentage, that requires additional refurbishment, material handling and transport operations.

At the same time, an efficient Material Flow Management implies an appropriate material movement along the supply chain duly supported by a continuous information sharing among all actors. Critical factors in this context are:

- No accurate quality control in laboratories/suppliers, which may also lead to Excessive defective percentage often verifiable only in stores, causing returns from clients;
 - Limited flexibility (Tang and Tomlin, 2008) and production capacity of suppliers that do not allow quickly changes in production orders;
 - No optimization due to strong differentiation of orders in terms of sizes and colors;
 - No control on production progress status able to guarantee the respect of the delivery schedule;
 - Poor raw material quality resulting in an appropriate value for money and a consequent customer dissatisfaction;
 - Need to optimize lots delivered by different suppliers : these lots may be already divided into customers orders, thus leading to not optimized transports for almost empty packages;
 - Overload for receiving entire production lot: it is typical of traditional companies that are based on planned manufacturing. They do not distribute supplies during the selling season, but they receive whole production lots before it;
 - High safety stock due to unreliable demand forecast (Wang et al., 2012a), which may lead to high holding costs and forced price markdowns;
 - Errors in clients assortment, leading to unnecessary transport and material handling operations for returns management;
 - Forced markdowns due to late deliveries or due to overstock : it is due to short product life cycle. The reduction of the selling price is not related to marketing strategies then represents a cost for the company;
 - Misalignment between virtual and physical inventory, due to errors or delays in material handling operations;
- Brand internationalization and market expansion risk factors***
- Market expansion is ensured by continuous product and process innovation which allows to meet requests of different customer targets and increase service level. In addition, an international expansion plan allows to access to new markets and increase brand prestige. In this perspective, possible critical issues are:
- Unstable political/economic conditions in target markets : excessive macro-economic variability impacts on purchasing possibilities;
 - Inappropriate selection of stores location, which may be inconsistent with brand image or not appropriately chosen in order to attract the largest number of people from the chosen market. The best choice must also evaluate market saturation and competitive pressure (Merino and Ramirez-Nafarrate, 2015);
 - High number of international competitors and Poor diversification from competitor's products, represent an obstacle in brand strengthening and recognition;
 - Wrong selection of international distributors, whose task is to develop the market and seek new customers;
 - Inability to expand clientele in already controlled markets due to inappropriate trend forecast;
 - No sharing procedure for sales plans by main company, in order to allow supplier to adapt and adjust processes according to retailers needs;
 - Weak infrastructures in new markets and Inadequate logistic system for international expansion, hampering transports and all other logistics operations due to inefficient facilities;
 - Poor brand recognition abroad, that can represent a stop in purchases.
- Environmental sustainability risk factors***
- In recent years, there is growing attention by consumers on Environmental Sustainability in all its aspects, from production to transports and recycling. Then, many company are launching their sustainable initiatives, such as Levi's with its entire Spring/Summer 2013 collection in recycled PET or H&M with its use of sustainable materials, reduction of

transport emissions and of electricity use. With this purpose, main risk factors are:

- Lack of attention to green consumers : they are a market segment that considers environmental impact significant (Braga Junior et al., 2015) especially for fashion products, raw materials and manufacturing techniques used;
- No use of organic fabrics, recyclable materials or local resources (eco-design): they should be introduced in the collection development already in the conceptual phase and are necessary to create a sustainable closed loop supply chain (Payne, 2015; Clancy et al., 2015);
- Limited use of excess fabrics with the purpose of reducing waste;
- No IT support to production (eg. To cutting), that may help in reducing wastes compared to manual operations;
- Long distances between raw materials and finished products producers, leading to increasing transport emissions;
- No assessment/control on suppliers environmental policies : in order to be effective, all plans and policies must be shared with all suppliers and logistics operators;
- Excessive production waste, due to production errors or to non-optimal use of raw materials;
- No packaging recovery/recycling : packaging is the major part of waste and the most difficult to recycle, the re-use must be encouraged (da Cruz and Simoes, 2014).

All the above-mentioned risk factors are related to a process, as indicated in Table 4 for the Pre-Season phase and in Table 5 for the in- and Post-Season.

It is clear that the most critical issues concern all the processes performed before the selling season, since traditional companies define their collection, forecasting and orders well before the introduction of the products into the market; 85% of the risk factors, in fact, are related to the Pre-Season phase. Then any possible error or deviation in this stage will be reflected and amplified during the actual selling season.

CLUSTERIZATION

Following the ANP approach, all the previously mentioned risk factors have been grouped into homogeneous clusters (ref. Figure 6), that are:

- Competitive environment, that includes external risks not directly controllable by main company. In particular we refer to the risks related to the target market and to competitors;
- Relationship between supply chain actors, that concerns policies and strategies with which all actors interacts;
- Offer : this cluster is specifically related to offered products and services;
- Informative flow, involving all factors connected to communication, informative systems and data exchange;

Target Process	MARKET DRIVEN ORIENTATION		COST REDUCTION		BRAND INTERNATION. & MARKET EXPANSION	ENVIRONMENTAL SUSTAINABILITY
	Improvement in Market Sensitivity	Brand Attractiveness	Time management	Material flow mgng		
Market trend Forecasting	Long-term horizon				Unstable political/economic conditions in target markets	Lack of attention to "green" consumers
	Inefficient item classification					
	Unstable demand					
	Market heterogeneity					
	Different purchase behaviour in each area					
	Competitive initiatives					
	Lack of historical data for fashion items					
Absence of in-store marketing analysis						
No comparison with fabric suppliers						
Creation of Seasonal collection		Many new product launches failed	Inefficient interaction Styling Office/Marketing Office		Poor diversification from competitor's products	No use of organic fabrics, recyclable materials or local resources (eco-design)
		Excessive focus on continuative items				
		Customisation in international markets	Inefficient interaction Styling Office/Suppliers			
		Design of only two collections a year				
Assortment presentation & sales campaign	Many actors between company and market	Poor diversification of sales channels				
	Lack of information from wholesalers	Wholesaler's reputation inconsistent with brand image	Delays in clothing sales campaign		Wrong selection of international distributors	
Production orders launch	Bullwhip effect		Increase in distributors orders		Inability to expand clientele	
	Few different suppliers		Forecasting error for some items		No sharing procedure for sales plans by main company	
Materials procurement & dispatch to production plants		Deviation between offered and expected product quality	Process misalignment between actors	No accurate quality control in laboratories/suppliers		Limited use of excess fabrics
			Production of more items by a single supplier	Limited flexibility		
			Production & delivery of whole lot before the sell. seas.	No optimisation due to order differentiation		
			Poor "mutual integration"	Limited production capacity		
			Orders launch close to the selling season	Excessive defective percentage		
			Long production lead time			
			Delivery delays	No control on production progress status		
Sole use of foreign suppliers						
Finished products receiving	Exclusive use of "top-front buying"		Wrong delivery scheduling	Poor raw materials quality		No packaging recovery/recycling
			Inefficient item division in warehouse	Need to optimise lots of different suppliers		
			Use of low cost transports	Overload for receiving entire production lot		
			Limited storage/material handling capacity - No automated warehouses	High safety stocks due to unreliable demand forecasts		
Deliveries to customers and stores	No use of real demand as replenish. driver	Limited On-Shelf Availability	Errors in clients assortment		Weak infrastructures in new markets	
	No sold/foreseen deviation analysis	Lack of "key" sizes in stores	Short delivery times for foreign clients	Forced markdowns due to late deliveries	Inadequate logistic system for international expansion	
	Replenishment solely based on stocks	Low service level	Urgent deliveries	Misalignment between virtual and physical inventory		

Figure 4: Risk map for the Pre-Season phase

Target Process	MARKET DRIVEN ORIENTATION		COST REDUCTION		BRAND INTERNATION. & MKT EXPANSION	ENVIRONM. SUSTAIN.
	Improvement in Market Sensitivity	Brand Attractiveness	Time management	Material flow management		
Sales to final customers		In-store shopping experience	No Electronic Data Interchange (EDI) system	Lost sales due to stock-out Forced mark down due to over-stock Items exchange between stores	Poor brand recognition abroad	
Returns of unsold stock from stores and clients	Different contractual terms for returns from wholesalers		Long lead time between returns and resending to customers Returns procedures not shared with multibrand customers	Overload at the end of the season Difficult returns identification without a detailed archive Deviations between delivery notes and actual deliveries Returns of entire lots for high defective percentage		
Outlet assortment & deliveries		Limited assortment in outlet stores				

Figure 5: Risk map for the In-Season and Post-Season phases

- Process and timing control, focused on management and optimisation of processes;
- Distribution, involving transports and material handling activities;
- Knowledge of customers/end-users, looking at the ability to appropriately capture trends and market needs;
- Quality and quantity control, focusing on the production processes.

NETWORK DEFINITION

The overall structure of the network, which shows relationships between criteria and clusters is shown in Figure 3, while Figure 4 shows into details the connections between risk factors of the different clusters. The numbers in it refer to the clusterization and numeration of Table 4. All these connections, represented by the arrows, have been identified through a cause-effect analysis.

Each risk factor represents a node and is related to the others with a parents- children connection. When a node is linked to other nodes in its own cluster, the arrows become loops on that cluster representing an inner dependence.

It is important to underline that Figure 7 and 4 just graphically shows the content of the correlation matrix which is reported in Appendix A.

PAIRWISE COMPARISON

This step is necessary to establish the relative importance of two elements in reference to their parent node. This pairwise comparison answers to the question: Given a target and two elements of a cluster, influencing a third element of the same or another cluster, which of the two elements is more important referred to the target and how much?. Then, each couple of children nodes will be pairwise compared with respect to their parent.

	1 - Competitive Environment	2 - Relationship between 3C actors	3 - Offer	4 - Informative flow	5 - Process and timing control	6 - Distribution	7 - Knowledge of customers	8 - Quality and quantity control
1	Long-term horizon	No expansion with fabric suppliers	Customisation in international markets	Lack of information from wholesalers	Low service level	Poor diversification of sales channels	Market heterogeneity	Dev. between offered and expected product quality
2	Unstable demand	Many actors between company and market	Design of only two collections a year	Inefficient interaction Styling O./Marketing O.	Lack of "key" sizes in stores	Use of low cost transports	Lack of historical data for fashion items	Limited On-Shelf Availability
3	Competitive initiatives	Bullwhip effect	Limited assortment in outlet stores	Poor "virtual integration"	Long production lead time	Short delivery times for foreign clients	Absence of in-store marketing analysis	No accurate quality control in laboratories/suppliers
4	High number of intern. competitors	Few different suppliers	Excessive focus on continuative items	No EDI system	Delivery delays	Urgent deliveries	No use of real dem. at replenish. driver	Poor raw materials quality
5	Unstable political/economic conditions	"On-Off" purchases	Poor diversification from competitor's products	Deviation between delivery notes and actual deliveries	Inefficient item division in warehouse	Frequent replenishments	Lack of attention to "green" consumers	Excessive defective percentage
6	Weak infrastructure in new markets	Exclusive use of "up-front buying"	Replenishments solely based on stocks	No IT support to production	Long lead time between returns and reordering	Forced markdowns due to late deliveries	In-store shopping experience	High safety stocks due to unreliable dem. forecasts
7	Inadequate logistic system for intern. expansion	Different contractual terms for returns from wholesalers	Inefficient item classification	Difficult returns identification	Limited production capacity	Need to optimize lots of different suppliers	Forecasting error for some items	Overload for receiving entire production lot
8	Poor brand recognition abroad	Wholesaler's reputation inconsistent with brand image	No (eco-design)	Misalignment between virtual and physical inventory	Limited flexibility	Items exchange between stores	Inability to expand clientele	Lost sales due to stock-out
9	Different purchase behaviour in each area	Inefficient interaction Styling Office/Suppliers	Limited use of excess fabrics		No optimisation due to order differentiation	Long distances between raw materials & finished products producers	Unappropriated selection of stores location	Forced mark down due to over-stock
10		Delays in closing sales campaign	Many new product launches failed		No control on prod. progress status	Wrong delivery scheduling	No sold/foreseen deviation analysis	Overload at the end of the season
11		Increase in distributors orders			Errors in clients assortment	Limited storage capacity - No automated warehouses		Returns of entire lots for high defective percentage
12		Process misalignment between actors			No control on suppliers environmental policies			Excessive production waste
13		Production of more items by one supplier			No packaging recovery/recycling			
14		Production & delivery of whole lot before the sell. sea.						
15		Orders launch close to the selling season						
16		No sharing procedure for sales plans by main company						
17		Returns procedure: not shared with multibrand customers						
18		Sole use of foreign suppliers						
19		Wrong selection of international distributors						

Figure 6: Clustering

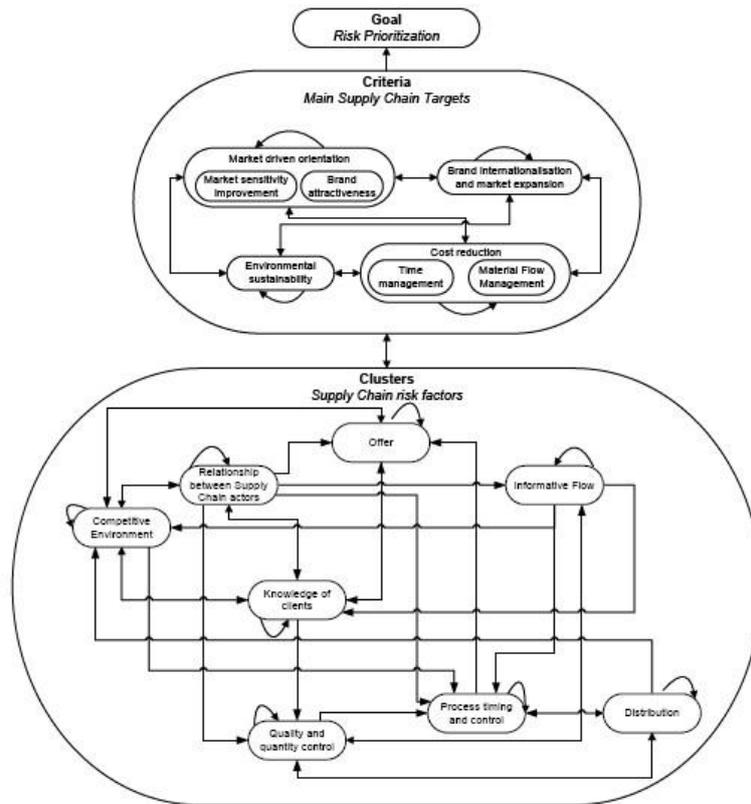


Figure 7: Network structure for the risk prioritization

Table 2: Prioritization of the targets according to their weights

Priority	Target	Weight
1	Time Management	0,4447
2	Material Flow Management	0,3137
3	Improvement in Market	0,1672
4	Brand Attractiveness	0,0628
5	Brand Intern. & Market	0,0087
6	Environmental Sustainability	0,0029

This relative importance is expressed by a numerical judgements taken from a numerical scale of 9 points, called fundamental scale of Saaty [70], in which the value 1 means that the two children nodes influence in the same way the parent node, while the value 9 means that one of the two children nodes completely influences the parent node.

In our research, this pairwise comparison is performed through the submission of a questionnaire survey, composed by 238 Questions, to 5 managers (da inventare). From this survey the comparison matrices originate.

PRIORITIZATION

All the steps that took us from the comparison matrices to the consistency index and to the limit matrix are well illustrated in [71]. The results obtained from the ANP approach for our analysis are reported as follows:

- Table 2 shows the targets ordered according to their priority, i.e. for decreasing weights. As expected, the Cost Reduction perspective (i. e. Time Mng and Material Flow Mng) is considered the most crucial for the business immediately followed by Market Driven Orientation (i. e. Improvement in Market Sensitivity and Brand Attractiveness) which is an important aspect especially for demand-driven supply chains, as fashion industry’s ones. Environmental sustainability instead, although is receiving increasing attention from researchers is still considered the less important by the interviewed managers;
- Table 3 shows the complete list of risk factors and the corresponding calculated weights;
- Figure 5, Table 8 and Table 9 show the ABC analysis for the risk factors according to their weights.

In Table 4 we can see that most of the A category risk factors are contained in clusters 4 (Informative flow) and 6 (Distribution), while C risk factors are mainly concentrated in clusters 1 (Competitive Environment), 3 (Offer) and 7 (Knowledge of customers). These results confirm that supply chain efficiency, in terms of correct management of both material (i.e. distribution of fashion products to final consumers) and informative flow, needs most of the company’s efforts for avoiding any possible disruption or delay. On the contrary, competition and the appropriate knowledge and management of the market are not considered highly risky fields, although fashion market trend and customer’s tastes are always changing.

Table 3: Normalized weight for each risk factor

#factor	Risk factor	Weight
1.1	Long-term horizon	4,494
1.2	Unstable demand	5,939
1.3	Competitive initiatives	3,247
1.4	High number of intern. competitors	3,276
1.5	Unstable pol./econ. conditions	0,08708
1.6	Weak infrastructures in new markets	0,05877
1.7	Inadequate logistic system for international expansion	0,1130
1.8	Poor brand recognition abroad	0,07086
1.9	Different purc. behaviour in each area	1,967
2.1	No comparison with fabric suppliers and market	5,643
2.2	Many actors between company	12,51
2.3	Bullwhip effect	2,314
2.4	Few different suppliers	3,321
2.5	On-off purchases	0,0170
2.6	Exclusive use of up-front buying	25,92
2.7	Different contractual terms for returns from wholesalers	0,4419
2.8	Wholesaler's reputation in consistent with brand image	8,177
2.9	Ineff. interaction Styling O./Suppl.	40,79
2.10	Delays in closing sales campaign	16,83
2.11	Increase in distributors orders	0,8547
2.12	Process misalignment between actors	21,46
2.13	Production of more items by one supplier	4,060
2.14	Production & delivery of whole lot before selling season	19,59
2.15	Orders launch close to the selling season	10,10
2.16	No sharing procedures for sales plans by main company	5,884
2.17	Returns procedures not shared with multibrand customers	60,64
2.18	Sole use of foreign suppliers	10,92
2.19	Wrong selection of intern. distributors	0,7786
3.1	Customisation in intern. markets	0,4357
3.2	Design of only two collections a year	0,8058
3.3	Limited assortment in outlet stores	0,4419
3.4	Excessive focus on continuative items	0,5741
3.5	Poor diversification from competitor's products	1,401
3.6	Repl. solely based on stocks	8,120
3.7	Inefficient item classification	12,18
3.8	No eco-design	0
3.9	Limited use of excess fabrics	0
3.10	Many new product launches failed	0,3376

Table 4: Percentage distribution of risk factors over the ABC classes for each cluster.

Category Cluster	A	B	C
1	0%	22%	78%
2	47%	21%	32%
3	10%	10%	80%
4	75%	13%	13%
5	15%	38%	46%
6	64%	27%	9%
7	20%	10%	70%
8	42%	42%	17%

Table 5: Percentage distribution of risk factors over the ABC classes for the three time phases

	# factors	A	B	C
Pre-Season	78	35%	23%	42%
In-season	6	33%	33%	33%
Post-Season	8	37,5%	25%	37,5%

Table 5 instead, highlights that, despite the 85% of all the risk factors is related to the Pre-Season phase, they are almost equally distributed over the ABC classes, indicating that only the 35% of them is considered highly crucial for the company.

CONCLUSIONS AND FUTURE PERSPECTIVES

Fashion retail industry, characterized by high dynamism and demand volatility and by very short product life cycle, is becoming more and more interesting for researchers in supply chain management and, in particular, in risk management. In this context, integration and cooperation of all actors in a supply network represent the key elements for improving performances of the entire value chain. Focusing on a traditional fashion company that is based on planned manufacturing, i.e. producing according to orders on hand and sales forecasts well ahead of the selling season, we defined all the production and logistics processes and identified the main targets.

The constant research for Cost Reduction and, in general, for the optimization of times and flows is considered by the interviewed managers as the most crucial aspect for risk management and is not specific for fashion retailing but is shared by all industries. Market driven orientation is, instead, a specific issue for any demand-driven supply chain as those of the fashion industry, which is constantly seeking for customers tastes and needs. The spread to global market and Brand Internationalization, instead, is a common issue and is a basic element in defining a company success. In the end, the Environmental Sustainability theme that is becoming essential for attracting the always increasing green market share is receiving increasing attention from companies but not as much as researchers. With these perspectives, the identified

risk map highlights a high number of factors related to each supply chain objective and to each process, especially in the Pre-Season phase in which all purchasing and delivery plans must be defined. The In-Season processes, instead, are crucial in defining the agility of the supply chain and its ability to promptly adapt to changes in market demand. At last, the correct management of factory outlet stores in the Post-Season phase, allows to absorb the risks of demand over-estimation. It is clear that all the risk factors are strictly connected to each other and mutually influencing, then defining a simple hierarchical structure is not enough for the clear definition of all the aspects in this complex framework. For this reason, the authors adopted an ANP approach for the risk prioritization. This method organizes feelings, intuitions and logic of experts in a structured approach for decision making. Then, after the clusterization and construction of the network through the definition of all the influencing relationships between factors, the pairwise comparison questionnaire has been submitted to a team of experts. The results of the ANP analysis show that, as for supply chains in most other industries, efficiency and the correct management of material and informative flow, is considered the most risky and crucial in order to avoid disruptions. On the contrary of what expected for the fashion industry instead, the appropriate knowledge and management of the market seems not to be affected by important risk factors.

Given these considerations, this paper aims to be a tool for fashion companies, not only in the mass market but also in the luxury one, for the identification and prioritization of the complete list of risk factors affecting the correct process flow avoiding supply chain disruptions.

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